# ACADEMIC REGULATIONS
# COURSE STRUCTURE
# AND
# DETAILED SYLLABI

## OF

## MECHANICAL ENGINEERING
### FOR
## B.TECH REGULAR FOUR YEAR DEGREE PROGRAM
*(For the batches admitted from 2019-2020)*
### &
## FOR B.TECH LATERAL ENTRY PROGRAM
*(For the batches admitted from 2020-2021)*

## CHOICE BASED CREDIT SYSTEM

# SREE VIDYANIKETHAN ENGINEERING COLLEGE (AUTONOMOUS)

**(Affiliated to JNTUA, Ananthapuramu, Approved by AICTE, Programs Accredited by NBA, Accredited by NAAC with 'A' grade)**
**SREE SAINATH NAGAR, A. RANGAMPET -517102:: NEAR TIRUPATI (A.P)**

# VISION

To be one of the Nation's premier Engineering Colleges by achieving the highest order of excellence in Teaching and Research.

# MISSION

- To foster intellectual curiosity, pursuit and dissemination of knowledge.
- To explore students' potential through academic freedom and integrity.
- To promote technical mastery and nurture skilled professionals to face competition in ever increasing complex world.

# QUALITY POLICY

Sree Vidyanikethan Engineering College strives to establish a system of Quality Assurance to continuously address, monitor and evaluate the quality of education offered to students, thus promoting effective teaching processes for the benefit of students and making the College a Centre of Excellence for Engineering and Technological studies.

# DEPARTMENT OF MECHANICAL ENGINEERING

## <u>VISION</u>

To become and be recognized as a nationwide center of excellence in Mechanical Engineering and allied areas for acquiring self-reliance through education, engagement and research

## <u>MISSION</u>

➢ Department of Mechanical Engineering is established to provide students with a sound Mechanical Engineering education, advance the understanding and application of Mechanical Engineering principles to work in multicultural and multidisciplinary environment.

➢ Engage and impart knowledge to the students for innovative, high-impact and leading edge research and development of modern Mechanical Engineering science through contemporary curriculum.

➢ Maintain a collegial, supportive, and diverse environment that encourages students, faculty, and staff to achieve to the best of their abilities.

➢ Train our students by teaching them problem solving, leadership and teamwork skills, and the value of a commitment, quality and ethical behavior for their employability.

➢ Serve the community and industry through proactive knowledge exchange.

# PROGRAM EDUCATIONAL OBJECTIVES

After few years of graduation, the graduates of B. Tech. (ME) Program will be:

1. Pursuing further education in Mechanical Engineering, business administration, or other disciplines.

2. In program related industry, allied industry, software industry, and able to start entrepreneurial ventures related to Mechanical Engineering.

3. Able to recognize the developing technology through life-long learning for solving problems related to Mechanical Engineering.

# PROGRAM OUTCOMES

On successful completion of the Program, the graduates of B. Tech. (ME) Program will be able to:

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. (**Engineering knowledge**)

2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. (**Problem analysis**)

3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. (**Design/development of solutions**)

4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the (**Conduct investigations of complex problems**) information to provide valid conclusions.

5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. (**Modern tool usage**)

6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. (**The engineer and society**)

7.   Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. (**Environment and sustainability**)

8.   Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. (**Ethics**)

9.   Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. (**Individual and team work**).

10.  Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. (**Communication**)

11.  Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. (**Project management and finance**)

12.  Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. (**Life-long learning**)

## PROGRAM SPECIFIC OUTCOMES

On successful completion of the Program, the graduates of B. Tech. (ME) Program will be able to:

PSO1. Design, develop, analyze and maintain of mechanical systems and processes by applying the concepts of material science, Manufacturing, Design and Computer aided Design & Manufacturing technologies

PSO2. Apply the principles of thermodynamics, Fluid mechanics and Heat Transfer in the thermal design of various components of thermal energy systems and assess the performance of various thermal energy systems.

PSO3. Identify, define, analyze, formulate, and solve problems related to manufacturing and service systems for optimized conditions by applying tools of Industrial Engineering for effective decision making and support purposes.

# SREE VIDYANIKETHAN ENGINEERING COLLEGE (AUTONOMOUS)
## (Affiliated to J.N.T. University Anantapur, Ananthapuramu)

**ACADEMIC REGULATIONS (SVEC-19)**

**CHOICE BASED CREDIT SYSTEM**

**B.Tech. Regular Four Year Degree Program**

**(For the batches admitted from the academic year 2019–20)**

**and**

**B.Tech. (Lateral Entry Scheme)**

**(For the batches admitted from the academic year 2020-21)**

For pursuing four year undergraduate Degree Program B.Tech offered by Sree Vidyanikethan Engineering College under Autonomous status and herein after referred to as SVEC:

## 1. Applicability:

All the rules specified herein, approved by the Academic Council, shall be in force and applicable to students admitted from the academic year 2019-2020 onwards. Any reference to "College" in these rules and regulations stands for SVEC.

## 2. Extent:

All the rules and regulations, specified hereinafter shall be read as a whole for the purpose of interpretation and as and when a doubt arises, the interpretation of the Chairman, Academic Council is final. It shall be ratified by the Academic Council in the forthcoming meeting. As per the requirements of statutory bodies, Principal, Sree Vidyanikethan Engineering College shall be the Chairman, Academic Council.

## 3. Admission:

### 3.1. Admission into First Year of Four Year B.Tech. Degree Program in Engineering:

**3.1.1. Eligibility:** A candidate seeking admission into the First Year of four year B.Tech. Degree Program should have:

Passed either Intermediate Public Examination (I.P.E.) conducted by the Board of Intermediate Education, Andhra Pradesh, with Mathematics, Physics and Chemistry as optional courses (or any equivalent examination recognized by JNTUA, Ananthapuramu) for admission as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE).

**3.1.2. Admission Procedure:** Admissions shall be made into the first year of four year B.Tech. Degree Program as per the stipulations of APSCHE, Government of Andhra Pradesh:

  (a) By the Convener, EAMCET, (for Category-A Seats).

  (b) By the Management (for Category-B Seats).

  (c) By the Management (for 15% Supernumerary Quota) for Persons of Indian Origin (PIO)/Foreign Nationals (FN)/ Children of Indian Workers in Gulf Countries/ Overseas Citizen of India (OCI)

**3.2. Admission into the Second Year of Four year B.Tech Degree Program in Engineering (Lateral Entry).**

**3.2.1. Eligibility:** A candidate seeking admission into the Second Year of four year B.Tech. Degree Program (Lateral Entry) should have:

  (i) Passed Diploma in Engineering in the relevant branch conducted by the Board of Technical Education, Andhra Pradesh (or equivalent Diploma recognized by JNTUA, Ananthapuramu).

  (ii) Candidates qualified in ECET and admitted by the Convener, ECET. In all such cases for admission, when needed, permissions from the statutory bodies are to be obtained.

**3.2.2. Admission Procedure:** 10% of the sanctioned strength in each Program of study as lateral entry students or as stipulated by APSCHE shall be filled in by the Convener, ECET.

**4. Programs of study offered leading to the award of B.Tech. Degree:**

Following are the four year undergraduate Degree Programs of study offered in various branches in SVEC leading to the award of B.Tech (Bachelor of Technology) Degree:

  1) Civil Engineering
  2) Electrical and Electronics Engineering
  3) Mechanical Engineering
  4) Electronics and Communication Engineering
  5) Computer Science and Engineering
  6) Electronics and Instrumentation Engineering
  7) Information Technology
  8) Computer Science and Systems Engineering

**5. Duration of the Program:**

**5.1     Minimum Duration:** The program shall extend over a period of four years leading to the Degree of Bachelor of Technology (B.Tech) of the JNTUA, Ananthapuramu. The four academic years shall be divided into eight semesters with two semesters per year. Each semester shall normally consist of 21 weeks (Minimum of 90 working days) having - Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), Choice Based Credit System (CBCS) and Credit Based Semester System(CBSS) as suggested by UGC and Curriculum/ Course Structure as suggested by AICTE are followed. Provision is made for lateral entry admission of students into the Second Year of the program in all the branches of study and they shall be required to satisfy the conditions of admissions thereto prescribed by the JNTUA, Ananthapuramu and Government of Andhra Pradesh.

**5.2 Maximum Duration:**

The student shall complete all the passing requirements of the B.Tech degree program within a maximum duration of 8 years (6 years for lateral entry), these durations reckoned from the commencement of the semester to which the student was first admitted to the program.

**6.     Structure of the Program:**

Each Program of study shall consist of:
(i)         HS (Humanities and Social Sciences) Courses
(ii)        BS (Basic Sciences) Courses
(iii)       ES (Engineering Sciences) Courses
(iv)       PC (Professional Core) Courses
(v)        PE (Professional Electives)
(vi)       OE (Open Electives) Courses
(vii)      Mandatory Courses (MC)
(viii)     Audit Courses (AC)
(ix)       Projects (PR) (Socially Relevant Projects, Internship, Project Work)

| S. No | Course Category | Course Type | No. of Credits |
|-------|-----------------|-------------|----------------|
| 1. | HS – Humanities and Social Sciences | Humanities, Social Sciences and Management. | 11 |
| 2. | BS – Basic Sciences | Mathematics, Physics and Chemistry Courses, etc. | 22 |
| 3. | ES – Engineering Sciences | Fundamental Engineering courses. | 22-23 |
| 4. | PC – Professional Core | Core courses related to the Parent Discipline/ Branch of Engg. | 60-61 |
| 5. | PE – Professional Electives | Elective courses related to the Parent Discipline/ Branch of Engg. | 15 |
| 6. | OE – Open Electives | Electives from other technical and /or emerging subjects | 15 |
| 7. | PR - Projects | Socially Relevant Projects, Internship, Project Work | 14 |
| 8. | MC - Mandatory Courses | Induction Program, Environmental Science, Universal Human Values | -- |
| 9. | AC - Audit Courses | Skill Development / Value Added Courses. | -- |

**Contact Periods:**

The contact periods per week are assigned depending on the complexity and volume of the course.

**7.    Credit Courses:**

All Courses are to be registered by a student in a Semester to earn Credits. Credits shall be assigned to each Course in a L: T: P: C (Lecture Hours: Tutorial Hours: Practical Hours: Credits) Structure, based on the following general pattern.

- **Theory Courses:** One Lecture Hour (L) per week in a semester: 01 Credit
- **Practical Courses:** One Practical Hour (P)  Per week in a semester: 0.5 Credit
- **Tutorial:** One Tutorial Hour (T) Per week in a semester: 01 Credit
- **Mandatory Courses:** No **CREDIT** is awarded.
- **Audit Courses:** No **CREDIT** is awarded.
- **Open Elective** (MOOC): 03 Credits

Student activities like NCC, NSS, Sports, Study Tour and Guest Lecture etc. shall not carry ANY Credits.

For Socially Relevant Projects, Internship and Project Work where formal contact periods are not specified, credits are assigned based on the complexity of the work to be carried out.

The four year curriculum of any B. Tech Program of study shall have a total of **160** credits. However the curriculum for students admitted under lateral entry shall have a total of **118** credits.

## 8. Choice Based Credit System (CBCS):

Choice Based Credit System (CBCS) is introduced in line with UGC guidelines in order to promote:

- Student centred learning
- Students to learn courses of their choice
- Interdisciplinary learning

A Student has a choice of registering for courses comprising program core, professional electives, open electives, MOOC courses, value added / Skill based courses. Besides, choice is also offered to students for registering courses to earn Minor in Engineering/Honors degree.

## 9. Course Enrollment and Registration

**9.1** Each student, on admission shall be assigned to a Faculty Advisor (Mentor) who shall advice and counsel the student about the details of the academic program and the choice of courses considering the student's academic background and career objectives.

**9.2** Each student on admission shall register for all the courses prescribed in the curriculum in the student's first and second Semesters of study. The student shall enroll for the courses with the help of the student's Faculty Advisor (Mentor). The enrollment for the courses from II B.Tech I Semester to IV B.Tech I Semester shall commence 10 days prior to the last instructional day of the preceding semester for registration process. If the student wishes, the student may drop or add courses (vide clause 8) 10 days prior to commencement of the concerned semester and complete the registration process duly authorized by the Chairman, Board of Studies of concerned department.

**9.3** If any student fails to register the courses in a semester, he shall undergo the courses as per the program structure.

**9.4** After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the Semester-end Examinations.

**9.5** Elective courses shall be offered by a Department only if a minimum of 40 students register for that course.

### 10. OPEN ELECTIVE (MOOC)

OPEN ELECTIVE (MOOC) is an online course aimed at unlimited participation and open access via the web.

**10.1** A Student is offered an Open Elective (MOOC), in the IV B.Tech I-Semester, and is pursued through Massive Open Online Course (MOOC) platforms. The duration of the MOOC courses shall be for a minimum period of 08 weeks.

**10.2** The student shall confirm registration by enrolling the course within 10 days prior to the last instructional day of the III B.Tech II-Semester along with other courses.

**10.3** The list of courses along with MOOC service providers shall be identified by the Chairman, BOS, and Head of the Department. The identified Open Elective (MOOC) courses are to be approved by the Chairman, Academic Council.

**10.4** The student has to submit MOOC certificate with percentage of Score earned to the Head of the Department at the end of the semester. Based on the score earned, the equivalent Grade Point and Credits will be assigned.

**10.5** Attendance is not applicable for MOOC Course and also attendance will not be monitored.

**10.6** If the student fails to submit the MOOC certificate at the end of the semester, his performance in MOOC will be shown as "Fail" in the Grade sheet. Then the student shall register for the supplementary examinations and submit the MOOC certificate.

### 11. BREAK OF STUDY FROM A PROGRAM (Gap Year)

**11.1** A student is permitted to go on break of study for a maximum period of two years either as two breaks of one year each or a single break of two years.

**11.2** In case, a student wishes to extend the gap year for one more consecutive year, he shall be permitted with the prior approval of the Principal on the recommendations of the Head of the Department prior to the beginning of the semester in which he has taken break of study.

**11.3** The student shall apply for break of study in advance, in any case, not later than the last date of the first assessment period in a semester. The gap year concept is introduced for start-up (or) incubation of an idea, National/International Internships, and professional Volunteering. The application downloaded from the website and duly filled in by the student shall be submitted to the Principal through the Head of

the department. A committee shall be appointed by the Principal in this regard. Based on the recommendations of the committee, Principal shall decide whether to permit the student to avail the gap year or not.

**11.4** The students permitted to rejoin the program after break of study shall be governed by the Curriculum and Regulations in force at the time of rejoining.

The students rejoining in new regulations shall apply to the Principal in the prescribed format through Head of the Department, at the beginning of the readmitted semester for registering additional/equivalent courses to comply with the curriculum in-force.

**11.5** The two years period of break of study shall not be counted for the maximum Period of graduation (i.e the maximum period of graduation is 10 years for Regular admitted students and 8 years for Lateral Entry admitted students availing Gap Year).

**11.6** If a student has not reported to the college after completion of the approved period of break of study he is deemed to be detained in that semester. Such students are eligible for readmission into the semester when offered next.

## 12. Examination System:

**12.1** All components in any Program of study shall be evaluated through internal evaluation and/or an external evaluation conducted as Semester-end examination.

| Sl. No. | Course | Marks | Examination and Evaluation | | Scheme of examination |
|---------|--------|-------|------------------|------|----------------------|
| 1. | Theory | 60 | Semester-end examination for 3 hours duration (External evaluation) | | The examination question paper in theory courses shall be for a maximum of 60 marks. The question paper shall be of descriptive type with 10 questions each of 12 marks, taken two from each unit. Each unit shall have internal choice and 5 questions shall be answered, one from each unit. |
| | | 40 | 10 | Assignments (Internal evaluation). | One Assignment shall be given to the student for 10 marks during the semester and Assignment Marks finalized. |
| | | | 30 | Mid-term Examination of 2 hours duration (Internal evaluation). | Two mid-term examinations each for 30 marks are to be conducted. For a total of 30 marks, 80% of better one of the two and 20% of the other one are added and finalized. **Mid-I:** After first spell of instruction (I & II Units). **Mid-II**: After second spell of instruction (III, IV & V Units). The question paper shall be of descriptive type with 5 essay type questions each of 8 |

| Sl. No. | Course | Marks | Examination and Evaluation | | Scheme of examination |
|---|---|---|---|---|---|
| | | | | | marks, out of which 3 are to be answered and evaluated for 24 marks. There shall also be 6 short answer questions each of 01 mark, all are to be answered and evaluated for 6 marks. |
| 2. | Laboratory | 50 | Semester-end Lab Examination for 3 hours duration (External evaluation) | | The examination shall be conducted by the faculty member handling the laboratory (Examiner-2) and another faculty member (Examiner-1) appointed by the Chief Controller of Examinations. |
| | | 50 | 30 | Day-to-Day evaluation for Performance in laboratory experiments and Record. (Internal evaluation). | Two laboratory examinations, which includes Day-to-Day evaluation and Practical test, each for 50 marks are to be evaluated by the faculty members handling the laboratory. For a total of 50 marks 80% of better one of the two and 20% of the other one are added and finalized. **Laboratory examination-I:** Shall be conducted just before FIRST mid-term examinations. **Laboratory examination-II:** Shall be conducted just before SECOND mid-term examinations. |
| | | | 20 | Practical test (Internal evaluation). | |
| 3. | Internship | 100 | Semester-end Examination | | The evaluation shall be done by the Department Evaluation Committee (**DEC**) at the end of the semester as given in 12.2.1. |
| 4. | Open Elective (MOOC) | 100 | - | | The student has to submit MOOC certificate with percentage of Score earned to the Head of the Department at the end of the semester. Based on the score the equivalent Grade Point and Credits will be assigned as given in 10.4. |
| 5. | Socially Relevant Project | 100 | 50 | Internal Evaluation | Shall be evaluated as given in 12.2.2(i) |
| | | | 50 | Semester-end evaluation | Viva-Voce examination shall be conducted at the end of the semester as given in 12.2.2(ii) |
| 6. | Mandatory Courses | 40 | Internal Evaluation | | Shall be evaluated as given in 12.2.4 |
| 7. | Audit Courses | - | - | | As detailed in 12.2.5 |
| 8. | Project Work | 200 | 100 | Internal evaluation | Continuous evaluation shall be done by the Project Evaluation Committee (**PEC)** as given in 12.2.3. |
| | | | 100 | Semester-end evaluation | Project Work Viva-Voce Examination shall be conducted by a Committee at the end of the semester as given in 12.2.3. |

### 12.2 Internship/Socially Relevant Project/Project Work/Mandatory Course/ Audit Course Evaluation:

#### 12.2.1 Internship:

The student shall undergo **Internship** in an Industry/National Laboratories/ Academic Institutions relevant to the respective branch of study. This course is to be registered during III B.Tech II-Semester and taken up during the summer vacation after completion of the III B.Tech II-Semester, for a period of FOUR weeks duration. The Industry Training/Internship shall be submitted in a Report form, and a presentation of the same shall be made before a Department Evaluation Committee (DEC) and it should be evaluated for 100 marks. The DEC shall consist of the Head of the Department, the concerned Supervisor and a Senior Faculty Member of the Department. The DEC is constituted by the Chief Controller of Examinations on the recommendations of the Head of the Department. There shall be no internal marks for Internship. The Internship shall be evaluated at the end of the IV B.Tech I-Semester.

#### 12.2.2 Socially Relevant Project:

A project for community services shall be carried out in teams (maximum 5 students per team) to solve real life problems of society. The Students shall visit the society (Villages/Hospitals/social service organizations etc,.) to identify the problem, conduct literature survey and provide a feasible solution. Each team shall work under the supervision of a guide (faculty member).

(i) <u>Internal Evaluation:</u> Two internal evaluations (First evaluation before the I-Mid-term examinations and second evaluation before the II-Mid-term examinations) shall be conducted by the guide and a faculty member nominated by the HOD. For a total of 50 marks, 80% of better one of the two and 20% of the other one are added and finalized.

(ii) <u>Semester-end Evaluation:</u> A report on socially relevant project shall be submitted by the team of students to the department at the end of the semester. The Viva-Voce examination shall be conducted by the concerned guide and a senior faculty member recommended by the Head of the Department and appointed by the Chief Controller of Examinations.

### 12.2.3 Project Work:

(i) <u>Internal Evaluation:</u> The Internal Evaluation shall be made by the Project Evaluation Committee (PEC) consisting of concerned supervisor and two senior faculty members, on the basis of TWO project reviews on the topic of the project. Each review shall be conducted for a maximum of "100" marks. For a total of 100 marks, 80% of better one of the two and 20% of the other one are added and finalized. The PEC is constituted by the Principal on the recommendations of the Head of the Department.

(ii) <u>Semester-end Evaluation:</u> The Semester-end Project Work Viva-Voce Examination shall be conducted by a Committee consisting of External examiner (nominated by the Chief Controller of Examinations), HOD and concerned Supervisor. The evaluation of project work shall be done at the end of the IV B.Tech II Semester.

Three copies of the dissertation certified in the prescribed format by the concerned Supervisor and HOD shall be submitted to the Department. One copy is to be submitted to the Chief Controller of Examinations. The examiner shall be nominated by the Chief Controller of the Examinations from the panel of SIX examiners submitted by the Department.

### 12.2.4 Mandatory Courses:

Mandatory courses carry **"ZERO"** credits. There shall be **NO Semester-end** examination. However, ATTENDANCE in Mandatory courses shall be considered while calculating aggregate attendance in a semester. The internal examination shall be conducted and evaluated similar to the THEORY courses. The student shall be declared to have passed the mandatory courses only when HE secures **40% marks in the internal examination.** If the student FAILS, a re-examination shall be conducted for FAILED candidates in the CONSEQUETIVE semester. The performance of the student shall be indicated in the grade sheets "**SATISFACTORY" (or) "NOT SATISFACTORY"** as given in 17.1**.** The student should pass all the mandatory courses, for the award of B.Tech degree.

### 12.2.5  Audit Courses:

Audit courses carry "ZERO" credits. There shall be **NO Internal** and **Semester-end examination**. However, ATTENDANCE in Audit courses shall be considered while calculating aggregate attendance in a semester. The student should study all the audit courses, and it shall be indicated in the GRADE Sheet.

**12.3. Eligibility to appear for the Semester-End Examination (SEE):**

**12.3.1**  A student shall be eligible to appear for semester-end examinations if he acquires a minimum of 75% of attendance in aggregate of all the courses in a semester.

**12.3.2**  Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

**12.3.3**  Shortage of Attendance below 65% in aggregate **shall in no case be condoned.**

**12.3.4**  Students whose shortage of attendance is not condoned in any semester are not eligible to take their semester-end examinations of that class and their registration shall stand cancelled.

**12.3.5**  A student shall not be promoted to the next semester unless he satisfies the attendance requirements of the current semester, as applicable. The student may seek readmission for the semester when offered next. He shall not be allowed to register for the courses of the semester while he is in detention. A student detained due to shortage of attendance, shall have to repeat that semester when offered next.

**12.3.6**  A stipulated fee shall be payable to the College towards Condonation of shortage of attendance.

**12.3.7**  The attendance in *Student Development Activities* shall be considered for finalization of aggregate attendance.

**12.3.8**  For the calculation of a student attendance in any semester, the total number of classes conducted shall be counted as scheduled in the class-work time table.

**12.4.  Evaluation:**

Following procedure governs the evaluation.

**12.4.1.**  Marks for components evaluated internally by the faculty shall be submitted to the Controller of Examinations one week before the commencement of the Semester-end examinations. The marks for the internal evaluation components shall be added to the external evaluation marks secured in the Semester-end examinations, to arrive at the total marks for any course in that semester.

**12.4.2.** Performance in all the courses is tabulated course-wise and shall be scrutinized by the Results Committee and moderation is applied if needed and course-wise marks are finalized. Total marks obtained in each course are converted into letter grades.

**12.4.3.** Student-wise tabulation shall be done and individual grade Sheet shall be generated and issued to the student.

**12.5. Recounting/Revaluation/Personal Verification/Challenging Evaluation:**

Students shall be permitted to apply for **Recounting/Revaluation/Personal Verification/Challenging Evaluation** of the Semester-end examination answer scripts within a stipulated period after payment of the prescribed fee. After completion of the process of **Recounting/Revaluation/Personal Verification/ Challenging Evaluation**, the records are updated with changes if any, and the student shall be issued a revised grade sheet. If there are no changes, the student shall be intimated the same through a notice.

**12.6. Supplementary Examination:**

In addition to the regular semester-end examinations conducted, the College may also schedule and conduct supplementary examinations for all the courses of other semesters when feasible for the benefit of students. Such of the candidates writing supplementary examinations may have to write more than one examination per day.

**13. Academic Requirements for promotion/completion of regular B.Tech Program of study:**

The following academic requirements have to be satisfied in addition to the attendance requirements for promotion/completion of regular B.Tech Program of study.

**For students admitted into B.Tech. (Regular) Program:**

**13.1** A student shall be deemed to have satisfied the minimum academic requirements for each theory course, laboratory course, socially relevant project and project work, if he secures not less than 40% of marks in the Semester-end examination and a minimum of 40% of marks in the sum total of the internal evaluation and Semester-end examination taken together. For the courses **"Internship"** and **"Open Elective (MOOC)",** he should secure not less than 40% of marks in the semester-end examination.

**13.2**   A student shall be promoted from second year to third year of Program of study only if he fulfills the academic requirement of securing 25 credits from the following examinations (Irrespective of whether or not the candidate appears for the semester-end examinations as per the normal course of study):

    a. **One** regular and **two** supplementary examinations of I B.Tech I Semester.

    b. **One** regular and **one** supplementary examinations of I B.Tech II Semester.

    c. **One** regular examination of II B.Tech I Semester.

**13.3**   A student shall be promoted from third year to fourth year of Program of study only if he fulfills the academic requirements of securing 42 credits from the following examinations (Irrespective of whether or not the candidate appears for the semester-end examinations as per the normal course of study):

    a. **One** regular and **four** supplementary examinations of I B.Tech I Semester.

    b. **One** regular and **three** supplementary examinations of I B.Tech II Semester.

    c. **One** regular and **two** supplementary examinations of II B.Tech I Semester.

    d. **One** regular and **one** supplementary examinations of II B.Tech II Semester.

    e. **One** regular examination of III B.Tech I Semester.

\* In case of getting detained for want of credits by sections 13.2 and 13.3 above, the student may make up the credits through supplementary examinations.

**13.4**   A student shall register for all the 160 credits and earn all the 160 credits. Marks obtained in all the 160 credits shall be considered for the calculation of the DIVISION based on CGPA.

**13.5**   A student who fails to earn 160 credits as indicated in the course structure within eight academic years from the year of their admission shall forfeit his seat in B.Tech. Program and his admission stands cancelled.

**For Lateral Entry Students (batches admitted from the academic year 2020-2021):**

**13.6**   A student shall be deemed to have satisfied the minimum academic requirements for each theory, practical course, Socially relevant project and Project Work, if he secures not less than 40% of marks in the semester-end examination and a minimum of 40% of marks in the sum total of the internal evaluation and semester-end examination taken together. For the courses "Internship" and "Open Elective (MOOC)", he shall be declared to have passed if he secures minimum of 40% of marks in the semester-end examination.

**13.7** A student shall be promoted from third year to fourth year only if he fulfills the academic requirements of securing 25 credits from the following examinations:

    a. **One** regular and **Two** supplementary examinations of II B.Tech I Semester.

    b. **One** regular and **One** supplementary examinations of II B.Tech II Semester.

    c. **One** regular examination of III B.Tech I Semester.

Irrespective of whether or not the candidate appears for the semester-end examination as per the normal course of study and in case of getting detained for want of credits the student may make up the credits through supplementary examinations.

**13.8** A student shall register for all 118 credits and earn all the 118 credits. Marks obtained in all the 118 credits shall be considered for the calculation of the DIVISION based on CGPA.

**13.9** A student who fails to earn 118 credits as indicated in the course structure within six academic years from the year of their admission shall forfeit his seat in B.Tech Program and his admission stands cancelled.

**14.** **Academic Regulations for Minor Degree:**

The concept of Minor degree is introduced in the curriculum of all B.Tech. programs offering a Major degree. The main objective of Minor degree in a discipline is to provide additional learning opportunities for academically motivated students and it is an optional feature of the B.Tech. Program. To earn a Minor degree in a discipline, a student has to earn 18 extra credits (By studying FIVE theory & THREE laboratory courses or SIX Theory Courses) from the core courses of the minor discipline.

a. Students having a CGPA of 8.0 or above up to II B.Tech I-Semester without any backlogs shall be permitted to register for a Minor degree by paying the requisite fee.

b. In the subsequent semesters, the student has to pass all the courses registered for Major and Minor Degrees in the first attempt i.e., regular examinations without any backlog to keep the Minor Degree registration active or else it shall be canceled.

c. If a student becomes ineligible for continuing the Minor Degree, the earned credits under Minor Degree cannot be transferred to Major Degree; they will remain extra. These additional courses will be mentioned in the transcript. However, they are eligible to receive B.Tech. Degree after satisfying its requirements.

d. The evaluation pattern of the courses shall be similar to the evaluation of regular program courses.

e. Minimum strength required for offering **Minor Degree in a** discipline is 40 students.

f. **A student registered for Minor degree shall pass in all subjects that**

**constitute the requirement for the Minor** degree program**.** No class/division (i.e., second class, first class and distinction, etc.) shall be awarded for **Minor** degree program.

g. The **Minor degree** shall be mentioned in the degree certificate as Bachelor of Technology in XXX with Minor in YYY. For example, Bachelor of Technology in Computer Science & Engineering with Minor in Title of the Minor Pursued. This shall also be mentioned in the transcripts, along with the list of courses taken for **Minor degree** program. However, the performance of the student in the Minor courses will not be considered for the calculation of SGPA and CGPA for the award of Major Degree.

h. Separate course/class work and time table shall be arranged for the various Minor degree programs. Attendance regulations for these Minor discipline programs shall be as per regular courses.

i. Students aspiring for Minor degree must register from III B.Tech I-Semester onwards and must opt for a Minor in a discipline other than the discipline he is registered in.

j. A Student shall register for Minor with the following combinations:

**Offering Theory and Laboratory Courses:** SEVEN credits in a semester starting from III B.Tech I-Semester to III B.Tech II-Semester (TWO theory & ONE laboratory courses) and FOUR credits in IV B.Tech I-Semester (ONE theory & ONE laboratory courses).

**Offering Theory Courses only:** SIX credits in a semester starting from III B.Tech I-Semester to IV B.Tech I-Semester (TWO theory courses).

**NOTE:** Interested meritorious students shall be permitted to register either for a Minor degree in a discipline (or) Honors Degree in a discipline only, but not both.

## 15. Academic Regulations for Honors Degree:

The concept of Honors degree is introduced in the curriculum for all B. Tech. programs. The main objective of Honors degree is to provide additional learning opportunities for academically motivated students in the same or allied discipline and it is an optional feature of the B. Tech. program. In order to earn Honors degree in a discipline, a student has to earn **18** extra credits (By studying FIVE theory & THREE laboratory courses or SIX Theory Courses).

a. Students having a CGPA of 8.0 and above up to II B.Tech I-Semester without any backlogs shall be permitted to register for Degree with Honors by paying the requisite fee.

b. In the subsequent semesters, the student has to pass all the courses registered for

Major and Honors Degrees in the first attempt i.e., regular examinations without any backlog to keep the Honors Degree registration active or else it shall be canceled.

c. If a student becomes ineligible for continuing the Honors Degree, the earned credits under Honors Degree cannot be transferred to Major Degree; they will remain extra. These additional courses will be mentioned the transcript. However, they are eligible to receive B.Tech. Degree after satisfying its requirements.

d. The evaluation pattern of the courses shall be similar to the evaluation of regular program courses.

e. Minimum strength required for offering **Honors in a** discipline is 10% of sanctioned intake.

f. A student registered for Honors degree shall pass in all subjects that constitute the requirement for the Honors degree program. No class/division (i.e., second class, first class and distinction, etc.) shall be awarded for Honors degree program.

g. The **Honors degree** shall be mentioned in the degree certificate as Bachelor of Technology Honors in XXX. Example, Bachelor of Technology (Honors) in Computer Science & Engineering. This shall also be reflected in the transcripts, along with the list of courses taken for **Honors degree** program. However, the performance of the student in the Minor courses will not be considered for the calculation of SGPA and CGPA for the award of Major Degree.

h. Separate course/class work and time table shall be arranged for the various Honors degree programs. Attendance regulations for these Honors discipline programs shall be as per regular courses.

i. Students aspiring for  Honors degree must register from III B.Tech I-Semester onwards.

j. A Student shall register for  Honors with following combinations:

   **Offering Theory and Laboratory Courses:** SEVEN credits in a semester starting from III B.Tech I-Semester to III B.Tech II-Semester (TWO theory &ONE laboratory courses) and FOUR credits in IV B.Tech I-Semester (ONE theory &ONE laboratory courses).

   **Offering Theory Courses only:** SIX credits in a semester starting from III B.Tech I-Semester to IV B.Tech I-Semester (TWO theory courses).

**NOTE:** Interested meritorious students shall be permitted to register either for Minordegree in a discipline (or) Honors Degree in a discipline only, but not both.

16. **Transitory Regulations:**

Students who got detained for want of attendance (or) who have not fulfilled academic requirements (or) who have failed after having undergone the Program in earlier regulations (or) who have discontinued and wish to continue the Program are eligible for admission into the unfinished semester from the date of commencement of class work with the same (or) equivalent courses as and when courses are offered and they shall be in the academic regulations into which they are presently readmitted.

A regular student has to satisfy all the eligibility requirements within the maximum stipulated period of eight years and a lateral entry student within six years for the award of B.Tech Degree.

17. **Grades, Semester Grade Point Average and Cumulative Grade Point Average:**

17.1. **Grade System:** After all the components and sub-components of any course (including laboratory courses) are evaluated, the final total marks obtained shall be converted into letter grades on a "10 point scale" as described below.

**Grades Conversion and Grade points Attached**

| % of Marks obtained | Grade | Description of Grade | Grade Points (GP) |
|---|---|---|---|
| > = 95 | O | Outstanding | 10 |
| > = 85  to  < 95 | S | Superior | 9 |
| > = 75  to  < 85 | A | Excellent | 8 |
| > = 65  to  < 75 | B | Very Good | 7 |
| > = 55  to  < 65 | C | Good | 6 |
| > = 45  to  < 55 | D | Fair | 5 |
| > = 40  to  < 45 | E | Pass | 4 |
| < 40 | F | Fail | 0 |
| Not Appeared | N | Absent | 0 |
| **For Mandatory Courses** | | | |
| >=40 | P | Satisfactory | - |
| <40 | I | Not Satisfactory | - |

**Pass Marks:**

A student shall be declared to have passed theory course, laboratory course, Socially relevant project and project work if he secures minimum of 40% marks in external examination, and a minimum of 40% marks in the sum total of internal evaluation and external examination taken together. For Industrial training/internship he shall be declared to have passed if he secures minimum of 40% of marks in the semester-end examination. Otherwise, he shall be awarded fail grade - '**F**' in such a course irrespective of internal marks. '**F**' is considered as a fail grade indicating that the student has to pass the Semester-End Examination in that course in future and obtain a grade other than '**F**' and '**N**' for passing the course.

*For the Mandatory Courses, if the student obtained 40% or more marks, then his performance shall be indicated as "P" (SATISFACTORY), otherwise the performance shall be indicated as "I" (NOT SATISFACTORY) in the grade sheet.*

**17.2. Semester Grade Point Average (SGPA):** SGPA shall be calculated as given below on a "10 point scale" as an index of the student's performance:

$$SGPA = \frac{\sum (C \ X \ GP)}{\sum C}$$

Where "C" denotes the "credits" assigned to the courses undertaken in that semester and "GP" denotes the "grade points" earned by the student in the respective courses.

**Note:** SGPA is calculated only for the candidates who appeared in the semester-end regular examinations in a particular semester:

**17.3. Cumulative Grade Point Average (CGPA):**

The CGPA shall be calculated for a candidate appeared in the Semester-end examinations for all the courses (including Regular & Supplementary) till that semester. The CGPA shall be displayed in the Grade sheet of the Regular Semester-end examinations and also in the consolidated Grade Sheet issued at the end of the program. The CGPA is computed on a 10 point scale as given below:

$$CGPA = \frac{\sum (C \ X \ GP)}{\sum C}$$

where C denotes the credits assigned to courses undertaken up to the end of the Program and GP denotes the grade points earned by the student in the respective courses.

18. **Grade Sheet:** A grade sheet (Marks Memorandum) shall be issued to each student on his performance in all the courses registered in that semester indicating the **SGPA and CGPA.**

19. **Consolidated Grade Sheet:** After successful completion of the entire Program of study, a Consolidated Grade Sheet indicating performance of all academic years shall be issued as a final record. Duplicate Consolidated Grade Sheet shall also be issued, if required, after payment of requisite fee.

20. **Award of Degree**: The Degree shall be conferred and awarded by Jawaharlal Nehru Technological University Anantapur, Ananthapuramu on the recommendations of the Chairman, Academic Council, SVEC (Autonomous).

20.1. **Eligibility:** A student shall be eligible for the award of B.Tech Degree if he fulfills all the following conditions:

- Registered and successfully completed all the components prescribed in the Program of study to which he is admitted.
- Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of study within the stipulated time.
- Obtained CGPA greater than or equal to 4.0 (Minimum requirement for declaring as passed).
- Has NO DUES to the College, Hostel, Library etc. and to any other amenities provided by the College.
- No disciplinary action is pending against him.

20.2. **Award of Division:** Declaration of Division is based on CGPA.

**Awarding of Division**

| CGPA | Division |
|---|---|
| > = 7.0 | First Class with Distinction |
| > = 6.0 and < 7.0 | First Class |
| > = 5.0 and < 6.0 | Second Class |
| > = 4.0 and < 5.0 | Pass Class |

**21.    Additional Academic Regulations:**

**21.1**    A student may appear for any number of supplementary examinations within the stipulated time to fulfill regulatory requirements for award of the degree.

**21.2**    In case of malpractice/improper conduct during the examinations, guidelines shall be followed as given in the ANNEXURE-I.

**21.3**    When a student is absent for any examination (Mid-term or Semester-end) he shall be awarded zero marks in that component (course) and grading shall be done accordingly.

**21.4**    When a component is cancelled as a penalty, he shall be awarded zero marks in that component.

**22.    Withholding of Results:**

If the candidate has not paid dues to the College/University (or) if any case of indiscipline is pending against him, the result of the candidate shall be withheld and he shall not be allowed/promoted to the next higher semester.

**23. Re-Registration for Improvement of Internal Marks**:

Following are the conditions to avail the benefit of improvement of internal marks.

**23.1**    The candidate should have completed the 4 years of B.Tech course work and obtained examinations results from I B.Tech I Semester to IV B.Tech II semester.

**23.2**    Out of the courses the candidate has failed in the examinations due to internal evaluation marks secured being less than 40%, the candidate shall be given a chance for improvement of internal evaluation marks in the failed theory courses.

**23.3**    This provision is only for Theory courses. The candidate has to register for the chosen courses and fulfil the academic requirements (i.e. a student has to attend the classes regularly and appear for the mid-examinations and satisfy the attendance requirements to become eligible for appearing at the semester-end examinations).

**23.4**    For each course, the candidate has to pay a fee of Rs. 10,000/- and the amount is to be remitted in the form of D.D. in favor of the Principal, Sree Vidyaniketan Engineering College payable at Tirupati along with the requisition through the concerned Head of the Department.

**23.5**    In the event of availing the provision of Improvement of Internal evaluation marks, the internal evaluation marks as well as the Semester-end Examinations marks secured in the previous attempt(s) for the re-registered courses shall stand cancelled.

24.  **Amendments to Regulations:**

The Academic Council of SVEC (Autonomous) reserves the right to revise, amend, or change the Regulations, Scheme of Examinations, and / or Syllabi or any other policy relevant to the needs of the society or industrial requirements etc., with the recommendations of the concerned Board(s) of Studies.

25.  **General:**

The words such as "he", "him", "his" and "himself" shall be understood to include all students irrespective of gender connotation.

**Note:** Failure to read and understand the regulations is not an excuse.

**GUIDELINES FOR DISCIPLINARY ACTION FOR MALPRACTICES /
IMPROPER CONDUCT IN EXAMINATIONS**

| Rule No. | Nature of Malpractices/Improper conduct | Punishment |
|---|---|---|
| | *If the candidate:* | |
| 1. (a) | Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the course of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the course of the examination) | Expulsion from the examination hall and cancellation of the performance in that course only. |
| (b) | Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter. | Expulsion from the examination hall and cancellation of the performance in that course only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him. |
| 2. | Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the course of the examination (theory or practical) in which the candidate is appearing. | Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses of that Semester. The Hall Ticket of the candidate is to be cancelled. |
| 3. | Impersonates any other candidate in connection with the examination. | The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred for four consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the courses of the examination (including labs and project work) already appeared and shall not be allowed to appear for examinations of the remaining courses of that semester. The candidate is also debarred for four consecutive semesters from class work and all Semester-end examinations, if his involvement is established. Otherwise, The candidate is debarred for two consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him. |

| Rule No. | Nature of Malpractices/Improper conduct | Punishment |
|---|---|---|
| | *If the candidate:* | |
| 4. | Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination. | Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred for two consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 5. | Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks. | Cancellation of the performance in that course only. |
| 6. | Refuses to obey the orders of the Chief Controller of Examinations/Controller of Examinations/any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the Controller of Examinations or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the Controller of Examinations, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination. | In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that course and all other courses the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the courses of that semester. If the candidate physically assaults the invigilator/Controller of the Examinations, then the candidate is also debarred and forfeits his/her seat. In case of outsiders, they will be handed over to the police and a police case is registered against them. |
| 7. | Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall. | Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred for two consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |

| Rule No. | Nature of Malpractices/Improper conduct | Punishment |
|---|---|---|
|  | *If the candidate:* |  |
| 8. | Possess any lethal weapon or firearm in the examination hall. | Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred and forfeits the seat. |

**Note:** Whenever the performance of a student is cancelled in any course(s) due to Malpractice, he has to register for Semester-end Examinations in that course(s) consequently and has to fulfill all the norms required for the award of Degree.

# SVEC-19 CURRICULUM
## Course Structure for B.Tech Program
(Effective from the Academic year 2019-20 onwards)

## MECHANICAL ENGINEERING

| Mandatory Induction Program | 03 weeks duration |
|---|---|
| Induction program offered before commencement of the I-Semester course work | Physical activity |
| | Creative Arts |
| | Universal Human Values |
| | Literary |
| | Proficiency Modules |
| | Lectures by Eminent People |
| | Visits to local Areas |
| | Familiarization to Department/Branch and Innovations |

# COURSE STRUCTURE
## MECHANICAL ENGINEERING
### I B.Tech. – I Semester

| S. No. | Course Code | Course Title | L | T | P | Total | C | Int. Marks | Ext. Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Contact Periods per week | | | | | Scheme of Examination Max. Marks | | |
| 1. | 19BT1BS01 | Differential Equations and Multivariable Calculus | 3 | 1 | - | 4 | 4 | 40 | 60 | 100 |
| 2. | 19BT1BS04 | Engineering Chemistry | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 3. | 19BT1HS01 | Communicative English | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 4. | 19BT10501 | Programming for Problem Solving | 3 | 1 | - | 4 | 4 | 40 | 60 | 100 |
| 5. | 19BT1BS32 | Engineering Chemistry Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 6. | 19BT1HS31 | Communicative English Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 7. | 19BT10331 | Computer Aided Engineering Drawing | - | 1 | 2 | 3 | 2 | 50 | 50 | 100 |
| 8. | 19BT10531 | Programming for Problem Solving Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| | | **Total:** | **12** | **3** | **8** | **23** | **19** | **360** | **440** | **800** |

### I B.Tech. – II Semester

| S. No. | Course Code | Course Title | L | T | P | Total | C | Int. Marks | Ext. Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Contact Periods per week | | | | | Scheme of Examination Max. Marks | | |
| 1. | 19BT2BS01 | Transformation Techniques and Linear Algebra | 3 | 1 | - | 4 | 4 | 40 | 60 | 100 |
| 2. | 19BT1BS02 | Biology for Engineers | 2 | - | - | 2 | 2 | 40 | 60 | 100 |
| 3. | 19BT2BS02 | Applied Physics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 4. | 19BT10201 | Basic Electrical and Electronics Engineering | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 5. | 19BT20301 | Basic Engineering Mechanics | 3 | 1 | - | 4 | 4 | 40 | 60 | 100 |
| 6. | 19BT20302 | Material Science and Engineering | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 7. | 19BT2BS31 | Applied Physics Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 8. | 19BT10231 | Basic Electrical and Electronics Engineering Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 9. | 19BT20331 | Engineering Workshop | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 10. | 19BT20332 | Material Science and Engineering Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| | | **Total:** | **17** | **2** | **8** | **27** | **23** | **440** | **560** | **1000** |
| 11. | 19BT1AC01 | Spoken English | 2 | - | - | 2 | - | - | - | - |

## II B.Tech. – I Semester

| S. No. | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 1. | 19BT3BS01 | Numerical Methods, Probability and Statistics | 3 | 1 | - | 4 | 4 | 40 | 60 | 100 |
| 2. | 19BT30301 | Engineering Thermodynamics | 3 | 1 | - | 4 | 4 | 40 | 60 | 100 |
| 3. | 19BT30302 | Kinematics of Machinery | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 4. | 19BT30303 | Manufacturing Technology | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 5. | 19BT30304 | Strength of Materials | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 6. | 19BT3HS31 | Soft Skills Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 7. | 19BT30132 | Strength of Materials Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 8. | 19BT30331 | Computer Aided Machine Drawing | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 9. | 19BT30332 | Manufacturing Technology Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| | | **Total:** | **15** | **2** | **8** | **25** | **21** | **400** | **500** | **900** |
| 10. | 19BT315AC | Design Thinking | 2 | - | - | 2 | - | - | - | - |

## II B.Tech. – II Semester

| S. No | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 1. | 19BT40301 | Dynamics of Machinery | 3 | 1 | - | 4 | 4 | 40 | 60 | 100 |
| 2. | 19BT40302 | Engineering Metrology | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 3. | 19BT40303 | Fluid Mechanics and Hydraulic Machinery | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 4. | 19BT40304 | Metal Cutting and Machine Tools | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 5. | 19BT40305 | Thermal Engineering-I | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 6. | **Open Elective-2** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 7. | 19BT40132 | Fluid Mechanics and Hydraulic Machinery Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 8. | 19BT40331 | Dynamics of Machinery Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 9. | 19BT40332 | Engineering Metrology and Machine Tools Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| | | **Total:** | **18** | **1** | **6** | **25** | **22** | **390** | **510** | **900** |
| 10. | 19BT3MC01 | Environmental Science | 2 | - | - | 2 | - | 40 | -- | 40 |

# III B.Tech. – I Semester

| S. No. | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 1. | 19BT50301 | Computer Aided Design and Manufacturing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 2. | 19BT50302 | Operations Research | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 3. | 19BT50303 | Thermal Engineering -II | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 4. | **Professional Elective-1** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BT50304 | Automobile Engineering | | | | | | | | |
| | 19BT50305 | Compressible Fluid Flow | | | | | | | | |
| | 19BT50306 | Engineering Metallurgy | | | | | | | | |
| | 19BT50307 | Statistical Inference and Modeling | | | | | | | | |
| | 19BT50308 | Tool Design | | | | | | | | |
| | 19BT50309 | Tribology | | | | | | | | |
| 5. | **Open Elective-1** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 6. | **Inter Disciplinary Elective-1** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BT50310 | Artificial Intelligence and Robotics | | | | | | | | |
| | 19BT50311 | Automotive Electronics | | | | | | | | |
| | 19BT50312 | Industrial Automation and Control Systems | | | | | | | | |
| | 19BT50313 | Non-Conventional Energy Sources | | | | | | | | |
| | 19BT50314 | Programmable Logic Controller in Automation | | | | | | | | |
| | 19BT50315 | Soft Computing Techniques in Mechanical Engineering | | | | | | | | |
| 7. | 19BT50331 | Computer Aided Design and Manufacturing Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 8. | 19BT50332 | Thermal Engineering Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 9. | 19BT50333 | Socially Relevant Project-1 | - | - | - | - | 1 | 50 | 50 | 100 |
| **Total:** | | | **18** | **-** | **4** | **22** | **21** | **390** | **510** | **900** |
| 10. | 19BT503AC | Foundations of Entrepreneurship | 2 | - | - | 2 | - | - | - | - |

# III B.Tech. – II Semester

| S. No | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 1. | 19BT60301 | Industrial Engineering and Management | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 2. | 19BT60302 | Design of Machine Elements | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 3. | 19BT60303 | Heat Transfer | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 4. | **Professional Elective–2** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BT60304 | Casting and Welding Technology | | | | | | | | |
| | 19BT60305 | Composite Materials | | | | | | | | |
| | 19BT60306 | Gas Turbines and Jet Propulsion | | | | | | | | |
| | 19BT60307 | Internal Combustion Engines | | | | | | | | |
| | 19BT60308 | Mechanical Vibrations | | | | | | | | |
| | 19BT60309 | Quality Management and Reliability Engineering | | | | | | | | |
| 5. | **Professional Elective–3** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BT60310 | Automotive Fuels and Combustion | | | | | | | | |
| | 19BT60311 | Design of Pressure Vessels and Piping Systems | | | | | | | | |
| | 19BT60312 | Mechanical Behavior of Materials | | | | | | | | |
| | 19BT60313 | Non Traditional Machining process | | | | | | | | |
| | 19BT60314 | Optimization Techniques | | | | | | | | |
| | 19BT60315 | Refrigeration and Air Conditioning | | | | | | | | |
| 6. | **Inter Disciplinary Elective–2** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BT50408 | Microelectromechanical Systems | | | | | | | | |
| | 19BT60316 | Instrumentation and Control systems | | | | | | | | |
| | 19BT60317 | Hydraulics and Pneumatics | | | | | | | | |
| | 19BT60318 | Industrial Internet of Things | | | | | | | | |
| | 19BT60319 | Machinery Fault Diagnosis and Signal Processing | | | | | | | | |
| | 19BT60320 | Mechatronics | | | | | | | | |
| 7. | 19BT61531 | Internet of Things Lab | - | 1 | 2 | 3 | 2 | 50 | 50 | 100 |
| 8. | 19BT60331 | Heat Transfer Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 9. | 19BT60332 | Socially Relevant Project-2 | - | - | - | - | 1 | 50 | 50 | 100 |
| | | **Total:** | **18** | **1** | **4** | **23** | **22** | **390** | **510** | **900** |
| 10. | 19BT5MC01 | Universal Human Values | 2 | - | - | 2 | - | 40 | - | 40 |

## IV B.Tech. – I Semester

| S. No. | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 1. | 19BT6HS01 | Principles of Business Economics and Accountancy | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 2. | 19BT70301 | Design of Transmission Systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 3. | 19BT70302 | Operations Management | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| 4. | **Professional Elective–4** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BT70303 | Computational Fluid Dynamics | | | | | | | | |
| | 19BT70304 | Finite Element Method | | | | | | | | |
| | 19BT70305 | Material Processing Techniques | | | | | | | | |
| | 19BT70306 | Power Plant Engineering | | | | | | | | |
| | 19BT70307 | Supply Chain Management | | | | | | | | |
| | 19BT70308 | Sustainable Manufacturing | | | | | | | | |
| 5. | **Professional Elective–5** | | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BT70309 | Cryogenics | | | | | | | | |
| | 19BT70310 | Design of Automotive components | | | | | | | | |
| | 19BT70311 | Project Management | | | | | | | | |
| | 19BT70312 | Rapid Prototyping | | | | | | | | |
| | 19BT70313 | Surface Engineering | | | | | | | | |
| | 19BT70314 | Hybrid and Electric Vehicles | | | | | | | | |
| 6. | 19BT7MOOC | MOOC | - | - | - | - | 3 | - | 100 | 100 |
| 7. | 19BT70331 | Industrial Automation and Robotics Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 8. | 19BT70332 | Simulation and Analysis Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| 9. | 19BT70333 | Internship | - | - | - | - | 2 | -- | 100 | 100 |
| | | **Total:** | **15** | **–** | **4** | **19** | **22** | **300** | **600** | **900** |
| 10. | 19BT703AC | MATLAB for Mechanical Engineers | 2 | - | - | 2 | - | - | - | - |

## IV B.Tech. – II Semester

| Sl. No. | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| 1. | 19BT80331 | Project Work | - | - | - | - | 10 | 100 | 100 | 200 |
| | | **Total:** | **-** | **-** | **-** | **-** | **10** | **100** | **100** | **200** |

# LIST OF COURSES FOR
# OPEN ELECTIVE–1 and OPEN ELECTIVE-2

| Course Code | Open Elective -1 | Course Code | Open Elective -2 |
|---|---|---|---|
| 19BT4BS01 | Material Science | 19BT4HS01 | Banking and Insurance |
| 19BT4HS02 | Business Communication and Career Skills | 19BT4HS03 | Cost Accounting and Financial Management |
| 19BT4HS04 | Entrepreneurship for Micro, Small and Medium Enterprises | 19BT4HS05 | Gender and Environment |
| 19BT4HS06 | German Language | 19BT4HS07 | Indian Economy |
| 19BT4HS08 | Indian History | 19BT4HS09 | Life Skills |
| 19BT4HS10 | Personality Development | 19BT4HS11 | Professional Ethics |
| 19BT4HS12 | Women Empowerment | 19BT4HS13 | Indian Tradition and Culture |
| 19BT4HS14 | Constitution of India | 19BT40106 | Disaster Mitigation and Management |
| 19BT40205 | Reliability and Safety Engineering | 19BT40107 | Sustainable Engineering |
| 19BT50107 | Environmental Pollution and Control | 19BT40108 | Contract Laws and Regulations |
| 19BT50108 | Planning for Sustainable Development | 19BT40306 | Global Strategy and Technology |
| 19BT50109 | Rural Technology | 19BT40307 | Management Science |
| 19BT50505 | Ethical Hacking | 19BT40504 | Cyber Laws and Security |
| 19BT51207 | AI in Healthcare | 19BT50208 | Intellectual Property Rights |
| 19BT51506 | Bioinformatics | 19BT50409 | Green Technologies |

# HONORS DEGREE and MINOR DEGREE

In addition to the Major Degree, Students have an opportunity to pursue either Minor Degree or Honors Degree as per the eligibility criteria mentioned in Academic Regulations Point No.: 14 & 15.

**Honors Degree:** Honors degree is awarded to the students who have undergone additional learning for 18 credits in the same discipline.

## HONORS DEGREE IN MECHANICAL ENGINEERING

| Semester | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I Semester (2 Theory) | 19BH50301 | Computer Integrated Manufacturing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH50302 | CNC Programming | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH50303 | Introduction to Mechanical systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| III B.Tech. II Semester (2 Theory) | 19BH60301 | Principles of Industrial Automation | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH60302 | Principles of Robotics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH60303 | Robot Kinematics and Dynamics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| IV B.Tech. I Semester (2 Theory) | 19BH70301 | Applied and Industrial Robotics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH70302 | Robot Programming | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH70303 | Sensors and Machine Vision Systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |

**Minor Degree:** Honor degree is awarded to the students who has undergone additional learning for 18 credits in any discipline other than parent discipline.

## MINOR DEGREES OFFERED UNDER SVEC-19 REGULATIONS

| Offering Department | Title of the Minor | Students of Eligible Branches |
|---|---|---|
| CSE | Artificial Intelligence and Machine Learning | All branches except CSE, IT and CSSE |
| IT | Internet of Things | All branches except IT |
| CSSE | Cyber Security | All branches except CSE, IT and CSSE |
| ECE | VLSI and Embedded Systems | All branches except ECE |
| EEE | Power Systems and Drives | All branches except EEE |
| EIE | Instrumentation and Control Engineering | All branches except EIE |
| ME | Robotics | All branches except ME |
| CE | Sustainable Engineering | All branches except CE |

**(19BT1BS01) DIFFERENTIAL EQUATIONS AND MULTIVARIABLE CALCULUS**

(Common to CE, ME, EEE, ECE, EIE, CSE, CSSE, IT, CSE (AI) and CSE (DS))

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| 40 | 60 | 100 | 3 | 1 | - | 4 |

**PRE-REQUISITES**: -

**COURSE DESCRIPTION:**

Ordinary Differential Equations; Partial Differential Equations; Multivariable Calculus (Differentiation); Multivariable Calculus (Integration); Multivariable Calculus (Vector Calculus).

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Formulate and solve differential equations by applying knowledge of calculus for engineering problems.

CO2. Demonstrate knowledge in multivariable calculus for evaluating multiple integrals through techniques of integration.

CO3. Identify scalar and vector valued functions and evaluate vector integrals through knowledge of vector integral theorems and techniques.

**DETAILED SYLLABUS:**

**UNIT I: ORDINARY DIFFERENTIAL EQUATIONS                    (9 Periods)**

Second and higher order linear differential equations with constant coefficients: Non-Homogeneous equations with R.H.S terms of the type $e^{ax}$, $\sin ax$, $\cos ax$, polynomials in $x$, $e^{ax}V(x)$ $and$ $xV(x)$; method of variation of parameters; Equations reducible to linear differential equations with constant coefficients: Cauchy's and Legendre's linear equations; Applications to L-C-R Circuit problems.

**UNIT II: PARTIAL DIFFERENTIAL EQUATIONS                    (9 Periods)**

Formation of PDE, solutions of first order linear and non-linear PDEs, Solution to homogenous and non-homogenous linear partial differential equations of second and higher order by complimentary function and particular integral method, method of separation of variables in Cartesian coordinates.

**UNIT III: MULTIVARIABLE CALCULUS (DIFFERENTIATION)          (9 Periods)**

Partial derivatives, Chain rule, Total derivative, Jacobian, Maxima and Minima of functions of two variables, Lagrange's method of undetermined multipliers.

**UNIT IV: MULTIVARIABLE CALCULUS (INTEGRATION)              (9 Periods)**

Evaluation of Double integrals (Cartesian and polar coordinates), Change of order of integration (Cartesian form only); Evaluation of Triple integrals; Change of variables: double integration from Cartesian to polar coordinates, Triple integration from Cartesian to spherical and cylindrical polar coordinates; Areas enclosed by plane curves.

## UNIT V: MULTIVARIABLE CALCULUS (VECTOR CALCULUS) (9 Periods)

**Vector Differentiation:** Scalar and Vector fields: Gradient of a scalar field, directional derivative, divergence of a vector field, solenoidal vector, curl of a vector field, irrotational vector, Laplacian operator. **Vector Integration:** Line integral-circulation-work done, Surface integral-flux and Volume integral; Vector integral theorems: Theorems of Green, Gauss and Stokes (without proofs).

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. T. K. V. Iyengar, B. Krishna Gandhi, S. Ranganatham and M.V.S.S.N. Prasad, *Engineering Mathematics, vol-1*, S. Chand and Company, 13th edition, 2014.

2. B. S. Grewal, *Higher Engineering Mathematics*, Khanna publishers, 44th edition, 2017.

**REFERENCE BOOKS:**

1. Dennis G. Zill and Warren S. Wright, *Advanced Engineering Mathematics*, Jones and Bartlett, 6th edition, 2011.

2. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, Alpha Science International Ltd., 6th edition, 2017.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| Average | 3 | 2 | | | | | | | | | | | | | |
| Correlation level | 3 | 2 | | | | | | | | | | | | | |

3. **Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

# I B. Tech. - I Semester

## (19BT1BS04) ENGINEERING CHEMISTRY

### (Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES**: -

**COURSE DESCRIPTION:**

Atomic Structure and Bonding Theories; Water Treatment; Electrochemistry and Applications; Corrosion; Instrumental Methods and Applications; Fuel chemistry and Lubricants.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Apply the basic knowledge of quantum mechanical approach to atomic structure and bonding theories to identify shapes of different orbitals and molecules.

CO2.  Analyze and solve problems associated with hardness of water, boiler troubles and address the societal, health and safety issues related to quality of water.

CO3.  Apply the basic knowledge of corrosion phenomenon to identify solutions for control of corrosion and demonstrate competency in the basic concepts of electrochemical cells.

CO4.  Demonstrate the basic knowledge of instrumental methods and their applications in the structural analysis of materials.

CO5.  Apply the basic knowledge of fuel chemistry and lubricants to identify the quality of fuels and lubricants.

**DETAILED SYLLABUS:**

**UNIT I: ATOMIC STRUCTURE AND BONDING THEORIES                (9 Periods)**

Quantum-mechanical model of atom, Schrodinger wave equation, significance of $\Psi$ and $\Psi^2$ , applications to particle in a box and hydrogen atom;  Molecular orbital theory – bonding in homo and hetero nuclear diatomic molecules – energy level diagrams of $N_2$, $O_2$, NO and CO; Π-molecular orbitals of butadiene and benzene; VSEPR theory and molecular shapes.

**UNIT II: WATER TREATMENT                                    (9 Periods)**

Introduction, types of water, Impurities in water and their consequences. Hardness of water, units of hardness, disadvantages of hardness, measurement of hardness by EDTA method, numerical problems on measurement of hardness of water, boiler troubles- priming & foaming, scales & sludge, caustic embrittlement, boiler corrosion, softening of water– Ion exchange process, zeolite process, desalination of brackish water by reverse osmosis, Drinking water treatment- Ozonisation & chlorination, specifications of potable water as per WHO and BIS standards. Fluoride in ground water: Effects on human health, defluoridation method – Nalgonda method; merits and demerits of various defluoridation methods.

**UNIT III: ELECTROCHEMISTRY AND APPLICATIONS                (10 Periods)**

Electrode potential, Nernst equation, reference electrodes (Calomel electrode and glass electrode), electrochemical cell, cell potential calculations. Primary cells – dry cell, alkali metal sulphide batteries, Secondary cells – lead acid, lithium ion batteries, Fuel cells - Hydrogen-oxygen fuel cell, Methanol-oxygen fuel cell, Solid-oxide fuel cell.

**Corrosion:** Introduction, Definition, Types of corrosion- wet (galvanic corrosion, concentration cell corrosion) and dry corrosion, Factors influencing corrosion, control of corrosion- sacrificial anodic protection, Impressed current cathodic protection, electroplating method (Nickel).

## UNIT IV: INSTRUMENTAL METHODS AND APPLICATIONS          (9 Periods)

Introduction to spectroscopy–types of energy present in molecules, types of spectra, UV-Vis spectroscopy – principle, types of electronic transitions, chromophore, auxochrome, Bathochromic shift, Hypsochromic shift, Instrumentation of UV-Vis spectrophotometer, applications; Infrared spectroscopy – principle, types of vibrational modes, group frequencies, Instrumentation of IR spectrophotometer, applications. principle and applications of physicochemical methods (SEM, TEM, X-ray diffraction).

## UNIT V: FUEL CHEMISTRY AND LUBRICANTS          (8 Periods)

**Fuel chemistry**: Types of fuels, calorific value, numerical problems based on calorific value; Liquid fuels, cracking of oils (Thermal and Fixed-bed catalytic cracking), knocking and anti-knock agents, Octane and Cetane values, Synthetic petrol: Fischer-Tropsch method and Bergius process.

**Lubricants**: Definition, functions of lubricants, mechanism of lubrication, classification of lubricants, properties of lubricants – viscosity and viscosity index, flash and fire points, cloud and pour points, Aniline points, neutralization number and mechanical strength.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. P. C. Jain & Monika Jain*, Engineering Chemistry*, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 16th edition, 2013.

2. K. N. Jayaveera, G. V. Subba Reddy and C. Ramachandriah, *Engineering Chemistry,* McGraw Hill Publishers, New Delhi.

**REFERENCE BOOKS:**

1. J. D. Lee, *Concise Inorganic Chemistry*, Oxford University Press, 5th edition 2010.

2. Skoog and West, *Principles of Instrumental Analysis*, Thomson, 6th edition, 2007.

3. Peter Atkins, Julio de Paula and James Keelar, Atkins' *Physical Chemistry*, Oxford University Press, 10th edition, 2010.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | 2 | - | - | - | 2 | 1 | - | - | - | - | - | | | |
| **CO3** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | | | |
| **CO4** | 3 | - | - | - | - | - | - | - | - | - | - | - | | | |
| **CO5** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | | | |
| **Average** | 3 | 1 | | | | 2 | 1 | | | | | | | | |
| **Correlation level** | 3 | 1 | | | | 2 | 1 | | | | | | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

# I B. Tech – I Semester

## (19BT1HS01) COMMUNICATIVE ENGLISH

(Common to CE, ME, CSE, CSSE, IT and CSBS)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES**: **-**

**COURSE DESCRIPTION:**

Introduction to communication; Active listening; Effective speaking; Reading; Technical writing.

**COURSE OUTCOMES**:

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of English language, examining and applying the aspects of Process of communication, Paralinguistic features, Skimming, Scanning, and Elements of style in writing.

CO2. Analyze the modes and techniques of listening, speaking, reading, writing and apply appropriately to communicate effectively with the engineering community and society.

CO3. Apply reading and writing techniques in preparing documents by examining SQ3R Technique, Writer's Block, and Précis Writing.

CO4. Communicate effectively applying appropriate speaking techniques by examining and applying the communication styles in Conferences, Symposia, Seminars and Persuasive Speaking.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO COMMUNICATION** **(9 Periods)**

Introduction – Language as a Tool of Communication – Communicative Skills (Listening, Speaking, Reading and Writing) – Effective Communication – Modes of Communication– Barriers to Communication (classification) - Case study

**UNIT II: ACTIVE LISTENING** **(9 Periods)**

Introduction –Traits of a Good Listener – Listening Modes – Types of Listening – Barriers to Effective Listening – Listening for General Content and Specific Information - Case study

**UNIT III: EFFECTIVE SPEAKING** **(9 Periods)**

Introduction – Achieving Confidence, Clarity and Fluency – Paralinguistic Features – Barriers to Speaking – Types of Speaking – Conferences; significance, planning and preparation and procedure – Symposia and Seminars - Persuasive Speaking - Case study

**UNIT IV: READING** **(9 Periods)**

Introduction – Reading and Interpretation – Intensive and Extensive Reading – Critical Reading –Techniques for Good Comprehension- SQ3R Reading Technique –Study Skills - Case study.

**UNIT V: TECHNICAL WRITING** **(9 Periods)**

Introduction – Language – Elements of Style – Techniques for Good Technical Writing – Paragraphs Construction – Essays: types, Steps to Essay Writing and Checklist – Précis Writing - Case study

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Meenakshi Raman & Sangeetha Sharma, *Technical Communication*, Oxford University Press, New Delhi, 2012.
2. Ashraf Rizvi*, Effective Technical Communication*, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 2018.

**REFERENCE BOOKS:**

1. Sanjay Kumar & Pushp Lata, *Communication Skills*, Oxford University Press, New Delhi, 2013.
2. Rajendra Pal and J. S. Korlahalli, *Essentials of Business Communication*, Sultan Chand and Son, New Delhi, 2010.

**ADDITIONAL LEARNING RESOURCES**

https://www.skillsyouneed.com/ips/active-listening.html: A useful summary of what active listening skills are.

https://en.wikipedia.org/wiki/Active_listening: Wikipedia entry about active listening.

https://www.forbes.com/sites/womensmedia/2012/11/09/10-steps-to-effective-listening/#4b27a2503891: Ten steps to Active Listening (by Forbes magazine).

https://goo.gl/t1Uqrt: 20 tips for organizing a conference.

https://goo.gl/kPMr9u: 10 important issues for speakers at a conference.

https://goo/gl/C5bDvv: Wikihow guide to organizing a conference.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | | - | - | - | - | - | - | - | | | |
| CO2 | 1 | 3 | - | - | - | | - | - | - | - | | - | | | |
| CO3 | 1 | 1 | - | - | 2 | - | - | - | - | - | - | - | | | |
| CO4 | 1 | 1 | - | - | 2 | - | - | - | - | 3 | - | 1 | | | |
| Average | 1.25 | 1.6 | | | 2 | | | | | 3 | | 1 | | | |
| Correlation level | 1 | 2 | | | 2 | | | | | 3 | | 1 | | | |

**Correlation Levels:      3– High      2 - Medium      1– Low**

(19BT10501) **PROGRAMMING FOR PROBLEM SOLVING**

(Common to CE, ME, CSE, CSSE, IT, CSE (AI) and CSE (DS)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | 1 | - | 4 |

**PRE-REQUISITES:**

A course on Basic Mathematics

**COURSE DESCRIPTION:**

Introduction to problem solving approach, Introduction to Python programming, control structures, sequences, sets, Dictionaries, Implementation of Data structures using Python, Modular programming, file handling, Data representation and Visualization.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

   CO1. Demonstrate knowledge on Python constructs to solve basic problems.

   CO2. Develop and use Python modules to provide solutions to problems.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO PROBLEM SOLVING AND PYTHON PROGRAMMING**

**(10 periods)**

**Problem Solving Aspect**: top-down design, implementation of algorithms, building blocks of flow charts, program verification and efficiency of algorithms.

**Python Programming:** tokens, literals, identifiers, keywords, special symbols and operators; fundamental data types, expressions, type conversions, handling Input and output in Python.

**UNIT II: CONTROL STRUCTURES** **(8 Periods)**

**Selection Statements**: if statement, if-else statement, if-elif-else statement, nested-if statement.

**Iterative Statements**: while loop, for loop, break statement, continue statement, pass and else statements used with loops.

**UNIT III: SEQUENCES, SETS, DICTIONARIES AND DATA STRUCTURES**

**(9 Periods)**

**Sequences: Lists and operations -** creating, inserting elements, updating elements, deleting elements, searching and sorting, list comprehensions, nested lists; **tuples -** creating, searching and sorting, nested tuples; **strings -** Initializing a string and string operations, string handling methods, string formatting; **sets -** set creation and operations; **dictionaries -** operations on dictionaries, dictionary methods, sorting elements using lambdas.

**Data structures: Stacks -** push, pop, peek and display operations on stack, applications of stack; **Queues –** enqueue, dequeue and display operations on queue, applications of queues.

**UNIT IV: MODULAR PROGRAMMING AND FILE HANDLING**          **(10 periods)**

**Modular Programming**: need for functions, function definition, function call, variable scope and lifetime, return statement, positional arguments, keyword arguments, default arguments and variable-length arguments, recursive functions; Modules - math, NumPy, date and time.

**File Handling:** types of files, opening and closing files, reading and writing data.

**UNIT V: DATA REPRESENTATION AND VISUALIZATION**          **(8 Periods)**

**Pandas:** creating data frame, reading data from CSV files, indexing and selecting data, dealing with rows and columns; Visualization - bar plots, histogram, Scatter Plot.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1. R. Nageswara Rao, *Core Python Programming,* 2nd edition, Dreamtech Press, 2018.

2. R. G. Dromey, *How to solve it by Computer,* Pearson, 2006.

**REFERENCE BOOKS**:

1. Reema Thareja, *Python Programming using Problem Solving Approach*, 1st edition, Oxford University Press, 2017.

2. Charles Dierbach, *Introduction to Computer Science using Python: A Computational Problem-Solving Focus*, Wiley India, 2016.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | | | |
| **Average** | 3 | 2.5 | 2.5 | 2.5 | 3 | - | - | - | - | - | - | - | | | |
| **Correlation level** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | | | |

**Correlation Levels:**          **3– High**          **2 - Medium**          **1– Low**

# I B. Tech. - I Semester
## (19BT1BS32) **ENGINEERING CHEMISTRY LAB**
(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE - REQUISITES**:  -

**COURSE DESCRIPTION:**

Estimation of hardness, alkalinity, dissolved oxygen of water samples, Iron, Strength of an acid in Pb-acid battery and residual chlorine in drinking water by volumetric methods; Measurement of viscosity of lubricants; Instrumental methods like conductivity meter, potentiometer, P$^H$ meter and colorimeter; Characterization of simple organic compounds by UV-Vis and IR spectroscopy.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply analytical skills for the quantitative estimation of materials through volumetric methods of analysis and address the societal, health issues related to quality of water.

CO2. Develop analytical skills for the quantitative estimation of materials through instrumental methods of analysis.

CO3. Work independently and in teams to solve problems with effective communication.

A minimum of any **Ten** experiments are to be conducted among the following:

## List of Experiments

1. Estimation of Hardness of water by EDTA method
2. Determination of alkalinity of Water sample
3. Estimation of Dissolved Oxygen in water by Winkler's method.
4. Estimation Fe (II) by Dichrometry
5. Conductometric titration of strong acid Vs strong base
6. Estimation of Ferrous ion by Potentiometry
7. Determination of strength of acid by P$^H$ metric method
8. Determination of Strength of an acid in Pb-Acid battery
9. Determination of Viscosity by Ostwald's viscometer
10. Determination of percentage of Iron in Cement sample by colorimetry
11. Estimation of residual chlorine in drinking water.
12. Identification of simple organic compounds by UV-Vis and IR spectroscopy

## TEXTBOOKS:

1. K. Mukkanti, *Practical Engineering Chemistry*, BS Publications, 2013.
2. K. N. Jayaveera, K.B. Chandra Sekhar, *Chemistry laboratory manual*, S.M. Enterprises Limited, 2013.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | - | - | - | 2 | 1 | - | - | - | - | - | | | |
| CO2 | 3 | 3 | - | - | 2 | - | - | - | - | - | - | - | | | |
| CO3 | - | - | - | - | - | - | - | 2 | 2 | 2 | - | - | | | |
| Average | 3 | 3 | | | 2 | 2 | 1 | 2 | 2 | 2 | | | | | |
| Correlation level | 3 | 3 | | | 2 | 2 | 1 | 2 | 2 | 2 | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## I B. Tech. - I Semester

### (19BT1HS31) COMMUNICATIVE ENGLISH LAB

(Common to CE, ME, CSE, CSSE, IT and CSBS)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES**: **-**

**COURSE DESCRIPTION:**

Phonetics; Vocabulary Building; Grammar; Just a Minute; Elocution/Impromptu; Giving Directions; Role Plays; Public Speaking; Describing Objects; Reading Comprehension; Listening Comprehension; Information Transfer; Letter Writing.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of Phonetics by examining and applying sounds of English in Phonetic Transcription.

*CO2.* Analyze sentence structures by applying and demonstrating the skills of Vocabulary and Grammar.

CO3. Apply appropriate listening and reading skills by analyzing the context and demonstrate in Listening Comprehension and Reading Comprehension.

CO4. Function effectively as an individual and as a member in diverse teams examining and applying speaking skills in Just A Minute and Role Play.

CO5. Communicate effectively applying appropriate writing and speaking techniques by examining and demonstrating knowledge through Describing Objects, Information Transfer and Letter Writing.

**\*First ten exercises are mandatory among the following:**

**List of Exercises:**

1. **Just a Minute, Elocution/Impromptu**
   *Steps to be followed – Useful tips – Dos & Don'ts – Preparation – Examples*
2. **Phonetics**
   *Sounds of English – Consonants – Vowels – Speech Organs – Phonetic Transcription – Word Accent – Basics of Intonation*
3. **Vocabulary Building**
   *Prefixes & Suffixes – Synonyms & Antonyms – Phrasal verbs – Idioms – One word substitutes – Words often confused*
4. **Grammar**
   *Tenses –Nouns – Word order and error correction*
5. **Giving Directions**
   *Useful phrases – Sample conversations - Exercises*
6. **Role Plays**
   *Useful tips – Dos & Don'ts – Exercises – Role Plays for practice*
7. **Public Speaking**
   *Stage presence – Voice control – Body Language – Rehearsals – Audience – Delivery - Dos & Don'ts – Project Submission*
8. **Letter Writing**
   *Introduction – Objective – Formats – Types – Exercises*
9. **Describing Objects**
   *Jargon – Useful Phrases – Do's & Don'ts – Exercises*
10. **Listening Comprehension**
    *Introduction – Types of listening – Practice – Benefits of listening – Exercises*

**11. Information Transfer**
   *Tables – Pie Charts – Venn Diagrams – Graphs – Flow Charts – Steps to be followed – Exercises*
**12. Reading Comprehension**
   *Introduction – Types of reading – Inferring – Critical analysis – Exercises*

**TEXTBOOK:**
   1. Communicative English Lab Manual (SVEC-19)

**REFERENCE BOOKS**:
   1. D. Sudha Rani, *A Manual for English Language Laboratories*, Pearson, Noida, 2010.
   2. Nira Kumar, English *Language Laboratories*, PHI Learning Pvt. Ltd., New Delhi, 2011.

**SUGGESTED SOFTWARE:**
   1. SoftX
   2. Speech Solutions
   3. English Pronunciation Dictionary by Daniel Jones
   4. Learning to Speak English 8.1, The Learning Company – 4 CDs.
   5. Mastering English: Grammar, Punctuation and Composition.
   6. English in Mind, Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
   7. Dorling Kindersley Series of Grammar.
   8. Language in Use 1, 2 & 3
   9. Cambridge Advanced Learner's Dictionary - 3rd Edition
   10. Centronix – Phonetics
   11. Let's Talk English, Regional Institute of English South India.

**ADDITIONAL LEARNING RESOURCES**
   1. https://goo.gl/IjE45p: Amazon India site – with thousands of different product descriptions
   2. https://goo.gl/3ozeO6: 15 ways to calm your nerves before giving a presentation.
   3. https://goo.gl/p20ttk: useful site for more language about introducing yourself.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | | -- | - | - | - | - | - | - | | | |
| CO2 | 2 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| CO3 | 1 | 1 | - | - | 1 | - | | | | | - | - | | | |
| CO4 | 1 | 1 | - | | 2 | | | | 1 | | | - | | | |
| CO5 | 1 | 2 | - | | 2 | | | | | 3 | | 1 | | | |
| Average | 1.4 | 1.7 | | | 1.6 | | | | 1 | 3 | | 1 | | | |
| Correlation level | 1 | 2 | | | 2 | | | | 1 | 3 | | 1 | | | |

   **Correlation Levels:      3– High      2 - Medium      1– Low**

## (19BT10331) **COMPUTER AIDED ENGINEERING DRAWING**
(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | 1 | 2 | 2 |

**PRE-REQUISITES**: **--**

**COURSE DESCRIPTION:**

Engineering drawing conventions; Importance of engineering drawing; fundamental concepts of sketching; computer aided drafting and different types of projections of geometric entities (both 2D and 3D) through computer aided drafting packages.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the principles of engineering drawing, Methods and CAD tools to draw the Geometries, Curves and Orthographic projections used to communicate in the engineering field.

CO2. Develop lateral surfaces of solids and draw Isometric views of given objects for engineering communication using principles of engineering drawing and CAD tools.

CO3. Work independently / in groups & communicate effectively in oral and written

forms.

**DETAILED SYLLABUS:**

**Introduction to Engineering Graphics and Design:**

Principles, significance -Conventions in drawing-lettering - BIS conventions-Dimensioning principles and conventional representations.

**Exercises:**

1. Practice exercise on Basic Lettering and Dimensioning
2. Practice exercise on Conventional representations

**Introduction to AutoCAD:** Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets, arrays, dimensions.

**Exercises:**

3. Practice exercise using basic drawing commands
4. Practice exercise using editing commands

**CONICS, CURVES, PROJECTION OF POINTS, LINES AND PLANES**

**Conics & Special Curves:** Conic sections including the rectangular hyperbola- eccentricity method only; Cycloid, Epicycloid and Hypocycloid, Involutes.

**Exercises:**

5. Practice exercises on Ellipse, Parabola, Hyperbola and Rectangular Hyperbola

6. Practice exercises on Cycloid, Epicycloid, Hypocycloid and Involutes

**Projection of points, lines and planes:** Projection of points in any quadrant, lines inclined to one or both planes, finding true lengths, angle made by line, Projections of regular plane surfaces.

**Exercises:**

7. Practice exercises on Projection of points
8. Practice exercises on projection of lines inclined to one plane
9. Practice exercises on projection of lines inclined to both planes
10. Practice exercises on Projections of regular plane surfaces

## PROJECTION OF SOLIDS AND SECTION OF SOLIDS

**Projection of solids:** Projection of regular solids inclined to one plane.

**Sections of solids:** Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone, True shapes of the sections.

**Exercises:**

11. Practice exercises on Projections of regular solids
12. Practice exercises on Sections of solids

## DEVELOPMENT OF SURFACES

**Development of surfaces:** Development of surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts.

**Exercises:**

13. Practice exercises on Development of surfaces of right regular solids

## ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS

**Orthographic Projections:** Systems of projections, conventions and application to orthographic projections.

**Isometric Projections:** Principles of isometric projection- Isometric scale; Isometric views: lines, planes, simple solids.

**Exercises:**

14. Practice exercises on Orthographic Projections
15. Practice exercises on Isometric Projections

**TEXTBOOKS**:

1. D. M. Kulkarni, A. P. Rastogi, A. K. Sarkar, *Engineering Graphics with AutoCAD*, PHI Learning Private Limited, New Delhi, Revised edition, 2010.
2. N. D. Bhatt and V. M. Panchal, *Engineering Drawing*, Charotar Publishing House, Gujarat, 51st edition, 2013.

**REFERENCE BOOKS/LABORATORY MANUALS**:

1. Sham Tickoo, *AutoCAD 2013 for Engineers and Designers*, Dreamtech Press, 2013.
2. M. H. Annaiah & Rajashekar Patil, *Computer Aided Engineering Drawing*, New Age International Publishers, 4th edition, 2012.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 3 | 1 | - | - | - | - | - | - | 3 | | |
| CO2 | 3 | 3 | 2 | 1 | 3 | 1 | - | - | - | - | - | - | 3 | | |
| CO3 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | 3 | | |
| Average | 3 | 3 | 2 | 1 | 3 | 1 | - | - | 3 | 3 | - | - | 3 | | |
| Correlation level | 3 | 3 | 2 | 1 | 3 | 1 | | | 3 | 3 | | | 3 | | |

**Correlation Levels:      3– High      2 - Medium      1– Low**

(19BT10531) **PROGRAMMING FOR PROBLEM SOLVING LAB**

(Common to CE, ME, CSE, CSSE, IT, CSE (AI) and CSE (DS))

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

A course on Basic Mathematics

**COURSE DESCRIPTION:**

The course is designed to provide hands on practice on Scratch programming and python programming for problem solving.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Develop scripts using Scratch tool to simulate simple problems.

CO2. Apply Python Constructs and Modules to develop solutions for real-life problems.

CO3. Function effectively as an individual and in a team to foster knowledge and creativity.

CO4. Write and present a substantial technical report/ document effectively.

**PRACTICAL EXERCISES:**

1) a) Design a script in Scratch to simulate Airplane for take-off and land.

   b) Design a script in Scratch to make a sprite to ask the user to enter two different numbers and an arithmetic operator and then calculate and display the result.

2) a) Design a script in Scratch to calculate factorial of a given number.

   b) Design a script in Scratch to simulate Maze game. (Hint: To get Maze images refer http://inventwithScratch.com/downloads/)

3) a) Write a python script to read two integer numbers and perform arithmetic operations.

   b) Write a python script to evaluate following expressions by considering necessary inputs.

   i) $ax^2 + bx + c$   ii) $ax^5 + bx^3 + c$      iii) $(ax + b) / (ax - b)$     iv) $x - a / b + c$

4) a) Write a python script to convert given decimal number into octal, hexa decimal and binary.

   b) Write a python script to read four integer values separated with commas and display the sum of those four numbers.

   c) Write a python script to print "SVEC" with prefix of ten spaces by using format().

5) a) Write a python script to calculate electricity bill based on following slab rates.

| Consumption units | Rate (in Rupees/Unit) |
|---|---|
| 0-100 | 4 |
| 101-150 | 4.6 |
| 151-200 | 5.2 |
| 201-300 | 6.3 |
| Above 300 | 8 |

(Hint: To get Consumption units take current Meter reading, old meter reading from the user as input)

b)  Print the following pattern using python script.

```
                1
            1   2   1
        1   2   3   2   1
    1   2   3   4   3   2   1
1   2   3   4   5   4   3   2   1
```

6)  a)  Write a python script to read *N* student details like name, roll number, branch and age. Sort the student details based on their names and display.

b)  Write a python script to delete duplicate strings from a list of strings. (Insertion order should maintain after deleting duplicate string).

c)  Write a python script to read N number of student details into nested list and convert that as a nested dictionary.

7)  a)  Design a function that can perform sum of two or three or four numbers.

b)  Write a python script to implement towers of Hanoi problem.

c)  Write a Python function prime square(l) that takes a nonempty list of integers and returns True if the elements of l alternate between perfect squares and prime numbers, and returns False otherwise. Note that the alternating sequence of squares and primes may begin with a square or with a prime. Here are some examples to show how your function should work.

>>>primesquare([4])
True
>>>primesquare([4,5,16,101,64])
True
>>>primesquare([5,16,101,36,27])
False

8)  a)  Write a python script to perform arithmetic operations on numpy arrays.

b)  Write a python script to perform following matrix operations using numpy.

i) Dot product     ii) Matrix product     iii) Determinant     iv) Inverse

9)  a)  Write a python script to Create Pandas data frame using list of lists.

b)  Write a python script to load data from a CSV file into a Pandas DataFrame and perform basic operations on it.

10) a)  Draw a Scatter Plot by considering an appropriate data set.

b)  Draw histograms by considering an appropriate data set.

11)  **Mini Project-1**

12)  **Mini Project-2**

**TEXTBOOK**:

1. R. Nageswara Rao, *Core Python Programming*, 2nd edition, Dreamtech Press, 2018.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | | | |
| **CO3** | - | - | - | - | - | - | - | - | 3 | - | - | - | | | |
| **CO4** | - | - | - | - | - | - | - | - | - | 3 | - | - | | | |
| **Average** | 3 | 2.5 | 3 | 3 | 3 | - | - | - | 3 | 3 | - | - | | | |
| **Correlation level** | 3 | 2.5 | 3 | 3 | 3 | - | - | - | 3 | 3 | - | - | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

# I B. Tech. - II semester
## (19BT2BS01) TRANSFORMATION TECHNIQUES AND LINEAR ALGEBRA
(Common to CE, ME, EEE, ECE, EIE, CSE, CSSE, IT, CSE (AI) and CSE (DS))

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | 1 | - | 4 |

**PRE-REQUISITES**: -

**COURSE DESCRIPTION:**

Fourier Series and Fourier Transforms; Laplace Transforms; Inverse Laplace Transforms; Linear Algebra-I (Matrices); Linear Algebra-II (Vector Spaces).

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the knowledge of Fourier and Laplace transform techniques to solve differential equations.

CO2. Analyze linear transformations and associated matrices to solve engineering problems by applying the knowledge of linear algebra.

**DETAILED SYLLABUS:**

**UNIT I: FOURIER SERIES AND FOURIER TRANSFORMS** $\qquad$ **(9 Periods)**

Fourier series: Determination of Fourier coefficients, Euler's formulae, convergence of Fourier series (Dirichlet's conditions), Fourier series in $(0, 2l), (-l, l)$; Fourier series of even and odd functions; Half-range Fourier sine and cosine expansions in $(0, l)$; Fourier integral theorem (statement only), Fourier sine and cosine integrals; Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier transforms.

**UNIT II: LAPLACE TRANSFORMS** $\qquad$ **(9 Periods)**

Definition of Laplace transform, existence conditions, Laplace transform of standard functions, Properties of Laplace transforms, Laplace transforms of derivatives, Laplace transforms of integrals, multiplication by $t^n$, division by t, Laplace transform of periodic functions, Laplace transforms of unit step function and unit impulse function.

**UNIT III: INVERSE LAPLACE TRANSFORMS** $\qquad$ **(9 Periods)**

Inverse Laplace transform by different methods; Convolution theorem (without proof), inverse Laplace transforms by convolution theorem; Applications of Laplace transforms to ordinary differential equations of first and second order with constant coefficients.

**UNIT IV: LINEAR ALGEBRA-I (MATRICES)** $\qquad$ **(9 Periods)**

Rank of a matrix: echelon form; Linear systems of equations: solving system of Homogeneous and Non-Homogeneous equations; Eigen values and Eigen vectors of a matrix and properties (without proofs), Diagonalization of a matrix by orthogonal transformation; Quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical form by orthogonal transformation.

**UNIT V: LINEAR ALGEBRA-II (VECTOR SPACES)** $\qquad$ **(9 Periods)**

Vector spaces, Linear dependence and independence of vectors, basis, dimension, Linear transformations (maps), range and kernel of a linear map, rank and nullity, inverse of a linear transformation, rank-nullity theorem (without proof), matrix associated with a linear map.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. T. K. V. Iyengar, B. Krishna Gandhi, S. Ranganatham and M. V. S. S.N. Prasad, *Engineering Mathematics-II*, S. Chand & Company, 10th edition, 2016.

2. B. S. Grewal, *Higher Engineering Mathematics*, Khanna publishers, 44th edition, 2017.

3. David Poole, *Linear Algebra: A Modern Introduction*, Brooks/Cole, 2nd edition, 2005.

**REFERENCE BOOKS**:

1. B.V. Ramana, *Higher Engineering Mathematics*, Tata McGraw hill, 1st edition, 2017.

2. V.Krishna Murthy, Mainra and Arora: *An Introduction to Linear Algebra*, Affiliated East-West Press, 1993.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | | | |
| **Average** | **3** | **1** | - | - | - | - | - | - | - | - | - | - | | | |
| **Correlation level** | **3** | **1** | - | - | - | - | - | - | - | - | - | - | | | |

**Correlation Levels:**        **3– High**        **2 - Medium**        **1– Low**

# (19BT1BS02) **BIOLOGY FOR ENGINEERS**

(Common to CE, ME, CSE, CSSE, IT and CSBS)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 2 | - | - | 2 |

**PRE-REQUISITES**: --

**COURSE DESCRIPTION:**

Living Organisms; Proteins, Nucleic acids and Enzymes; Genetics and Molecular Biology; Recombinant DNA technology; Human Physiology and Applied Biology.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Apply the basic knowledge of biology to understand the significance of various biological techniques.

CO2.  Identify the role of DNA in the molecular basis of information transfer and understand single gene disorders related to the health perspective.

CO3.  Apply the basic knowledge of bio-analytical devices and methods to assess health issues.

**DETAILED SYLLABUS:**

**UNIT I: LIVING ORGANISMS**                                                      **(6 Periods)**

Comparison of biological organisms with man-made systems,  Classification of living organisms, Cellular basis of life, differences between prokaryotes and eukaryotes, classification on the basis of carbon and energy sources, molecular taxonomy

**UNIT II: PROTEINS, NUCLEIC ACIDS AND ENZYMES**                **(6 Periods)**

Biomolecules, structure and functions of proteins and nucleic acids, Industrial applications of enzymes, Fermentation and its industrial applications

**UNIT III: GENETICS AND MOLECULAR BIOLOGY**                     **(6 Periods)**

Mendel's laws, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation.

**UNIT IV: RECOMBINANT DNA TECHNOLOGY**                          **(6 Periods)**

Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.

**UNIT V: HUMAN PHYSIOLOGY AND APPLIED BIOLOGY**          **(6 Periods)**

Fundamentals of Human physiology, neurons, synaptic and neuromuscular junctions, Introduction to EEG, DNA fingerprinting, DNA Micro array and Genomics.

                                                                              **Total Periods: 30**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1.  Rajiv Singal, Gaurav Agarwal, *Biology for Engineers*, CBS, 2019.
2.  S. Sing and T. Allen, *Biology for Engineers*, Vayu Education of India, 2014.

**REFERENCE BOOKS**:

1. B. Alberts, A. Johnson et al., *The molecular biology of the cell*, Garland Science, 6th edition, 2014.
2. A. T. Johnson, *Biology for Engineers*, CRC press, 2011.

**ADDITIONAL LEARNING RESOURCES:**

1. Structure and function of Proteins: **https://nptel.ac.in/courses/104102016/16**

2. Enzyme catalysis:**https://nptel.ac.in/courses/103103026/module3/lec35/4.html**

3. Biochips: **https://nptel.ac.in/courses/112104029/3**

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | - | - | - | 2 | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | - | - | - | - | - | - | - | - | - | - | - | | | |
| **CO3** | 3 | - | - | - | - | 2 | - | - | - | - | - | - | | | |
| **Average** | **3** | **-** | **-** | **-** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | | | |
| **Correlation level** | **3** | **-** | **-** | **-** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | | | |

**Correlation Levels:**          **3– High**          **2 - Medium**          **1– Low**

(19BT2BS02) **APPLIED PHYSICS**

(Common to CE and ME)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE - REQUISITES**: --

**COURSE DESCRIPTION**:

Fiber Optics; Acoustics and Ultrasonics; Kinematics and Kinetics; Thermal Physics; Modern Engineering Materials.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the knowledge of fiber optics, acoustics and ultrasonics to provide solutions for various engineering problems.

CO2. Analyze and solve the problems associated with kinetics, kinematics and thermal physics.

CO3. Demonstrate the knowledge on characteristics and applications of modern engineering materials.

**DETAILED SYLLABUS:**

**Unit I:  FIBER OPTICS                                                         (8 Periods)**

Introduction, structure of an optical fiber, total internal reflection, acceptance angle, acceptance cone and numerical aperture, modes of propagation, classification of optical fibers, V-number (qualitative), fabrication of optical fiber by double crucible technique, applications of optical fibers, sensors (temperature, displacement, liquid level detector).

**UNIT II: ACOUSTICS AND ULTRASONICS                              (9 Periods)**

**Acoustics** - Introduction, classification of sound, sound intensity level (decibel), reverberation, reverberation time, absorption coefficient and its determination, Sabine's formula (qualitative), factors affecting acoustics and their remedies, basic requirements of an acoustically good hall.

**Ultrasonics** - Introduction to ultrasonic waves, production of ultrasonic waves by piezoelectric method, magnetostriction method, detection of ultrasonics (qualitative), industrial applications (ultrasonic welding, ultrasonic soldering and ultrasonic drilling).

**UNIT III: KINEMATICS AND KINETICS                               (10 Periods)**

**Kinematics of particles** - Rectilinear motion (displacement-time curve, velocity-time curve, acceleration-time curve), curvilinear motion (velocity and angle of projection, equation of trajectory path, horizontal range) - inclined projection (equation of trajectory, maximum height, time of flight of projectile, horizontal range, angle of projection).

**Kinetics** - Bodies in rectilinear translation, kinetics of bodies rotating about fixed axis, work, energy, power, work-energy equation for translation.

**UNIT IV: THERMAL PHYSICS                                            (8 Periods)**

Introduction, modes of heat transfer (conduction, convection and radiation), coefficient of thermal conductivity, rectilinear flow of heat along a uniform bar, thermal conductivity of bad conductor (Lee's disc method), heat conduction through compound media (materials in series and parallel).

**UNIT V: MODERN ENGINEERING MATERIALS**            **(10 Periods)**

**Metallic glasses** - Introduction, preparation of metallic glasses by RF sputtering technique, properties (structural, thermodynamic, mechanical, electrical, chemical and optical), applications of metallic glasses.

**Shape memory alloys (SMA)** – Introduction, shape memory effect and its types, characteristics of SMA, properties of NiTi alloy, applications of SMA.

**Composites** - Introduction, types and applications.

                                                          **Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. M. N. Avadhanulu, P. G. Kshirsagar, T. V. S Arun Murthy, *A Textbook of Engineering Physics,* S. Chand Publications, 11th edition, 2019.

2. S. S. Bhavikatti and K. G. Rajashekarappa, *Engineering Mechanics*, New Age International Publishers, 2nd edition, 2015.

**REFERENCE BOOKS:**

1. B. K. Pandey and S. Chaturvedi, *Engineering Physics*, Cengage Learning, 2012.

2. Brij Lal and N. Subrahmanyam, *Heat and Thermodynamics,* S. Chand and Company Ltd., 1995.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| **CO3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| **Average** | **3** | **2.6** | | | | | | | | | | | | | |
| **Correlation level** | **3** | **3** | | | | | | | | | | | | | |

**Correlation Levels:**         **3– High**        **2 - Medium**        **1– Low**

## (19BT10201) **BASIC ELECTRICAL AND ELECTRONICS ENGINEERING**

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES**: --

**COURSE DESCRIPTION:**

Principles of Electrical Systems; AC Machines; Semiconductor Devices and Op-Amps.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze electrical circuits by applying the conceptual knowledge of circuit elements.

CO2. Demonstrate knowledge on various generation technologies, protection devices, safety procedures and BEE standards.

CO3. Demonstrate knowledge on characteristics and applications of transformers and AC machines.

CO4. Demonstrate knowledge on characteristics and applications of diode, BJT and Op-amps.

**DETAILED SYLLABUS:**

**UNIT I: PRINCIPLES OF ELECTRICAL SYSTEMS-I                (9 Periods)**

Basic electrical sources: DC-Battery, AC sources–Single loop generator; Single phase and three phase supply; Electrical circuit elements (R, L and C), Ohm's law, Kirchhoff's laws,Representation of sinusoidal waveforms, peak and RMS values, phasor representation, reactive power, apparent power, real power, energy and power factor.

**UNIT II: PRINCIPLES OF ELECTRICAL SYSTEMS-II               (9 Periods)**

Significance of Power factor and power factor correction, most economical power factor. Typical layout of electrical grid; Typical layout and operation of Hydro, Thermal and Solar Power Plants; Fuse, circuit breaker (MCB, MCCB, RCCB, ELCB), relay (elementary treatment); Inverter and UPS (block diagram approach only). Earthing – importance of earthing, pipe earthing and plate earthing; Safety measures. Energy Efficiency (Star rating) standards by BEE.

**UNIT III: TRANSFORMERS AND AC MACHINES                (9 Periods)**

Construction and working of a single phase transformer, EMF Equation; Construction and working of three phase induction motor, torque equation, torque-slip characteristics, applications; Construction and working of a resistor start &capacitor start and run single phase induction motor, applications; Construction and working of synchronous machine, applications.

**UNIT IV: SEMICONDUCTOR DEVICES                (10 Periods)**

PN Junction diode, Characteristics, applications - half wave and full wave rectifier. Zener diode, characteristics, application–Regulator. BJT - operation, configurations, characteristics, applications - switch and amplifier.

**UNIT V: OP-AMPS                (8 Periods)**

Operational Amplifier: Block diagram of Op-Amp, equivalent circuit, Op-Amp AC and DC Characteristics, Inverting and Non-Inverting modes. Applications - Adder, Comparator, Integrator and Differentiator.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS**:

1. Ashfaq Hussain*, Fundamentals of Electrical Engineering,* Dhanpatrai & Co. (P) Ltd., 3rd edition, New Delhi, 2009.
2. R. L. Boylestad and Louis Nashelsky, *Electronic Devices and Circuits*, PHI, 11th edition, 2009.

**REFERENCE BOOKS**:

1. M.S. Naidu, S. Kamakshaiah, *Introduction to Electrical Engineering,*Tata McGraw-Hill Education, New Delhi, 2007.
2. D. Roy Chowdhury, *Linear Integrated Circuits*, New Age International Pvt. Ltd., 4th edition, 2011.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | - | - | - | - | -- | 1 | 1 | - | - | - | - | | | |
| **CO3** | 3 | - | - | - | - | 1 | - | - | - | - | - | - | | | |
| **CO4** | 3 | 1 | - | - | - | 1 | - | - | - | - | - | - | | | |
| **Average** | 3 | 2 | - | - | - | 1 | 1 | 1 | - | - | - | - | | | |
| **Correlation level** | 3 | 3 | - | - | - | 1 | 1 | 1 | - | - | - | - | | | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

## (19BT20301) **BASIC ENGINEERING MECHANICS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | 1 | - | 4 |

**PRE-REQUISITES**: -

**COURSE DESCRIPTION:**

Statics of Particles and Rigid Bodies; Support Reactions; Analysis of Perfect Frames; Friction; Centroid, Centre of Gravity and Moment of Inertia; Kinetics and Vibrations

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the equilibrium of forces in static particles, rigid bodies, and the effect of friction by applying the principles of Engineering Mechanics, and solve the problems.

CO2. Analyze composite areas and bodies to find centroid, centre of gravity and moment of inertia.

CO3. Apply D'Alembert's Principle for analyzing the kinetics of rigid bodies.

CO4. Apply the basic principles of Simple Harmonic Motion and vibrations to solve problems in mechanical systems.

**DETAILED SYLLABUS:**

**UNIT I: STATICS OF PARTICLES**            **(9 Periods)**

Basic concepts, System of units, System of concurrent coplanar forces in plane, Resultant of forces, Laws of mechanics, Parallelogram and triangular law of forces, Equilibrium of forces, Lami's theorem, Vectorial representation of forces, Vector operations of forces –additions, subtraction, dot product, cross product of vectors, Principle of transmissibility.

**UNIT II: STATICS OF RIGID BODIES**           **(9 Periods)**

Moment of a force, Varignon's theorem, Moment of a couple, Vectorial representation of moments and couples, Coplanar non-concurrent forces, Equilibrium of rigid bodies, Types of supports and loads, Types of frames, Perfect frame analysis, Method of joints, Method of sections, Principle of virtual work.

**UNIT III: FRICTION**               **(9 Periods)**

Frictional force, Types of friction, Laws of friction, Co-efficient of friction, Angle of friction, Angle of repose, Cone of friction, Applications: Body on horizontal/inclined plane, Two bodies in contact, Ladder friction, Wedge friction.

**UNIT IV: CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA**

            **(9 Periods)**

Centroids of simple and composite areas, centre of gravity of bodies, Theorems of Pappus and Guldinus, Parallel axis and perpendicular axis theorems, Moment of Inertia of Composite areas, Radius of gyration – Section modulus, Mass Moment of Inertia of simple and composite masses.

**UNIT V: KINETICS AND MECHANICAL VIBRATIONS**     **(9 Periods)**
**Kinetics of Rigid Bodies:**

Introduction, Problems on D'Alembert's principle, Impulse-momentum equation, Kinetics of circular motion, Rotation.

**Mechanical Vibrations:**

Definitions, Concepts – Simple Harmonic Motion – Free vibrations – Simple, compound and Torsional pendulum – Numerical problems.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. S. S. Bhavikatti and K. G. Rajashekarappa, *Engineering Mechanics*, New Age International (P) Ltd., 3rd edition, 2009.
2. A. K. Tayal, *Engineering Mechanics Statics and Dynamics*, Umesh Publications, Delhi, 14th edition, 2011.

**REFERENCE BOOKS:**

1. S. Rajasekaran and G. Sankarasubramanian, *Engineering Mechanics – Statics and Dynamics*, Vikas Publishing House Pvt. Ltd., 3rd edition, 2009.
2. Arthur P. Boresi and Richard J. Schmidt, *Engineering Mechanics - Statics and Dynamics,* Cengage Learning, 1st edition, Indian edition, 2008.
3. K. Vijaya Kumar Reddy and J. Suresh Kumar, *Singer's Engineering Mechanics - Statics and Dynamics*, BS Publications, 3rd edition, 2010.
4. S. Timoshenko, D. H. Young and J. V. Rao, *Engineering Mechanics*, Tata McGraw-Hill Education Pvt. Ltd., Revised 4th edition, Special Indian edition, 2007.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| CO2 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| CO3 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| CO4 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| Average | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| Correlation level | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |

5. **Correlation Levels:** 3– High 2 - Medium 1– Low

6.

# I B. Tech. - II Semester
## (19BT20302) MATERIAL SCIENCE AND ENGINEERING

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES**:

Courses on Engineering Chemistry and Intermediate Physics

**COURSE DESCRIPTION:**

Materials Structure and Constitution of Alloys; Heat treatment of steels; Properties of ferrous materials and its alloys; Properties of non-ferrous materials and its alloys; Properties and applications of ceramics, polymers and composite materials.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Demonstrate the principles of physical metallurgy, calculate atomic packing factor of different structures and discuss the properties of materials improvement through heat treatment processes

CO2.  Identify and select commercially available important metals, alloys, ceramics, polymers and composite materials based upon their properties for various applications.

**DETAILED SYLLABUS:**

**UNIT I: MATERIALS STRUCTURE AND CONSTITUTION OF ALLOYS        (10 periods)**

**Materials Structure**: Space lattice, Unit cells and Metallic crystal structures (SC, BCC, FCC and HCP), Crystal defects: Point, Line, Interstitial and Volume, Primary and secondary bonding in materials, Critically resolved shear stress.

**Constitution of Alloys:** Necessity of Alloying, Gibbs's phase and Hume Rothery rule, Binary isomorphous and eutectic alloy system (Lead-Tin System); monotectic, eutectic, peritectic, eutectoid, peritectoid and reactions. Iron carbide diagram and microstructural aspects of ferrite, cementite, austenite, ledeburite and cast iron.

**UNIT II:  HEAT TREATMENT OF STEELS                                (9 periods)**

Annealing, Normalizing, Tempering, Carburization and Hardening- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening, Isothermal transformation diagrams, Time-temperature-transformation diagrams and Continuous cooling transformation diagrams.

**UNIT III:  FERROUS MATERIALS AND ALLOYS                          (9 periods)**

**Steels**: Structure, properties, classifications and applications of plain steels, Specifications of steels, Structure, properties, classifications and applications of low alloy steels, Hadfield manganese steels, Stainless steel and Tool steels.

**Cast iron**: Structure, properties and applications of Gray cast iron, White cast iron, Malleable cast iron, Nodular cast iron, Mottled cast iron, chilled cast iron and Alloy cast iron.

**UNIT IV: NON-FERROUS MATERIALS AND ALLOYS                        (8 periods)**

Structure, properties and applications of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Nickel and its alloys, Cobalt and its alloys, Magnesium and its alloys, Beryllium and its alloys, Refractory and Precious metals.

## UNIT V: CERAMICS, POLYMERS AND COMPOSITE MATERIALS        (9 periods)

Synthesis and processing of ceramics, Properties and applications of Ceramics, Glass-ceramics, Classification of Polymers, Polymerization Reaction, Processing and Recycling of polymers, Particle reinforced composites, Fiber reinforced composites (PMC, CMC, MMC, CCC and HC), Structural composites.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1. V. Raghavan, *Materials Science & Engineering*, Prentice Hall of India, 5th edition, 2004.
2. R. Balasubramaniam, *Callister's Materials Science & Engineering*, John Wiley and sons, 2nd edition, 2014.

**REFERENCE BOOKS**:

1. Sidney H. Avner, *Introduction to Physical Metallurgy*, Tata McGraw Hill, 2nd edition, 1997.
2. George E Dieter, *Mechanical Metallurgy*, Tata McGraw Hill, 3rd edition, 2013.
3. Kodigre V D, *Material Science and Metallurgy*, Everest Publishing House, 31st edition, 2011.
4. O.P. Khanna, *Material Science and Metallurgy*, Dhanpat Rai Publications, 2nd edition, 2014.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | | | | | 1 | | | 3 | | |
| CO2 | 3 | 3 | 2 | 1 | | 1 | | | | 1 | | | 3 | | |
| Average | 3 | 3 | 2 | 1 | | 1 | | | | 1 | | | 3 | | |
| Correlation level | 3 | 3 | 2 | 1 | | 1 | | | | 1 | | | 3 | | |

**Correlation Levels:        3– High        2 – Medium        1– Low**

**(19BT2BS31) APPLIED PHYSICS LAB**

(Common to CE and ME)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE–REQUISITES:** --

**COURSE DESCRIPTION:**

Determination of Moment of Inertia, Elastic Moduli, and Thermal properties of materials; Estimation of carrier concentration and energy gap of a semiconductor; Verification of Newton's Law of Cooling; Characteristics of Optical Fiber;

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the experimental procedures to compute the frequency of a tuning fork, hall coefficient, energy gap, moment of inertia, rigidity modulus and thermal conductivity of materials.

CO2. Apply skills to plot various characteristic curves of an optical Fiber and also determine thermal conductivity, thermo emf and energy gap.

CO3. Work independently and in teams to solve problems with effective communication.

A minimum of **Ten** experiments are to be conducted among the following:

**List of Experiments:**

1. Determination of moment of inertia of a bar and acceleration due to gravity - Compound Pendulum.
2. Moment of inertia of a Flywheel.
3. Bifilar Pendulum - Moment of inertia of a rectangular body.
4. Melde's Experiment – Determine the frequency of electrically driven tuning fork.
5. Determination of thermal conductivity of a good conductor (Forbe's Apparatus).
6. Determination of thermal conductivity of a bad conductor (Lee's disc method).
7. Thermal Expansion of Solids - Bimetallic Strip.
8. Study the characteristics of an optical Fiber.
9. Verification of Newton's Law of Cooling for any two liquids.
10. Determination of number of charge carriers per unit volume and hall coefficients of a given material using Hall Effect.
11. Rigidity Modulus of a material of a wire - Torsional Pendulum
12. Thermocouple - Seebeck Effect.
13. Determine the energy gap of a material by varying temperatures.

**REFERENCE BOOKS:**

1. Balasubramanian S, Srinivasan M.N and Ranganathan, *A Textbook of Practical Physics,* R, Sultan Chand & Sons, 2017.

   https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=354&cnt=1

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| CO2 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| CO3 | - | - | - | - | - | - | - | 2 | 2 | 2 | - | - | | | |
| Average | 3 | 3 | | | | | | 2 | 2 | 2 | | | | | |
| Correlation level | 3 | 3 | | | | | | 2 | 2 | 2 | | | | | |

**Correlation Levels:**      **3– High**      **2 – Medium**      **1– Low**

# I B. Tech. – II Semester

## (19BT10231) BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES**:

Physics at intermediate level.

**COURSE DESCRIPTION:**

Practical investigations on Electrical circuits, AC Machines, Semiconductor Devices and Op-Amps.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze, measure, interpret and validate the practical observations by applying the fundamental knowledge of electrical circuits, machines and electronic devices.

CO2. Design Op-amp based amplifier, voltage summer and integrator circuits for desired specifications.

CO3. Work independently and in teams to solve problems with effective communication.

**List of Experiments:**

Minimum Ten experiments are to be conducted.

1. Measurement of electrical quantities (AC & DC) using Voltmeter, Ammeter and Wattmeter.

2. Verification of Ohm's law and Kirchhoff's laws.

3. Circuit

   (a) with one lamp controlled by one switch and provision of 2-pin or 3-pin socket PVC surface conduit system.

   (b) With two lamps controlled by two switches with PVC surface conduit system.

   (c) for Stair case wiring and Godown wiring.

4. Measurement of Power factor and it's improvement.

5. Load test on 1-Phase Transformer.

6. Brake test on 3-Phase Induction Motor.

7. Brake test on 1- phase induction motor.

8. VI Characteristics of PN and Zener Diodes.

9. Ripple factor and load regulations of rectifier with and without filters.

10. Input and output characteristics of CE configuration.

11. Design of inverting and non-inverting amplifiers using op-amp.

12. Design of voltage summer and integrator using op-amp.

13. Soldering practice.

**REFERENCE BOOKS/ LAB MANUALS:**

1. P. S. Dhogal, *Basic Practicals in Electrical Engineering*, Standard Publishers, 2004.
2. Yannis Tsividis, *A First Lab in Circuits and Electronics*, Wiley, 1st edition, 2001.

**ADDITIONAL LEARNING RESOURCES:**

1. www.vlab.co.in, Virtual Electric Circuits Lab, A initiative of MHRD under NMEICT.
2. www.vlab.co.in, Basic Electronics Lab, A initiative of MHRD under NMEICT.
3. https://nptel.ac.in/courses/117106108/
4. https://ocw.mit.edu/high-school/physics/exam-prep/electric-circuits/
5. https://nptel.ac.in/courses/108105017/
6. https://nptel.ac.in/courses/108108112/
7. https://nptel.ac.in/courses/117107094/

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - | | | |
| **CO2** | 1 | 2 | 3 | 2 | - | - | - | - | - | - | - | | | | |
| **CO3** | - | - | - | - | - | - | - | - | 2 | 2 | - | - | | | |
| **Average** | 2 | 2.5 | 2.5 | 2 | 1 | - | - | - | 2 | 2 | - | - | | | |
| **Correlation level** | 2 | 3 | 3 | 2 | 1 | - | - | - | 2 | 2 | - | - | | | |

**Correlation Levels:**     **3– High**     **2 – Medium**     **1– Low**

## (19BT20331) **ENGINEERING WORKSHOP**
### (Common to CE, ME, CSE, CSSE, IT, CSE (AI) and CSE (DS))

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Knowledge on various workshop hand and power tools; hands on experience in different manufacturing trades such as fitting, carpentry, sheet metal forming and foundry; Demonstration on dismantling and assembling of various two wheeler parts, power tools in machining and metal joining, basics of plumbing and working of 3D printer.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Design and model various basic prototypes in the trade of fitting such as square/half round mating, V- mating and dovetail mating from the given MS workpieces using fitting tools.

CO2. Develop different prototypes in the carpentry trade such as cross lap joint, dovetail / bridle joints and Mortise and Tenon joint using carpentry tools.

CO3. Design and model different prototypes in the sheet metal forming trade such as rectangular tray, square vessel/cylinder, Funnel as per the dimensions using sheet metal forming tools.

CO4. Develop sand mold using single piece pattern and split piece pattern in the foundry trade using foundry tools.

CO5. Demonstrate the knowledge on automobile parts, power tools, plumbing operation, 3D printing technology involved in different engineering applications.

CO6. Work independently / in groups & communicate effectively in oral and written forms.

**DETAILED SYLLABUS:**

**FITTING:** Conduct a detailed study on various aspects in fitting trade which includes the details of fitting operations, safety precautions, types of tools, tool holders, miscellaneous tools, care and maintenance of hand tools, marking and measurement tool, and finishing tool.

**List of Exercises :**

1. Make a square/half round mating from the given MS workpieces
2. Make a V- mating from the given MS workpieces
3. Make a dovetail mating from the given MS workpieces

**CARPENTRY:** Conduct a detailed study on various aspects in carpentry trade which includes the details of types of wood, carpentry tools, wood working techniques, types of joints, safety precautions, and care and maintenance of tools.

**List of Exercises:**

    4.    Prepare a cross lap joint

    5.    Prepare dovetail / bridle joints

    6.    Prepare a Mortise and Tenon joint.

**SHEET METAL FORMING:** Conduct a detailed study on various aspects in sheet metal forming which includes the details of sheet materials, hand        tools,        sheet        metal fabrication, and safety and precautions

**List of Exercises:**

    7.     Fabricate a rectangular tray as per the dimensions

    8.    Fabricate square vessel/cylinder as per the dimensions

    9.    Fabricate a Funnel as per the dimensions

**FOUNDRY:** Conduct a detailed study on various aspects in foundry which includes the details of moulding sand, properties of moulding sand, types of patterns and pattern, materials, foundry tools, and safety and precautions

**List of Exercises:**

    10.    Prepare a sand mold, using the given single piece pattern (stepped pulley/cube)

    11.    Prepare a sand mold, using the given split piece pattern (pipe bent/dumbbell)

**DEMONSTRATION:**

    12.    Demonstrate the dismantling and assembling of various two wheeler parts

    13.    Demonstrate the usage of power tools.

    14.    Demonstrate the plumbing operation and identify the essential tool and materials required for plumbing.

    15.    Demonstrate the working of 3D printer

Note: Student shall perform any **Twelve Exercises**

**REFERENCE BOOKS/LABORATORY MANUALS**:

1.    P. Kannaiah and K. L. Narayana, *Workshop Manual*, SciTech Publishers, 2009.

2.    K. Venkata Reddy, *Workshop Practice Manual*, BS Publications, 2008.

3.    V. Ramesh Babu, *Engineering Workshop Practice*, V R B Publishers Private Limited, 2009.

**ADDITIONAL LEARNING RESOURCES:**

1.    R. K. Jain, *Production Technology*, Khanna Publishers, 17th edition, 2012.

2.    Kalpakjian, Serope, *Manufacturing Engineering and Technology*, Pearson Education, 7th edition, 2014.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |
| CO2 | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |
| CO5 | 3 | 1 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |
| CO6 | | | | | | | | | 3 | 3 | | | 3 | | |
| Average | 3 | 2.6 | 3 | 1 | 1 | 1 | | | 3 | 3 | | | 3 | | |
| Correlation level | 3 | 3 | 3 | 1 | 1 | 1 | | | 3 | 3 | | | 3 | | |

**Correlation Levels:** **3– High** **2 – Medium** **1– Low**

# I B. Tech. - II Semester
## (19BT20332) MATERIAL SCIENCE AND ENGINEERING LAB

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES**:

Intermediate Physics, Engineering Chemistry

**COURSE DESCRIPTION:**

Characterization of microstructures of steels, cast irons and non-ferrous metals; heat treatment procedures; data acquisition and recording; grain size analysis; phase segmentation; non-destructive tests.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze metallographic study of various metals using tools & software

CO2. Determine the mechanical properties of heat treated materials using tools & equipment

CO3. Apply non destructive methods to identify and analyze the metal defects

CO4. Work individually or in a team to solve problems with effective communication

**LIST OF EXPERIMENTS:**

(**Note:** Student shall perform minimum of **twelve** experiments.)

1. Study of metallurgical instruments & microscope
2. a) Preparation of specimen using cold setting die

   b) Preparation of specimen using hydraulic press
3. Preparation and study of the microstructure of cast irons
4. Preparation and study of the microstructure of carbon steels
5. Preparation and study of the microstructure of Non-Ferrous Alloys
6. Study of the microstructures of heat treated steels
7. Measurement of hardness of heat treated and untreated steels
8. Determination of hardenability of steel by Jominy End Quench Test
9. Determination of grain size, and phase distribution of specimens (any four materials) by Material Plus software
10. Experiment on Ultrasonic flaw detection
11. Experiment on Magnetic particle inspection
12. Experiment on Die-penetration
13. Study on Eddy current testing
14. Study of microstructure of ceramics, polymeric materials
15. Study of microstructure of super alloy and nano-materials

**REFERENCE BOOKS / LAB MANUALS:**

1. Material Science and Engineering Lab Manual (SVEC-19).

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| CO2 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| CO3 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| CO4 | | | | | | | | | 3 | 3 | | | 3 | | |
| Average | 3 | 3 | 2 | 1 | | | | | 3 | 3 | | | 3 | | |
| Correlation level | 3 | 3 | 2 | 1 | | | | | 3 | 3 | | | 3 | | |

**Correlation Levels:**     **3– High**     **2 – Medium**     **1– Low**

## (19BT1AC01) **SPOKEN ENGLISH**

(Audit Course)

(Common to CE, ME, CSE, CSSE, IT and CSBS)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| - | - | - | 2 | - | - | - |

**PRE-REQUISITES**: **-**

**COURSE DESCRIPTION:**

Functional English; Vocabulary Building; Functional Grammar-I; Functional Grammar – II; Communication Skills.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of grammar and vocabulary in writing effective formal letters and e-mails.

CO2. Communicate effectively by applying appropriate speaking and writing techniques by examining and applying functional English.

**DETAILED SYLLABUS:**

**UNIT I: FUNCTIONAL ENGLISH:** (6 Periods)

Introduction - Functional Spoken English; Self Introduction; **Listening – Speaking:** Do's and Don'ts; **Expressing:** Ability / Admiration / Agreement / Annoyance / Appreciation / Pleasure / Sarcasm / Satisfaction / Surprise / Approval / Certainty/ Doubt / Gratitude / Possibility / Fear / Worry / Condolences; **Asking for:** Advice / Clarification / Direction / Information / Permission; **Making:** Predictions / recommendations.

**UNIT II: VOCABULARY BUILDING:** (6 Periods)

Introduction: Vocabulary for day-to-day conversations; Vegetables / Groceries / Fruits / Weather; Parts of a Human body / Dresses / Furniture / Relations; Birds / Cries of Animals; Food / Hospitality / Houses / Rooms / Tools; Airport / News Paper / Books / Gems; Corporate Vocabulary / Jobs / Occupations / Diseases; British / American spelling; Slang Words and Technical Jargon.

**UNIT III: FUNCTIONAL GRAMMAR - I:** (6 Periods)

Parts of Speech, Verb forms; Tenses; Voice; Speech.

**UNIT IV: FUNCTIONAL GRAMMAR - II:** (6 Periods)

Universal Auxiliaries; Sentence Structure - WH - Questions - How to frame Questions and give answers; Question Tags; Subject and verb agreement; Spotting Errors.

**UNIT V: COMMUNICATION SKILLS:** (6 Periods)

Polite, Courteous and Diplomatic expressions; Good Manners and Etiquette; Conversation Techniques; Narrating Stories.

**Total Periods: 30**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. L. Adinarayana and V. Prakasam, *Spoken English*, Neelkamal Publications Pvt. Ltd., New Delhi, 2008.
2. Ram Bhasker Raju, *The Complete Book on Spoken English*, Goutham Buddha Publications, Hyderabad, 2002.

**REFERENCE BOOKS :**

1. Sabina Pillai, *Spoken English for my World,* Oxford University Press, New Delhi, 2016.
2. K. R. Lakshminarayanan, *Speak in English,* Scitech Publications, Chennai, 2009.

**ADDITIONAL LEARNING RESOURCES**

- https://www.britishcouncil.in/programmes/english-partnerships/state/skills-projects/AP-English-Skills.
- https://www.fluentu.com/blog/english/websites-to-learn-english

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | 1 | | | | | 1 | | | | | |
| CO2 | 2 | 3 | | | 1 | | | | | 2 | | | | | |
| Average | 2.5 | 2 | | | 1 | | | | | 1.5 | | | | | |
| Correlation level | 3 | 2 | | | 1 | | | | | 2 | | | | | |

**Correlation Levels:**　　　**3– High**　　　**2 – Medium**　　　**1– Low**

# (19BT3BS01) NUMERICAL METHODS, PROBABILITY AND STATISTICS

(Common to CE, ME, CSE, CSSE, IT, CSE (AI) and CSE (DS))

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | 1 | -- | 4 |

**PRE-REQUISITES**: -

**COURSE DESCRIPTION**:

Numerical solutions of equations; interpolation; numerical differentiation and integration; random variables; mathematical expectations; probability distributions; test of hypothesis.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyse the data and develop skills to solve equations and integrals by applying numerical methods.

CO2. Demonstrate knowledge in statistics and analyse the data for validations by applying statistical testing methods and distributions.

**DETAILED SYLLABUS**

**UNIT I: NUMERICAL SOLUTIONS OF EQUATIONS AND INTERPOLATION**

**(8 Periods)**

Solutions of algebraic and transcendental equations: Regula-falsi method, Newton-Raphson method; Interpolation: Forward and backward differences, interpolation using Newton's forward and backward difference formulae, Lagrange's interpolation formula, partial fractions using Lagrange's interpolation formula.

**UNIT II: NUMERICAL DIFFERENTIATION AND INTEGRATION        (9 Periods)**

Numerical differentiation using Newton's forward and backward interpolation formulae; Numerical integration using Simpson's $1/3^{rd}$ and $3/8^{th}$ rules; Numerical solutions of first order ordinary differential equations using Taylor's series method, fourth order Runge-Kutta method.

**UNIT III: RANDOM VARIABLES AND MATHEMATICAL EXPECTATIONS   (8 Periods)**

Random Variables: Discrete and continuous random variables, distribution function of random variable, properties, probability mass function, probability density function; mathematical expectation, properties of mathematical expectation, mean and variance.

**UNIT IV: PROBABILITY DISTRIBUTIONS                          (9 Periods)**

Discrete probability distributions: Binomial, Poisson- mean, variance, standard deviation (without derivations); Continuous probability distributions: Normal, uniform and exponential distributions- mean, variance, standard deviation (without derivations), area under the normal curve.

**UNIT V:  TEST OF HYPOTHESIS                                 (11 Periods)**

Population and sample, parameter and statistic, null and alternative hypothesis, Type I and Type II errors, level of Significance, critical region, degrees of freedom; Large sample test: Tests of significance for proportions and means; Small sample test: Student's t-test- single mean, difference of means; F-test for equality of population variance; Chi-Square test for independence of attributes.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1. T. K. V. Iyengar, B. Krishna Gandhi, S. Ranganatham and M. V. S. S. N. Prasad, *Mathematical Methods,* S. Chand & Company, 5th edition, 2016.

2. T. K. V. Iyengar, B. Krishna Gandhi, S. Ranganatham and M. V. S. S. N. Prasad, *Probability and Statistics,* S. Chand & Company, 5th edition, 2016.

**REFERENCE BOOKS**:

1. B. S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44th edition, 2017.

2. P. Kandasamy, K. Thilagavathy, K. Gunavathi, *Numerical Methods*, S. Chand and Company, 2nd edition, Reprint 2012.

3. S. C. Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons Publications, 11th edition, 2012.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| CO2 | 3 | 2 | - | 1 | - | - | - | - | - | - | - | - | | | |
| Average | 3 | 2 | | 1 | | | | | | | | | | | |
| Correlation level | 3 | 2 | | 1 | | | | | | | | | | | |

**Correlation Levels:**     **3– High**     **2 – Medium**     **1– Low**

## II B. Tech. - I Semester
### (19BT30301) **ENGINEERING THERMODYNAMICS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | 1 | - | 4 |

**PRE-REQUISITES:**

Courses on Applied Physics, and Engineering Chemistry.

**COURSE DESCRIPTION:**

Thermodynamic system; Energy interactions; Heat and work Transfer in flow and non- flow systems; Laws of thermodynamics; Reversible and irreversible processes; Entropy; Equation of state; Pure substance; Thermodynamic Relations; Gases and gas mixtures and Gas power cycles.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1: Analyze thermodynamic systems using thermodynamic laws and estimate the thermodynamic properties during energy interactions in engineering application.

CO2: Calculate the properties of steam using PVT diagrams, H-S diagrams and steam tables considering steam power plant.

CO3: Determine the properties of ideal gases, real gases and gas mixtures using gas laws, volumetric analysis and gravimetric analysis for engineering applications.

CO4: Analyze the air stand cycles using P-V and T-S diagrams used in power generation systems and estimate the performance characteristics it.

**DETAILED SYLLABUS:**

**UNIT I**: **BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS**      **(9 periods)**

Microscopic and macroscopic point of view, Thermodynamic systems, Control volume, Thermodynamic properties, Processes, Cycle, Homogeneous and Heterogeneous systems, Thermodynamic equilibrium, Quasi-static process, Work transfer and Heat transfer, Point and path function, Zeroth law of thermodynamics.

**First Law of Thermodynamics**: First law for a closed system undergoing a cycle, change of state, Limitations of first Law, Perpetual motion machine (PMM1) of first kind, Energy a property of system, First law applied to a flow process - steady flow energy equation (SFEE).

**UNIT II: SECOND LAW OF THERMODYNAMICS**                **(9 periods)**

**Second Law of Thermodynamics:** Energy reservoir, Kelvin Planck and Clausius statements of second law and their equivalence, PMM of second kind, Heat engine, Refrigerator, Heat pump, Reversibility and Irreversibility, Carnot cycle, Carnot's theorem, Absolute thermodynamics temperature scale.

**Entropy and Availability:** Introduction, Clausius theorem, Clausius inequality, Entropy as a property, Principle of entropy increase and applications, Third law of thermodynamics. Availability and irreversibility, Available Energy, Maximum Work in a Reversible Process, Availability in Non - Flow and Flow Processes.

**UNIT III: PURE SUBSTANCE AND THERMODYNAMIC RELATIONS**      **(9 periods)**

**Properties of pure substances**: Introduction, P-V, P-T and T-S Diagrams for a Pure Substance, Quality and Dryness Fraction, Use of Steam Tables and Mollier Chart for thermodynamic properties.

**Thermodynamic Relations:** T-dS relations, Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations, Joule-Thomson coefficient, coefficient of volume expansion

## UNIT IV: PROPERTIES OF GASES AND GAS MIXTURES                    (9 periods)

**Properties of gases**: Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties-Compressibility factor-.Principle of Corresponding states.

**Properties of gas mixtures**: Ideal gas, equation of state, Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Equivalent Gas constant and Molecular Internal Energy, Enthalpy, Specific Heats and Entropy of Mixture of perfect Gases and Vapour.

## UNIT V: POWER CYCLES                                             (9 periods)

Otto cycle, Diesel cycle and Dual cycle; Comparison of Otto, Diesel and Dual cycles - Description and representation on P–V and T-S diagram, Stirling cycle, Ericsson cycle, Joule cycle representation on P–V and T-S diagram.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. P. K. Nag, *Engineering Thermodynamics*, TMH, 6th Edition, 2017.
2. Chatttopadhyay, *Engineering Thermodynamics*, Oxford Publishers, 2nd edition, 2016.

**REFERENCE BOOKS:**

1. Yunus Cengel & Boles, *Thermodynamics–An Engineering Approach*, TMH, 8th Edition, 2015
2. Dr.R.Yadav, *Fundamentals of Engineering Thermodynamics*, Central publishing House, 7th Edition, 2004.

**Note:** Steam Tables with Mollier Chart shall be supplied during examination.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 2 | 1 | | 1 | | | | | | | | 3 | |
| **CO2** | 3 | 3 | 2 | 1 | | 1 | | | | 1 | | | | 3 | |
| **CO3** | 3 | 3 | 2 | 1 | | 1 | | | | | | | | 3 | |
| **CO4** | 3 | 3 | 2 | 1 | | 1 | | | | 1 | | | | 3 | |
| **Average** | 3 | 3 | 2 | 1 | | 1 | | | | 1 | | | | 3 | |
| **Correlation level** | 3 | 3 | 2 | 1 | | 1 | | | | 1 | | | | 3 | |

**Correlation Levels:        3– High        2 – Medium             1– Low**

**II B. Tech. - I Semester**

(19BT30302) **KINEMATICS OF MACHINERY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Basic Engineering Mechanics and Computer Aided Engineering Drawing.

**COURSE DESCRIPTION:**

Basic concepts and description of various plane mechanisms; Calculation of Displacement; Velocity and acceleration of simple plane mechanisms; Straight line mechanisms; Steering mechanisms; Hooke's joint; Concepts of Gears and Gear trains; Preparation of cam profiles.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Calculate degrees of freedom of kinematic pairs, kinematic chains and its inversions used in machines for engineering applications.

CO2. Demonstrate the knowledge on straight line motion mechanisms for exact straight line motion and approximate straight line motion conditions.

CO3. Analyze steering gear mechanisms for correct steering and Hookes joints for uniform velocity ratios.

C04. Analyze the gears to avoid interference and gear trains to find the velocity and number of teeth of its components.

CO5. Draw the profile of the cam based on follower motons and calculate the velocity and acceleration of the follower.

CO6. Analyze planar mechanisms for displacement, velocity and acceleration of different Points of it using relative velocity and Instantaneous center methods.


**DETAILED SYLLABUS:**

**UNIT I**: **MECHANISMS AND MACHINES** **(8 Periods)**

Elements or Links, Classification- Rigid, Flexible and Fluid link; Types of kinematic pairs-Sliding, Turning, Rolling, Screw and Spherical pairs, Lower and Higher pairs, Closed and Open pairs; Constrained motions- Completely, Partially or successfully and incompletely constrained motion; Kinematic chain, Types of joints- Binary, Ternary and Quaternary joints; Number of Degrees of Freedom, Kutzbach and Grubler's Criteria, Inversions of plane mechanisms- Quadric cycle, Single slider and Double slider crank chains.

**UNIT II: STRAIGHT LINE, STEERING GEAR MECHANISMS AND HOOKE'S JOINT**

**(10 periods)**

Pantograph, Exact Straight Line Motion Mechanisms- Peaucellier, Hart and Scott Russell's mechanism; Approximate Straight Line Motion Mechanisms- Modified Scott Russell's mechanism, Watt's, Grasshopper, Tchebicheff's and Robert mechanisms; Steering mechanisms, Condition for correct steering, Davis Steering gear and Ackerman steering gear mechanisms, Single and double Hooke's joints.

**UNIT III: GEARS AND GEAR TRAINS** **(11 Periods)**

Friction wheels and toothed gears, Types, Law of gearing, Sliding velocity of teeth, Forms of teeth- Cycloidal, Involute profiles; Expressions for path of contact and arc of contact, Contact ratio, Phenomena of interference, Condition for minimum number of teeth to avoid interference, Gear trains - Simple, Compound, Reverted and Epicyclic gear train; Compound Epicyclic Gear Train (sun and planet wheel), Differential gearbox for automobile.

**UNIT IV: CAMS** (8 Periods)

Introduction to cams and followers, Types, Terminology, Types of follower motion, Cam profile- For uniform velocity, SHM, Cycloidal and Uniform acceleration- and retardation of Knife edge, Roller followers (axis of follower passes through the axis of camshaft and offset), Maximum velocity and maximum acceleration during outward and return stroke.

**UNIT V: VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS** (8 Periods)

Instantaneous center of rotation, Centrode and Axode, Relative motion between two bodies, Kennedy theorem (Three centers in line), Instantaneous center method to determine angular

velocity of links and linear velocity of point, Relative velocity method to determine velocity and acceleration diagrams for four bar mechanism, Slider-crank mechanism and its inversions, Coriolis component of acceleration.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. S. S. Rattan, *Theory of Machines and Mechanisms*, Tata McGraw Hill Education, 4thEdition, 2016.
2. R.S. Khurmi, *Theory of machines,* S.Chand Publications, 14th Revised Edition, 2012

**REFERENCE BOOKS:**

1. Ballaney. P. L., *Theory of Machines and Mechanisms*, Khanna Publishers, 2005
2. Joseph Edward Shigley and John Joseph Uicker,Jr., *Theory of Machines and Mechanisms*, MGH, 4th Edition, New York, August 2013.
3. Bevan T, *Theory of Machines*, CBS Publishers and Distributors, New Delhi, 2002.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| **CO2** | 3 | 2 | 1 | 1 | | 1 | | | | 1 | | | 3 | | |
| **CO3** | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| **CO4** | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| **CO5** | 3 | 3 | 1 | 1 | | 1 | | | | 1 | | | 3 | | |
| **CO6** | 3 | 3 | 1 | 1 | | 1 | | | | 1 | | | 3 | | |
| **Average** | **3** | **2.8** | **1** | **1** | | **1** | | | | **1** | | | **3** | | |
| **Correlation level** | **3** | **3** | **1** | **1** | | **1** | | | | **1** | | | **3** | | |

**Correlation Levels:** 3– High 2 - Medium 1– Low

## II B. Tech. - I Semester

## (19BT30303) **MANUFACTURING TECHNOLOGY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Material Science and Engineering

**COURSE DESCRIPTION:**

Introduction to manufacturing processes; casting, welding, cutting of metals, metalworking processes, forging processes, extrusion of metals, Sheet Metal Operations and Plastic Processing.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1: Design the gating system using the knowledge of foundry.

CO2: Demonstrate the knowledge on casting process, cast defects and operational procedures required in manufacturing the cast part.

CO3: Demonstrate the operational and procedural steps required in sheet metal process for manufacturing of sheet metal parts.

CO4: Demonstrate knowledge on welding processes required for weld parts.

CO5: Demonstrate knowledge on plastic processing and its sequences operations required for manufacturing a plastic product.

**DETAILED SYLLABUS**

**UNIT I: FOUNDRY                                                (9 Periods)**

Introduction, Sand mould making procedure, Types of Patterns, Pattern Materials, Pattern Allowances, Gates and Risers, Design of Gating systems, Properties of Moulding Sand, Testing of Moulding Sand, Moulding Machines, Cores - Types of Cores and Applications, Melting furnaces: Blast and Cupola Furnaces.

**UNIT II: SPECIAL CASTING PROCESSES                        (9 Periods)**

Introduction, Special Casting Processes – Shell Moulding, Carbon Dioxide Moulding, Casting, Precision Investment Casting, Permanent Mould Casting, Full Mould Casting, Die Casting, Centrifugal casting, Continuous Casting, Cleaning and Finishing of Castings - Inspection and Testing of Castings, Casting Defects.

**UNIT III: METAL FORMING PROCESSES AND SHEET METAL OPERATIONS**

**                                                                (9 Periods)**

**Metal forming processes:** Introduction, Hot Working and Cold Working, Forging, Extrusion – Direct, Indirect and Tube Extrusion; Rolling – Types of Rolling Mills; Drawing –Rod, Wire and Tube Drawing.

**Sheet Metal Operations**: Shearing operations, Types of dies - Progressive Die, Compound Die and Combination Die, Special sheet metal forming processes – Explosive Forming, Magnetic Pulse Forming, Electro-Hydraulic Forming.

**UNIT IV: METAL WELDING PROCESSES                        (9 Periods)**

Introduction, Classification of Welding Processes - Arc Welding, TIG Welding, MIG Welding, Submerged Arc Welding; Gas Welding Process – Types of Flames; Resistance Welding – Spot Welding, Seam Welding; Thermit Welding, Electron Beam Welding, Laser Beam

Welding, Ultrasonic Welding, Welding Defects - Causes and Remedies; Destructive and Nondestructive Testing of Welds, Soldering and Brazing.

**UNIT V: PLASTIC PROCESSING** **(9 Periods)**

Introduction, Plastics – Properties of Plastics, Additives in Plastics; Types of Plastics-Thermoforming Plastics, Thermosetting Plastics; Injection Moulding, Blow Moulding, Compression Moulding, Transfer Moulding, Extrusion Process, Calendering, Casting of Plastics, Plastic Product Design

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. P.N.Rao, *Manufacturing Technology*, Vol.1, TMH, 4th Edition, 2013
2. Kalpakjian, Serope, *Manufacturing Engineering and Technology*, Pearson Education, 7th Edition, 2014.
3. Hazra Choudary S.K. and Hazra Choudary A.K., *Elements of Workshop Technology*, Vol I, Media Promoters, 12th Edition, 2007.

**REFERENCE BOOKS:**

1. R.K.Jain, *Production Technology*, Khanna Publishers, 17th Edition, 2010.
2. Rosenthal, *Principles of Metal Castings*, McGraw-Hill Professional Publishing, 3rd Edition, 2013.
3. MikellP.Groover, Fundamentals *of Modern Manufacturing, Materials, Processes and Systems*, John Wiley and Sons, 9th Edition,2007.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 1 | | | 1 | 1 | | | | | | **3** | | |
| **CO2** | 3 | 1 | | | | 1 | 1 | | | | | | **3** | | |
| **CO3** | 3 | 1 | | | | 1 | | | | | | | **3** | | |
| **CO4** | 3 | 1 | | | | 1 | 1 | | | | | | **3** | | |
| **CO5** | 3 | 1 | | | | 1 | 1 | | | | | | **3** | | |
| **Average** | **3** | **1.4** | **1** | | | **1** | **1** | | | | | | **3** | | |
| **Correlation level** | **3** | **1** | **1** | | | **1** | **1** | | | | | | **3** | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## II B. Tech. - I Semester
## (19BT30304) **STRENGTH OF MATERIALS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Basic Engineering Mechanics.

**COURSE DESCRIPTION:**

Analysis of stresses and strains of mechanical and structural components; Shear force and Bending moment of beams; Bending and Torsional stresses and Deflection beams.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Calculate stresses, strains and elastic constants of structural member subjected to external loading.

CO2. Draw shear force and bending momentum diagrams for beams and articulate stresses in beam structure under transverse loading.

CO3. Estimate the torsional shear stress and deflection on circular shafts subjected torsion and find principal stresses from mohr's circle diagram.

CO4. Analyze deflections of cantilever and simply supported beams using Double Integration method and Macaulay's method

**DETAILED SYLLABUS:**

**UNIT I: SIMPLE STRESSES AND STRAINS**         **(8 Periods)**

Types of Stresses, Strains, Hooke's law, Stress–Strain diagram, Working Stress, Factor of safety, Lateral strain, Poisson's ratio, Volumetric strain, Elastic Moduli and relationship between them, Bars of Varying section, Composite bars, Temperature stresses, Strain energy.

**UNIT II: SHEAR FORCE AND BENDING MOMENT**     **(10 Periods)**

Concept of shear force and bending moment, S.F and B.M. diagrams for cantilever, Simply supported, Overhanging beams subjected to Point loads, Uniformly distributed loads, Uniformly varying loads and combination of these loads, Point of contra flexure.

**UNIT III: BENDING AND SHEAR STRESSES**       **(10 Periods)**

Theory of simple bending, Bending equation, Determination of flexural stresses for simple cases, Section modulus, Shear stress formula, Shear stress distribution across various beams & sections - Rectangular, Circular, Triangular, I, T sections.

**UNIT-IV: TORSION**           **(8 Periods)**

Theory of pure torsion, Torsion Equation, Torsional moment of resistance, Polar section modulus; Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

**Mohr's circle:** Principal stresses and Mohr's circle for Biaxial Stresses – like stresses and unlike stresses; Mohr's circle for Complex Stresses.

**UNIT - V: DEFLECTION OF BEAMS**       **(9 Periods)**

Relationship between curvature, slope and deflection, Slope and deflection of cantilever and simply supported beams by Double Integration method and Macaulay's method

**Total Periods: *45***

***Topics for self-study are provided in the lesson plan.***

*SVEC19 – B.TECH – MECHANICAL ENGINEERING*         86

**TEXTBOOKS:**

1. S.Ramamrutham, R.Narayanan, *Strength of Materials*, Dhanpat Rai Publications, 14th Edition, 2011.
2. Ferdinand L. Singer & Andrew, *Strength of Materials*" Addison Wesley publisher, 4th Edition, 1990.

**REFERENCE BOOKS:**

1. James M.Gere, Stephen Timoshenko, *Mechanics of Materials*, CBS Publications, 2nd Edition, 2004.
2. Beer, ýJohnston & Dewolf, *Mechanics of Materials*, Tata McGraw-Hill Education, 3rd Edition, 2004.
3. R.K.Rajput, *Strength of materials*, S. Chand Publications, Revised Edition, 2006.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| CO2 | 3 | 3 | 2 | 1 | | | | | | 1 | | | 3 | | |
| CO3 | 3 | 3 | 2 | 1 | | | | | | 1 | | | 3 | | |
| CO4 | 3 | 3 | 2 | 1 | | | | | | | | | 3 | | |
| Average | 3 | 3 | 2 | 1 | | | | | | 1 | | | 3 | | |
| Correlation level | 3 | 3 | 2 | 1 | | | | | | 1 | | | 3 | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT3HS31) **SOFT SKILLS LAB**

(Common to CE, ME, EEE, ECE and EIE)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Body Language; Assertiveness; Goal Setting; Thinking Skills; Team Building; Conflict Management; Technical Report Writing; Résumé Writing; Group Discussions; Interview Skills; Interpersonal Skills; Etiquette.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of career skills by examining and applying the styles and strategies of Goal Setting, Thinking Skills, and Etiquettes.

CO2. Analyze the limitations and possibilities of favourable situations by applying the skills of Body Language and demonstrate through Assertiveness, and Interpersonal Skills.

CO3. Apply appropriate soft skills by analyzing the problem situations that arise in professional career through demonstrating remedies in Conflict Management.

CO4. Demonstrate ability to function effectively as an individual and as a member in diverse teams examining and applying soft skills in Interviews, Group Discussion and Team Building.

CO5. Apply appropriate speaking and writing techniques in preparing documents and to communicate effectively by examining and demonstrating knowledge in Technical Report Writing and Résumé Writing.

**List of Exercises:**

**\*First TEN exercises are mandatory among the following:**

1. **Body Language**

   Types of Body Language – Parts of Body – Facial Expressions – Eye Contact Insights – Good Posture

2. **Assertiveness**

   Communications Styles – Benefits – Being Unassertive – Role Playing

3. **Goal Setting**

   Seven Steps of Goal Setting – Self Motivation – Personal Goal Setting – Setting Career Goals

4. **Thinking Skills**

   Positive Thinking – Creative Thinking – Lateral Thinking – Logical Thinking – Intitutive Thinking

5. **Team Building**

   Learning Activities – Management Essentials – Team Building Scenarios

6. **Conflict Management**

   Ways of Resolving Conflict – Personality Types and Conflict – Conflict Resolution Process – Team Conflict

7. **Technical Report Writing**

   Objectives – Formats – Writing Styles

8. **Résumé Writing**

   Structure and Presentation – Planning – Defining Career Objectives – Projecting One's Strengths and Skills – Cover Letter – Formats and Styles

9. **Group Discussions**

   Types of GD – Dos and Don'ts – Dynamics of GD – Intervention – Summarization Techniques

10. **Interview Skills**

    Planning – Opening Strategies – Answering Strategies – Tele Conferencing – Video Conferencing

11. **Interpersonal Skills**

    Starting a Conversation – Responding to a Conversation – Conversation Examples – Body Language – Role Play

12. **Etiquette**

    Basic Social Etiquette – Telephone Etiquette – Dinning Etiquette – Conference Etiquette

**TEXTBOOKS:**
   1. Soft Skills Lab Manual, SVEC.

**REFERENCE BOOKS:**
   1. R. C. Sharma & Krishna Mohan, *Business Correspondence and Report Writing*, Tata McGraw-Hill Publishing Company Limited, 3rd edition, New Delhi, 2012.

**SUGGESTED SOFTWARES:**
1. KVAN SOLUTIONS
2. Learning to Speak English 8.1, The Learning Company – 4 CDs.
3. English in Mind, Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
4. Language in Use 1, 2 & 3.
5. Cambridge Advanced Learner's Dictionary - 3rd Edition.
6. Let's Talk English, Regional Institute of English South India.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | | | 1 | | | | - | - | | | | | |
| CO2 | 3 | 3 | | | 1 | | | | - | - | | | | | |
| CO3 | 2 | 2 | | | 3 | | | | - | - | | | | | |
| CO4 | 2 | 2 | | | 2 | | | | 3 | 2 | | | | | |
| CO5 | 1 | 1 | | | 2 | | | | - | 3 | | | | | |
| Average | 2.2 | 2 | | | 1.8 | | | | 3 | 2.5 | | | | | |
| Correlation level | 3 | 2 | | | 2 | | | | 3 | 3 | | | | | |

**Correlation Levels:**　　　3– High　　　2 - Medium　　　1– Low

# II B. Tech. - I Semester
## (19BT30132) **STRENGTH OF MATERIALS LAB**
### (Common to CE and ME)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:**

Course on Mechanics of Solids/Strength of Materials.

**COURSE DESCRIPTION:**

Tests on strength of materials**:** Tension test; Compression test; Bending test; Shear test; Torsion test; Hardness test; Verification of Maxwell reciprocal theorem.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Evaluate the strength of materials such as steel, timber, metal using appropriate tools/techniques to solve complex problems in accordance with codal provisions ensuring safety.

CO2. Evaluate the load-deflection behavior for the materials used in beams and springs using appropriate tools/techniques to solve complex problems in accordance with codal provisions ensuring safety.

CO3. Perform material testing individually or in a team besides communicating effectively in written, oral and graphical forms on strength of materials.

**LIST OF EXPERIMENTS:**

1. Tension test on mild steel/HYSD bar
2. Compression test on wood/bricks/mild steel
3. Compression test on coiled spring
4. Tension test on coiled spring
5. Bending test on carriage spring
6. Brinell and Rockwell hardness tests
7. Charpy and Izod impact tests
8. Shear test on mild steel
9. Bending test on simply supported beam
10. Bending test on cantilever beam
11. Bending test on fixed beam
12. Bending test on continuous beam
13. Bending test on overhanging beam
14. Verification of Maxwell's reciprocal theorem
15. Torsion test on mild steel

**Note:** Minimum 12 experiments shall be conducted.

**REFERENCE BOOKS/LABORATORY MANUALS:**

1. SVEC 19 *Strength of Materials Lab Manual*.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 3 | | 1 | 3 | 1 | | 2 | | | | | | | |
| CO2 | 2 | 3 | | 1 | 3 | 1 | | 2 | | | | | | | |
| CO3 | | | | | | | | | 3 | 3 | | | | | |
| Average | 2 | 3 | | 1 | 3 | 1 | | 2 | 3 | 3 | | | | | |
| Correlation level | 2 | 3 | | 1 | 3 | 1 | | 2 | 3 | 3 | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT30331) **COMPUTER AIDED MACHINE DRAWING**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

A Course on Computer Aided Engineering Drawing.

**COURSE DESCRIPTION:**

Principles of machine drawing; Sectional views; Tolerances; Thread profiles; Bolted joints; Locking arrangements for nuts; Foundation bolts; Keys; Assembling and Disassembling; Part drawing.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to: .

CO1. Develop suitable drawing views of machine elements and simple parts using CAD software.

CO2. Draw assembled views for the part drawings with suitable tolerances using conventions and CAD software.

CO3. Work independently and Communicate about the assembly and part drawings through the computer aided drawings.

**SYLLABUS:**

1. **Exercises on machine drawing conventions using drafting software.**

   (Any three exercises)

   a) Conventional representation of materials.

   b) Conventional representation of machine components.

   c) Conventional representation sectional views.

   d) Conventional representation of limits, Fits and tolerances-form and positional tolerances and machining symbols.

   e) Conventional representation of dimensioning on the drawings.

2. **Exercises on drawing of machine elements and simple parts using drafting software.** (Any three exercises )

   a) Types of thread profiles-Square, Metric, ACME, Worm.

   b) Bolted joints-Hexagonal bolt and nut, Square bolt and nut.

   c) Locking arrangements for nuts-Locking by split pin, castle nut.

   d) Foundation bolts- Eye, Bent and Rag foundation bolts.

   e) Keys-Saddle key, Sunk key, Woodruff key, Kennedy key.

   f) Riveted joints-Single riveted lap joints, Butt joints with single cover straps(Chain and zigzag using snap head riveters).

3. **Assembly drawings.**

   Drawing of assembled views for the part drawings of the following, using conventions and easy drawing proportions. Representation of limits, fits and tolerances on assembly drawings. (Any three assembly drawings represented with dimensional and geometric tolerances)

a) Stuffing box

b) Pipe vice

c) Eccentric

d) Screw jack

### 4. Part drawings.

Preparation of part drawing representing limits fits and tolerances and surface finish indications (Below mentioned part drawings ONLY).

a) Petrol Engine connecting rod

b) Single tool post

c) Plummer block

**Note:** Minimum 12 experiments shall be conducted.


**REFERENCE BOOKS/LABORATORY MANUALS**:

SVEC19 Computer Aided Machine Drawing Manual


## CO-PO–PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 3 | 1 | | | | | | | | | |
| CO2 | 3 | 3 | 2 | 1 | 3 | 1 | | | | | | | | | |
| CO3 | | | | | | | | | 3 | 3 | | | | | |
| Average | 3 | 3 | 2 | 1 | 3 | 1 | | | 3 | 3 | | | | | |
| Correlation level | 3 | 3 | 2 | 1 | 3 | 1 | | | 3 | 3 | | | | | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

## II B. Tech. - I Semester
### (19BT30332) **MANUFACTURING TECHNOLOGY LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

Course on Material Science and Engineering

**COURSE DESCRIPTION:**

Provides skill on sand testing; Pattern making; Mould preparation; Metal casting; Mechanical press working; Welding; Sheet metal works; Plastic moulding; Manufacturing of composites.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1: Develop cast components using sand/die/stir casting process considering societal and safety issues.

CO2: Develop welding joints using given welding process for the given design requirements considering societal and safety issues and simulate the welding process.

CO3: Develop sheet metal components with metal forming techniques using fly press and hydraulic press machines considering safety and societal issues.

CO4: Develop different components using plastic molding based on the given design requirements considering societal and safety issues.

CO5: Work independently / in groups & communicate effectively in oral and written forms.

**List of Experiments:**

1. Determination of grain fineness number of sand using Sieve Shaker.
2. Determination of moisture content, clay content and the permeability of moulding sand.
3. Preparation of green sand moulding arrangement and metal casing of solid pattern.
4. Preparation of green sand moulding arrangement and metal casing of split pattern.
5. Design and making a solid pattern using wood turn lathe.
6. Manufacturing of composites by using Stir-Casting.
7. Simulation of welding.
8. Development of Lap joint and butt joint using arc welding process.
9. Development of Lap joint and butt joint using gas welding process.
10. Development of Lap joint by TIG and MIG welding process.
11. Development of Lap joint by the spot welding process.
12. Blanking and Piercing operations using fly press machine.
13. Deep drawing and Extrusion operations using hydraulic press.
14. Producing a component using injection moulding machine.
15. Producing a component using blow moulding machine.

**Note:** Minimum of 12 experiments shall be conducted.

**REFERENCE BOOKS/LABORATORY MANUALS**:

SVEC19 Manufacturing Technology Lab Manual

**Software used:** Simulation software for welding

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | 1 | 1 | | | | | | 3 | | |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | | | | | | 3 | | |
| CO3 | 3 | 3 | 2 | 1 | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 2 | 1 | | 1 | 1 | | | | | | 3 | | |
| CO5 | | | | | | | | | 3 | 3 | | | | | |
| Average | 3 | 3 | 2 | 1 | 1 | 1 | 1 | | 3 | 3 | | | 3 | | |
| Correlation level | 3 | 3 | 2 | 1 | 1 | 1 | 1 | | 3 | 3 | | | 3 | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT315AC) **DESIGN THINKING**

(Audit Course)
(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. | Total Marks | L | T | P | C |
|------------|------|-------------|---|---|---|---|
| - | - | - | 2 | - | - | - |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Design thinking process, Design thinking phases, empathy tools; Idea generation, visualizing and empathizing; Fidelity for prototypes, prototyping; prototyping for physical products.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze design thinking concepts and principles to perform human centered design process for creative problem solving.

CO2. Create empathy maps to visualize user attitudes and behavior for gaining insights of customers.

CO3. Develop innovative products or services for a customer base using ideation techniques.

CO4. Build prototypes for complex problems using gathered user requirements.

CO5. Apply design thinking tools techniques to produce good design and relevant products or services for a specific target market.

CO6. Improve prototype by testing it with a specific set of users for making it sustainable by following ethics.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO DESIGN THINKING** **(6 Periods)**

Design Thinking Process: Types of the thinking process, Common methods to change the human thinking process, Design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking, Problem solving, Understanding design thinking and its process model, Design thinking tools.

**UNIT II: EMPATHIZE** **(6 Periods)**

Design thinking phases, How to empathize, Role of empathy in design thinking, purpose of empathy maps, Things to be done prior to empathy mapping, Activities during and after the session, Understanding empathy tools : Customer Journey Map, Personas.

**UNIT III: IDEATION** **(6 Periods)**

Challenges in idea generation, need for systematic method to connect to user, Visualize, Empathize, and Ideate method, Importance of visualizing and empathizing before ideating, Applying the method, Ideation Tools: How Might We? (HMW), Story board, Brainstorming.

**UNIT IV: PROTOTYPING** **(6 Periods)**

What is a prototype? - Prototyping as a mindset, prototype examples, prototyping for products; Why we prototype? Fidelity for prototypes, Process of prototyping- Minimum Viable prototype

**UNIT V: TESTING PROTOTYPES** (6 Periods)

Prototyping for digital products: What's unique for digital, Preparation; Prototyping for physical products: What's unique for physical products, Preparation; Testing prototypes with users.

**Total Periods: 30**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. S.Salivahanan, S.Suresh Kumar, D.Praveen Sam, "*Introduction to Design Thinking*",Tata Mc Graw Hill, First Edition,2019.
2. Kathryn McElroy, "*Prototyping for Designers: Developing the best Digital and Physical Products*", O'Reilly,2017.

**REFERENCE BOOKS**

1. Michael G. Luchs, Scott Swan , Abbie Griffin,"*Design Thinking – New Product Essentials from PDMA*", Wiley, 2015.
2. Vijay Kumar, "*101 Design Methods: A Structured Approach for Driving Innovation in Your Organization*", 2012.

**ADDITIONAL LEARNING RESOURCES:**

1. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process
2. https://www.ibm.com/design/thinking/page/toolkit
3. https://www.interaction-design.org/literature/article/define-and-frame-your-design-challenge-by-creating-your-point-of-view-and-ask-how-might-we
4. https://www.culturepartnership.eu/en/article/ten-tools-for-design-thinking
5. https://nptel.ac.in/courses/109/104/109104109/
6. https://nptel.ac.in/courses/110106124/

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | - | 3 | 2 | - | - | - | - | - | - | - | - | | | |
| CO2 | 1 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| CO3 | 1 | - | - | 3 | 1 | - | - | - | - | - | - | - | | | |
| CO4 | - | 3 | - | 3 | - | - | - | - | - | - | - | - | | | |
| CO5 | - | - | - | - | 1 | 2 | 3 | - | - | - | - | - | | | |
| CO6 | 1 | 3 | 1 | - | - | - | 1 | 1 | - | - | - | - | | | |
| Average | 1 | 3 | 2 | 2.6 | 1 | 2 | 2 | 1 | | | | | | | |
| Correlation level | 1 | 3 | 2 | 3 | 1 | 2 | 2 | 1 | | | | | | | |

**Correlation Levels:** 3– High 2 - Medium 1– Low

## II B. Tech. – II Semester
### (19BT40301) **DYNAMICS OF MACHINERY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | 1 | - | 4 |

**PRE-REQUISITES:**

Courses on Basic Engineering Mechanics & Kinematics of Machinery.

**COURSE DESCRIPTION:**

Force analysis; Clutches, brakes and dynamometers; Gyroscopic couple, Turning moment diagrams, flywheel design; Analysis and balancing of shaking forces in machines; Governors; Vibrations, single degree, Multi degrees of freedom vibrations, spring mass systems; transmissibility of forces, Dunkerley's method, Rayleigh's method; Whirling of shafts; isolation of systems.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the mechanism, clutches, brakes and dynamometers for the forces acting on it during its operation and calculate the forces involved in it.

CO2. Determine the effect of gyroscopic couple on transport vehicles for stabilization.

CO3. Analyze turning moment diagram for fluctuations of energy and flywheel for controlling the speed variations in machines.

CO4. Analyze the governors and calculate the forces acting on it during its operation.

CO5. Analyze the unbalanced forces of masses in engines using analytical and graphical methods.

CO6. Calculate the frequency of vibration in beams and rotating shafts.


**DETAILED SYLLABUS**

**UNIT I: FORCE ANALYSIS, CLUTCHES, BRAKES AND DYNAMOMETER     (10 Periods)**

**STATIC AND DYNAMIC ANALYSIS:** Static force analysis of four bar mechanism and slider crank mechanism by principle of superposition; Dynamic force analysis: Four-bar mechanism

**Clutches:** Friction clutches- Single Disc or plate clutch, Multiple Disc Clutch, Cone Clutch, Centrifugal Clutch;

**Brakes and Dynamometers:** Simple block brakes-Single block, Pivoted block, Double block; simple Band brake, Differential Band Brake, Band and Block Brake, internal expanding brake. Dynamometers–absorption and transmission types.

**UNIT II: GYROSCOPE & TURNING MOMENT DIAGRAMS                (9 Periods)**

Gyroscope: Gyroscopic couple, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships; Turning moment diagrams and Fly wheels: Turning moment diagrams for steam engine, IC Engine and multi cylinder engine, Crank effort - coefficient of Fluctuation of energy, coefficient of Fluctuation of speed – Fly wheels and their design, Fly wheels for Punching machines.

**UNIT III: GOVERNORS:                                                        (8 Periods)**

Introduction to Governors, Watt, Porter and Proell governors; spring loaded governors – Hartnell and Hartung governors with auxiliary springs; Sensitiveness, isochronism and hunting; Effort and power of a governor.

## UNIT IV: BALANCING OF MASSES: (9 Periods)

Balancing of Rotating Masses - Single and several masses in Single and multiple planes; Balancing of Reciprocating Masses - Primary and complete balancing of reciprocating parts of an engine, Analytical and graphical methods, Unbalanced forces and couples –V Engine balancing, Multi cylinder inline engine balancing and radial engine balancing.

## UNIT V: VIBRATIONS: (9 Periods)

Classification, Free and forced vibration of single degree of freedom system, Role of damping, whirling of shafts and critical speeds, Simple problems on free, forced and damped vibrations, Vibration Isolation & Transmissibility, Transverse vibrations of beams with concentrated and distributed loads, Dunkerly's method, Rayleigh's method, Torsional vibrations - two and three rotor systems.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1. S.S.Rattan, *Theory of Machines and Mechanisms*, Tata McGraw Hill Publishers, 4th Edition, 2016.
2. R.S Khurmi, *Theory of Machines*, S.Chand Publications, 14th Revised Edition, 2012.

**REFERENCE BOOKS**:

1. Joseph Edward Shigley and John Joseph Uicker, Jr. *Theory of Machines and Mechanisms*, Second Edition, MGH, New York.
2. Ballaney P L, Theory of Machines and Mechanisms, Khanna Publishers, New Delhi,2005
3. Bevan T, *Theory of Machines*, CBS Publishers and Distributors, NewDelhi, Third Edition,2002.
4. J.S. Rao and R.V. Dukkipati, *Mechanism and Machine Theory*, New age International, Second Edition, 2007.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| CO2 | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| CO5 | 3 | 3 | 1 | 1 | | 1 | | | | | | | 3 | | |
| CO6 | 3 | 3 | 1 | 1 | | 1 | | | | | | | **3** | | |
| Average | **3** | **3** | 1 | 1 | | 1 | | | | | | | **3** | | |
| Correlation level | **3** | **3** | **1** | **1** | | **1** | | | | | | | **3** | | |

**Correlation Levels:** 3– High 2 - Medium 1– Low

# II B. Tech. – II Semester
## (19BT40302) **ENGINEERING METROLOGY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**
Courses on Applied Physics and Computer Aided Machine Drawing.

**COURSE DESCRIPTION:**
Limits, Fits and Tolerances; Limit Gauges and Gauge Design; Comparators; Linear Measurement; Measurement of Angles and Tapers; Flatness Measurement, Surface Roughness Measurement; Measurement of Displacement; Measurement of Speed, Stress & Strain Measurements; Measurement of Temperature; Measurement of Pressure.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge on the linear measurements, fits and tolerances using principles of metrology.

CO2. Demonstrate the knowledge of limit gauges, comparators, angle measuring methods and instruments.

CO3. Determine surface roughness using surface measuring methods and discuss the flatness measuring methods and instruments.

CO4. Derive the equations for screw thread and gear teeth parameters and calculate the parameters for the given application.

CO5. Demonstrate the knowledge on methods and instruments used for the measurement of stress, strains, temperature and pressure.

**DETAILED SYLLABUS:**

**UNIT I: LINEAR MEASUREMENT, LIMITS, FITS AND TOLERANCES      (9 Periods)**

**Introduction:** Metrology, Measurement, units, Range, accuracy, precision, types of errors, readability, calibration and reproducibility.

**Linear Measurement:** Length standard, Line, End and Wavelength standards, Slip Gauges - Calibration of the slip gauges, Numerical related to slip gauges, Dial indicator, micrometers.

**Limits, Fits and Tolerances:** Introduction, Definitions, fits and their types, Allowances, Unilateral and Bilateral Tolerance System, Hole and Shaft basis systems, Fundamental Tolerance, Numerical related to limits and fits. Interchangeability and Selective Assembly.

**UNIT II: LIMIT GAUGES, COMPARATORS, ANGULAR AND TAPER MEASUREMENT**

**(9 Periods)**

**Limit Gauges:** Gauges- Plug, Ring, Snap, Gap, Taper gauges, Taylor's principle.

**Comparators:** Introduction to comparator, Characteristics, Classification of comparators, Mechanical comparators- Sigma Comparators, Optical Comparators, LVDT, Pneumatic Comparators.

**Measurement of Angles and Tapers:** Different methods-Bevel protractor, Angle gauges Spirit levels, Sine bar, Sine plate, Rollers and Spheres used to determine the tapers.

## UNIT III: FLATNESS, SURFACE ROUGHNESS MEASUREMENT          (9 Periods)

**Flatness Measurement:** Measurement of flatness of surfaces, Straight edges, Surface plates, optical flat and Auto collimators, Interferometer and their uses.

**Surface Roughness Measurement:** Differences between surface roughness and Surface waviness, Methods of measurement of surface finish- Profilograph, Talysurf; BIS symbols for indication of surface finish.

## UNIT IV: SCREW THREAD AND GEAR MEASUREMENT          (9 Periods)

**Screw Thread Measurement:** Elements of measurement, Errors in screw threads, Measurement of effective diameter, Angle of thread and Thread pitch by 2-wire and 3-wire methods, Profile thread gauges.

**Gear Measurement:** Gear measuring instruments, Gear tooth profile measurement, Measurement of diameter, Pitch, Finding pressure angle and Tooth thickness.

## UNIT V: STRESS, STRAIN, TEMPERATURE AND PRESSURE MEASUREMENT

                                                        (9 Periods)

**Measurement of Stress and Strain**: Various types- Electrical strain gauge, Gauge factor, Method of usage of resistance strain gauge for bending, Compressive and tensile strains, Usage for measuring torque, Strain gauge rosettes.

**Measurement of Temperature and Pressure:** Standards and calibration, Thermal expansion methods, Thermoelectric sensors (thermocouples), Electrical Resistance sensors, Junction semiconductor sensors, Digital thermometers, Radiation methods, Pressure measurements - Standards and Calibration, Basic methods of pressure measurement, Dead weight gauge.

                                                        **Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. R.K. Jain, *Engineering Metrology*, Khanna Publishers, 20th edition, 2013.
2. N.V Raghavendra, L.Krishnamurthy, *Engineering Metrology and Measurements*, Oxford University Publisher, 2013.
3. M. Mahajan, Engineering Metrology, DhanpatRai and Co., 2nd edition, 2013.

**REFERENCE BOOKS:**

1. Thomas G. Beckwith, Roy D. Maragoni, John H. Lienhard V, *Mechanical Measurements*, Pearson Education International Publishers, 6th edition, 2013 .
2. Anand K Bewoor, Vinay A Kulkarni, *Metrology & Measurement*, McGraw Hill, 1st Edition, 2013.
3. B .C.Nakra& K .K .Choudhary, In strumentation , *Measurement & Analysis*, Tata Mcgraw Hill, 6th edition, 2011.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | | |
| CO2 | 3 | 2 | 1 | 1 | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 1 | 1 | | | | | | | | | 3 | | |
| CO5 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | | |
| Average | 3 | 2.4 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT40303) **FLUID MECHANICS AND HYDRAULIC MACHINERY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Engineering Mechanics.

**COURSE DESCRIPTION:**

Properties of Fluids; Pressure Measurements; Types of flow; One-dimensional steady flow energy & momentum Equations; Flow measurements; Fluid flow; Impact of jets on stationary & moving plate; Hydraulic turbines & Pumps Components and its performance.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Calculate the properties of fluids using the principles of fluid properties.

CO2. Apply the principles of fluid kinematics and dynamics and determine the flow properties of the fluid.

CO3. Calculate the loss of energy in fluid flows using the principles of fluid flows.

CO4. Evaluate the hydrodynamic force acting on jets and the performance of Hydraulic turbines under various loading and head conditions.

CO5. Evaluate the performance pumps under various head conditions and analyze its performance characteristics curves.

**DETAILED SYLLABUS:**

**UNIT I:  PROPERTIES OF FLUIDS AND PRESSURE MEASUREMENT       (9 Periods)**

**Properties of Fluids:** Dimensions and units, Physical properties of fluids - Density, Specific weight, Specific volume, Specific gravity, Viscosity, Surface tension, Capillarity, Buoyancy, Vapor pressure and its influence on fluid motion, Bulk modulus, compressibility; Types of fluids.

**Pressure Measurement:** Absolute Pressure, Gauge Pressure, Atmospheric Pressure, Vacuum Pressure, Manometers types - Piezometer, U-tube, Single column manometer and Differential manometers.

**UNIT II: FLUID KINEMATICS AND DYNAMICS                    (9 Periods)**

**Kinematics:** Classification of flow, the continuity equation for three dimensional flow (Cartesian coordinate only), Types of flow lines - stream, streak and path lines.

**Dynamics:** Equations of motion- Euler's and Bernoulli's equations, Application of Bernoulli's equations, Momentum equation and its application to pipe bend, moment of momentum equations.

**Measurement of Flow:** Venturimeter, Orifice meter, Rotameter and Pitot tube.
**UNIT III: FLUID FLOWS                                      (9 Periods)**

**Flow Over Flat Plate:** Boundary Layer- Definition, thicknesses, characteristics along thin plate, laminar and turbulent boundary layers (No derivation) boundary layer in transition, separation of boundary layer; submerged objects – drag and lift.

**Flow Through Pipes:** Reynold's experiment, Darcy Weisbach equation, Chezy's equation, Minor losses in pipes, Equivalent pipe, Pipes in series and pipes in parallel, Total energy line and Hydraulic Gradient Line.

**UNIT IV: IMPACT OF JETS AND HYDRAULIC TURBINES** **(9 periods)**

**Impact of Jets:** Force exerted on stationary and moving plates- vertical, inclined and curved, Velocity diagrams, Work done and Efficiency.

**Hydraulic turbines:** Classification of turbines -Impulse, Reaction turbines; Pelton wheel, Francis turbine, Kaplan turbine – Construction, Working principle, velocity triangles and work done, Efficiencies; Draft tube theory, Types of draft tubes; Performance of hydraulic turbines -Geometric similarity, Specific speed, Unit quantities, Characteristic curves, Governing of turbines, Water hammer, Cavitation.

**UNIT V: HYDRAULIC PUMPS** **(9 periods)**

**Centrifugal pumps:** Classification, Single stage Centrifugal pump - Working Principle, Work done and Efficiencies; Multi stage Centrifugal pump, Pumps in series, Pumps in parallel, Characteristic curves, Specific speed.

**Reciprocating pumps**: Construction and Working Principle of single acting, Double acting reciprocating pumps, Discharge, Work done, Slip, Indicator diagrams, Air vessels.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. R.K. Rajput, *Fluid Mechanics and Hydraulic Machines*, S. Chand, 4th Edition, 2013.
2. Modi and Seth, *Fluid Mechanics and Hydraulic Machinery*, Standard book house, 17th Edition, 2011.

**REFERENCE BOOKS:**

1. R.K. Bansal, *Fluid Mechanics and Hydraulic Machinery*, Laxmi publications, 9th Edition, 2017.
2. K Subramanya, Fluid *Mechanics and hydraulic machines*, Mc Graw Hill Education, 2nd Edition, 2011.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| CO2 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| CO3 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| CO4 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| CO5 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| Average | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| Correlation level | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT40304) **METAL CUTTING AND MACHINE TOOLS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Manufacturing Technology.

**COURSE DESCRIPTION:**

Theory of Metal Cutting; Geometry of Cutting Tools; Merchants Force Diagram; Lathe Machine-Principle of Operation; Tools; Multi spindle lathes; shaping; slotting and planning machines; drilling; boring; jig boring; milling machine Specifications; grinding; lapping; honing;

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Demonstrate the knowledge on  principles of metal cutting, machining methods, tool geometries, tool materials in connection with various machine tools.

CO2.   Analyze cutting forces during machining and calculate machining parameters.

CO3.   Illustrate the constructional features and describe the various operations related to the lathe.

CO4.   Demonstrate the knowledge on Shaping, Slotting, planning, Drilling and Boring Machines.

CO5.   Discuss the constructional features and the terminologies related to grinding, broaching and honing machines.

CO6.   Demonstrate the knowledge on milling machines and describe the indexing mechanism for a milling machine.

**DETAILED SYLLABUS:**

**UNIT I: THEORY OF METAL CUTTING                                 (9 Periods)**

**Introduction**- Purpose, principle, definition and requirement of machining; Machinability, **Concept of Generatrix and Directrix**; Basic elements of machining; **cutting parameters**- Cutting speed, Feed, Depth of cut; **Cutting tool geometry**– concept of rake and clearance angles, Nomenclature and Geometry of single point cutting tool; **ASA, ORS and NRS systems**; Conversion of tool angles using graphical method – ASA to ORS; Geometry of twist dril and milling cutter; Tool materials;

**UNIT II: MECHANICS OF MACHINING                                 (9 Periods)**

**Mechanism of chip formation in** – ductile and brittle materials; Types of chips; Chip breakers; Orthogonal and Oblique cutting; **Mechanics of Orthogonal cutting** – Shear angle, velocity relationship, shear strain; **Cutting forces** - Merchant's circle diagram and simple problems; Tool life; Tool failure; Thermal aspects-Coolants;

**UNIT  III: LATHE MACHINES                                          (9 Periods)**

**Engine Lathe -** Principle of operation, Specifications of lathe, Types of lathes, Work and tool holding devices, Operations on Lathe, Methods of Taper turning, Special attachments; **Automatic lathes** - Classification–single spindle and multi-spindle automatic lathes.

## UNIT IV: SPECIAL MACHINES-I                  (8 Periods)

**Shaping, Slotting and planning machines** - Principle of operation, Classification, Principal parts, specifications, Operations performed, Machining time calculations.

**Drilling and Boring Machines** - Principle of operation, Specifications, Types of Drilling machines, Different Operations, Tool holding devices, Boring machines –Jig boring machines.

## UNIT V: SPECIAL MACHINES-II                  (10 periods)

**Grinding machine** - Principle of operation, Types - cylindrical grinding machine, Surface grinding machine, Tool and cutter grinding machine, special types of grinding machines; Different types of abrasives, bonds, specification and selection of grinding wheel, Balancing, Loading and Glazing, Truing, Dressing of grinding wheel, Comparison of grinding, lapping and honing.

**Milling machine**: Principle of operation, Classification,  Specifications, Up milling and Down milling, Types of Horizontal milling machines, Vertical milling machines, Milling operations, Types of milling cutters, Tool and work holding devices, Methods of indexing, Accessories.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. A.B. Chattopadhyay, *Machining and Machine Tools*, Wiley, 2nd Edition, 2017.
2. Hazra Choudary S.K. and Hazra Choudary A.K., *Elements of Workshop Technology*, Vol II,  Media Promoters, 12th Edition, 2007.
3. B.S.Raghuwanshi, *A course in Workshop technology*, Vol II, Dhanpat Rai and Co(P) Ltd, 9th Edition, 1998.

### REFERENCE BOOKS:

1. H.M.T. (Hindustan Machine Tools), *Production Technology*, Tata Megrawhill Education, 2013.
2. Vijay K Jain, Advanced *machining processes*, Allied publishers, 2012.
3. R.K. Jain, *Production Technology*,  Khanna Publishers, 17th Edition, 2012.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | 1 | | 1 | | | | | | | 3 | | |
| CO2 | 3 | 3 | 1 | 1 | | | | | | | | | 3 | | |
| CO3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | | |
| CO4 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | | |
| CO5 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | | |
| CO6 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | | |
| Average | 3 | 2.1 | 1 | 1 | | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 2 | 1 | 1 | | 1 | | | | | | | 3 | | |

**Correlation Levels:**       3– High       2 - Medium       1– Low

(19BT40305) **THERMAL ENGINEERING – I**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Engineering Thermodynamics.

**COURSE DESCRIPTION:**

Introduction to Internal Combustion (IC) engines; Components and working of 2-stroke and 4-stroke engines; Combustion phenomena in spark ignition and compression ignition engines; Performance parameters of an internal combustion engine; Gas turbines; Jet propulsions and Rocket propulsions; Reciprocating compressors; Rotary compressors; Concept of steam power cycles.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1: Analyze the combustion process in IC engines and calculate the Performance parameters of IC Engines under various testing conditions.

CO2: Analyze the gas turbines and jet propulsions using PV and TS diagrams and solve problems on it.

CO3: Calculate the performance parameters of air compressors using principles of air compressors.

CO4: Analyze the steam power cycles using PV and TS diagrams and calculate the thermal efficiencies of these cycles.

**DETAILED SYLLABUS:**

**UNIT I: INTERNAL COMBUSTION ENGINES** (10 Periods)

Introduction, Classification of IC Engines, Engine components, Working of two stroke and four IC engines, Valve and port timing diagrams; Air-fuel and actual cycles; Combustion in Spark Ignition (SI) Engines **-** Stages of combustion in SI engines, Factors influencing the flame speed, Phenomenon of knock in SI engines; Combustion in Compression Ignition (CI) Engines **-** Stages of combustion in CI engines, Factor affecting delay period; Phenomenon of knock in C.I engine, comparison of knock in SI and CI engines.

**UNIT II: PERFORMANCE OF INTERNAL COMBUSTION ENGINES** (9 Periods)

Performance parameters - Brake power, indicated power, Friction power, Mean effective pressure, Specific fuel consumption, Engine efficiencies, Performance calculations, Heat balance sheet; Measurement of brake power; Measurement of indicated power; Measurement of Friction power - Willian's line method, Morse test, motoring test and retardation test; Air and fuel measurement.

**UNIT III: GAS TURBINES AND JET PROPULSIONS** (9 Periods)

**Gas Turbines:** Classification of Gas Turbines, Components of simple gas turbine plant-Ideal Gas Turbine Cycle and its deviations with actual cycle; Turbine Work and Efficiency of Simple Gas Turbine Cycle, Condition for Optimum Pressure Ratio, Methods to improve Turbine Work - Inter cooling and Reheating; Methods to improve efficiency -Regeneration.

**Jet Propulsion:** Introduction, Classification of Jet Propulsion devices, Working of Air breathing engines- Turbojet Engine, Turbo Prop Engine, Ram Jet Engine and Pulse Jet Engine; Introduction to Rocket Engine.

## UNIT IV: AIR COMPRESSORS                                    (9 Periods)

Introduction, Classification, Reciprocating Compressors - Principle of operation, work required, Isothermal efficiency, volumetric efficiency and effect of clearance, Single Stage and Multi Stage Compressors, Effect of Inter cooling and Pressure Drop in Multi - Stage Compressors; Rotary compressor - Working principles of Roots blower, Vane type Blower, Centrifugal Compressor, Axial Flow Compressors.

## UNIT V: STEAM POWER CYCLES                                  (8 Periods)

Carnot Cycle, Rankine Cycle-Schematic Layout, Thermodynamic Analysis; Effect of operating variables on the performance, Reheating and Regeneration, Modified Rankine Cycle; Low temperature power cycles, Binary vapour cycle and Cogeneration.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. R.K.Rajput, *Thermal Engineering*, Laxmi Publication, 9th Edition,2013.

2. V.Ganesan,*I.C.Engines*,TMH,3$^{rd}$Edition,2010

**REFERENCE BOOKS:**

1. M.L. Mathur & R. P. Sharma, *Internal combustion engines*, Dhanpat Rai & Sons, 8$^{th}$Edition, 2014.

2. R. S. Khurmi & J.S. Gupta, *Thermal Engineering*, S.Chand, 15$^{th}$ Edition, 2015.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| CO2 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| CO3 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| CO4 | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| Average | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |
| Correlation level | 3 | 3 | 1 | 1 | | | | | | | | | | 3 | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

## II B. Tech. – II Semester

### (19BT4HS01) BANKING AND INSURANCE

#### (Open Elective-2)

#### (Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Scope, Objectives and Elements of cost Accounting; Cost Sheet and Tender quotations; Variance Analysis: Material variances, Labor variances; Meaning and Scope, Liquidity, Profitability Ratios: concept of Risk and Return on Investment.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge in concepts and functions of Banking and Insurance, RBI, bank and customer relationship, types of accounts, types of loans and advances, types of insurance and risk.

CO2. Develop skills to provide solutions in electronic payment system, business models and insurance claims.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO BANKING** (9 periods)

Meaning - Importance of banking - Functions of banking - **Reserve Bank of India**: Functions – Role of RBI in sustainable development.

**UNIT II: BANK-CUSTOMER RELATIONSHIP** (9 periods)

Debtor-creditor relationship, deposit products or services, payment and collection of cheques. Accounts – Types of accounts, procedure for opening and closing an account - Loans and Advances- Principles of lending and types of loans.

**UNIT III: ELECTRONIC PAYMENT SYSTEM & BUSINESS MODELS** (9 periods)

Introduction to Online Banking - types of e-payment system, e-cash, NEFT, RTGS, Credit cards, Debit cards and Electronic Wallet - Business models: B2B, B2C, C2C and B2G.

**UNIT IV: INTRODUCTION TO RISK AND INSURANCE** (9 periods)

Concept of risk, risk *Vs* uncertainty. **Insurance**: Definition, Insurance as risk mitigation mechanism, elements of insurance.

**UNIT V: INSURANCE OVERVIEW** (9 periods)

Principles and Functions of Insurance - Types of Insurance - LIC and GIC - IRDA - Insurance Players in India.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

## TEXTBOOKS:

1. RanganadhaChary,A.V.   and Paul, R.R., *Banking and Financial system*, Kalyani Publisher, New Delhi, 3rd edition, 2016.
2. Sharma,R.K., Shashi K. Gupta and Jagwant Singh, *Banking and Insurance*, Kalyani Publishers, New Delhi, 17th edition, 2014.

## REFERENCES BOOKS:

1. *Indian Institute of Banking & Finance,Digital Banking*, Taxmann Publications Pvt. Ltd., 2016
2. Jyotsna Sethi and Nishwan Bhatia, *Elements of Banking and Insurance*, PHI Learning Pvt. Ltd., 2nd edition, 2012.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | 2 | | | | 3 | 2 | - | - | | | 3 | | | |
| CO2 | - | - | | | | - | 2 | 3 | 3 | | | 1 | | | |
| Average | 1 | 2 | | | | 3 | 2 | 3 | 3 | | | 2 | | | |
| Correlation level | `1 | 2 | | | | 3 | 2 | 3 | 3 | | | 2 | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT4HS03) **COST ACCOUNTING AND FINANCIAL MANAGEMENT**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Scope, Objectives and Elements ofcost Accounting; Cost Sheet and Tender quotations; Variance Analysis: Material variances, Labor variances; Meaning and Scope, Liquidity, Profitability Ratios: concept of Risk and Return on Investment.

**COURSE OUTCOMES:**

*After successful completion of this course, the students will be able to:*

CO1.  Demonstrate knowledge in Costing, Material, Labor, Overheads, Cost control, risk and return, security analysis and portfolio management.

CO2.  Design solutions for effective investment decisions, cost analysis, tenders, quotations, variance analysis, ratio analysis and capital budgeting techniques.

**DETAILED SYLLABUS:**

**UNIT I: COST ACCOUNTING**                                              **(9 periods)**

Meaning of Cost and Cost Accounting, Objectives, Scope, Advantages and disadvantages – Cost Accounting *Vs* Management Accounting – Elements of Costing – Installation of costing system – Material Control, Labour Control, Overhead Control.

**UNIT II: COST SHEET & PREPARATION OF COST SHEET**        **(9 periods)**

Analysis of Cost – Importance of Costing while pricing the products - Preparation of cost sheet, estimate, tender and quotation (Simple problems).

**UNIT III: STANDARD COSTING & VARIANCE ANALYSIS**        **(9 periods)**

Introduction to Standard Costing & Variances – Variance Analysis: Material variances, Labour variances (Simple Problems).

**UNIT IV: FINANCIAL MANAGEMENT& RATIO ANALYSIS**        **(9 periods)**

Meaning, Objectives - Nature and Scope, Importance of FM – **Ratio Analysis**: Solvency ratios, Liquidity ratios, Profitability ratios, Financial Statement Analysis through ratios (Simple Problems).

**UNIT V: INTRODUCTION TO INVESTMENT**                        **(9 periods)**

Investment – Meaning and Definition- concept of risk and returns-Investment Alternatives-Capital Budgeting techniques – Security Analysis and Portfolio Management (Basic concepts).

**Total periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. S.P. Jain and K.L. Narang: *Cost Accounting*, Kalyani Publishers, Ludhiana, 10th edition, 2016.

2. I.M. Pandey, *Financial Management*, Vikas Publishing House Pvt. Ltd., 14th edition, 2016.

**REFERENCE BOOKS:**

1. The Institute of Company Secretaries of India, *Cost and Management Study Material*, New Delhi.

2. CA SaravanaPrasath, *Cost Accounting and Financial management*, Wolters Kluwer India Pvt. Ltd., New Delhi, 2018 edition, 2018.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 2 | | - | | | | | - | 1 | | | | |
| **CO2** | 2 | - | 3 | | 3 | | | | | 2 | 1 | | | | |
| **Average** | 2.5 | 3 | 2.5 | | 3 | | | | | 2 | 1 | | | | |
| **Correlation level** | 3 | 3 | 3 | | 3 | | | | | 2 | 1 | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## II B. Tech. - II Semester
### (19BT4HS05) **GENDER AND ENVIRONMENT**
(Open Elective-2)
(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Gender and the environment relationship, Gendered Roles in the family & community, Gender and sustainable development, Gender in environmental justice, Gender & environmental security.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the knowledge of gender & environment connections, key issues and topics within global environmental politics in environmental decision-making.

CO2. Comprehend the concepts of gender and sustainable development through debates, and policy documents.

CO3. Analyze the concept of environmental security and justice by identifying the sources of insecurity.

**DETAILED SYLLABUS:**

**UNIT I: GENDER ANDENVIRONMENT RELATIONSHIP           (9 periods)**

Introduction–Gender and Environment–Development of gender roles–Society, gender & environment – Understanding environmental politics – Gender-environment connections–Eco-feminism - Cultural eco-feminism–Social eco-feminism - Feminist political ecology.

**UNIT II: GENDERED ROLES IN THE FAMILY & COMMUNITY           (9 periods)**

Organization of the household – Domestic division of labour - Food: growing, harvesting, shopping, preparing, and cooking.

Gender & Power- Planning – Politics – NGO – Gendering of environmental protest – Environmental decision-making.

**UNIT III: GENDER ANDSUSTAINABLE DEVELOPMENT           (9 periods)**

Concept of sustainability & its achievement – Concept of sustainable development – Ecological Modernization – Gender & sustainability debates – Gender & sustainable development debates - Gender in policy documents – Gender, poverty & equity in sustainable development.

**UNIT IV: GENDER IN ENVIRONMENTAL JUSTICE           (9 periods)**

Normative Concerns ( Fairness, Inequality & Justice) - Making sense of Environmental justice – Ecological debt, Transnational harm, & human rights – Ecological justice – Gender & Environmental Justice – Gender, Vulnerability & risk – Women in environmental justice movements – Knowledge & participation – Gender, sustainability & justice as guiding concepts.

**UNITV: GENDER AND ENVIRONMENTAL SECURITY** **(9 periods)**

Connections between security & the environment – **Gender, environment & security**: Sustainability as security - poverty & insecurity – Insecurity as injustice – Competing ways of thinking security – Reflecting on sources of insecurity – **Case Study** – Food Security - **Case Study** – The impacts of natural disasters.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Nicole Detraz, *Gender and the Environment*, Polity Press, Cambridge, UK, 2017.

2. Susan Buckingham- Hatfield, *Gender and Environment*, Routledge, London, 2000.

**REFERENCE BOOKS:**

1. Promillakapur (ed). (2000). "*Empowering Indian Women*" Publication Division, Government of India, New Delhi.

2. Ronnie Vernooy, (Ed). (2006). "*Social and gender Analysis Natural Resource Management:  Learning studies and lessons from Aisa*" Sage, New Delhi.

3. Swarup, Hemlata and Rajput, Pam. (2000). *Gender Dimensions of Environmental and Development Debate: The Indian Experience*" In SturatS.Nagel, (ed). "India"s Development and Public Policy", Ashgate, Burlington.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | 3 | 3 | - | - | - | - | - | | | |
| CO2 | 3 | - | - | - | - | 2 | 3 | 1 | - | 2 | - | - | | | |
| CO3 | 3 | - | - | - | - | 3 | 3 | - | - | - | - | 2 | | | |
| Average | 3 | - | - | - | - | 2.66 | 3 | 1 | - | 2 | - | 2 | | | |
| Correlation level | 3 | - | - | - | - | 3 | 3 | 1 | - | 2 | - | 2 | | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT4HS07) **INDIAN ECONOMY**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Introduction; Time Value of Money; Elementary Economic Analysis; Value Analysis/Value Engineering; Economic Planning.

**COURSE OUTCOMES:**

*After successful completion of this course, the students will be able to:*

CO1.  Understand the basic concepts of economics, economic analysis, economic planning and strate.

CO2.  Demonstrate knowledge in capital budgeting, evaluation of engineering projects, depreciation policy and familiarize with the concepts of value analysis vs value engineering.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION                                    (9 periods)**

Economics - Flow in an Economy, Law of Supply and Demand; Micro and Macro Economics; Relationship between Science, Engineering, Technology and Economic Development; Concept of Engineering Economics-Types of Efficiency, Definition and Scope of Engineering Economics.

**UNIT II: ELEMENTARY ECONOMIC ANALYSIS            (9 periods)**

Economic Analysis – Meaning, Significance, Simple Economic Analysis; Material Selection for a Product, Substitution of Raw Material; Design Selection for a Product; Material Selection-Process Planning, Process Modification.

**UNIT III: ECONOMIC PLANNING                          (9 periods)**

Introduction - Need For Planning in India, Five year plans(1951-2012), NITI Aayog (from 2014 onwards); Inclusive Growth-Meaning, Significance, Need for inclusive growth in India, Strategy for more inclusive growth,  Challenges and Prospects; Employment and Inclusive Growth in India, Role of engineers in sustaining inclusive growth.

**UNIT IV: TIME VALUE OF MONEY                        (12 periods)**

Concepts and Application; Capital Budgeting-Traditional and Modern Methods; Simple and Compound Interest, Cash Flow Diagram, Principle of Economic Equivalence; Evaluation of Engineering Projects – Present Worth Method, Future Worth Method, Annual Worth Method, Internal Rate of Return Method, Cost-benefit Analysis in Public Projects; Depreciation Policy-Depreciation of Capital Assets, Causes of Depreciation, Straight Line Method and Declining Balance Method.

**UNIT V: VALUE ANALYSIS/VALUE ENGINEERING          (6 periods)**

Introduction - Value Analysis, Value Engineering, Functions, Aims; Value Analysis vs Value Engineering; Value Engineering Procedure- Advantages, Application Areas.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Panneerselvam. R., *Engineering Economics*, PHI Learning Private Limited, New Delhi, 2nd edition, 2013.
2. Jain. T. R., V. K. Ohri, O. P. Khanna. *Economics for Engineers*. VK Publication, 1st edition, 2015.

**REFERENCE BOOKS:**

1. DuttRudar and Sundhram K. P. M., *Indian Economy*, S. Chand, New Delhi, 62$^{nd}$ revised edition, 2010.
2. Misra. S. K. and V. K. Puri., *Indian Economy*: Its Development Experience, Himalaya Publishing House, Mumbai, 32$^{nd}$ edition, 2010.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | | | | | 2 | | | | | | - | | | |
| **CO2** | 3 | | | | | 2 | | | | | | 2 | | | |
| **Average** | 3 | | | | | 2 | | | | | | 2 | | | |
| **Correlation level** | 3 | | | | | 2 | | | | | | 2 | | | |

**Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

## II B. Tech. – II Semester

(19BT4HS09) **LIFE SKILLS**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Positive attitude; Self-discovery-Interpersonal relationships; Cross-cultural communication; Core thinking-Problem solving and Decision making; Business presentations and Public speaking.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Gain knowledge in strategies involved in developing positive attitude, process of knowing oneself and managing effective interpersonal relationships.

CO2.   Analyse problem solving strategies in Decision Making and SWOT analysis.

CO3.   Communicate effectively with Engineering Community and Society by demonstrating presentation skills in professional arena.

**DETAILED SYLLABUS:**

**UNIT I: POSITIVE ATTITUDE** **(9 periods)**

Introduction, Features of attitudes, Formation of attitudes, Ways of changing attitude in a person, Attitude in a work place, Developing positive attitude, Obstacles in developing positive attitude, Measuring attitude.

**UNIT II: SELF DISCOVERY AND INTERPERSONAL RELATIONSHIPS** **(9 periods)**

Importance of knowing yourself, Process of knowing yourself, SWOT Analysis, Elements of attitude in interpersonal relationships, Methods to deal with different types of interpersonal relationship skills.

**UNIT III: CROSS-CULTURAL COMMUNICATION** **(9 periods)**

Different Communication Styles, Cultural variables, communication sensitivity and variables of national culture, Individual Cultural Variables, Cross-cultural Communication Strategies, Potential hot spots in cross-cultural communication, Cross-cultural communication – Basic Tips.

**UNIT IV: CORE THINKING, PROBLEM SOLVING AND DECISION MAKING (9 periods)**

Process of developing core thinking skills, Categories of thinking: Critical & Creative, Understanding problem solving, Cause of problems, Stages of problem solving, Methods of problem solving, Types of decision making.

**UNIT V: BUSINESS PRESENTATIONS AND PUBLIC SPEAKING** **(9 periods)**

Business presentations and speeches, structuring the material, Types of delivery, Guidelines for delivery, Effective sales presentation, Controlling nervousness and stage fright.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Dr. K. Alex (2018) *Soft Skills*, S. Chand and Company Limited, New Delhi.
2. Manmohan Joshi (2017) *Soft Skills*, bookboon.com, Bangalore.

**REFERENCE BOOKS:**

1. Meenakshi Raman and Prakash Singh (2013), *Business Communication*, Oxford University Press, New Delhi.
2. Jeff Butterfield (2011) *Soft Skills for Everyone*, Cengage Learning India Private Limited, Delhi.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | - | | | - | | | | 3 | - | | | | | |
| CO2 | - | 3 | | | 3 | | | | 3 | - | | | | | |
| CO3 | 2 | - | | | - | | | | - | 3 | | | | | |
| Average | 1 | 3 | | | 3 | | | | 3 | 3 | | | | | |
| Correlation level | 1 | 3 | | | 3 | | | | 3 | 3 | | | | | |

**Correlation Levels:**　　　**3– High**　　　**2 - Medium**　　　**1– Low**

(19BT4HS11) **PROFESSIONAL ETHICS**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Engineering Ethics; Professional Ideals and Virtues; Engineering as Social Experimentation; Responsibilities and Rights; Global Issues.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Demonstrate knowledge in Engineering Ethics, Responsibilities and Rights.

CO2.  Analyze the concepts of Engineering in Social Experimentation and Global Issues.

CO3.  Apply the nuances of professional ideals at work place and in social context.

**DETAILED SYLLABUS:**

**UNIT I: ENGINEERING ETHICS**                                       **(9 periods)**

Scope and aim of engineering ethics, Senses of engineering ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral autonomy-Kohlberg's theory, Gilligan's theory, Consensus and controversy.

**UNIT II: PROFESSIONAL IDEALS AND VIRTUES**                         **(8 periods)**

Theories about virtues, Professions, Professionalism, Characteristics, Expectations, Professional responsibility, Integrity, Self-respect, Sense of responsibility, Self-interest, Customs and religion, Self-interest and ethical egoism, Customs and ethical relativism, Religion and divine command ethics, Use of ethical theories, Resolving moral dilemmas and moral leadership.

**UNIT III: ENGINEERING AS SOCIAL EXPERIMENTATION**                  **(10 periods)**

Engineering as experimentation, Similarities to standard experiments, Learning from the past and knowledge gained, Engineers as responsible experimenters, Conscientiousness, Moral autonomy and accountability, The challenger case, Codes of ethics and limitations, Industrial standards, Problems with the law of engineering.

**UNIT IV: RESPONSIBILITIES AND RIGHTS**                             **(9 periods)**

Collegiality and loyalty, Respect for authority, Collective bargaining, Confidentiality, Conflict of interests, Occupational crime, Rights of engineers, Professional rights, Whistle-blowing, The BART case, Employee rights and discrimination.

**UNITV: GLOBAL ISSUES**                                             **(9 periods)**

Multinational corporations, Professional ethics, Environmental ethics, Computer ethics, Engineers as consultants, Witnesses, Advisors and Leaders, Engineers as Managers, Managerial ethics applied to Engineering Profession, moral leadership.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Mike W. Martin and Roland Schinzinger, *Ethics in Engineering*, Tata McGraw-Hill, 3rd edition, 2007.
2. Govindarajan, M., Nata Govindarajan, M., Natarajan, S. and Senthilkumar, V. S., *Engineering Ethics*, Prentice Hall of India, 2004.

**REFERENCE BOOKS:**

1. S. Kannan and K. Srilakshmi, *Human Values and Professional Ethics*, Taxmann Allied Services Pvt Ltd., 2009.
2. Edmund G. Seebauer and Robert L. Barry, *Fundamental of Ethics for Scientists and Engineers*, Oxford University Press, 2001.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | - | | | | | | 2 | | | | | | | |
| **CO2** | 1 | 3 | | | | | | 2 | | | | | | | |
| **CO3** | 1 | 1 | | | | | | 3 | | | | | | | |
| **Average** | 1.66 | 2 | | | | | | 2.33 | | | | | | | |
| **Correlation level** | 2 | 2 | | | | | | 2 | | | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT4HS13) **INDIAN TRADITION AND CULTURE**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Basic traits of Indian Culture; Humanistic Reforms under Jainism and Buddhism; Culture in the medieval period; Socio Religious reforms in Indian Culture; Reform movements for harmonious relations.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge in Vedic culture, cultural aspects of Buddhism, Jainism and cultural conditions in the medieval period.

CO2. Understandthe impact ofsocio religious reforms and movements on Indian tradition and culture to improve harmonious relations within society.

**DETAILED SYLLABUS:**

**UNIT I: BASIC TRAITS OF INDIAN CULTURE**           **(9 periods)**

Meaning and definition and various interpretations of culture, Culture and its features. The Vedic and Upanishadic culture and society. Human aspirations and values in these societies. Chaturvidhapurushardhas, Chaturashrma and Chaturvarna theory.

**UNIT II: HUMANISTIC REFORMS UNDER JAINISM AND BUDDHISM**    **(9 periods)**

Salient features of Jainism - contributions of Jainism to Indian culture. Contributions of Aachaarya and Mahaapragya. Buddhism as a humanistic culture. The four noble truths of Buddhism. Contributions of Buddhism to Indian culture.

**UNIT III: CULTURE IN THE MEDIEVAL PERIOD**         **(9 periods)**

Unifications of India under Mouryas and Guptas and their cultural achievements.Cultural conditions under satavahanas. Contributions to pallavas and cholas to art and cultural achievements of vijayanagara rulers.

**UNIT IV: SOCIO RELIGIOUS REFORMS IN INDIAN CULTURE**     **(9 periods)**

Western impact on India, Introduction of western education, social and cultural awakening and social reform movements of Rajaramohan Roy - Dayanandha Saraswathi- Anne Besant (theosophical society).

**UNIT V: REFORM MOVEMENTS FOR HARMONIOUS RELATIONS**    **(9 periods)**

Vivekananda, Eswarchandravidyasagar and Veeresalingam - emancipation of women and struggle against caste. Rise of Indian nationalism. Mahatma Gandhi- Nonviolence and satyagraha and eradication of untouchability.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOK**:

1. ValluruPrabhakaraiah, *Indian Heritage and Culture*, Neelkamal Publications Pvt. Ltd. Delhi, First Edition, 2015.

**REFERENCE BOOKS:**

1. L. P. Sharma, *History of Ancient India*, Konark Publishers, Pvt. Ltd. New Delhi, 2010.
2. L. P. Sharma, *History of Medieval India*, Konark Publishers, Pvt. Ltd. New Delhi, 2010.
3. L. P. Sharma, *History of Modern India*, Konark Publishers, Pvt. Ltd. New Delhi, 2010.
4. The Cultural Heritage of India Vol-I, II, III, IV, V, The Ramakrishna Mission Institute of Culture, Calcutta.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | - | - | - | - | 2 | - | - | | | | | | | |
| **CO2** | 2 | - | - | - | - | 3 | | | | | | | | | |
| **Average** | 2.5 | - | - | - | - | 2.5 | | | | | | | | | |
| **Correlation level** | 3 | - | - | - | - | 3 | | | | | | | | | |

**Correlation Levels:**　　　**3– High**　　　**2 - Medium**　　　**1– Low**

(19BT40106) **DISASTER MITIGATION AND MANAGEMENT**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Disasters; Earthquakes; Floods; Cyclones; Droughts; Landslides; Disaster management.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the vulnerability of an area to natural and man-made disasters/hazards as per the guidelines to solve complex problems using appropriate techniques ensuring safety, environment and sustainability.

CO2. Propose appropriate mitigation strategies for earthquake and tsunami impacts as per code of practice using suitable techniques ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO3. Analyze the causes and impacts of floods, cyclones and droughts using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO4. Analyze the causes and impacts of landslides using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.

CO5. Design disaster management strategies to solve pre, during and post disaster problems using appropriate tools and techniques following the relevant guidelines and latest developments ensuring safety, environment and sustainability besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: DISASTERS** (9 periods)

Types of disasters - Natural disasters; Impact of disasters on environment, infrastructure and development; Concepts of hazards and vulnerability analysis, Hazard Assessment, Guidelines for hazard assessment and vulnerability analysis, Basic principles and elements of disaster mitigation.

**UNIT II: EARTHQUAKES** (9 periods)

Introduction to earthquake, Intensity scale (MSK–64), Seismic zones and activity in India, Action plan for earthquake disaster preparedness, Elements at risk, Recovery and rehabilitation after earthquake, Concepts of Earthquake resistant design and construction of buildings; Tsunami – Onset, Types and causes,Warning, Elements at risk, Typical effects, Specific preparedness and mitigation strategies, Case studies.

## UNIT III–FLOODS, CYCLONES AND DROUGHTS                    (11periods)

**Floods and Cyclones:** Onset, Types, Causes, Warnings, Elements at risk, Typical effects, Indian floods and cyclones, Hazard zones, Potential for reducing hazards, Mitigation strategies and community based mitigation, Case studies.

**Droughts:** Onset, Types and warning; Causes, Impact, Early warning and response mechanisms, Mitigation strategies, Droughts in India, Case studies.

## UNIT IV: LANDSLIDES                                        (8 periods)

Onset, Types and warning; Causes, Elements at risk, Indian landslides, Hazards zones, Typical effects, Mitigation strategies and community based mitigation, Case studies.

## UNIT V–DISASTER MANAGEMENT                                 (8periods)

Disaster management organization and methodology, Disaster management cycle, Disaster management in India – Typical cases and Cost–benefit analysis, Disaster management programs implemented by NGOs and Government of India, Usage of GIS and Remote sensing techniques in disaster management, Leadership and Coordination in Disaster management, Emerging trends in disaster management.


**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*


**TEXTBOOKS:**

1. V. K. Sharma, *Disaster Management, Medtech Publishing, 2nd Edition, 2013*.

2. Anand S. Arya, Anup Karanth, and Ankush Agarwal, *Hazards, Disasters and Your Community: A Primer for Parliamentarians*, GOI–UNDP Disaster Risk Management Programme, Government of India, National Disaster Management Division, Ministry of Home Affairs, New Delhi, Version 1.0, 2005.


**REFERENCE BOOKS:**

1. Donald Hyndman and David Hyndman, *Natural Hazards and Disasters*, Cengage Learning, 3rd Edition, 2011.

2. *Disaster Management in India,* A Status Report, Ministry of Home Affairs, Govt. of India, May 2011.

3. Rajendra Kumar Bhandari, *Disaster Education and Management: A Joyride for Students, Teachers, and Disaster Managers*, Springer India, 2014.

4. R. B. Singh, *Natural Hazards and Disaster Management*, Rawat Publications, 2009.


**ADDITIONAL LEARNING RESOURCES:**

1. Tushar Bhattacharya, *Disaster Science and Management*, McGraw Hill, 2014.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | - | 2 | 2 | 2 | 2 | 2 | - | - | - | - | | | |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | | 2 | - | - | | | |
| CO3 | 3 | 3 | - | 2 | 2 | 2 | 2 | - | - | 2 | - | - | | | |
| CO4 | 3 | 3 | - | 3 | 2 | 2 | 2 | - | - | | - | - | | | |
| CO5 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | | 1 | 3 | 2 | | | |
| Average | 3 | 2.8 | 3 | 2.4 | 2 | 2 | 1.6 | 2 | | 1.8 | 3 | 2 | | | |
| Correlation level | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT40107) **SUSTAINABLE ENGINEERING**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Principles of sustainability; Sustainability metrics and assessment tools; Sustainable engineering practices; Sustainable engineering applications; Sustainable urbanization and industrialization.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the principles of sustainability to solve complex environmental problems following relevant standards/protocols considering society, health, safety and environment.

CO2. Analyze sustainability metrics and assessment tools to solve complex environmental problems following relevant standards and emerging trends considering society, health, safety, environment and economics besides communicating effectively in graphical form.

CO3. Analyze sustainable engineering practices to solve complex environmental problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

CO4. Design sustainable engineering applications to solve complex environmental problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

CO5. Analyze sustainable urbanization and industrialization principles to solve complex environmental problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: PRINCIPLES OF SUSTAINABILITY                    (9 periods)**

Emerging challenges, Sustainability and sustainable engineering; Environmental concerns; Social, economic and legal issues; Availability and depletion of natural resources, Disaster resiliency; Multilateral environmental agreements – Basel convention, Clean development mechanism (CDM), Montreal and Kyoto protocols.

**UNIT II: SUSTAINABILITY METRICS AND ASSESSMENT TOOLS     (9 periods)**

Sustainability indicators, metrics and assessment tools, Material flow analysis and material budget, Carbon footprint analysis, Life cycle assessment, Streamlined life-cycle assessment (SLCA), Economic input output-life cycle analysis, Environmental health risk assessment, Other emerging assessment tools.

## UNIT III: SUSTAINABLE ENGINEERING PRACTICES (9 periods)

Sustainable energy engineering, Sustainable waste management, Green and sustainable buildings and infrastructure, Sustainable civil infrastructure, Sustainable remediation of contaminated sites, Climate geoengineering.

## UNIT IV: SUSTAINABLE ENGINEERING APPLICATIONS (9 periods)

Environmental and chemical engineering projects, Materials engineering projects, Infrastructure engineering projects – Background, Methodology, Goal and Scope, Study area, Technical design, Environmental sustainability, Life cycle assessment, Economic sustainability, Social sustainability, Rating systems – ENVISION, LEED, GRIHA, IGBC; Conclusions.

## UNIT V: SUSTAINABLE URBANIZATION AND INDUSTRIALIZATION (9 periods)

Sustainable urbanization and industrialization, United Nations sustainable development goals – Right to education, Poverty eradication, Social and technological changes; Industrial Processes - Material selection, Energy efficiency, Pollution prevention and control techniques, Industrial Ecology, Industrial symbiosis.

**Total Periods: 45**

***Topics for self-study are provided in the lesson plan***

**TEXTBOOKS:**

1. Reddy, K.R., Cameselle, C., and Adams, J.A., *Sustainable Engineering: Drivers, Metrics, Tools, and Applications*, John Wiley &Sons, Inc., Hoboken, New Jersey, 2019, 544p (ISBN: 978-1-119-49393-8).

2. Allen, D. T. and Shonnard, D. R., *Sustainability Engineering: Concepts, Design and Case Studies*, Pearson Education, 1st Edition, 2012.

**REFERENCE BOOKS:**

1. Bradley. A.S; Adebayo,A.O., Maria, P.,*Engineering Applications in Sustainable Design and Development*, Cengage Learning, 1st Edition, 2016.

2. Purohit, S. S., *Green Technology: An Approach for Sustainable Environment*, Agrobios Publication, 1st Edition, 2016.

3. *Energy Conservation Building Code (ECBC) 2007*, Bureau of Energy Efficiency, Govt. of India, New Delhi.

4. Twidell, J. W. and Weir, A. D., *Renewable Energy Resources*, Routledge, Taylor & Francis Group, 3rd Edition, 2015.

**ADDITIONAL LEARNING RESOURCES:**

1. Daniel A. Vallero and Chris Brasier, *Sustainable Design: The Science of Sustainability and Green Engineering*, Wiley-Blackwell, 1st Edition, 2008.

2. Jorge A. Vanegas, *Sustainable Engineering Practice: An Introduction*, Committee on Sustainability, American Society of Civil Engineers, https://doi.org/10.1061/9780784407509, 2004.

3. Mackenthun, K.M., *Basic Concepts in Environmental Management*, CRC Press, Taylor & Francis Group, 1st Edition, 1999.

4. *Environment Impact Assessment Guidelines*, Notification of Government of India, 2006.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | - | 3 | - | 2 | 3 | 2 | - | - | - | - | | | |
| CO2 | 3 | 3 | - | 2 | 2 | 2 | 2 | 2 | - | 1 | 2 | 1 | | | |
| CO3 | 3 | 3 | - | 2 | 2 | 2 | 2 | 2 | - | 1 | 2 | - | | | |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | - | 1 | 2 | - | | | |
| CO5 | 3 | 3 | - | 2 | 2 | 2 | 2 | 2 | - | 1 | 2 | - | | | |
| Average | 3 | 3 | 3 | 2.2 | 2 | 2 | 2.2 | 2 | | 1 | 2 | 1 | | | |
| Correlation level | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | 1 | 2 | 1 | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT40108) **CONTRACT LAWS AND REGULATIONS**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Construction contracts; Tenders; Arbitration; Legal requirements; Labour regulations.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Develop construction contracts to solve complex contract related problems by following laws and regulations considering project schedule, cost, quality and risk.

CO2. Prepare tenders as per the specifications by following latest developments, laws and regulations to solve complex tender problems considering project schedule, cost, quality and risk.

CO3. Analyze arbitration problems to address the contract disputes following the laws and regulations in the context of society.

CO4. Analyze legal issues pertaining to contracts and tenders considering society.

CO5. Analyze labour regulations to address labour safety issues.

**DETAILED SYLLABUS:**

**UNIT I: CONSTRUCTION CONTRACTS                               (9 periods)**

Indian contracts act, Elements of contracts, Types of contracts, Features, Suitability, Design of contract documents, International contract document and laws, Standard contract document, Law of torts.

**UNIT II: TENDERS                                             (9 periods)**

Prequalification, Bidding, Accepting; Evaluation of tender from technical, contractual and financial points of view; Two cover system, Preparation of the documentation, Contract formation and interpretation, Potential contractual problems, Price variation clause, Comparison of actions and laws, Subject matter, Violations, Latest developments in tendering.

**UNIT III: ARBITRATION                                        (9 periods)**

Arbitration, Comparison of actions and laws, Agreements, Appointment of arbitrators, Conditions of arbitration, Powers and duties of arbitrator, Rules of evidence, Enforcement of award, Arbitration disputes, Dispute review board.

**UNIT IV: LEGAL REQUIREMENTS                                  (9 periods)**

Legal requirements for planning, Property law, Agency law, Tax laws – Income tax, Sales tax, Excise and custom duties, Local government approval, Statutory regulations, Insurance and bonding, Laws governing purchase and sale, Use of urban and rural land, Land revenue codes, EMD, Security deposits, Liquidated damages.

**UNITV: LABOUR REGULATIONS**                                          **(9 periods)**

Social security, Welfare legislation; Laws relating to wages, bonus and industrial disputes; Labour administration, Insurance and safety regulations, Workmen's compensation act, Maternity benefit act, Child labour act, Other labour laws.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. SubbaRao, G.C.V., *Law of Contracts I & II*, S. Gogia& Co., 11th Edition, 2011.
2. Jimmie Hinze, *Construction Contracts,* McGraw Hill, 3nd Edition, 2011.

**REFERENCES BOOKS:**

1. Kishore Gajaria, *GT Gajaria's Law Relating to Building and Engineering Contracts in India*, Lexis NexisButterworths India,4th Edition, 2000.
2. Patil, B. S., *Civil Engineering Contracts and Estimates*, University Press (India) Private Ltd., 4thEdition, 2015.
3. Joseph T. Bockrath, *Contracts and the Legal Environment for Engineers and Architects*, McGraw Hill Education,7th Edition, 2010.
4. AkhileshwarPathak, *Contract Law*, Oxford University Press, 2011.

**ADDITIONAL LEARNING RESOURCES:**

1. P.C. Markanda, Naresh Markanda, Rajesh Markanda, *Building and Engineering Contracts- Law and Practice*, Vol-I and II, 5thEdition, LexisNexis Publication.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 3 | 3 | - | 3 | - | 3 | - | 2 | 1 | - | | | |
| **CO2** | 3 | 3 | 3 | 3 | - | 3 | - | 3 | - | 2 | 1 | 2 | | | |
| **CO3** | 2 | 2 | - | 3 | - | 3 | - | 3 | - | - | - | - | | | |
| **CO4** | 2 | 2 | - | - | - | 3 | - | 3 | - | - | - | - | | | |
| **CO5** | 2 | 2 | - | - | - | 3 | - | 3 | - | - | - | - | | | |
| **Average** | 2.4 | 2.4 | 3 | 3 | | 3 | | 3 | | 2 | 1 | 2 | | | |
| **Correlation level** | 3 | 3 | 3 | 3 | | 3 | | 3 | | 2 | 1 | 2 | | | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

(19BT40306) **GLOBAL STRATEGY AND TECHNOLOGY**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITES**: --

**COURSE DESCRIPTION**:

Introduction to strategic management; Strategic management process; Principles of good strategy; Globalization strategies; Research and Development strategies; Technology Management and Transfer; Elements of Transfer Process; Corporate Governance in the Indian scenario.

**COURSE OUTCOMES:**

*After successful completion of this course, the students will be able to:*

CO1. Demonstrate the knowledge on strategic management, its approaches, and tools through ethical decision making.

CO2. Analyze the globalization challenges for scrupulous selection of globalization strategies.

CO3. Apply the R&D strategies and trends to enhance the technological breakthroughs for new products and applications.

CO4. Demonstrate the knowledge on technology management and transfer that strengthen the economy and accelerate the application of technology and resources.

CO5. Analyze the challenges of corporate governance in Indian scenario for the effective development of value oriented organizations.

**DETAILED SYLLABUS:**

**UNIT I: STRATEGIC MANAGEMENT** **(9 periods)**

Introduction, Classes of decisions, Levels of strategy, Core competence, Strategic intent and stretch, Approaches to strategy making, Roles of different strategists, Strategic management-Process, Benefits, Limitations; Ethics in strategic decision making, Principles of good strategy, Strategic Management in India; Common managerial strategy formulation tools.

**UNIT II: GLOBALIZATION** **(9 periods)**

Definition, Stages, Essential conditions for globalization, Globalization strategies, Competitive advantage of Nations and regions, Factors affecting Globalization, Globalization of Indian business.

**UNIT III: RESEARCH & DEVELOPMENT STRATEGIES** **(9 periods)**

Concept, Evolution of R and D Management, R and D as a business, R and D as competitive advantage, Elements of R and D strategies, Integration of R and D, Selection and implementation of R and D strategies, R and D trends and challenges.

**UNIT IV: TECHNOLOGY MANAGEMENT AND TRANSFER** **(9 periods)**

**TechnologyManagement:** Introduction, Technology-Definition, Components, Classification Features; Technology Management-Concept, Nature; Drivers of Management of Technology-Significance, Scope, Responding to technology challenges.

**Technology Transfer:** Introduction, Definition, Classification, Significance, Elements of process, Types of Technology Transfer, Package, Modes of Transfer, Routes, Channels and Effectiveness of Technology Transfer.

## UNIT V: CORPORATE GOVERNANCE: THE INDIAN SCENARIO                    (9 periods)

Emergence of corporate governance in India-Landmarks, Models, Codes and status in India, Role and Responsibilities of Regulators, The Board of Directors; Corporate Governance-Specific issues in India, Family owned Business, Corporate Governance and the Indian ethos.

**Total periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Francis Cherunilam, *Strategic Management*, Himalaya Publishing House, 3rdEdition, 2002.
2. C. S. G. Krishnamacharyulu and Lalitha Ramakrishnan, *Management of Technology*, Himalaya Publishing House, Second Edition, 2012.

**REFERENCE BOOKS:**

1. White and Bruton, *The Management of Technology and Innovation:A Strategic Approach*, Cengage Learning, 1stEdition, 2007.
2. S.K.Mandak, *Ethics in Business and Corporate Governance*, TMH, 2ndEdition, 2012.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | 1 | 1 | | 1 | | 2 | | | | | | | |
| **CO2** | 3 | 3 | 1 | 1 | | 1 | | 1 | | | | | | | |
| **CO3** | 3 | 2 | 2 | 1 | | 1 | | | | | | | | | |
| **CO4** | 3 | 2 | 1 | 1 | | 1 | | | | | | | | | |
| **CO5** | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| **Average** | 3 | 2.2 | 1.2 | 1 | | 1 | | 1.5 | | | | | | | |
| **Correlation level** | 3 | 2 | 1 | 1 | | 1 | | 2 | | | | | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT40307) **MANAGEMENT SCIENCE**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Concepts of Management; Concepts Related to ethics and social responsibility; Human Resource Management; Operations Management; Statistical Process Control; Inventory Management; Marketing; Project Management; Project Crashing.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the concepts of management, its functions and processes used in optimum resource utilization within the context of ethics and social responsibility.

CO2. Apply the concepts of HRM for selection and management of human resources.

CO3. Analyze different operations management problems using quality management tools to produce effective, efficient and adoptable products/services.

CO4. Identify different marketing strategies to maximize enterprise profitability and customer satisfaction within the realistic constraints.

CO5. Develop network models in time-cost tradeoff for effective project management.

**DETAILED SYLLABUS:**

**UNIT I: MANAGERIAL FUNCTION AND PROCESS                      (10 periods)**

Concept and foundations of management, Evolution of management thought; Managerial functions – Planning, Organizing, Directing and Controlling; Decision-making; Role of manager, managerial skills; Managing in a global environment, Flexible systems management; Social responsibility and managerial ethics; Process and customer orientation; Managerial processes on direct and indirect value chain.

**UNIT II: HUMAN RESOURCE MANAGEMENT                      (8 periods)**

Human Resource challenges; Human Resource Management functions; Human Resource Planning; Job analysis; Job evaluation, Recruitment and selection; Training and Development; Promotion and transfer; Performance management; Compensation management and benefits; Employee morale and productivity; Human Resource Information System.

**UNIT III: OPERATIONS MANAGEMENT                      (10 periods)**

Fundamentals of Operations Management, Services as a part of operations management; Facilities location and layout; Line balancing; Quality management – Statistical Process Control, Total Quality Management, Six sigma; Role and importance of materials management, Value analysis, Make or Buy decision, Inventory control, Materials Requirement Planning, Enterprise Resource Planning, Supply Chain Management.

**UNIT IV: MARKETING MANAGEMENT** **(8 periods)**

Concept, evolution and scope; Marketing strategy formulation and components of marketing plan; Segmenting and targeting the market; Positioning and differentiating the market offering, Analyzing competition; Product strategy; Pricing strategies; Designing and managing marketing channels; Integrated marketing communications.

**UNIT V: PROJECT MANAGEMENT** **(9 periods)**

Project management concepts; Project planning – Work Breakdown Structure, Gantt chart; Project scheduling – Critical Path Method, Program Evaluation and Review Technique, Crashing the project for time-cost trade off; Resource Levelling.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. MartandT.Telsang, *Industrial Engineering and Production Management*, S. Chand, 2nd Edition, 2006.

2. Koontz and Weihrich, *Essentials of Management*,TMH, 6th Edition, New Delhi, 2007.

**REFERENCE BOOKS:**

1. O.P. Khanna, *Industrial Engineering and Management*, Dhanpat Rai and Sons,2010.

2. N.D. Vohra, *Quantitative Techniques in Management*, TMH, 2nd Edition, New Delhi.

3. L.M. Prasad, *Principles and practice of Management*, S. Chand and Sons, 2006.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | 1 | | 1 | 1 | 1 | 1 | | | 1 | | | | |
| CO2 | 3 | 2 | 1 | | 1 | | | | | | 1 | | | | |
| CO3 | 3 | 3 | 1 | 1 | 1 | | | | | | 1 | | | | |
| CO4 | 3 | 2 | 1 | | 1 | 1 | | | | | 1 | | | | |
| CO5 | 3 | 3 | 3 | 1 | 1 | 1 | | | | | 2 | | | | |
| Average | 3 | 2.2 | 1.4 | 1 | 1 | 1 | 1 | 1 | | | 1.2 | | | | |
| Correlation level | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT40504) **CYBER LAWS AND SECURITY**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES**: --

**COURSE DESCRIPTION:**

Evolution of Cyberspace, Jurisdiction in the borderless Cyberspace, E-Contracting, Models of E-Commerce, Modes of Electronic signatures, E-Money, Intellectual Property Rights, Cybercrimes, Privacy and data security.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on jurisdiction in cyberspace and the impact of cybercrime to protect privacy on the Internet.

CO2. Analyze the Indian cyber laws on E-Contracting, E-Commerce, E-signatures and E-money to promote digital law enforcement.

CO3. Apply the knowledge of digital rights in Indian context to protect intellectual properties in electronic world.

CO4. Practice ethics and cyber law regulations for leading electronic transactions on the Internet.

**DETAILED SYLLABUS:**

**UNIT I: EVOLUTION OF CYBERSPACE AND JURISDICTION IN BORDERLESS CYBERSPACE** **(9 periods)**

**The Evolution of Cyberspace:** Significance of information technology, Drawbacks in information technology, the digital divide, E-governance, Origin of cyberspace, Legal issues in cyberspace, regulating the Internet.

**Jurisdiction in the Borderless Cyberspace:** Meaning of jurisdiction, Three pre-requisites of jurisdiction, Jurisdictional theories in jurisdiction to prescribe, Tests to determine jurisdiction in Internet law cases, Indian laws to determine personal jurisdiction, Jurisdiction clauses in click wrap agreement.

**UNIT II: ELECTRONIC CONTRACTING AND ELECTRONIC COMMERCE** **(9 periods)**

**Electronic Contracting**: Formation of offline contracts under English common law, Fundamental requirements of an offline contract, Forming an E-contract through website, E-mail contracting, The Indian approach of E-contracts, Contract formation on the Internet and Information Technology Act 2000, B2C E-contracts.

**Electronic Commerce:** Models, Advantages, Restricted activities, Laws, India's information Technology Act2000, Online customer protection in India(B2B, B2C).

**UNIT III: ELECTRONIC SIGNATURES AND ELECTRONIC MONEY** **(9 periods)**

**Electronic Signatures:** The role of signatures, Significance of electronic signatures, Modes of electronic signatures, UNCITRAL model law on electronic signatures 2001, Cryptography, Role of certifying authority in PKI, The Indian Information Technology Act and electronic signatures- Electronic signatures, Prescribed authentication mechanisms, Secure electronic record.

**Electronic Money:** E-Money, RBI's guidelines on mobile banking and payments, The current E-payment systems, Earlier E-payment systems, Credit cards, Use of SET in online payment system.

## UNIT IV: INTELLECTUAL PROPERTY RIGHTS AND THE INTERNET WORLD

**(9 periods)**

Protecting copyright in the E-world, International organizations protecting Intellectual Property, Copyright issues on the Internet, Digital rights management, Patent protection and computer software, India and copyright protection for computer software, Business method patents- Position of Business methods patents in India, Trademark protection on the Internet, Cybersquatting, The Indian trademark law and legal remedies, Hyper linking and framing.

## UNIT V: CYBERCRIMES AND PROTECTING PRIVACY ON INTERNET (9 periods)

**Cybercrimes:** What is cybercrime, Categories, Different kinds of cybercrime, Cybercrimes and Information Technology Act, 2000 - Territorial scope and applicability, India's national cyber security policy.

**Protecting Privacy on the Internet:** Meaning of privacy, Threat to privacy on the Internet, Use of cookies and web bugs, Terms of use and privacy policy, Government right to interception, Employee privacy rights, Indian legal framework for data protection and privacy, Challenges to right of privacy in India.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOK(S):**

1. Karnika Seth, *Computers Internet and New technology Laws*, LexisNexis, 2013.


**REFERENCE BOOKS:**

1. Sarika Gupta, Gaurav Gupta, *Information Security and Cyber Laws*, Khanna Publishing, 2019.

2. Vivek Sood, *Cyber Law Simplified*, McGraw Hill,2018.

3. Pavan Duggal, *Textbook on Cyber Law*, Universal LexisNexis, 2019.

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd2_cec20_cs09/preview
- https://swayam.gov.in/nd2_nou19_cs08/preview

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | 3 | - | - | - | - | - | - | | | |
| CO2 | 3 | 2 | - | - | - | 3 | - | - | - | - | - | - | | | |
| CO3 | 3 | - | - | - | - | 3 | - | - | - | - | - | - | | | |
| CO4 | - | - | - | - | - | - | - | 3 | - | - | - | - | | | |
| Average | 3 | 2 | - | - | - | 3 | - | 3 | - | - | - | - | | | |
| Correlation level | 3 | 2 | - | - | - | 3 | - | 3 | - | - | - | - | | | |

**Correlation Levels:      3– High       2 - Medium        1– Low**

(19BT50208) **INTELLECTUAL PROPERTY RIGHTS**
(Open Elective-2)
(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Introduction to Intellectual Property; Trade Marks; Law of Copy Rights; Law of Patents; Trade Secrets; Unfair Competition; New Development of Intellectual Property.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand the concepts of intellectual property right and new amendments enforced in filling intellectual property right.

CO2. Understand the processes and principles of trade mark registration and apply them for registering trade mark.

CO3. Understand the process and principles of copy rights for registration and judicial consequences for violating laws of copyright/patents.

CO4. Understand the process and principles of trade secrets and judicial consequences for coping trade secrets.

**DETAILED SYLLABUS:**

**UNITI: INTRODUCTION TO INTELLECTUAL PROPERTY                    (10 periods)**

Introduction and the need for intellectual property rights (IPR); types of intellectual property- Design, Geographical Indication; International organizations, agencies and treaties.

**UNIT II: TRADEMARKS                                                          (8 Periods)**

Introduction to trademark, Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

**UNIT III: LAW OF COPYRIGHTS                                               (9 Periods)**

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

**Law of patents:** Foundation of patent law, patent searching process, ownership rights and transfer.

**UNIT IV: TRADESECRETS                                                       (9 periods)**

Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

**Unfair competition:** Misappropriation right of publicity, false advertising.

**UNIT V: NEW DEVELOPMENT OF INTELLECTUAL PROPERTY          (9 periods)**

New developments in: trade mark law, copy right law, patent law, intellectual property audits. International overview on intellectual property; international - trade mark law, copy right law, international patent law, international development in trade secrets law.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Deborah, E. Bouchoux, *Intellectual property: The law of Trademarks, Copyright, Patents, and Trade Secrets,* Cengage learning, 4th edition, 2013.

2. PrabuddhaGanguli, *Intellectual property right - Unleashing the knowledge economy*, Tata McGraw Hill Publishing Company Ltd.

**REFERENCE BOOKS:**

1. Neeraj P and Khusdeep D. *Intellectual Property Rights*. India, IN: PHI learning Private Limited. 1st edition 2019.

**ADDITIONAL LEARNING RESOURCES:**

1. Subramanian, N., &Sundararaman, M. (2018). *Intellectual Property Rights – An Overview*. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf

2. World Intellectual Property Organisation. (2004). *WIPO Intellectual property Handbook*. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | 3 | - | 3 | - | - | - | - | | | |
| CO2 | 2 | - | - | - | - | 2 | - | 2 | - | - | - | - | | | |
| CO3 | 2 | - | - | - | - | 3 | - | 2 | - | - | - | - | | | |
| CO4 | 2 | - | - | - | - | 3 | - | 2 | - | - | - | - | | | |
| Average | 2.2 | | | | | 2.7 | | 2.2 | | | | | | | |
| Correlation level | 2 | | | | | 3 | | 2 | | | | | | | |

**Correlation Levels:** 3– High 2 - Medium 1– Low

(19BT50409) **GREEN TECHNOLOGIES**

(Open Elective-2)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Principles of green engineering; Green communications; Green energy; Green computing; Green construction; Green manufacturing.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze energy efficient communication systems such as Telecommunication systems, ICT, Wireless networks and cellular networks by understanding the principles of green communications.

CO2. Understand the impact of conventional energy sources on environment and realize the significance and principles of green energy sources for sustainability.

CO3. Understand the environmental impacts of IT and approaches for Green IT.

CO4. Analyze concepts of sustainable green construction using appropriate tools and techniques following latest developments and considering safety and environment besides communicating effectively in graphical form.

CO5. Demonstrate the environmental impact of traditional manufacturing and explore the need for green manufacturing process promoting sustainability.

**DETAILED SYLLABUS:**

**UNIT I: PRINCIPLES OF GREEN ENGINEERING AND GREEN COMMUNICATIONS**
**(9 periods)**

**Principles of Green Engineering:** Introduction, Definition of green engineering, Principles of green engineering

**Green Communications:** Introduction, Origin of Green Communications, Energy Efficiency in Telecommunication systems, Telecommunication system model and energy Efficiency, Energy saving concepts, Quantifying energy efficiency in ICT, Energy efficiency metrics of green wireless networks, Embodied energy of communication devices- Introduction, The extended energy model, Embodied/Operating Energy of a BS in Cellular network- A Case study; Energy efficient standards for wireline communications.

**UNIT II: GREEN ENERGY** **(9 periods)**

Introduction, green energy systems - composition, adverse impacts,Green energy and sustainability, the target and solution.Diversification and localization of energy systems, green energy and sustainable development.Energy sources and their availability. Green energy sources - solar energy, wind energy, geothermal energy, ocean energy, biomass and biogas.

**UNIT III: GREEN IT** **(9 periods)**

Introduction, Awareness to Implementation: Green IT Trends, Green Engineering, Greening by IT: Using RFID for Environmental Sustainability, Smart Grids, Smart Buildings and Homes, Green Supply Chain and Logistics, Enterprise-Wide Environmental Sustainability, A

Seven-Step Approach to Creating Green IT Strategy: Balancing the Costs and Benefits of Going Green, Research and Development Directions.

## UNIT IV: GREEN CONSTRUCTION                                    (9 periods)

**Green Building:** Concept, Necessity, Characteristics, Benefits, Requisites for green building construction, Sustainability, Concept of REDUCE, REUSE, RECYCLE, RETHINK, REPLENISH AND REFUSE (6 R's), Sustainable construction focus point – Site selection, Planning, Water, Energy, Material, Indoor air quality, Construction procedures, case studies of residential and commercial green buildings.

**Vastu:** Concept, History, scientific approach, elements of vastu for selecting a plot.

**Indian Green Building Council:** Introduction to IGBC green homes, Benefits of IGBC, IGBC green home rating system, Introduction to USGBC, LEED rating system, Procedure to get IGBC certification, GRIHA Rating.

## UNIT V: GREEN MANUFACTURING                                   (9 periods)

Green Manufacturing - Introduction, Background and Definition; Impact of traditional manufacturing in environmental ecology, Need for green manufacturing, Motivation and barriers to green manufacturing, Advantages and Limitations of green manufacturing, Green manufacturing strategies,Green manufacturing and sustainability, Green manufacturing through clean energy supply, Green packaging and Supply chain.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. KonstantinosSamdanis, Peter Rost, Andreas Maeder, MichelaMeo, Christos Verikoukis, *Green Communications: Principles, Concepts and Practice*, John Wiley & Sons, 2015.

2. G.D. Rai, *Non-conventional Energy Sources*, KhannaPublishers, Delhi, 5th Edition,2011.

3. San Murugesan, G.R. Gangadharan, *Harnessing Green IT – Principles and Practices*, John Wiley & Sons Ltd., 2008.

4. Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison, *Green Building Handbook*, Volume 1, E & FN Spon, an imprint of Thomson Science & Professional.

5. J Paulo Davim, *Green Manufacturing: Processes and Systems*, Springer, 2012.

6. David A Dornfeld, *Green Manufacturing: Fundamentals and Applications*, Springer, 2013.

**REFERENCE BOOKS:**

1. Soli J. Arceivala, *Green Technologies for a better future,* McGraw Hill Education (India) Pvt. Ltd, 2014.

2. *Marty Poniatowski, Foundation of Green Information Technology, Prentice Hall, 2009.*

3. Athanasios V Alavanidis, ThomaisVlachogianni, *Green Chemistry and Green Engineering*, SynchronaThemata, 2012.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 3 | - | - | - | 2 | - | - | - | - | - | - | | | |
| CO2 | 3 | 1 | - | - | - | 2 | 3 | - | - | - | - | - | | | |
| CO3 | 3 | - | - | - | - | 2 | 3 | - | - | - | - | - | | | |
| CO4 | 3 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | | | |
| CO5 | 3 | 2 | - | - | - | - | 3 | - | - | - | - | - | | | |
| Average | 2.8 | 2.2 | | 2 | 2 | 2 | 3 | | | | | | | | |
| Correlation level | 3 | 2 | | 2 | 2 | 2 | 3 | | | | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

**(19BT40132) FLUID MECHANICS AND HYDRAULIC MACHINERY LAB**

(Common to CE and ME)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

Courses on Fluid Mechanics, Hydraulic Engineering/Fluid Mechanics and Hydraulic Machinery

**COURSE DESCRIPTION:**

Calibration of flow meters; Verification of Bernoulli's equation; Performance of turbines and pumps; Losses through pipes.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Evaluate fluid flow characteristics using appropriate tools and techniques to solve fluid mechanics problems by following latest developments and ensuring safety.

CO2. Evaluate the performance and behaviour of hydraulic machinery using appropriate tools and techniques to solve hydraulic machinery problems by following latest developments and ensuring safety.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on fluid mechanics and hydraulic machinery.

**LIST OF EXPERIMENTS:**

1. Calibration of venturimeter
2. Calibration of orificemeter
3. Determination of coefficient of discharge for a small orifice by a constant head
4. Determination of coefficient of velocity for small orifice by variable head method
5. Calibration of rectangular notch
6. Determination of loss of head due to sudden contraction
7. Determination of coefficient of friction for pipes
8. Verification of Bernoulli's equation
9. Study of impact of jet on vanes
10. Study of hydraulic jump
11. Performance test on Pelton wheel
12. Performance test on Francis turbine
13. Performance test on Kaplan turbine
14. Performance test on single stage centrifugal pump
15. Performance test on multi stage centrifugal pump
16. Performance test on reciprocating pump

**REFERENCE BOOKS/LABORATORY MANUALS:**

SVEC19 Fluid Mechanics and Hydraulic Machinery Laboratory Manual

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 2 | - | 3 | 1 | 1 | - | - | 2 | 1 | - | 2 | | | |
| **CO2** | 3 | 2 | - | 3 | 1 | 1 | - | - | 2 | 1 | - | 2 | | | |
| **CO3** | 3 | 2 | - | 3 | 1 | 1 | - | - | 2 | 1 | - | 2 | | | |
| **Average** | **3** | **2** | | **3** | **1** | **1** | | | **2** | **1** | | **2** | | | |
| **Correlation level** | **3** | **2** | | **3** | **1** | **1** | | | **2** | **1** | | **2** | | | |

**Correlation Levels:  3– High  2 - Medium  1– Low**

## II B. Tech. – II Semester
### (19BT40331) **DYNAMICS OF MACHINERY LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:**

A course on Basic Engineering Mechanics and Kinematics of Machinery.

**COURSE DESCRIPTION:**

Determination of gyroscopic couple; Unbalanced couple and forces in static and dynamic balancing of rotating masses; Radius of gyration of compound pendulum; Moment of inertia of a flywheel; mass moment of inertia and radius of gyration of bifilar suspension; Coriolis component of acceleration; Pressure distribution in journal bearing; sensitivity and effort for governors; cam - follower mechanism; Vibration parameters of spring mass system, single rotor shaft, two rotor systems, cantilever beam, fixed beam and whirling of shaft.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Determine the characteristics of the control mechanisms such as Governors, Gyroscope, Cam-follower, flywheel and Journal bearings.

CO2. Analyze the unbalanced forces and couple in masses (Rotating & Reciprocating) in different planes and determine the position and direction of the given masses.

CO3. Calculate the vibration parameters of spring mass system, single rotor shaft, two rotor systems, cantilever beam, fixed beam and whirling of shaft.

CO4. Compute the mass moment of inertia and radius of gyration of bifilar suspension, simple pendulum, compound pendulum.

CO5. Analyze the effect of the Coriolis component of acceleration of the link and derive the equations for Coriolis force.

CO6. Work independently / in groups & communicate effectively in oral and written forms.

**LIST OF EXPERIMENTS:**

1.  Determination of gyroscopic couple using Motorized gyroscope.
2.  Determination of unbalanced couple and forces in static and dynamic balancing of rotating masses.
3.  Determination of radius of gyration of a given compound pendulum.
4.  Determination of moment of inertia of a flywheel.
5.  Determination of mass moment of inertia and radius of gyration of bifilar suspension.
6.  Determination of the Coriolis component of acceleration.
7.  Determination of pressure distribution in journal bearing.
8.  Determination of sensitivity, effort for Porter, Proell and Hartnell governors.
9.  Draw the cam profile and study the jump-off phenomenon in a cam - follower mechanism.
10. Estimation of the frequency of undamped and damped force vibration of a spring mass system.
11. Determine the frequency response curve under different damping conditions for single degree freedom system of vibration.

12. Determination of the natural frequencies of undamped and damped torsional vibration using single rotor shaft system.
13. Determination of critical speed of shaft with concentrated loads using whirling of shaft.
14. Determine the natural frequency of torsional vibration of two rotor system and position of node.
15. Determination of natural frequency and deflection of cantilever beam and fixed beam under transverse vibration
16. Analysis of machine vibration, signature, using FFT analyzer.

Note: Minimum Twelve experiments are to be conducted.

**REFERENCE BOOKS/LABORATORY MANUALS**:

SVEC19 Dynamics of Machinery Lab Manual

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO2 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO3 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO4 | 3 | 3 | 1 | 1 | | | | | | | | | | | |
| CO5 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO6 | | | | | | | | | 3 | 3 | | | | | |
| Average | 3 | 3 | 1 | 1 | | 1 | | | 3 | 3 | | | | | |
| Correlation level | 3 | 3 | 1 | 1 | | 1 | | | 3 | 3 | | | | | |

**Correlation Levels:     3– High      2 - Medium      1– Low**

## II B. Tech. – II Semester

## (19BT40332) **ENGINEERING METROLOGY AND MACHINE TOOLS LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Demonstration on lathe; drilling; milling; slotting machine; shaper; grinding machine; milling machine; provides skill on making products using machines tools; Demonstration on Calibration of instruments such as Vernier calipers, Micrometer, Vernier height gauge; Measure dimensions of shafts, bearings; Straightness and flatness measurements; Identifying uncertainties in dimensional metrology; Measurement of gear and threaded profiles.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Design and model different components by performing metal cutting operations using machine tools with in the realistic constraints.

CO2. Determine physical parameters using tools, instruments and measurement systems in practical applications.

CO3. Work independently / in groups & communicate effectively in oral and written forms.

**List of Exercises/List of Experiments**

**Metrology**

1. Measurement of lengths, heights, diameters by Vernier callipers and micrometers.

2. Measurement of bores by internal micrometer and dial bore indicators

3. Chordal addendum, chordal height of spur gear by gear teeth Vernier callipers

4. Measurement of straightness and flatness using spirit level and Autocollimator

5. Study of Toolmakers Microscope and its applications

6. Angle and Taper Measurements by Bevel Protractor, sine bar etc.

7. Thread measurement by two/three wire method.

8. Surface roughness measurement by Talysurf instrument

9. Measurement of screw elements by using profilometer

**Machine Tools**

1. Demonstration of construction and operations of general purpose machines: Lathe, drilling machines, Milling machine, shaper, planer, slotting machine, cylindrical grinder, surface grinder and tool and cutter grinder.

2. Job on step turning and taper turning on Lathe machine.

3. Job on thread cutting and knurling on Lathe machine.

4. Drilling, tapping and reaming using radial drilling machine

5. V - Block shaping using shaping machine

6. Internal splines cutting using slotting machine

7. Single point cutting tool Grinding using tool and cutter grinder

8. Profile cutting using vertical milling machine

9. Spur gear cutting using horizontal milling machine

10. Surface grinding operation using surface grinder

11. Cylindrical grinding machine using cylindrical grinder

Note: Minimum Twelve Experiments are to be conducted (Minimum 6 Experiments from each section)

**REFERENCE BOOKS/LABORATORY MANUALS**:

SVEC19 Engineering Metrology and Machine Tools Lab Manual

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | | | 1 | | | | | | | | | |
| CO2 | 3 | 2 | 1 | | 1 | 1 | | | | | | | | | |
| CO3 | | | | | | | | | 3 | 3 | | | | | |
| Average | 3 | 2 | 1 | | 1 | 1 | | | 3 | 3 | | | | | |
| Correlation level | 3 | 2 | 1 | | 1 | 1 | | | 3 | 3 | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## II B. Tech. – II Semester

### (19BT3MC01) **ENVIRONMENTAL SCIENCE**

(Mandatory Course)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | - | 40 | 2 | - | - | - |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Natural resources; Ecosystems; Biodiversity; Environment pollution and control; Social issues and environment; Human population and environment.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze natural resources to solve complex environmental problems and natural resource management considering society, environment and sustainability.

CO2. Analyze ecosystems and biodiversity to solve complex environmental problems by following environmental ethics considering society, environment and sustainability besides communicating effectively in graphical form.

CO3. Analyze various types of pollution and their control measures to solve environmental problems through appropriate tools and techniques following latest developments considering society, ethics, environment and sustainability.

CO4. Analyze social issues and its impact on environment, environmental acts to solve complex environmental problems considering society, environment and sustainability besides communicating effectively in graphical form.

CO5. Analyze human population and its impact on environment to solve complex environmental problems through team work and using appropriate tools and techniques considering ethics, society, environment and sustainability.

**DETAILED SYLLABUS:**

**UNIT I: NATURAL RESOURCES**               **(7 Periods)**

Multidisciplinary nature of environment; Natural Resources: Renewable and non-renewable resources; Forest, Water, Mineral, Food and Energy resources -Causes, Effects, Remedies, Case studies; Role of an individual in conservation of natural resource and equitable use of resources for sustainable lifestyles.

**UNIT II: ECOSYSTEMS AND BIODIVERSITY**         **(7 Periods)**

***Ecosystems:*** Concept of an ecosystem, Structure and function of an ecosystem - Producers, Consumers, Decomposers; Food chains, Food webs, Ecological pyramids – Types; Characteristic features, Structure and functions of forest ecosystem, Desert ecosystem, Aquatic ecosystem.

***Biodiversity:*** Concept and value of biodiversity, Role of biodiversity in addressing new millennium challenges, Hot spots of biodiversity, Threats to biodiversity, Man-wild life conflicts, Endemic, Endangered and extinct species of India, Conservation of biodiversity – In-situ and ex-situ.

## UNIT III: ENVIRONMENTAL POLLUTION AND CONTROL  (6 Periods)

Causes, Adverse effects and control measures of pollution - Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear pollution, Solid waste management – Urban waste, industrial waste; Latest developments in pollution control, Hazards and disaster management – Floods, Earthquakes, Tsunamis, Case studies.

## UNIT IV: SOCIAL ISSUES AND THE ENVIRONMENT  (6 Periods)

Sustainable development, Urban problems related to energy, Environmental ethics –Issues, Solutions; Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and case studies, Wasteland reclamation, Consumerism and waste products, Concept of green technologies, Environment justice: National Green Tribunal and its importance; Environment protection act, Air act, Water act, Wildlife protection act, Forest conservation act, Issues involved in enforcement of environmental legislation, Public environmental awareness.

## UNIT V: HUMAN POPULATION AND THE ENVIRONMENT  (4 periods)

Population growth, Population characteristics and variation among nations, Population explosion, Family welfare programme, Environment and human health, Human rights, Value education, HIV/AIDS, Women and child welfare, Role of information technology in environment and human health; Case studies - Field Work/Assignment/Seminar on Environmental assets – Water bodies/Forest/Grassland/Hill/Mountain.

**Total Periods: 30**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Anubha Kaushik and C. P. Kaushik, *Perspectives in Environmental Studies*, New Age International (P) Ltd. Publications, 6th Edition, 2018.

2. Erach Barucha, *Environmental Studies,* Orient Blackswan, 2nd Edition, 2013.

**REFERENCE BOOKS:**

1. Cunningham W.P. and Cunningham M.A., *Principles of Environmental Science*, Tata McGraw-Hill Publishing Company, New Delhi, 8th Edition,2016.

2. Benny Joseph, *Environmental Studies*, Tata McGraw-Hill, 2nd Edition, 2009.

3. M. Anji Reddy, *Textbook of Environmental Sciences and Technology*, BS Publications, 2014

4. R. Rajagopalan, *Environmental Studies*, Oxford University Press, 2nd Edition, 2011.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | - | 2 | - | 1 | 1 | - | - | - | 1 | - | | | |
| **CO2** | 3 | 3 | - | 2 | - | 1 | 1 | 1 | - | 1 | - | - | | | |
| **CO3** | 3 | 3 | - | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 | | | |
| **CO4** | 3 | 3 | - | 3 | - | 1 | 1 | 1 | - | 1 | - | - | | | |
| **CO5** | 3 | 3 | - | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | | | |
| **Average** | 3 | 3 | - | 2.7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| **Correlation level** | 3 | 3 | - | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | |

**Correlation Levels:**  **3– High**  **2 - Medium**  **1– Low**

## III B. Tech. – I Semester

## (19BT50301) COMPUTER AIDED DESIGN AND MANUFACTURING

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Manufacturing Technology.

**COURSE DESCRIPTION:**

Fundamental and conventional CAD processes; Raster scan graphics co-ordinate system; Transformations; Geometric construction models; Curve representation methods; Computer Control in NC; GT; CAPP.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the basic concepts of CAD to generate a suitable geometric model of an object.

CO2. Analyze algorithms for computer graphics and use geometric models to generate complex contours

CO3. Develop the CNC code for the complex machining process.

CO4. Demonstrate Computer aided manufacturing and computer aided quality control application over manufacturing.

CO5. Demonstrate knowledge of automation, robotics and applications.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO CAD/CAM, CIM**           **(10 Periods)**

Computers in Industrial Manufacturing, Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Integrated Manufacturing (CIM), Design process, Product Life Cycle, CAD hardware, CAD Standards-Introduction, classification and Importance of CAD standards. Computer Integrated Manufacturing - Introduction, Types of Manufacturing System, Nature and role of the elements of CIM System, CIMS Benefits, Database requirements for CIM.

**UNIT II: COMPUTER GRAPHICS & GEOMETRIC MODELING**        **(10 Periods)**

**Computer graphics:** Raster Scan Graphics – DDA Line Algorithm, Bresenham's Line algorithm, Coordinate system, 2D &3DTransformations (Scaling, Translation, Rotation&Reflection)

**Geometric Modeling:** Requirements of Geometric Modeling, Definition to Parametric and Non-parametric representation, Introduction to curve representation, Analytical and Synthetic curve representation(Bezier, B-spline & Nurbs).

**UNIT III: COMPUTER NUMERICAL CONTROL**           **(09 Periods)**

Introduction to CNC, CNC Hardware basics (Structure of CNC machine tools, Actuation systems, Feedback devices), CNC Tooling (Automatic tool changers, Work holding, CNC programming, Part Programming fundamentals, Manual part programming methods, Preparatory Functions, Miscellaneous Functions, Canned Cycles.

## UNIT IV: COMPUTER AIDED PROCESSPLANNING&QUALITY CONTROL (08 Periods)

Group Technology: Introduction, Part Family, Classification and Coding, Types of coding systems, Identification systems (RFID, Barcodes), Group Technology Cells, Benefits of Group Technology. Computer Aided Process Planning: Retrieval & Generative Computer Aided Process Planning and CAPP systems, CAPP implementation considerations, Benefits of CAPP.

Computer Aided Quality Control: Introduction, Inspection and Testing, Contact & Non-Contact inspection methods.

## UNIT V: AUTOMATION AND ROBOTICS                (08 Periods)

**Automation:** Introduction to automation, Elements of automation, Types of automation systems, part transfer methods and mechanisms- flow lines-types.

**Robotics**: Introduction to robotics, Law of robotics, Anatomy, Configuration of robots, Robot end effectors-classification, Robotic joints, grippers.


**Total Periods: *45***


**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. P.N. Rao, *CAD/CAM: Principles and Applications*, TMH, 2004
2. Radhakrishnan and Subramaniah, *CAD/CAM/CIM*, New Age International, 2004
3. Michael E.Mortenson*, Geometric Modelling*,Wiley 2013

**REFERENCE BOOKS:**
1. Ibrahim Zeid, CAD/CAM Theory and Practice, McGraw Hill,2010.
2. MikellP.Groover, Computer Aided Design & Computer Aided Manufacturing, Pearson Education,2006.
3. E. Micheal, *Geometric Modelling*, John Wiley & Sons,3rdedition 2013.

**4.**

5. **CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | 1 | | 1 | 1 | | | | | | | **3** | | |
| **CO2** | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | **3** | | |
| **CO3** | 3 | 3 | 1 | 1 | 2 | 1 | | | | | | | **3** | | |
| **CO4** | 3 | 1 | 1 | 1 | 1 | 1 | | | | | | | **3** | | |
| **CO5** | 3 | 1 | | | 1 | 1 | | | | | | | **3** | | |
| **Average** | **3** | **1.8** | **1** | **1** | **1.2** | **1** | | | | | | | **3** | | |
| **Correlation level** | **3** | **2** | **1** | **1** | **1** | **1** | | | | | | | **3** | | |

6. **Correlation Levels:**        **3– High**        **2 - Medium**        **1– Low**

**(19BT50302) OPERATIONS RESEARCH**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Requirements of Linear Programming Problem, Formulation, Graphical solution, Simplex method, Big-M method, Two Phase Method;  Vogel's approximation method; Modified distribution (MODI) method to find optimal solution; Two person zero sum games; Saddle point; Inventory costs and deterministic inventory control models; Project management through network analysis.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Apply linear programming techniques to solve complex problems and obtain optimal solutions.

CO2.  Analyze games through appropriate strategies to influence the game outcome.

CO3.  Apply suitable inventory control models for cost reduction and simulate them.

CO4.  Develop network models and solve project management issues involving diverse resources.

CO5.  Apply queuing models to compute the relevant characteristics and simulate them.

**DETAILED SYLLABUS:**

**UNIT I:  LINEAR PROGRAMMING PROBLEM** (10 periods)

Requirements of Linear Programming Problem, Formulation, Graphical solution, Simplex method, Big-M method, Two Phase Method, Dual formulation, Dual Simplex Method, Linear Programming special cases- Infeasible solution, Unboundedness, Redundancy, Alternate optimal solutions.

**UNIT II: TRANSPORTATION AND ASSIGNMENT MODELS** (08 periods)

**Transportation model:** Methods to find Basic Feasible Solution- North-West corner rule, Least cost method, Vogel's approximation method; Modified Distribution (MODI) method to find optimal solution, Special cases of transportation problems, Transshipment problem.

**Assignment model:** Hungarian method, Variants of Assignment Problem, Travelling Salesman Problem

**UNIT III: GAME THEORY AND INVENTORY  MODELS** (10 periods)

**Game Theory** – Two person zero sum games, Saddle point, Pure strategy, Mixed strategy – Dominance, Algebraic method and Graphical method.

**Inventory Models** – Functions, Types, Associated costs, Factors involved in inventory problem analysis, Inventory costs and deterministic inventory control models - single item inventory control models without shortages and with shortages, with quantity discounts.

## UNIT IV: NETWORK MODELS                                (09 periods)

Network Flow models – Minimal Spanning Tree, Shortest Path Problem and Maximal Flow Problem, Project management through network analysis- Critical Path Method, Program Evaluation Review Technique, Cost analysis and Crashing.

## UNIT V: QUEUING AND SIMULATION                        (08 periods)

**Queuing**: Infinite queue length model, Poisson arrivals and Exponential service times - single server and multi-server.

**Simulation:** Monte Carlo simulation, Simulation of a waiting line problem, Simulation of inventory model.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan.**

### TEXTBOOKS:

1. Hamdy A Taha, *Introduction to Operations Research*, Pearson India, 10th Edition, 2017

2. J.K. Sharma, *Operations Research: Theory and Applications*, Macmillan, New Delhi, 5th Edition, 2013.

### REFERENCE BOOKS:

1. Hillier, Libermann, *Introduction to Operations Research*, McGraw Hill Education (India) Private Limited, 10th Edition, 2017.
2. KantiSwarup, P.K. Gupta, Manmohan, *Operations Research*, Sultan Chand & Sons, 2019.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | 1 | | | | | 1 | | | | 3 |
| CO2 | 3 | 3 | 2 | 1 | | 1 | | | | | 1 | | | | 3 |
| CO3 | 3 | 3 | 2 | 1 | | 1 | | | | | 1 | | | | 3 |
| CO4 | 3 | 3 | 3 | 1 | | 1 | | | | | 3 | | | | 3 |
| CO5 | 3 | 3 | 2 | 1 | | 1 | | | | | 1 | | | | 3 |
| Average | 3 | 3 | 2.2 | 1 | | 1 | | | | | 1.4 | | | | 3 |
| Correlation level | 3 | 3 | 2 | 1 | | 1 | | | | | 1 | | | | 3 |

**Correlation Levels:        3– High        2 - Medium        1– Low**

## (19BT50303) **THERMAL ENGINEERING-II**

| Int. Marks | Ext.Marks | TotalMarks | L | T | P | C |
|------------|-----------|------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Engineering Thermodynamics and Thermal Engineering-I.

**COURSE DESCRIPTION:**

Steam Boiler; Classification of Boilers; Working of Steam Boilers; Functions of Various Boiler Mountings and Accessories; Performance parameters of boiler; Characteristics of flowthrough steam nozzles; Working of Steam Condensers and their performance; Cooling water requirements; Steam turbines and their analysis; Compounding and governing; Refrigeration systems; Psychrometry; Air conditioning systems.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1: Analyze the functional and performance characteristics of boiler systems to determine their performance parameters.

CO2: Analyze the performance characteristic of steam nozzles and condensers and calculate its performance characteristics.

CO3: Analyze the performance characteristic of steam turbines using velocity diagrams and determine their performance characteristics.

CO4: Calculate the performance characteristics of refrigeration systems**.**

CO5: Calculate the psychometric properties during the psychometric process in air conditioning systems.

**DETAILED SYLLABUS:**

**UNIT I: STEAM BOILERS                                                              (09 Periods)**

Classification of Boilers, Working of Fire Tube Boilers - Simple Vertical Boiler, Cochran Boiler, Cornish Boiler and Locomotive Boiler; Working of Water Tube Boilers–Babcock and Wilcox Boiler, Lamont Boiler and Benson Boiler; Functions of Boiler Mountings and Accessories; Boiler horsepower, equivalent evaporation, efficiency and heat balance.

Draught: classification – Height of chimney for given draught and discharge, condition for maximum discharge, the efficiency of chimney – artificial draught, induced and forced draught

**UNIT II: STEAM NOZZLES AND CONDENSERS                              (09 Periods)**

**Steam Nozzles:** Classification, functions, Flow of steam through the Nozzles, Velocity of Steam at the exit of Nozzle- Ideal and Actual expansion through the Nozzle; Discharge through the Nozzle-Condition for maximum discharge through the Nozzle, Critical Pressure Ratio; Nozzle Efficiency and Velocity Coefficient, Wilsons Line.

**SteamCondensers:** Classification, Working of Jet and Surface Condensers, Vacuum Efficiency, Condenser Efficiency, Sources of air, Effect of air leakage in Condenser-Edward's Air Pump; Cooling Water Requirement.

## UNIT III: IMPULSE TURBINES AND REACTION TURBINES          (09 Periods)

**Impulse turbine**: Classification of Steam Turbines, Working of De-laval Impulse Steam Turbine, Pressure velocity variations, Combined Velocity diagrams of Impulse turbine, Effect of friction, Axial thrust, Tangential thrust and Power developed, Compounding and Governing.

**Reaction Turbines:** Working of Parson's Reaction Turbine, Degree of Reaction, Pressure velocity variations and combined velocity diagram of Reaction turbine.

## UNIT IV: REFRIGERATION          (09 Periods)

Introduction to Refrigeration, Units of Refrigeration, Carnot Refrigerator, COP of a refrigerator, Heat Pump, Air refrigeration System-Working Principle and Essential Components of the Plant – COP – Representation of Cycle on T-S and P-h diagram; Vapour Compression Refrigeration (VCR) System – Working Principle and Essential Components of the Plant – COP – Representation of Cycle on T-S and P-h; Vapour absorption system-Working Principle and Essential Components of the Plant – COP; Introduction to refrigerants.

## UNIT V: AIR CONDITIONING          (09 Periods)

**Psychrometry:** Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using charts and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Introduction Air Conditioning Systems-Classification of Air conditioning systems.

**Total Periods: *45***


*Topics for self-study are provided in the lesson plan.*


**TEXTBOOKS:**

1. R.K.Rajput, *Thermal Engineering*, Laxmi Publication, 10th Edition,2018.

2. Mahesh M. Rathore*, Thermal Engineering,* Tata McGraw-Hill Education, 1st Edition,2010.


**REFERENCE BOOKS:**

1. R.S.Khurmi& J.S. Gupta, Thermal Engineering, S.Chand, 15th Edition, 2015.

*2.* R.S.Khurmi& J.S. Gupta*, Refrigeration and Air conditioning,* S.Chand, 5th Edition, 2020.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO2 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO3 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO4 | 3 | 3 | 1 | 1 | | 1 | 1 | | | | | | | | |
| CO5 | 3 | 3 | 1 | 1 | | 1 | 1 | | | | | | | | |
| Average | 3 | 3 | 1 | 1 | | 1 | 1 | | | | | | | | |
| Correlation level | 3 | 3 | 1 | 1 | | 1 | 1 | | | | | | | | |

**Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

(Professional Elective – 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Thermal Engineering-I

**COURSE DESCRIPTION:**

Basic components and classification of automobiles; Fuel Supply System; Cooling System; Ignition System; Electrical Systems; Electronic Systems; Transmission System; Steering System; Suspension and Braking System.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Demonstrate knowledge of vehicle structure, chassis layout and fuel supply systems.

CO2.  Demonstrate the knowledge of cooling systems and ignition systems used in an automobile.

CO3.  Demonstrate the knowledge of electrical and electronic systems used in the automobile.

CO4.  Demonstrate the knowledge on construction and working of transmission systems and steering systems of an automobile.

CO5.  Demonstrate the knowledge on construction and working of suspension and braking systems of an automobile.

**DETAILED SYLLABUS:**

**UNIT I**: **AUTOMOBILE BASICS AND FUEL SYSTEMS**                    **(09 periods)**

Classification of automobiles, Components of a four wheeler automobile, Chassis and body, Rear wheel drive, Front wheel drive, Four wheel drive, Turbocharging, Supercharging, Oil filters, Oil pumps.

Fuel system: S.I. Engine - Fuel supply system, Mechanical and electrical fuel pump, Air and fuel filters, Carburetor types; C.I. Engine - Requirements of diesel injection systems, Types of injection systems, Fuel pump, Types of nozzles, Nozzle spray formation, Injection timing.

**UNIT II: COOLING AND IGNITION SYSTEMS**                    **(10 periods)**

**Cooling systems:** Necessity of cooling system, Requirements of cooling systems, Types, Natural and Forced Circulation System, Thermostat, Types of radiators, Cooling Fan, Water pump, Antifreeze solutions.

**Ignition systems:** Function of an ignition system, Battery ignition system, Magneto coil ignition system, Electronic ignition system using contact breaker, Capacitive discharge ignition system.

**UNIT III: ELECTRICAL AND ELECTRONIC SYSTEMS** **(08 periods)**

**Electrical Systems:** Electrical Systems - Introduction, Charging circuit, Generator, Current – voltage regulator; starting system; Bendix drive mechanism, solenoid switch, lighting systems, Horn, wiper.

**Electronic Systems:** Electronics Systems - Introduction, Electronic Control Unit (ECU), Variable Valve Timing (VVT), Active Suspension System (ASS), Electronic Brake Distribution (EBD), Electronic Stability Program(ESP) Traction Control System (TCS), Global Positioning System (GPS).

**UNIT IV: TRANSMISSION AND STEERING SYSTEMS** **(10 periods)**

**Transmission systems**: Types of clutches - Cone clutch, Single and multi plate clutch, Centrifugal clutch; Types of Gearbox - Constant mesh, Sliding mesh, Synchromesh gearbox; Gear shifting mechanism, Automatic transmission, Propeller shaft, Universal joint, Differential, Real axle arrangement.

**Steering systems**: Requirements and functions of steering system, Layout of steering system, Steering gears, Steering linkages; Under steering, Oversteering, Steering ratio, Steering geometry - Camber, Caster, Toe-in, Toe out; Power steering, Wheel alignment and Balancing.

**UNIT V: SUSPENSION AND BRAKE ACTUATING SYSTEMS** **(08 periods)**

**Suspension systems**: Introduction, Functions of suspension system, Elements of suspension systems, Rigid axle suspension system, Torsion bar, Shock absorber, Telescopic damper, Independent suspension system.

**Brake actuating systems**: Need and functions of braking system, Classification of brakes, Mechanical, Hydraulic, Pneumatic, Vacuum brake systems.

**Total Periods:** *45*

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. Dr. Kirpal Singh, *Automobile Engineering*, Vol.1&Vol.2, Standard Publishers distributor, 12th edition, 2011
2. R.K.Rajput, *Automobile Engineering*, Lakshmi Publication, 2 nd Edition, 2014.

**REFERENCE BOOKS:**

1. V.M.Domkundwar, *Automobile Engineering*, Dhanpat Rai & Co, 1st Edition, 2013.
2. V.Ganesan, *IC Engines*, Tata McGraw-Hill, 3rd Edition, 2007.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| CO2 | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| CO3 | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| CO4 | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| CO5 | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| Average | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| Correlation level | 3 | 1 | | | | 1 | | | | | | | | 3 | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## (19BT50305) **COMPRESSIBLE FLUID FLOW**

(Professional Elective – 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Engineering Thermodynamics and Fluid Mechanics and Hydraulics Machinery.

**COURSE DESCRIPTION:**

Fundamentals of compressible flows; Mach number; Effect of Mach number on compressibility; One dimensional isentropic flow; Development and strength of the shock Waves; Supersonic flows; Fanno flow and Rayleigh flow.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Analyze the flow characteristics of compressible flows by solving governing equations.

CO2.  Analyze one-dimensional flows in diffusers and nozzles.

CO3.  Analyze compressible flow having shock waves and determine the strength of shock waves.

CO4.  Apply governing equations to compressible flow through constant area duct with friction.

CO5.  Apply governing equations to compressible flow through constant area duct with heat transfer

**DETAILED SYLLABUS:**

**UNIT I:  Fundamentals of Compressible Flows                    (09 periods)**

Introduction to Compressible Flow, Concept of continuum-system and control volume approach, Conservation of mass, momentum and energy-stagnation state, compressibility, Entropy relations; Wave propagation, Acoustic velocity, Mach number-effect of Mach number on compressibility, Pressure coefficient, the physical difference between incompressible, subsonic, sonic and supersonic flows, Mach cone, Sonic boom, Reference velocities, Impulse function-adiabatic energy equation, Representation of various flow regimes on steady flow adiabatic ellipse.

**UNIT II:  One Dimensional Isentropic flow:                    (09 periods)**

One dimensional steady isentropic flow-Adiabatic and isentropic flow of perfect gas-basic equations, Area-Velocity relation using 1D approximation-nozzle and diffuser-mass flow rate-chocking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser-working tables-charts and tables for isentropic flow-operation of nozzle under varying pressure ratios –over expansion and under expansion in nozzles.

**UNIT III: Normal shock Waves** **(09 periods)**

Irreversible discontinuity in supersonic flow-one dimensional shock wave-stationary normal shock-governing equations-Prandtl-Meyer relations-Shock strength-Rankine-Hugoniot Relation-Normal Shock on T-S diagram-working formula-curves and tables-Oblique shock waves -supersonic flow over compression and expansion corners (basic idea only)

**UNIT IV: Flow in constant area duct with friction(Fanno flow)** **(09 periods)**

Fanno curve and Fanno flow equations, solution of Fanno flow equations, variation of flow properties, variation of Mach number with duct length, isothermal flow in constant area duct with friction, tables and charts for Fanno flow, Experimental friction coefficients.

**UNIT V: Flow in constant area duct with heat transfer (Rayleigh flow)**

**(09 periods)**

Flow through constant area duct with heat transfer (Rayleigh Flow)-Governing equations-Rayleighline on h-s and P-v diagram-Rayleigh relation for perfect gas-maximum possible heat addition-location of maximum enthalpy point-thermal chocking-working tables for Rayleigh flow.

Compressible flow field visualization and measurement – Shadowgraph, Schlieren technique, Interferometer, Subsonic compressible flow field, Measurement (Pressure, Velocity and Temperature) - Wind tunnels –closed and open type

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. S.M.Yahya, *Fundamentals of Compressible Flows*, New age international publication, Delhi, 2018.
2. V. Babu, *Fundamentals of Gas Dynamics, John Wiley & Sons, 2nd Edition, 2008*

**REFERENCE BOOKS:**

1. Robert D. Zucker, *Fundamentals of Gas Dynamics*, John Wiley & Sons, 2nd Edition, 2002.
2. John. D. Anderson, *Modern Compressible Flow*, Mc Graw Hill.3rd Edition, 2017.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |
| CO2 | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |
| CO3 | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |
| CO4 | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |
| CO5 | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |
| Average | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |
| Correlation level | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT50306) **ENGINEERING METALLURGY**

(Professional Elective – I)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Engineering Chemistry and Materials Science& Engineering.

**COURSE DESCRIPTION:**

Iron ores, Alloys and their phase diagrams; various heat treatments; Materials and their classifications; Ferrous and Nonferrous materials application; processing techniques; Material characterization; analyzing the properties of materials.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of the melting process in various metals and alloys.

CO2. Analyze different phase transformations involved in metals and alloys.

CO3. Demonstrate knowledge of dislocation characteristics and strengthening mechanisms.

CO4. Analyze the mechanical and microstructural properties of materials by applicable tests and characterization techniques.

CO5. Demonstrate knowledge of powder metallurgy process for manufacturing complex parts.

**DETAILED SYLLABUS:**

**UNIT I: MELTING OF METALS**                                 **(09 periods)**

Introduction, Ores of various metals, melting of iron, Blast furnace, Cupola furnace, puddling furnace, melting of steel, Bessemer converter process, L-D process, Basic open-hearth process, Electric furnace Melting of superalloys, Vacuum induction melting, Vacuum arc remelting.

**UNIT II: PHASE TRANSFORMATIONS**                        **(09 periods)**

Introduction - Solidification of metal in Ingot mould – Types of phase transformations – Nucleation and Growth Kinetics – Multiphase transformations, Pearlitic, Bainitic, Martensitic transformations – Formation of austenite – Precipitation and age hardening – Special purpose heat treatment – Ferritic nitrocarbonizing, Cementation, Boronizing, Metalliding, Toyota diffusion, Salt nitriding.

**UNIT III: DISLOCATIONS AND STRENGTHENING MECHANISMS**      **(09 periods)**

Basic Concepts, Characteristics of Dislocations, Slip Systems, Slip in Single Crystals, Plastic Deformation of Polycrystalline Materials, Deformation by Twinning, Strengthening by Grain SizeReduction, Solid Solution Strengthening, Strain Hardening, Recovery, Recrystallization, Grain Growth.

## UNIT IV: MATERIAL TESTING AND CHARACTERIZATION TECHNIQUES (09 periods)

**Material Testing:**Introduction, Tensile Testing, Hardness, Impact fracture testing, Fatigue, Creep.

**Material characterization techniques:** Introduction, Steps in metallographic specimen preparation, Optical microscope (OM), Scanning electron microscope (SEM), Transmission electron microscope (TEM), X-ray diffraction (XRD), Fourier Transform Infra-red Spectroscopy (FTIR).

## UNIT V: POWDER METALLURGY                                      (09 periods)

Introduction, Methods of production of metal powders, Atomization process, Electrolysis, Reduction, Mechanical Alloying, Particle size, Shape and distribution, Mixing, Blending, Compacting, Hot Isostatic pressing, Cold Isostatic pressing, Sintering, Applications, Advantages and limitations of powder metallurgy.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Avner S. "*Introduction to Physical Metallurgy*", Tata McGraw Hill, 2nd Edition, 2001.R.
2. Balasubramaniam, *Callister's Materials Science & Engineering*, John Wiley and sons, 2nd edition, 2014.

**REFERENCE BOOKS:**

1. Agrawal B.K. "*Introduction to Engineering Materials*", Tata McGraw Hill, 1st Edition, 2007.
2. George E Dieter, *Mechanical Metallurgy*, Tata McGraw Hill, 3rd edition, 2013

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **CO2** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **CO3** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **CO4** | 3 | 3 | - | - | - | 1 | - | - | - | - | - | - | 3 | - | - |
| **CO5** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 3 | - | - |
| **Average** | 3 | 1.8 | | | | 1 | | | | | | | 3 | | |
| **Correlation level** | 3 | 2 | | | | 1 | | | | | | | 3 | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

## (19BT50307) STATISTICAL INFERENCE AND MODELING

(Professional elective 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES :** --

**COURSE DESCRIPTION:**

Random vs Non-random sampling;Two tailed and one tailed Hypothesis testing, Type 1 and Type 2 errors, Hypothesis testing using z and t statistics; Completely Randomized design; Simple and Multiple Linear Regression; residual analysis; Decision making under uncertainty - Laplace, Hurwicz and Savage criteria

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Apply sampling and estimation procedures to appropriately use and construe complex data.

CO2.  Demonstrate the plausibility of pre-specified ideas about the parameters of the model by Hypothesis Testing

CO3.  Design experiments by ANOVA and determine the existence of a statistically significant difference among several groups means.

CO4.  Develop appropriate regression models to predict the desired parameters.

CO5.  Apply non-parametric tests for uncertain distributions and decision analysis to identify feasible and viable decision alternatives

**DETAILED SYLLABUS:**

**UNIT I: SAMPLING AND ESTIMATION                    (08 periods)**

Random vs Non-random sampling, Errors in sampling, Central Limit Theorem, Types of estimates, Estimating population mean using z and t statistics, Confidence interval estimation, Maximum likelihood estimation

**UNIT II: HYPOTHESIS TESTING                    (09 periods)**

Procedure for Hypothesis testing, Two tailed and one tailed Hypothesis testing, Type 1 and Type 2 errors, Hypothesis testing using z and t statistics, Chi-square test – Goodness of fit, Test of independence and test of homogeneity

**UNIT III: ANALYSIS OF VARIANCE AND EXPERIMENTAL DESIGNS      (09 periods)**

Analysis of variance, Completely Randomized design (One way ANOVA), Randomized Block design, Factorial Design (Two way ANOVA)

**UNIT IV: REGRESSION MODELING STRATEGIES            (10 periods)**

Planning for modeling, Choice of the model, model formulation, Interpreting Modeling parameters, Assessment of model fit, Missing data; describing, Resampling, validating and

Simplifying the model; Simple and Multiple Linear Regression, residual analysis, Collinearity, Multiple regression model with two independent variables

## UNIT V: NON-PARAMETRIC STATISTICS AND STATISTICAL DECISION THEORY

**(09 periods)**

Runs Test, Mann-Whitney Test, Wilcoxon Test, Kruskal-Walis Test, Friedman Test, Spearman's Rank correlation.

Decision making under uncertainty - Laplace, Hurwicz and Savage criteria; Decision making under risk – Expected monetary Value, Expected Opportunity Loss, Expected Value of Perfect Information; Decision trees.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Naval Bajpai, *Business Statistics*, Pearson, Second Edition 2013.

2. Casella and Berger, *Statistical Inference*, Cengage Learning, 2001.

**REFERENCE BOOKS:**

1. Frank E HarrelJr.,*Regression Modeling Strategies*, Springer, Second Edition, 2006

2. Andrew Gelman and Jennifer Hill, *Data Analysis using Regression and multi level/hierarchical models*, Cambridge, 2007

3. J K Sharma, *Business Statistics*, Vikas, Fifth Edition, 2020

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | 3 |
| **CO2** | 3 | 1 | | | | 1 | | | | | | | | | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 |
| **CO5** | 3 | 2 | | | | 1 | | | | | | | | | 3 |
| **Average** | 3 | 2.4 | 2.3 | 1.6 | 1 | 1 | | | | | | | | | 3 |
| **Correlation level** | 3 | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

# III B. Tech. – I Semester

(19BT50308) **TOOL DESIGN**

(Professional Elective-1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Metal Cutting and Machine Tools

**COURSE DESCRIPTION:**

Basic cutting parameters; Determination of cutting forces; design of single and multi-point cutting tools; design of dies; design of jigs and fixtures.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of cutting tools and tool cost estimation for machining of materials.

CO2. Design single point cutting tools for metal removal.

CO3. Design multi-point cutting tool for effective metal removal rate and enhanced productivity.

CO4. Design dies for sheet metal operations.

CO5. Design jigs and fixtures for holding the work and guiding the tool.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO CUTTING TOOLS                    (09 periods)**

Introduction, Different types of cutting tools used for machining, Designation of cutting tools, Types of systems used for designating cutting tools, Selection of tool material, Types, Properties and Characteristics of tool Material, Tool wear, Tool life criteria, variables affecting tool life and machinability, Taylor's tool life equation, Types of coolants, Elements of machining cost, Tool cost estimation.

**UNIT II: DESIGN OF SINGLE POINT CUTTING TOOLS                    (09 periods)**

Introduction, Basic Elements, Design of Tool Shank, Geometry of single point cutting tool, Nomenclature of single point cutting tool, Influence of Various Angles on Tool Design, Calculation of Forces and Design for Cutting Forces, Mechanics of orthogonal cutting, Merchant's circle diagram, Geometry and their interrelation, Theories of formation of chip and their effect.

**UNIT III: DESIGN OF MULTI POINT CUTTING TOOLS                    (09 periods)**

Introduction, Classification of multi point cutting tools, Drill geometry, Design of Drills, Rake & Relief angles of twist drill, Speed, Feed and depth of cut, Machining time.

**Milling cutters:** Up milling & down milling, Cutting speeds and Feed machining times-Design of form cutters, combination tools & reamers.

## UNIT IV: DESIGN OF DIES FOR SHEET METAL OPERATIONS    (09 periods)

Design of sheet metal blanking and piercing: Fundamentals of die cutting operations, Types of presses, Die block design, Punch design, Cutting action in a die, Die clearance, Considerations in Press Tool Design, Design procedure for blanking die.

### Design of sheet metal bending, forming, drawing and forging dies:

Bending dies, Forming dies, Drawing dies, Determination of blank size, Drawing force, Design procedure for a drawing die, Forging design, Design of forging dies.

## UNIT V: DESIGN OF JIGS AND FIXTURES    (09 periods)

Introduction, Concept of degrees of freedom, 3-2-1 principle of location, Principles of location and clamping for jig and fixtures design, Different types of locators and clamps, Jig bushes and its types, Different types of jigs and its design, Essential features of different types of fixtures, Design of fixtures, Indexing jigs and fixtures, Automatic clamping devices.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. Donaldson, Lecain and Goold, *Tool Design*, Tata McGraw Hill, 4th edition, 2012.

2. G.R.Nagpal, *Tool Engineering & Design*, Khanna Publishers, Tata McGraw Hill, 6th edition, 2008.

### REFERENCE BOOKS:

1. Surendra Kenav and Umesh Chandra, Satyaprakashan, *Production Engineering Design (Tool Design)*, New Delhi.

2. Amitabha Battacharya and Inyong Ham, *Design of Cutting Tools use of Metal Cutting Theory*, ASTME Publication, Michigan USA.

3. V.Arshinov, G.Alekseev, *Metal Cutting Theory and Cutting Tool Design*, MIR Publications.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | - | - | - | - | | | 1 | | 3 | | |
| **CO2** | 3 | 3 | 3 | 1 | - | 1 | | | | | | | 3 | | |
| **CO3** | 3 | 3 | 3 | 1 | - | 1 | | | | | | | 3 | | |
| **CO4** | 3 | 3 | 3 | 1 | - | 1 | | | | | | | 3 | | |
| **CO5** | 3 | 3 | 3 | 1 | - | 1 | | | | | | | 3 | | |
| **Average** | 3 | 3 | 3 | 1 | | 1 | | | | | 1 | | 3 | | |
| **Correlation level** | 3 | 3 | 3 | 1 | | 1 | | | | | 1 | | 3 | | |

**Correlation Levels:      3– High      2 - Medium      1– Low**

(19BT50309) **TRIBOLOGY**

(Professional Elective-1)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Basic Engineering Mechanics

**COURSE DESCRIPTION:**

Surface friction; characteristic, sources, wear of various metals; lubricants, types, lubrication necessity; film lubrication theory; loads on bearing; surface modification; surface coatings; fusion processes; material for bearings.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of friction characteristics of surfaces.

CO2. Analyze wear mechanisms in different materials and determine wear rate.

CO3. Demonstrate the knowledge of lubricants.

CO4. Analyze geometric Characteristics of Surfaces considering Health and safety aspects.

CO5. Demonstrate knowledge of Surface Engineering and Bearing Materials.

**DETAILED SYLLABUS:**

**UNIT I: SURFACES AND FRICTION**           **(09 Periods)**

Introduction to tribology, Economic aspects of tribology, Topography of engineering surfaces, Contact between surfaces, Sources of sliding Friction, Adhesion, Ploughing, Energy dissipation mechanisms; Friction Characteristics: metals, non metals, lamellar solids, Ceramic materials and polymers, Rolling Friction, Source of Rolling Friction, Stick slip motion, laws of Friction.

**UNIT II: WEAR**           **(09 Periods)**

Types of wear, Simple theory of Sliding Wear, Mechanism of sliding wear of metals, Ceramics and Polymers, Wear mechanisms- Abrasive wear, Adhesive, Abrasive wear situations, tribochemical reactions, Corrosive wear, Surface Fatigue wear situations, Fracture wear, fretting, erosion, Estimation of wear rate.

**UNIT III: LUBRICANTS**           **(09 Periods)**

Introduction, effect and necessity of lubrication, Lubrication types, properties, Requirements of Lubricants, Testing methods, Hydrodynamic Lubrication, Elasto-hydrodynamic lubrication, Boundary Lubrication, solid and semi solid lubricants, Solid Lubrication, Hydrostatic Lubrication.

**UNIT IV: SURFACE TOPOGRAPHY**           **(09 Periods)**

Geometric Characteristics of Surfaces, Computation of Surface Parameters-Mean, Ten point average, CLA methods, Load bearing curves, Film Parameters for Different Lubrication Regimes, Transition Between Lubrication Regimes, Health and safety aspects of lubricants.

## UNIT V: SURFACE ENGINEERING AND BEARING MATERIALS        (09 Periods)

Scope of surface engineering, Surface modifications, Transformation Hardening, Surface fusion, Thermochemical processes, Surface coatings, Plating and anodizing, Fusion Processes, Vapour Phase processes, Chemical vapour deposition.

Bearing materials: selection of bearing materials, metal bearings, Non-metal bearings.

**Total Periods: *45***

***Topics for self-study are provided in the lesson plan.***

**TEXTBOOKS:**

1. I.M. Hutchings, *Tribology, Friction and Wear of Engineering Material*, Edward Arnold, London, 1992.

2. A.Harnoy, *Bearing Design in Machinery*, Marcel Dekker Inc, New York, 2003

**REFERENCE BOOKS:**

1. Kenneth C Ludema, *Friction, Wear, Lubrication: A Textbook in Tribology*, CRC Press,1996.

2. A.Cameron, *Basic Lubrication Theory*, Longman, U.K., 1981.

3. M.J.Neale, *Tribology Handbook*, Newnes. Butter worth, Heinemann, U.K.,1995.

4. T.A. Stolarski, *Tribology in Machine Design*, Industrial Press Inc., 1990.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | | | | | | | | 3 | | |
| CO2 | 3 | 3 | | | | | | | | | | | 3 | | |
| CO3 | 3 | 1 | | | | | | | | | | | 3 | | |
| CO4 | 3 | 3 | | | | 2 | 1 | | | | | | 3 | | |
| CO5 | 3 | 1 | | | | | | | | | | | 3 | | |
| Average | 3 | 1.8 | | | | 2 | 1 | | | | | | 3 | | |
| Correlation level | 3 | 2 | | | | 2 | 1 | | | | | | 3 | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

**III B. Tech. – I Semester**

(19BT4BS01) **MATERIAL SCIENCE**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Introduction to Material Science and Engineering; Composite Materials; Smart Materials; Nano and Biomimetic Materials; Emerging Materials.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Attain the basic knowledge on composites, smart materials, biomimetic materials and nano materials.

CO2.  Demonstrate essential information about structure and properties of various composites used in various engineering applications.

CO3.  Understand the basic properties of electro-rheostatic, magneto-rheostatic and shape memory alloys used in device applications.

CO4.  Accomplish the basic knowledge in nano materials to familiarize various nano structured device applications.

CO5.  Outline the processing and properties of functionally graded materials and identify its applications in various fields.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO MATERIAL SCIENCE AND ENGINEERING**

**(08 Periods)**

Introduction - historical perspective - material science and engineering, classification of materials (metals, ceramics, polymers and composites) and advanced materials and their applications (biomaterials, smart materials and nano materials), modern materials needs. Processing, properties and applications of metals, polymers and ceramics (Qualitative).

**UNIT II: COMPOSITE MATERIALS** **(10 Periods)**

Composite Materials - Classification, Laminated composites and Reinforced composite materials – Classification, structure and properties of sandwich composites – applications (commercial Aircraft, Marine Grade Sandwich, Automobile Grade Sandwich and Wind Turbine Blades), properties and applications of Nano composites - Advantages and Limitations of composites.

**UNIT III:SMART MATERIALS** **(07 Periods)**

Classification of smart materials -Magneto-rheostatic (MR) and Electro-rheostatic (ER) materials - Shape Memory Alloys (SMA)- characteristics, Shape memory effect applications in different fields, advances in smart materials.

**UNIT IV: NANO AND BIOMIMETIC MATERIALS** **(10 Periods)**

**Nanomaterials:** Introduction, Low dimensional structures and energy quantization. Fabrication of nano materials - Lithographic technique using photons, metallic, semiconducting and magnetic properties of nano materials and applications (renewable energy and nano electro-mechanical systems (NEMS)).

**Biomimetic materials** – Introduction- classification and their applications (Lotus effect, Dolphin sound wave technology and viper as a model in defence)

**UNIT V: EMERGING MATERIALS** **(10 Periods)**

Functionally graded materials (FGM) - Types, processing, properties and potential applications, functionally graded fibre cement – structural material, Functionally Graded Nanoelectronic, Optoelectronic and Thermoelectric Materials (Qualitative) and its applications.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. William D Callister, David G Rethwisch, *Materials Science and Engineering*, Wiley, 9th edition, 2014.

2. K M Gupta, *Engineering Materials – Research, Applications and Advances*, CRC press (Taylor & Francis group), 2015.

**REFERENCE BOOKS:**

1. Sulabha K Kulkarni*, Nanotechnology: Principles and practices*, Springer, 9th edition, 2014.

2. Charles P. Poole and Frank J. Owens, *Introduction to Nanotechnology*, Wiley-Interscience, May 2003.

3. Sulabha K Kulkarni, *Nanotechnology: Principles and Practices,* Springer, 3rd edition, 2014.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| CO2 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| CO4 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| CO5 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |
| Average | 3 | 2.4 | - | - | - | - | - | - | - | - | - | - | | | |
| Correlation level | 3 | 3 | - | - | - | - | - | - | - | - | - | - | | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT4HS02) **BUSINESS COMMUNICATION AND CAREER SKILLS**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Nature and Scope of Communication; Corporate Communication; Writing Business Messages & Documents; Careers and Résumés; Interviews.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of professional communication by examining and applying the styles and strategies of business communication in Communication Networks and Writing Messages.

CO2. Analyze the limitations of business communication by applying and demonstrating corporate communication aspects for effective communication through Interpersonal Communication, Informal Communication, and Crisis Management and Communication.

CO3. Apply appropriate writing techniques for effective professional communication in preparing documents by demonstrating and examining Stages in Writing Business Messages, Strategies for Writing the Body of a Letter, and Structuring Résumés.

CO4. Apply appropriate speaking techniques by examining and demonstrating effective communication in distinguished situations through Corporate Communication and Cross Cultural Communication

**DETAILED SYLLABUS:**

**UNIT I: NATURE AND SCOPE OF COMMUNICATION**           **(9 periods)**

Introduction: Communication Basics - Functions of Communication – Communication Networks - Interpersonal Communication – Informal Communication - Communication Barriers - Roles of a Manager.

**UNIT II: CORPORATE COMMUNICATION**           **(9 periods)**

Introduction: Corporate Communication - Cross-Cultural Communication; Concept & Styles - Corporate Communication Strategy - Corporate Citizenship - Crisis Communication: Case Study.

**UNIT III**: **WRITING BUSINESS MESSAGES &DOCUMENTS**       **(9 periods)**

Introduction: Importance of Written Business Communication - Types of Business Messages - Five Main Stages of Writing Business Messages – Business Letter Writing; Kinds of Business Letters – Common Components of Business Letters – Strategies for Writing the Body of a Letter.

**UNIT IV: CAREERS AND RÉSUMÉS**           **(9 periods)**

Introduction - Career Building - Résumé Formats; Traditional, Electronic and Video Resumés – Sending Résumés - Follow-up Letters - Business Presentations and Speeches; Planning –

Structuring - Organizing – Delivery.

## UNIT V: INTERVIEWS                                                                    (9 periods)

Introduction - General Preparation for an Interview - Success in an Interview - Important Non-verbal Aspects – Types of Interviews – Styles of Interviewing - Types of Interviewing Questions - Online Recruitment Process.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1. Meenakshi Raman and Prakash Singh, *Business Communication*, Oxford University Press, New Delhi, 2nd edition, 2012.
2. Neera Jain and Sharma Mukherji, *Effective Business Communication*, Tata McGraw-Hill Education, Pvt. Ltd., New Delhi, 2012.

**REFERENCE BOOKS**:

1. Courtland L.Bovee et al., *Business Communication Today*, Pearson, New Delhi, 2011.
2. Krizan, *Effective Business Communication*, Cengage Learning, New Delhi, 2010.

**ADDITIONAL LEARNING RESOURCES**

1. http://www.career.vt.edu/interviewing/TelephoneInterviews.html
2. http://job-search-search.com/interviewing/behavioral_interviews
3. https://goo.gl/laEHOY (dealing with complaints)
4. http://www.adm.uwaterloo.ca/infocecs/CRC/manual/resumes.html
5. https://goo.gl/FEMGXS
6. http://www.resumania.com/arcindex.html

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | 3 | - | - | - | - | 3 | - | | | | |
| **CO2** | 1 | 3 | - | - | 3 | - | - | - | - | 3 | - | | | | |
| **CO3** | 1 | 2 | - | - | 3 | - | - | - | - | 3 | - | | | | |
| **CO4** | 1 | 1 | - | - | 2 | - | - | - | - | 2 | - | | | | |
| **Average** | 1.5 | 1.75 | - | - | 2.25 | - | - | - | - | 2.25 | - | | | | |
| **Correlation level** | 2 | 2 | - | - | 3 | - | - | - | - | 3 | - | | | | |

**Correlation Levels:         3– High         2 - Medium         1– Low**

(19BT4HS04) **ENTREPRENEURSHIP FOR MICRO, SMALL AND MEDIUM ENTERPRISES**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Introduction to Entrepreneur Development; Idea generation and formation of Business Plan; Micro and Small Enterprises; Institutional Finance and Support to Entrepreneur; Woman Entrepreneurship.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge in concepts, functions, Micro and Macro units, NGOs, Bharatiya Mahila Bank, Women Entrepreneurship, Schemes and Programmes.

CO2. Analyze the idea generation, business plans, business acumen, institutional finance and rural entrepreneurship.

**DETAILED SYLLABUS:**

**UNIT I: ENTREPRENEURSHIP DEVELOPMENT                         (9 periods)**

Introduction to Entrepreneurship Development - Concept of Entrepreneurship – Growth of Entrepreneurship in India **-** Factors affecting Entrepreneurship growth - Characteristics of an Entrepreneur – Functions of Entrepreneur – Entrepreneurial Decision Process – Types of Entrepreneurs – Distinction between an Entrepreneur and a manager.

**UNIT II: IDEA GENERATION AND FORMULATION OF BUSINESS PLANS (9 periods)**

Sources of Ideas – Methods of idea generation – Steps in Setting up of a Small Business Enterprise – Formulation of Business Plan – Contents and Significance of Business Plan – Common Errors in Business Plan Formulation – The role of incubation centers for promoting entrepreneurship and start-ups.

**UNIT III: MICRO AND SMALL ENTERPRISES                         (9 periods)**

Meaning and Definition – Micro and Macro units – Essentials – Features – Characteristics – Scope of Micro and Small Enterprises – Objectives of Micro Enterprises  – Relationship between Micro and Macro Enterprises- Problems of Micro and Small Enterprises

**UNIT IV: INSTITUTIONAL FINANCE                         (9 periods)**

Institutional Finance **–** Need-Scope-Services - Various Institutions offering Institutional support: – Small Industries Development of Bank of India (SIDBI), State Industrial Development Corporations – Small Industries Development Organisation (SIDO) – Small Industries Service Institutes (SISIs) – SFCs - National Institute of Entrepreneurship and Small Business Development (NIESBUD) – Micro Units Development and Refinance Agency Bank (MUDRA).

**UNIT V: WOMEN & RURAL ENTREPRENEURSHIP                         (9 periods)**

Concept of Women entrepreneur - Functions of Women entrepreneurs - Growth of women entrepreneurship in India - Challenges of Women entrepreneurs- Programmes supporting women entrepreneurship – Rural Entrepreneurship – Meaning, Need for Rural entrepreneurship, Problems of rural entrepreneurship, Role of NGOs, Role of Bharatiya

Mahila Bank for encouraging Women Entrepreneurs – Micro Finance & Self Help Groups (Basic Concepts).

**Total periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Dr.S.S.Khanka*, Entrepreneurial Development*, S. Chand and Company Ltd, Revised edition, 2012.
2. MadhurimaLall&ShikhaSahai, *Entrepreneurship*, Excel Books India, 4th edition, 2014.

**REFERENCE BOOKS:**

1. Nandan, H., *Fundamentals of Entrepreneurship*, PHI Learning Pvt. Ltd., New Delhi, 3rd edition, 2013.
2. BholanathDutta, *Entrepreneurship Management* – Text and Cases, Excel Books, 3rd edition, 2015.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | - | - | - | 2 | 1 | - | - | - | - | - | | | |
| **CO2** | 2 | 1 | - | - | - | 3 | 3 | - | - | - | 2 | - | | | |
| **Average** | 2.5 | 2 | - | - | - | 2.5 | 2 | - | - | - | 2 | - | | | |
| **Correlation level** | 3 | 2 | - | - | - | 3 | 2 | - | - | - | 2 | - | | | |

**Correlation Levels:**    **3– High**    **2 - Medium**    **1– Low**

(19BT4HS06) **GERMAN LANGUAGE**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Oral communication; Basic grammar; Basic writing; Berufsdeutcsch (Business German)

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Communicate every day using familiar words with expressions and simple sentences.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION** (9 Periods)

Introduction - German alphabets, numbers, days in a week, names of months, seasons. Grammar: Nouns –(i)Nominative case and (ii) Nominative personal pronouns, simple sentence, Verb Conjugation $1^{st}$ and $2^{nd}$ type, verb Conjugation $3^{rd}$ type, 'Wh' questions (simple sentences) Nominative (definite and indefinite) Articles

**UNIT II: CITY AND FOOD** (9 Periods)

In the city: naming places and buildings, means of transport, basic directions. Food: drink, groceries and meals. Apartments: rooms, furniture, colours.

Grammar: Nouns-articles negation–(kein and nicht); imperative and the accusative case; Nominative Possessive Pronouns.

**UNIT III: DAY TO DAY CONVERSATIONS** (9 Periods)

Everyday life, telling time, making appointments, leisure activities, and celebrations. Different types of professions, Health and the body, Holiday and weather, Clothes and Dresses.

**UNIT IV: BASIC GRAMMAR** (9 Periods)

Grammar: Possessive articles, Prepositions (am, um, von. bis); Modal verbs, Separable verbs, the accusative, past tense of 'to have' and 'to be', the imperative sentences, dative case, perfect tense.

**UNIT V: BASIC WRITING** (9 Periods)

Translation from English to German and German to English, Contacts, Writing letters and Email Writing.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Heuber,Tangram Aktuelleins, HeuberVerlag Publications, 2011.

**REFERENCE BOOKS:**

1. Anta Kursisa, Gerhard Newner, Sara vicenta, Fir fuer Deutsch 1 und Deutsch 2, HeuberVerlag Publications, 2005.

2. Herman Funk, Studio D A1 Cornelsen, GOYAL SAABPublication, Year 2011.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | - | - | - | - | - | - | - | - | 2 | - | - | | | |
| **Average** | 3 | - | - | - | - | - | - | - | - | 2 | - | - | | | |
| **Correlation level** | 3 | - | - | - | - | - | - | - | - | 2 | - | - | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT4HS08) **INDIAN HISTORY**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**CORSE DESCRIPTION:**

Introduction; Ancient India; Classical and Medieval era; Modern India; India after independence.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate contextual knowledge on evolution of ancient and medieval Indian History and acquire awareness on societal and cultural issues.

CO2. Analyze the situations before and after Independence and assess the societal reforms implemented in India after Independence.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION** (8 Periods)

Elements of Indian History; History Sources: Archaeology, Numismatics, Epigraphy & Archival research; Methods used in History; History & historiography; sociological concepts-structure, system, organization, social institutions, Culture and social stratification (caste, class, gender, power), State& Civil Society.

**UNIT II: ANCIENT INDIA** (9 Periods)

Mohenjo-Daro civilization; Harappa civilization; Mauryan Empire.

**UNIT III: CLASSICAL & MEDIEVAL ERA** (12 Periods)

Classic Era (200 BC - 1200 AD); Hindu - Islamic Era (1200 - 1800 AD).

**UNIT IV: MODERN INDIA** (6 Periods)

Age of Colonialism (17th - 19th centuries); First war of Indian Independence;

Freedom Struggle (1857-1947).

**UNIT V: INDIA AFTER INDEPENDENCE (1947 - )** (10 Periods)

The Evolution of the Constitution and Main Provisions; Consolidation of India as a Nation; Politics in the States; Indian economy; Modernization and globalization, Secularism and communalism, Nature of development, Processes of social exclusion and inclusion, ChangingNature of work and organization.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOK:**

1. K. Krishna Reddy, *Indian History,* Tata McGraw-Hill, 21ˢᵗ reprint, 2017.

**REFERENCE BOOKS:**

1. Guha, Ramachandra, *India after Gandhi*, Pan Macmillan, 2007.

2. Thapar, Romila, *Early India*, Penguin, 2002.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | - | - | - | - | 2 | - | - | - | - | - | - | | | |
| CO2 | 2 | 2 | - | - | - | 2 | - | - | - | - | - | - | | | |
| Average | 2 | 2 | - | - | - | 2 | - | - | - | - | - | - | | | |
| Correlation level | 2 | 2 | - | - | - | 2 | - | - | - | - | - | - | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## (19BT4HS10) **PERSONALITY DEVELOPMENT**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course onSoft Skills Laboratory

**COURSE DESCRIPTION:**

Personalities and Leadership Qualities; Self Esteem and self Development; Attitude; Communication Relationship; Critical Work Skills and Ethics.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of leadership qualities by examining and applying personality traits through  Positive self esteem, Open Communication and Self-Righteousness.

CO2. Analyze the limitations of Attitudes by applying and demonstrating communication   traits through Decision Making, Ethics and Self Actualization.

CO3. Apply appropriate Analyzing techniques for comprehending different personalities by examining Positive and Negative Characteristic Traits and demonstrating through Leadership Styles, Mentoring and Behaviour Modification.

CO4. Apply appropriate techniques in Solving Problems by examining and demonstrating Time Management, Stress Management and Anger Management.

**DETAILED SYLLABUS:**

**UNIT I: PERSONALITIES AND LEADERSHIP QUALITIES               (9 periods)**

Introduction: Different Personalities **-** Personality Analysis **-** Freudian Analysis **–** Vedantic Concept: Swamy Vivekananda**-** Personality Begets - Types- Leadership Qualities – Decision Making **-** Case Studies: Personalities.

**UNIT II: SELF ESTEEM AND SELF DEVELOPMENT               (9 periods)**

**Know  Yourself**: Self Image - Positive Self Esteem -Turn Failure into Success - Be Sensitive to Feedback - Build Self Confidence – Self Actualization - Set Goals - Action Plans - Accountability – Behavior Modification – Mentoring - Learning- Counseling – Challenge yourself with Aptitude Tests and Internships.

**UNIT III: ATTITUDE                                                    (9 periods)**

Importance – Difference between Behavior and Attitude - Changing Negative Attitude- Impact of Attitudes on others - Unproductive Attitudes –Assess your Behaviour.

**UNIT IV: COMMUNICATION RELATIONSHIP               (9 periods)**

Introduction – Positive and Negative Characteristic Traits - Grapevine Communication – Open Communication; Team Player - Leadership styles – Performance Expectations - Electronic Communication; TextMessaging – Voicemail – E-Mail

**UNIT- V: CRITICAL WORK SKILLS AND ETHICS**             **(9 periods)**

Time Management - Balancing Life and Work - Stress Management - Anger Management - Making Decisions and Solving Problems - Developing Creativity - Ethics and Self-Righteousness – Being Judgemental in the Real World - Striving for Integrity.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Harold R. Wallace and L. Ann Masters, *Personal Development for Life and Work*, Cengage Learning, Delhi, 10ᵗʰ edition Indian Reprint, 2011. (6ᵗʰ Indian Reprint 2015)
2. Barun K. Mitra, *Personality Development and Soft Skills,* Oxford University Press, 2011.

**REFERENCE BOOKS:**

1. K. Alex, *Soft Skills*, S. Chand & Company Ltd, New Delhi, 2ⁿᵈ Revised Edition, 2011.
2. Stephen P. Robbins and Timothy A. Judge*, Organizational Behaviour*, Prentice Hall, Delhi, 16ᵗʰ edition, 2014.

**ADDITIONAL LEARNING RESOURCES**

1. https://www.ncbi.nlm.nih.gov/pubmed/25545842

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | 3 | - | - | - | - | 1 | - | - | | | |
| **CO2** | 1 | 3 | - | - | 3 | - | - | - | - | 1 | - | - | | | |
| **CO3** | 1 | 2 | - | - | 3 | - | - | - | - | 2 | - | - | | | |
| **CO4** | 1 | 1 | - | - | 2 | - | - | - | - | 3 | - | - | | | |
| **Average** | 1.5 | 1.75 | - | - | 2.75 | - | - | - | - | 1.75 | - | - | | | |
| **Correlation level** | 2 | 2 | - | - | 3 | - | - | - | - | 2 | - | - | | | |

**Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

# III B. Tech. - I Semester

## (19BT4HS12) **WOMEN EMPOWERMENT**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Concept & Framework, Status of Women, Women's Right to work, International Women's Decade, and Women Entrepreneurship.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the characteristics of empowered women, their achievements, and framework for women empowerment, legal laws, and political status of women.

CO2. Apply the knowledge of women rights to address various societal issues and obstacles in different fields including science and technology.

CO3. Understand the significance of participation in policy debates, National conferences and common forums for women's equality and development.

CO4. Analyze the concept of women entrepreneurship, government schemes and entrepreneurial challenges and opportunities.

**DETAILED SYLLABUS:**

**UNIT I: CONCEPT & FRAMEWORK**         **(9 Periods)**

Introduction- Empowered Women's Characteristics- Achievements of Women's Empowerment **Concept of Empowerment:** Meaning& Concept- Generalizations about Empowerment - Empowerment Propositions - Choices women can make for empowerment - Women's participation in decision making, development process & in Governance. **Framework for Women's Empowerment** - Five levels of equality- Tenets of Empowerment- Elements - Phases and aspects - Techniques - Categories and Models – Approaches.

**UNIT II: STATUS OF WOMEN**         **(9 Periods)**

**Legal Status:** Present Scenario- Call for Social change- Significant trends - Legal & Schemes - Personal Law- Joint Family- Criminal Law- Shift towards Dowry - Deterrent Punishment - Criminal Law(II Amendment) - Discrimination in Employment

**Political Status:** Present Scenario - Political Participation & its Nature- Socio-economic Characteristics - Political Mobilization: Mass Media - Campaign Exposure - Group Orientation - Awareness of issues and participation - Progress & Future Thrust.

**UNIT III: WOMEN'S RIGHT TO WORK**         **(9 Periods)**

Introduction- Present Scenario - Changes in Policy &Programme - National Plan of Action- Women's Cells and Bureau - Increase in work participation rate- Discrimination in labour market - Women in unorganized sector - Issues and Obstacles- Women in Education - Women in Science & Technology - **Case Study:** Linking Education to Women's Access to resources.

**UNIT IV:  WOMEN'S PARTICIPATORY DEVELOPMENT          (9 Periods)**

Dynamics of social change- conscious participation - Information Explosion - Organized Articulation  - National Conference - Common Forums -  Participatory Development  - New Issues Identified  - Role of other Institutions.

**UNIT V:  WOMEN ENTREPRENEURSHIP                  (9 Periods)**

Introduction–Definition-Concept-  Traits  of  women  Entrepreneurs-  Role  of  Women Entrepreneurs in India -Reasons of Women Entrepreneurship- Government schemes & Financial Institutions to develop Women Entrepreneurs - Key policy recommendations - Project Planning-Suggestions and measures to strengthen women entrepreneurship - Growth & Future challenges - Training and Opportunities - **Case Study:** Training Women as Hand-pump Mechanics-  **Case  Study**: Literacy for Empowering Craftswomen

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. NayakSarojini, Nair Jeevan(2017), "*Women's Empowerment in India*". Pointer Publishers, Jaipur

2. SahaySushama(2013), "*Women and Empowerment*"  Discovery Publishing House, New Delhi.

**REFERENCE BOOKS:**

1. Baluchamy. S (2010), "*Women's Empowerment of Women*". Pointer Publishers, Jaipur.

2. KhobragadeGrishma (2020), "*Women's Empowerment: Challenges and Strategies Empowering Indian Women*, BooksclinicPublishing, Chhattisgarh.

3. https://www.economicsdiscussion.net/entrepreneurship/women-entrepreneurs-in-india

4. https://www.businessmanagementideas.com/entrepreneurship-2/women-entrepreneurs

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | - | - | - | - | 3 | - | 1 | - | - | - | - | | | |
| **CO2** | 3 | - | - | - | - | 2 | - | - | - | - | - | - | | | |
| **CO3** | 3 | - | - | - | - | 2 | - | - | - | 3 | - | - | | | |
| **CO4** | 3 | - | - | - | - | - | - | - | - | - | 2 | - | | | |
| **Average** | 3 | - | - | - | - | 2.33 | - | 1 | - | 3 | 2 | - | | | |
| **Correlation level** | 3 | - | - | - | - | 3 | - | 1 | - | 3 | 2 | - | | | |

**Correlation Levels:       3– High       2 - Medium       1– Low**

## III B. Tech. - I Semester

### (19BT4HS14) **CONSTITUTION OF INDIA**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Preamble and its Philosophy; Union Legislature; Federalism in India; Judiciary and Public Services; Nation Building

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Gain knowledge in Parliamentary proceedings, Election Commission, Public Services and Foreign Policy of India.

CO2. Apply the reasoning informed by the various aspects in the Constitution, its provisions to assess societal issues and the consequent responsibilities relevant to the professional engineering practice.

**DETAILED SYLLABUS:**

**UNIT I: PREAMBLE AND ITS PHILOSOPHY** (8 Periods)

Introduction and Evolution of Indian Constitution, preamble and its philosophy

**UNIT II: UNION LEGISLATURE** (9 Periods)

The Parliament, Parliamentary Structure, Process of Legislation; President of India – Powers and Functions; Vice President, Prime Minister and Council of Ministers; Constitution Amendment Procedure and Financial Legislation.

**UNIT III: FEDERALISM IN INDIA** (10 Periods)

Features of Federal System, Centre-State relations, Directive Principles of State Policy, Administrative Relationship between Union and States; Governors - Powers and Functions; State Legislature - Composition and powers; Chief Ministers - Powers and Functions, Council of Ministers; The Election Commission – Powers and Functions.

**UNIT IV: JUDICIARY AND PUBLIC SERVICES** (9 Periods)

The Union Judiciary - Supreme Court and High Court; Fundamental Rights and Duties All India Services - Central Civil Services - State Services - Local Services.

**UNIT V: INTERNATIONAL PARTICIPATION** (9 Periods)

Foreign Policy of India; International Institutions Influence: UNO, WTO, WHO, SAARC, International Summits: BRICS, NSS, UNEP – India's Role in International Negotiations; Environmentalism in India.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOK:**

1. Briji Kishore Sharma, *Introduction to the Constitution of India*, Prentice Hall of India, 2005.

**REFERENCE BOOK:**

1. Mahendra Pal Singh,V. N. Shukla's, *Constitution of India*, Eastern Book Company, 2011.
2. Pandey J. N., Constitutional Law of India - Central Law Agency, 1998.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | - | - | - | - | 3 | 2 | - | - | - | - | - | | | |
| CO2 | 2 | - | - | - | - | 3 | - | 3 | - | - | - | - | | | |
| Average | 1 | - | - | - | - | 3 | 2 | - | - | - | - | - | | | |
| Correlation level | 2 | - | - | - | - | 3 | - | 3 | - | - | - | - | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT40205) **RELIABILITY AND SAFETY ENGINEERING**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses onDifferential Equations and Multi-Variable Calculus & Transformation Techniques and Linear Algebra.

**COURSE DESCRIPTION:**

Fundamentals of reliability engineering;Network modeling and reliability evaluation; Markov chain and Markov processes; basics of safety concepts and safety techniques and applications.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Develop mathematical model of a network to evaluate the parameters for assessing the reliability of a system.

CO2. Analyze the time dependent/independent characteristics of a repairable system and frequency durations techniques to assess reliability.

CO3. Understand various safety management, policy, and planning strategies for personal and industrial safety.

CO4. Understand various safety and hazard identification techniques and follow appropriate safety measures in industry and society.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTALS OF RELIABILITY ENGINEERING** (9 periods)

Random variables, probability concepts, rules for probabilities of events.Probability density and distribution functions.Binomial distribution - Expected value and standard deviation for binomial distribution. Reliability functions, f(t), F(t), h(t) - Relationship between these functions, Exponential density and distribution functions, expected value and standard deviation of exponential distribution. Measures of reliability - MTTF, MTTR, MTBF.Bathtub curve.

**UNIT II: NETWORK MODELING AND RELIABILITY EVALUATION** (9 periods)

Basic concepts - Evaluation of network reliability/unreliability, series systems, parallel systems, series - Parallel configuration systems.Redundant systems and its types. Evaluation of network Reliability / Unreliability using conditional probability method, tie-set and cut-set based approach, complete event tree and reduced event tree methods.

**UNIT III: MARKOV CHAIN AND MARKOV PROCESSES** (9 periods)

Basic concepts, stochastic transitional Probability matrix, time dependent probability evaluation, Limiting State Probability evaluation, Absorbing states. Modelling concepts – State space diagrams, time dependent reliability evaluation of single component repairable model, two component repairable model. Frequency and duration techniques.

## UNIT IV: BASICS OF SAFETY CONCEPTS                    (9 periods)

Introduction, goals, need for safety, history of safety movement - Evolution of modern safety concept, general concepts of safety management.  Planning for safety- productivity, quality and safety, line and staff functions, budgeting for safety, safety policy.

## UNIT V: SAFETY TECHNIQUES AND APPLICATIONS          (9 periods)

Introduction to safety techniques, Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety. Hazard identification techniques, components of safety audit, types of audit, audit methodology, Process of safety reporting.  Applications of industrial Safety, environmental safety, health safety, electrical safety, fire safety.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Roy Billintonand Ronald N Allen, *Reliability Evaluation of Engineering Systems*, 2$^{nd}$ edition, Springer, New York, 2013.

2. Frank R. Spellman, Nancy E. Whiting, *Safety Engineering: Principles and Practices*, 3$^{rd}$ edition, Rowman& Littlefield, 2018.

**REFERENCE BOOKS:**

1. Charles E. Ebeling, *An introduction to reliability and maintainability engineering*,2$^{nd}$ edition Tata McGraw-Hill Education, 2010.

2. Dan Petersen, *Techniques of Safety Management: A Systems Approach*, 4$^{th}$edition american society of safety engineers, 2003.

**ADDITIONAL LEARNING RESOURCES:**

1. https://nptel.ac.in/courses/105/108/105108128/
2. https://nptel.ac.in/courses/110/105/110105094/
3. https://www.youtube.com/watch?v=uutg8jKrL9w
4. https://www.youtube.com/watch?v=_c-iZ2BAXPw
5. https://www.youtube.com/watch?v=GeMCF3s5EDk
6. https://www.youtube.com/watch?v=xYWyype7cxE

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | -- | 2 | 1 | 1 | -- | -- | -- | -- | -- | | | |
| CO2 | 3 | 3 | -- | -- | 2 | 1 | 1 | -- | -- | -- | -- | -- | | | |
| CO3 | 3 | -- | -- | -- | 2 | 1 | 1 | 1 | -- | -- | -- | -- | | | |
| CO4 | 3 | -- | -- | -- | 2 | 1 | 1 | 1 | -- | -- | -- | -- | | | |
| CO5 | 3 | 2.5 | 1 | -- | 2 | 1 | 1 | 1 | -- | -- | -- | -- | | | |
| Average | 3 | 3 | 1 | -- | 2 | 1 | 1 | 1 | -- | -- | -- | -- | | | |
| Correlation level | | | | | | | | | | | | | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT50107) **ENVIRONMENTAL POLLUTION AND CONTROL**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITES: -**

**COURSE DESCRIPTION:**

Fundamentals of air pollution; Dispersion of pollutants; Effects and control of air pollution; Water pollution; Soil pollution and control; Municipal solid waste management.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze air and noise pollution using appropriate tools and techniques to solve complex environmental issues following relevant standards considering society, environment and sustainability besides communicating effectively in graphical form.

CO2. Analyze air and noise pollution control measures using appropriate tools and techniques to solve complex environmental issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO3. Analyze water pollution and its control measures using appropriate tools and techniques to solve complex environmental issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO4. Analyze soil pollution and its control measures using appropriate tools and techniques to solve complex environmental issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

CO5. Analyze solid waste and its management measures using appropriate tools and techniques to solve solid waste disposal issues following relevant standards and latest developments considering society, environment and sustainability besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: AIR AND NOISE POLLUTION**                              (08 Periods)

*Air Pollution:*Scope, Significance, Classification, Sources – Line, Area, Stationary, Mobile; Effects of air pollutants on man, material and vegetation; Global effects of air pollution; Air pollution meteorology - Lapse rate, Inversion, Plume pattern;Dispersion of air pollutants - Dispersion models and applications; Ambient air quality standards.

*Noise Pollution:* Sound pressure, Power and intensity,Impacts of noise, permissible limits of noise pollution, measurement of noise, Noise standards.

**UNIT II: AIR AND NOISE POLLUTIONCONTROL**                     (10 Periods)

Self cleansing properties of the environment,Dilution method, Control at source, Process changes and equipment modifications, Control of particulates–Types of equipment, Design and operation - Settlingchambers,Centrifugal separators, Bag house filters, Wet scrubbers, Electrostatic precipitators; Control of gaseouspollutants – Adsorption, Absorption,

Condensation, Combustion; Control of air pollution from automobiles,  Control of noise pollution, Case studies, Latest developments in the air and noise pollution control.

## UNIT III: WATER POLLUTION    AND CONTROL                                    (10 Periods)

Water pollution – Sources, Causes, Effects; Surface and groundwater quality – Physical, Chemical, Biological; Drinking water quality standards, Water purification – Processes, Engineered systems – Aeration, Solids separation, Settling operations, Coagulation, Softening, Filtration, Disinfection; Wastewater – Sources, Causes, Effects, Treatment process and disposal – Primary, Secondary, Tertiary; Case studies, Latest developments in the water pollution control.

## UNIT IV: SOIL POLLUTION AND CONTROL                                        (08 Periods)

Soil pollutants, Sources of soil pollution, Causes, Effectsand control of soil pollution, Diseases caused by soil pollution, Methods to minimize soil pollution, Effective measures to control soil pollution, Soil quality standards, Case studies, Latest developments in the soil pollution control.

## UNIT V: MUNICIPAL SOLID WASTE MANAGEMENT                                    (09 Periods)

Municipal solid waste – Types, Composition and characteristics; Methods of collection and transportation; Methods of disposal – Opendumping, Sanitary landfill, Composting and

Incineration; Utilization -6R Concept, Recovery and recycling and Energy Recovery; Latest developments in solid waste management

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Peavy, H. S, Rowe, D. R., and Tchobanoglous, G., *Environmental Engineering*, McGraw Hill Inc., 1985.
2. C.S.Rao, *Environmental Pollution Control Engineering*, New Age International Pvt. Ltd., 2nd Edition, 2007.
3. Ibrahim A. Mirsa, *Soil Pollution: Origin, Monitoring & Remediation*, Springer, UK, 2nd Edition, 2008.

**REFERENCE BOOKS:**

1. M.N. Rao and H.V.N. Rao, *Air Pollution,* Tata McGraw–Hill Education Pvt. Ltd., 19th Edition, 2010.
2. Daniel Vallero, *Fundamentals of Air Pollution,* Academic Press (Elsevier)*,* 5th Edition, 2014.
3. S.M.Khopkar,*Environmental Pollution Monitoring and Control,* New Age International Pvt. Ltd., 2nd Edition, 2007.
4. V. M. Domkundwar, *Environmental Engineering*, DhanpatRai& Co. Pvt. Ltd., New Delhi, 2014.

**ADDITIONAL LEARNING RESOURCES:**

1. *National Ambient Air Quality Standards*, Central Pollution Control Board, New Delhi
2. *Specifications for Drinking Water Standards*, IS10500:2012
3. *Solid Waste Management Rules*, 2016

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | | 2 | 2 | 2 | 3 | 2 | | 1 | | | | | |
| CO2 | 3 | 3 | | 2 | 2 | 2 | 2 | 1 | | 1 | | 1 | | | |
| CO3 | 3 | 3 | | 2 | 2 | 2 | 2 | 1 | | 1 | | 1 | | | |
| CO4 | 3 | 3 | | 2 | 2 | 2 | 2 | 2 | | 1 | | 1 | | | |
| CO5 | 3 | 3 | | 2 | 2 | 2 | 2 | 1 | | 1 | 2 | 1 | | | |
| Average | 3 | 3 | | 2 | 2 | 2 | 2 | 1.4 | | 1 | 2 | 1 | | | |
| Correlation level | 3 | 3 | | 2 | 2 | 2 | 2 | 2 | | 1 | 2 | 1 | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## III B. Tech. - I Semester
### (19BT50108) **PLANNING FOR SUSTAINABLE DEVELOPMENT**
(Open Elective-1)
(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITES: -**

**COURSE DESCRIPTION:**

Sustainable development; Environmental impact; Sustainable Policies; Governance; Theories and strategies; Media and education for sustainability.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Compare sustainable development theories in national and global context to protect the society and environment.

CO2. Analyze the unforeseen environmental impacts on sustainable development to protect the society and environment.

CO3. Analyze policies and governance for sustainable development considering ethics, economics, society and environment.

CO4. Analyze systems and strategies for sustainable development using appropriate tools and techniques considering ethics, economics, society and environment.

CO5. Analyze the role of media and education in sustainable development using appropriate tools and techniques considering ethics, society and environment besides communicating effectively.


**DETAILED SYLLABUS:**

**UNIT I: SUSTAINABLE DEVELOPMENT                    (09 Periods)**

Definition and concepts of sustainable development, Capitalization of sustainability- National and global context; Sustainable development goals, Emergence and evolution of sustainability and sustainable development, Theories of sustainability, Case studies.

**UNIT II: ENVIRONMENTAL IMPACT                    (09 Periods)**

Climate change – Science, Knowledge and sustainability; Unforeseen environmental impacts on development, Challenges of sustainable development, Centrality of resources in sustainable development, Case studies.

**UNIT III: SUSTAINABLE POLICIES AND GOVERNANCE            (09 Periods)**

Governance - Democracy and Eco–welfare; Global civil society and world civil politics, Civic environmentalism, Policy responses to sustainable development, Economics of sustainability, Social responsibility in sustainability, National action, ISO 14001: Environmental management system.

**UNIT IV: SUSTAINABLE SYSTEMS AND STRATAGIES            (09 Periods)**

Need for system innovation, Transition and co–evolution, Theories and methods for sustainable development, Strategies for eco–innovation, Ecological foot print analysis, Socio ecological indicators – Eco labels; Policy programmes for system innovation, Case studies.

## UNIT V: MEDIA AND EDUCATION FOR SUSTAINABILITY          (09 Periods)

Role of emerging media, Remarkable design and communication art, Activism and the public interest, Education for sustainability, Participation in decision making, Critical thinking and reflection, Case studies.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. John Blewitt, *Understanding Sustainable Development*, Earth Scan Publications Ltd., 2nd Edition, 2008.
2. Jennifer A. Elliot, *An Introduction to Sustainable Development*, Earth Scan Publications Ltd., 4th Edition, 2006.

### REFERENCE BOOKS:

1. Peter Rogers, Kazi F Jalal and John A Boyd, *An Introduction to Sustainable Development*, Earth Scan Publications Ltd., 2006.
2. Simon Dresner, *The Principles of Sustainability*, Earth Scan Publications Ltd., 2nd Edition, 2008.
3. Peter Bartelmus, *Environment Growth and Development: The Concepts and Strategies of Sustainability*, Routledge, 3rd Edition, 2003.
4. Gabriel Moser, Enric Pol, Yvonne Bernard, MiriliaBonnes, Jose Antonio Corraliza and Maria Vittoria Giuliani, *People Places and Sustainability*, Hogrefe& Huber Publishers, 2nd Edition, 2003.

### ADDITIONAL LEARNING RESOURCES:

1. Anil Markandya , Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | | | 1 | 2 | 3 | | | | | | | | |
| CO2 | 3 | 3 | | | | 3 | 3 | | | | | | | | |
| CO3 | 3 | 3 | | | | 2 | 1 | 1 | | | 1 | | | | |
| CO4 | 3 | 3 | | | 1 | 2 | 1 | 1 | | | 1 | | | | |
| CO5 | 2 | 2 | | | 2 | 2 | 1 | 1 | | 2 | | | | | |
| Average | 2.8 | 2.8 | | | 1.3 | 2.2 | 1.8 | 1 | | 2 | 1 | | | | |
| Correlation level | 3 | 3 | | | 1 | 2 | 2 | 1 | | 2 | 1 | | | | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

(19BT50109) **RURAL TECHNOLOGY**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITES: -**

**COURSE DESCRIPTION:**

Technology forrural development; Nonconventional energy; Technologies for rural development; Community development; IT in rural development.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Compare various technologies for rural development by solving rural problems through different schemes by considering ethics, society, environment and sustainability.

CO2. Analyzenon conventional energy sources using appropriate tools and techniques to solve rural energy problems considering society, environment and sustainability besides communicating effectively in graphical form.

CO3. Select appropriate technologies in different areas of rural development to solve rural issues following latest developments considering society, environment and sustainability.

CO4. Relate water conservation, health, safety and rural employment issues for community development to solve rural problems through appropriate technologies considering ethics, society, environment and sustainability.

CO5. Analyze the impact of IT, public and private partnership on rural development to solve complex rural problems using appropriate tools and techniques considering ethics, society, environment and sustainability.

**DETAILED SYLLABUS:**

**UNIT I: TECHNOLOGY FOR RURAL DEVLOPMENT                           (09 Periods)**

India - Technology and rural development, Pre and post independence period, Rural India Life, Indian farmer, Role of science and technology in rural development, Rural technology and poverty eradication, Rural business hubs, Technology in improving rural infrastructure, Various organizations related to innovation, Issues of technology transfer - CAPART, NABARD, CSIR, NIF.

**UNIT II: NON CONVENTIONAL ENERGY                           (09 Periods)**

Definition of energy, Types of alternative sources of energy, Sources of non conventional energy – Solar energy: Solar pump in agriculture, Solar dryer, Solar cooker, Solar heater; Biogas, Recycling and management, Wastes conservation, Assessment and production of biomass products and their utilization.

**UNIT III: TECHNOLOGIES FOR RURAL DEVELOPMENT                           (09 Periods)**

Food and agro based technologies, Tissue culture, Nursery, Building and construction technologies, Cultivation and processing of economic plants, Cottage and social industries, Latest developments in rural technologies.

## UNIT IV: COMMUNITY DEVELOPMENT (09 Periods)

Water conservation, Rain water Harvesting, Drinking water Standards and simple treatments used, Environment and Sanitation, Bio fertilizers, Medical and aromatic plants, Employment generating technologies–Apiculture, Pisciculture, Aquaculture.

## UNIT V: IT IN RURAL DEVELOPMENT (09 Periods)

Role of information technology (IT) in rural areas, Impact of IT in rural development, Need and necessity of technology, Corporate social responsibilities, Private sector participation (Activities in different spheres: Employment, Education, Health, Agriculture and service sectors) and SaansadAdarsh Gram Yojana (SAGY), Village adoption schemes.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. M. S. Virdi, *Sustainable Rural Technologies*, Daya Publishing House, 2nd Edition 2018.

2. S. V. Prabhath and P. Ch. Sita Devi, *Technology and Rural India*, Serials Publications, 1st Edition, 2012.

**REFERENCE BOOKS:**

1. R. Chakravarthy and P. R. S. Murthy, *Information Technology and Rural Development*, Pacific Book International, 1st Edition, 2012.

2. Shivakanth Singh, *Rural Development Policies and Programmes*, Northern Book Centre, 1st Edition, 2002.

3. Katar Singh and Anil Shishodia*, Rural Development: Principles, Policies, and Management,* SAGE Publications India Private Limited, 4th Edition, 2016.

4. A. Vinayak Reddy, M. YadagiraCharyulu, *Rural Development in India: Policies & Initiatives,* New Century Publications, 1st Edition, 2008.

**ADDITIONAL LEARNING RESOURCES:**

1. L. M. Prasad, *Principles and Practice of Management*, S. Chand & Sons, 9th Edition, 2019.

2. Venkata Reddy, K., *Agriculture and Rural Development - Gandhian Perspective*, Himalaya Publishing House, 1st Edition, 2017.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 2 | 3 | | 3 | 2 | 1 | 1 | 1 | | | | | | | |
| CO2 | 2 | 3 | | 2 | 2 | 1 | 1 | | | 1 | | | | | |
| CO3 | 2 | 3 | | 2 | 2 | 1 | 1 | | | | | 1 | | | |
| CO4 | 2 | 3 | | 2 | 2 | 1 | 2 | 1 | | | | | | | |
| CO5 | 2 | 3 | | 3 | 2 | 1 | 1 | 1 | | | | | | | |
| Average | 2 | 3 | | 2.4 | 2 | 1 | 1.2 | 1 | | 1 | | 1 | | | |
| Correlation level | 2 | 3 | | 3 | 2 | 1 | 1 | 1 | | 1 | | 1 | | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT50505) **ETHICAL HACKING**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITES: -**

**COURSE DESCRIPTION:**

Ethical hacking, Network and computer attacks, Footprinting, Social engineering, Port scanning, System hacking, Sniffers, Denial of service, Hacking web servers, Wireless hacking, Cryptography, Network Protection System.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Demonstrate knowledge on computer security, social engineering and the intent of ethical hacking.

CO2.  Select and apply footprinting and port scanning tools to discover vulnerabilities of the computer system.

CO3.  Investigate hacking techniques and tools to maintain computer security.

CO4.  Analyze cryptosystems and network protection systems for information security and intrusion prevention.

**DETAILED SYLLABUS:**

**UNIT I: ETHICAL HACKING, NETWORK AND COMPUTER ATTACKS       (9 periods)**

**Introduction to Ethical Hacking**: The role of security and penetration testers, Penetration-Testing methodologies, What you can and cannot do legally.

**Network and Computer Attacks:** Malicious software, Trojans, Backdoors, Viruses, and Worms, Protection against malware attacks, Intruder attacks on networks and computers, Addressing physical security.

**UNIT II: TCP/IP CONCEPTS AND SOCIAL ENGINEERING              (9 periods)**

**TCP/IP Concepts:** Overview of TCP/IP – Application layer, Transport layer, Internet layer; IP addressing – Planning IP address assignments, IPv6 addressing.

**Social Engineering:** What is social engineering, What are the common types of attacks, Understand insider attacks, Understand identity theft, Describe phishing attacks, Understand online scams, Understand URL obfuscation, Social engineering countermeasures.

**UNIT III: FOOTPRINTING ANDPORT SCANNING                      (9 Periods)**

**Footprinting:** Using web tools for footprinting, Conducting competitive intelligence, Using domain name system zone transfers.

**Port Scanning:** Port scanning, Using port scanning tools, Conducting ping sweeps, Understanding scripting.

**UNIT IV: SYSTEM HACKING                                      (9 Periods)**

System hacking -Password cracking techniques, Types of passwords, Key loggers and other spyware technologies, Escalating privileges, Root kits, How to hide files, Steganography technologies, How to cover your tracks and evidences; Sniffers - Protocols susceptible to

sniffing, Active and passive sniffing, ARP poisoning, Ethereal capture and display filters, MAC flooding, DNS spoofing techniques, Sniffing countermeasures; Denial of Service - Types of DoS attacks, How DDoS attacks work, How BOTs/BOTNETs work, Smurf attack, SYN flooding, DoS/DDoS counter measures; Session hijacking - Spoofing vs. hijacking, Types of session hijacking, Sequence prediction, Steps in performing session hijacking, Preventing session hijacking.

## UNIT V: CRYPTOGRAPHY, NETWORK PROTECTION SYSTEMS          (9 periods)

**Cryptography:** Understanding Cryptography basics, Symmetric and asymmetric algorithms, Public key infrastructure, Cryptography attacks.

**Network Protection Systems:** Understanding routers, Firewalls, Honeypots.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Michael T. Simpson, Kent Backman, James E. Corley, *Hands-On Ethical Hacking and Network Defense*, 3rdEdition, Cengage Learning, 2017.
2. Kimberly Graves, *CEH: Official Certified Ethical Hacker Review Guide*, Wiley, 2007.

**REFERENCE BOOK:**

1. Michael Gregg, *Certified Ethical Hacker (CEH) Cert guide*,3rdEdition, Pearson, 2019.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | - | - | - | - | 3 | - | 3 | - | - | - | - | | | |
| **CO2** | 3 | - | 3 | - | - | - | - | - | - | - | - | - | | | |
| **CO3** | 3 | - | 3 | - | - | - | - | - | - | - | - | - | | | |
| **CO4** | 3 | 2 | 3 | - | - | - | - | - | - | - | - | - | | | |
| **Average** | 3 | 2 | 3 | - | - | - | - | - | - | - | - | - | | | |
| **Correlation level** | 3 | 2 | 3 | - | - | 3 | - | 3 | - | - | - | - | | | |

**Correlation Levels:          3– High          2 - Medium          1– Low**

(19BT51207) **AI IN HEALTHCARE**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITES: -**

**COURSE DESCRIPTION:**

Concepts of Artificial Intelligence (AI) in Healthcare; The Present State and Future of AI in Healthcare Specialties; The Role of Major Corporations in AI in Healthcare; Applications of AI in Healthcare.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand the fundamental concepts of AI in the Healthcare sector.
CO2. Understand the applications of AI in Healthcare specialities.
CO3. Demonstrate AI applications developed by corporate companies.
CO4. Demonstrate knowledge on future applications of Healthcare using AI.
CO5. Understand the principles of AI applications through case studies.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE IN HEALTHCARE**

**(08 periods)**

Introduction to AI in Healthcare, Benefits and Risks, AI in the health sector, AI versus Human Intelligence, The future of AI in health sector, AI and Neural networks.

**UNIT II: THE PRESENT STATE AND FUTURE OF AI IN HEALTHCARE SPECIALTIES**

**(10 periods)**

**Artificial Intelligence in:** preventive healthcare, Radiology, Pathology, Surgery, Anesthesiology, Psychiatry, Cardiology, Pharmacy, Dermatology, Dentistry, Orthopedics, Ophthalmology.

**UNIT III: THE ROLE OF MAJOR CORPORATIONS IN AI IN HEALTHCARE**

**(08 periods)**

IBM Watson, The role of Google and Deep mind in AI in Healthcare, Baidu, Facebook and AI in Healthcare, Microsoft and AI in Healthcare.

**UNIT IV: FUTURE OF HEALTHCARE IN AI** **(10 periods)**

Evidence-based medicine, personalized medicine, Connected medicine, Disease and Condition Management, Virtual Assistants, Remote Monitoring, Medication Adherence, Accessible Diagnostic Tests, Smart Implantables, Digital Health and Therapeutics, Education, Incentivized Wellness.Artificial Intelligence, Blockchain, Robots, Robot-Assisted Surgery, Exoskeletons, Inpatient Care, Companions, Drones, Smart Places, Smart Homes, Smart Hospitals, Reductionism, Innovation vs. Deliberation.

**UNIT V: APPLICATIONS OF AI IN HEALTHCARE** **(09 periods)**

**Case Study 1:** AI for Imaging of Diabetic Foot Concerns and Prioritization of Referral for Improvements in Morbidity and Mortality.

**Case Study 2:** Outcomes of a Digitally Delivered, Low-Carbohydrate, Type 2 Diabetes Self-Management.

**Case Study 3:** Delivering a Scalable and Engaging Digital Therapy.

**Case Study 4:** Improving Learning Outcomes for Junior Doctors through the Novel Use of Augmented and Virtual Reality for Epilepsy

**Case Study 5:** Big Data, Big Impact, Big Ethics-Diagnosing Disease Risk from Patient Data.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Dr. ParagMahajan, *Artificial Intelligence in Healthcare, MedManthra Publications*, First Edition 2019.

2. *ArjunPanesar, Machine Learning and AI for Healthcare Big Data for Improved Health*, Apress Publications, 2019.

**REFERENCE BOOKS:**

1. Michael Matheny, SonooThadaneyIsrani, Mahnoor Ahmed, and Danielle Whicher,*Artificial Intelligence in Health Care: The Hope, the Hype, the Promise, the Peril*, National Academy of Medicine Publication, First Edition, 2019.

**ADDITIONAL LEARNING RESOURCES:**

1. https://www.udacity.com/course/ai-for-healthcare-nanodegree--nd320

   (AI for Healthcare).

2. https://builtin.com/artificial-intelligence/artificial-intelligence-healthcare

   (Surgical robots, new medicines and better care: 32 examples of AI in healthcare).

3. https://healthtechmagazine.net/article/2020/02/future-artificial-intelligence-healthcare
   (Future of Artificial Intelligence in Healthcare).

**CO–PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | - | | | |
| CO2 | 2 | 3 | - | 2 | - | 2 | 2 | - | - | - | - | - | | | |
| CO3 | 2 | - | 2 | 2 | - | - | - | - | - | - | - | - | | | |
| CO4 | 2 | - | - | - | 2 | 2 | - | - | - | - | - | - | | | |
| CO5 | 2 | - | - | - | 2 | 2 | - | - | - | - | - | - | | | |
| Average | 2.2 | 2.5 | 2 | 2 | 2 | 2 | 2 | -- | -- | -- | -- | -- | | | |
| Correlation level | 2 | 3 | 2 | 2 | 2 | 2 | 2 | -- | -- | -- | -- | -- | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT51506) **BIOINFORMATICS**

(Open Elective-1)

(Common to CE, ME, CSE, CSSE and IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Biology for Engineers.

**COURSE DESCRIPTION:**

Biological Data Acquisition, Databases, Data Processing, Methods of Analysis, Applications of Bio-informatics

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand basic biological data acquisition in bioinformatics.

CO2. Identify the proper databases for the information search by choosing the biological databases and also submission and retrieval of data from databases.

CO3. Analyze the results of bioinformatics data using text and sequence-based searching techniques.

CO4. Analyze the secondary and tertiary structures of proteins by applying different alignment programs

CO5. Design biological databases and novel drugs by using contextual knowledge on bioinformatics.

**DETAILED SYLLABUS:**

**UNIT I: BIOLOGICAL DATA ACQUISITION**                              **(9 Periods)**

Biological information, Retrieval methods for DNA sequence, protein sequence and protein structure information

**UNIT II: DATABASES**                                                **(9 Periods)**

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary and secondary sequence databases, protein sequence and structure databases.

**UNIT III: DATA PROCESSING**                                         **(9 Periods)**

Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Local and global. Distance metrics. Similarity and homology. Scoring matrices, PAM and BLOSUM

**UNIT IV: METHODS OF ANALYSIS**                                      **(9 Periods)**

Dynamic programming algorithms, Needleman-Wunsch and Smith-waterman.Heuristic Methods of sequence alignment, FASTA and BLAST; Multiple Sequence Alignment and software tools for pair wise and multiple sequence alignment, CLUSTAL program, Prediction of Tertiary structure of proteins.

## UNIT V: APPLICATIONS (9 Periods)

Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis, Genomics, Proteomics, Genome analysis – Genome annotation, DNA Microarray, computer aided drug design (CADD).

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. Lesk, A. K., "*Introduction to Bioinformatics*" 4th Edition, Oxford University Press, 2013

2. Dan Gusfield, "*Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology*" Cambridge University Press, 1997.

### REFERENCE BOOKS:

1. Baldi, P. and Brunak, S., "*Bioinformatics: The Machine Learning Approach*" 2nd Edition, MIT Press. 2001

2. Mount, D.W., "*Bioinformatics Sequence and Genome Analysis*" 2nd Edition, Cold Spring Harbor Laboratory Press, 2004

3. Tindall, J., "*Beginning Perl for Bioinformatics: An introduction to Perl for Biologists*" 1st Edition, O'Reilly Media, 2001

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| CO2 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| CO3 | 3 | 3 | 2 | - | 3 | - | - | - | - | - | - | - | - | - | 3 |
| CO4 | 3 | 3 | 2 | - | 3 | - | - | - | - | - | - | - | - | - | 3 |
| CO5 | 3 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | - | - | - | 3 |
| Average | 3 | 2.5 | 2.3 | 2 | 2.6 | - | - | - | - | - | - | - | - | - | 3 |
| Correlation level | 3 | 3 | 3 | 2 | 3 | - | - | - | - | - | - | - | - | - | 3 |

**Correlation Levels: 3– High 2 - Medium 1– Low**

## III B. Tech. – I Semester

## (19BT50310) ARTIFICIAL INTELLIGENCE AND ROBOTICS

(Interdisciplinary elective – 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Design of machine elements

**COURSE DESCRIPTION:**

Introduction of Artificial Intelligence; Introduction of Robots classifications; Components; Robot drive mechanisms; Mechanical transmission methods aided in the functioning of robots; Forward kinematics; inverse kinematics; Manipulator dynamics; Trajectory planning and avoidance of obstacles; Robot programming; Robot Application in Industry; Future Application and Challenges and Case Studies.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge on applications of AI, and select search strategies based on application requirements.

CO2. Demonstrate the concepts involved in robot systems.

CO3. Analyze kinematics and dynamics of robots.

CO4. Analyze trajectory planning to avoid obstacles involving sensors and control.

CO5. Develop programming for robotic applications.


**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION OF AI                                    (09 periods)**

Artificial Intelligence: Introduction to Artificial Intelligence (AI), History. AI techniques, LISP programming, AI and Robotics, LISP in the factory, sensoring and digitizing function in machine vision, image processing and analysis, training and vision system.

Intelligent Agents: Agents and Environments, the Concept of Rationality, the Nature of Environments, the Structure of Agents.

SLE: State of the Art of AI applications.

**UNIT II:  INTRODUCTION OF ROBOTICS                          (09 periods)**

Robot, Brief History, Classifications, Laws of Robotics, Robotic system, Robot anatomy, common robot configurations, coordinate system,  Joint notation schemes, Work volume, Degrees of freedom, Components, End effectors – Classification of End effectors, Tools as end effectors; Teach pendant, sensors, Specification of robots, Applications, safety measures.

**UNIT III: MANIPULATOR KINEMATICS & DYNAMICS              (10 periods)**

**Manipulator kinematics:** Mathematical Preliminaries on Vectors & Matrices, Homogeneous transformations as applicable to rotation and translation, (D-H) notation, Forward kinematics, Inverse kinematics, Manipulators with two, Three degrees of freedom.

**Manipulator dynamics:** Introduction, Inertia of a Link, Lagrangian formulation for a planar 2R manipulator.

## UNIT IV: TRAJECTORY PLANNING & SENSORS                (10 periods)

**Trajectory planning:** Trajectory planning and avoidance of obstacles, Path planning, Skew motion, Joint integrated motion, straight line motion.

**Sensors:** Position sensors, Velocity sensors, Tactile sensors, Proximity sensors, Machine vision sensors, Fail safe hazard sensor systems and Compliance mechanism

## UNIT V: ROBOT PROGRAMMING AND APPLICATIONS          (07 periods)

**Robot programming:** Types, Features of languages and Software packages.

**Robot application:** Robot Application in Industry, Task programming, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges, and Case Studies.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. Stuart Russell and Peter Nowig, *Artificial Intelligence: A Modern Approach*, Pearson Publication, 4th edition, 2020.

2. M.P.Groover, *Industrial Robotics: Technology, Programming, and Applications*, Tata McGraw-Hill Edition 2008.

3. John. J. Craig, *Introduction to Robotics: Mechanics and Control*, Edition 3, Pearson/Prentice Hall, 2005.

**REFERENCE BOOKS:**

1. DAN.W.Patterson, *Introduction to Artificial Intelligence and Expert Systems*, PHI, 2nd edition, 2009.

2. Richard. D.Klafter, *Robotics Engineering: an integrated approach*, Prentice-Hall publisher, 1st Edition 1988.

3. K. S. Fu., R. C. Gonzalez, C. S. G. Lee , *Robotics: Control Sensing, Vision and Intelligence*, International Edition, TATA McGraw Hill, 2008.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | 1 | 1 | | | | | | | 3 | | |
| CO2 | 3 | 1 | | | 1 | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |
| CO5 | 3 | 3 | 3 | 1 | 1 | 1 | | | | | | | 3 | | |
| Average | 3 | 2.2 | 1.6 | 1 | 1 | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 2 | 2 | 1 | 1 | 1 | | | | | | | 3 | | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

(19BT50311) **AUTOMOTIVE ELECTRONICS**

(Interdisciplinary elective – 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on thermal engineering-I and Basics of Electrical and Electronics Engineering.

**COURSE DESCRIPTION:**

Electronic control in various systems in automobile; Importance of microcontrollers; Sensors and actuators used in automobile; Electronics engines; Automotive instrumentation in signal conversion and lightening system.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of automotive systems, electronic controls in automobiles.

CO2. Demonstrate the knowledge of automotive grade microcontrollers and components of the microcomputer in an automobile.

CO3. Demonstrate knowledge of sensors, actuators, signal conditioning techniques, interfacing techniques and actuator mechanisms used in automotive systems.

CO4. Analyze functional and operational characteristics of electronics interventions in engines.

CO5. Demonstrate knowledge of automotive instrumentation systems.

**DETAILED SYLLABUS**

**UNIT 1: AUTOMOTIVE SYSTEMS** (09 periods)

Introduction, Need for electronic control in automobiles; various sub-systems of automobile: Engine, Transmission System, Steering and Brake Systems; Classification and working of IC engine: Gasoline, Diesel engines, 2-stroke, 4-stroke engines; Engine Control methods: Air-fuel ratio control, Spark timing, Start of fuel injection.

**UNIT II: MICROCOMPUTERS** (09 periods)

Microcomputer: Buses, memory, timing, CPU registers; Microprocessor architecture: Initialization, operation codes, program counter, branch and jump instructions, subroutine. Analog to digital converters and Digital to analog converters, sampling, polling and interrupts, digital filters, lookup table.

**UNIT III: SENSORS AND ACTUATORS** (09 periods)

Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensors, Position sensors: Throttle position sensors, accelerator pedal position sensors and crankshaft position sensors, Air mass flow sensors. Solenoids, stepper motors and relays.

**UNIT IV: ELECTRONIC ENGINE AND VEHICLE MANAGEMENT SYSTEM** (09 periods)
Electronic engine control: Input, output and control strategies, electronic fuel control system, fuel control modes: open loop and closed loop control at various modes, EGR control, Electronic ignition systems–Spark advance correction schemes, fuel injection timing control. Cruise control system, Antilock braking system, electronic suspension system,

electronic steering control, traction control system, Transmission control, Safety: Airbags, collision avoiding system, low tire pressure warning system.

**UNIT V: AUTOMOTIVE INSTRUMENTATION SYSTEM                    (09 periods)**
Input and output signal conversion, multiplexing, fuel quantity measurement, coolant temperature and oil pressure measurement, display devices- LED, LCD, VFD and CRT, On-board diagnostics (OBD), OBD-II, off-board diagnostics.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. William Bribbens, *Understanding Automotive Electronics*, NewneButterworth-Heinermann, 6th Edition, 2002.

2. Crouse W H, *Automobile Electrical Equipment*, McGraw Hill, New York 2005.

**REFERENCE BOOKS:**

1. Bechhold, *Understanding Automotive Electronics*, SAE, 1998.

2. Robert Bosch *Automotive Hand Book*, SAE 5th Edition, 2000.

3. Tom Denton, *Automobile Electrical and Electronic Systems*"Edward Arnold, 3rd Edition, 2004.

4. Eric Chowanietz*, Automotive Electronics*, SAE International, USA, 1995.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| **CO2** | 3 | 1 | | | 1 | 1 | | | | | | | | 3 | |
| **CO3** | 3 | 1 | | | 1 | 1 | | | | | | | | 3 | |
| **CO4** | 3 | 3 | | | 1 | 1 | | | | | | | | 3 | |
| **CO5** | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| **Average** | 3 | 1 | | | 1 | 1 | | | | | | | | 3 | |
| **Correlation level** | 3 | 1 | | | 1 | 1 | | | | | | | | 3 | |

**Correlation Levels:          3– High          2 - Medium          1– Low**

# III B. Tech. – I Semester

## (19BT50312) INDUSTRIAL AUTOMATION AND CONTROL SYSTEMS

(Interdisciplinary elective – 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Automation in Production System; Advanced Automation Functions; Material Handling Systems; GT and Cellular Manufacturing; FMS; Industrial Control Systems; AI in manufacturing.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of Industrial automation components and systems used in automated manufacturing industries.

CO2. Design material handling systems for a manufacturing plant based on its working principle and capabilities.

CO3. Analyze transfer lines in automation involving Manufacturing Cells, GT, Cellular Manufacturing, FMS, and FMS.

CO4. Demonstrate the knowledge on control systems in manufacturing.

CO5. Develop mathematical models for manufacturing plants using AI.

**DETAILED SYLLABUS:**

**UNIT I:  INTRODUCTION TO AUTOMATION:** **(07 periods)**
Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

**UNIT II: MATERIAL HANDLING SYSTEMS** **(10 periods)**
Overview of Material Handling Systems, Rotary feeders, oscillating force feeder, vibratory feeder, elevator type and Centrifugal type feeders, Principles and Design Consideration, Material Transport Systems, Storage Systems.

**UNIT III: AUTOMATION IN MANUFACTURING** **(09 periods)**
Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation, Flow lines &Transfer Mechanisms, Fundamentals and Analysis of Transfer Lines, product design for automatic assembly.

**UNIT IV: CONTROL SYSTEM IN MANUFACTURING** **(09 periods)**
Industrial Control Systems, Process Industries Verses Discrete - Manufacturing, Industries Continuous Verses Discrete Control, Computer Process and its Forms. Sensors Actuators and other Control System Components, Application of control system in manufacturing

**UNIT V: ARTIFICIAL INTELLIGENCE IN MANUFACTURING** **(10 periods)**
Introduction/need for system Modeling, Building Mathematical Model of a manufacturing Plant, ModernTools – Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation.

(**Total Periods: 45)**

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. R.C. Dorf, John Wiley and Sons, *Hand book of design, manufacturing and Automation*, Wiley-Interscience; 1st edition, 1994.
2. M.P. Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson Education, 4th Edition, 2016.

**REFERENCE BOOKS:**

1. W.P.David, *Industrial Automation*, Wiley-Interscience, 1st Edition, 1991.

2. Krishna Kant, *Computer Based Industrial Control*, PHI, 2nd Edition, 2011.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | - | - | - | - | - | - | - | - | **3** | - | - |
| **CO2** | 3 | 3 | 3 | 1 | 1 | 1 | - | - | - | - | - | - | **3** | - | - |
| **CO3** | 3 | 3 | 1 | | 1 | 1 | - | - | - | - | - | - | **3** | - | - |
| **CO4** | 3 | 1 | 1 | | 1 | 1 | - | - | - | - | - | - | **3** | - | - |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 1 | - | - | - | - | - | - | **3** | - | - |
| **Average** | 3 | 2.2 | 2 | 1 | 1.5 | 1 | - | - | - | - | - | - | **3** | - | - |
| **Correlation level** | 3 | 2 | 2 | 1 | 2 | 1 | | | | | | | **3** | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT50313) **NON- CONVENTIONAL ENERGY SOURCES**

(Interdisciplinary elective – 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

**COURSE DESCRIPTION:**
Overview and importance of nonconventional energy sources; Solar Energy collection, solar energy storage and applications; Wind energy conversion; Biomass energy conversion; Geothermal energy Conversion; Ocean energy conversion: Ocean thermal energy conversion, Wave energy and tidal energy conversion.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of energy resources, energy conservation and solar energy.
CO2. Analyze the performance characteristics of solar heat collectors.
CO3. Demonstrate knowledge of PV systems, energy storage and conversion systems.
CO4. Demonstrate the knowledge on construction and working of wind energy and bio-energy conversion systems.
CO5. Demonstrate the knowledge on construction and working of Geothermal and Ocean Energy conversion systems.

**DETAILED SYLLABUS:**

**UNIT I**: **ENERGY CONSERVATION AND SOLAR ENERGY** **(09 periods)**

**Energy sources and Conservation:** Introduction, Conventional energy sources**,** Classification, Importance of renewable energy sources, energy alternatives, need and Principles of energy conservation.

**Fundamentals of Solar Energy:** Site selection for solar plant, Solar constant and solar radiation geometry, Solar time and day length, Estimation of monthly average daily total radiation on horizontal surface and tilted surface, Measurement of solar radiation - Pyranometer, Pyrheliometer and Sunshine recorder.

**UNIT II: SOLAR ENERGY COLLECTION DEVICES** **(09 periods)**
Flat plate collector, Losses through flat plate collector; Transmissivity of the cover system, Transmittance – Absorptance product, Parameters affecting the collector performance, Efficiency of flat plate collector, Selective surfaces, Air collectors and types, Classification of concentrating collectors.

**UNIT III: SOLAR ENERGY APPLICATIONS** **(09 periods)**
**Solar Photo Voltaic Systems:** Basic principle of PV cell, Arrangements of PV cells, classification of PV cell, Solar PV Applications.

**Solar Thermal Applications:** Methods of storing solar energy - sensible heat storage, latent heat storage, Applications -Solar water heating, Solar Refrigeration, Solar thermal power generation, Solar distillation.

## UNIT IV: WIND ENERGY AND BIOMASS ENERGY CONVERSION (09 periods)

**Wind Energy Conversion:** Introduction, Site selection for wind energy plant, General formula - Betz limit - Lift and Drag - Basis of wind energy conversion - Effect of density, frequency variances, angle of attack, and wind speed, classification and working of horizontal axis wind turbine - vertical axis Wind turbines, Types of blades, Wind energy conversion systems, environmental consideration.

**Biomass Energy Conversion:** Pyrolysis of Biomass to produce solid, liquid and gaseous fuels , Classification of biogas plants, Types of Digesters – Floating drum, fixed dome type biogas plants, comparison; variations of Biogas models – Pragati biogas model, Jwala biogas model, CAMATEC model and Deenabandhu biogas model, Factors affecting digester performance.

## UNIT V: GEOTHERMAL AND OCEAN ENERGY CONVERSION (09 periods)

**Geothermal Energy Conversion:** Introduction, geothermal sources - Hydrothermal resources, geo pressurized resources, hot dry rocks, Power generation through liquid dominated system, vapour dominated system, applications of geothermal energy, environmental consideration.

**Ocean Energy Conversion:** Ocean thermal energy conversion - Lambert's law, OTEC conversion technologies- Claude cycle and Anderson cycle, Environmental impacts of OTEC; Tidal energy conversion - Principles of tidal and wave power generation, tidal energy conversion - single basin and double basin systems.

**Total Periods: *45***

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. G.D, Rai, *Non-conventional Energy Sources*, Khanna Publishers, 5th Editon, 2011.

2. B.H.Khan, *Non-conventional Energy Sources*, TMH, 3rd Edition, 2016.

**REFERENCE BOOKS:**

1. S.P.Sukhatme and J.K Nayak, *Solar Energy Principles of Thermal Collection and Storage*, TMH, 3rd edition, 2008.
2. W.R.Murphy & G.Mckay, *Energy Management*, Butterworth, London, 2nd Edition, 2007**.**

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| CO2 | 3 | 3 | 1 | 1 | | 1 | 1 | | | | | | | 3 | |
| CO3 | 3 | 1 | 1 | | | 1 | 1 | | | | | | | 3 | |
| CO4 | 3 | 1 | 1 | | | 1 | 1 | | | | | | | 3 | |
| CO5 | 3 | 1 | 1 | | | 1 | 1 | | | | | | | 3 | |
| Average | 3 | 1.4 | 1 | | | 1 | 1 | | | | | | | 3 | |
| Correlation level | 3 | 1 | 1 | 1 | | 1 | 1 | | | | | | | 3 | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

## (19BT50314) PROGRAMMABLE LOGIC CONTROLLER IN AUTOMATION

(Interdisciplinary elective – 1)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**
A course on Basic Electrical and Electronics Engineering
**COURSE DESCRIPTION:**
Introduction to Microprocessors; basic microcontrollers; Assembly language programming concepts; Digital signal controls and processing; Controls for robots in automation.
**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of the internal architecture of 8085 processor.
CO2. Demonstrate the architecture and capabilities of microprocessors and microcontrollers.
CO3. Apply assembly language programs for interrupt and timer programming in different modes.
CO4. Apply the concept of Z-Transform, digital filters and algorithms for digital control.
CO5. Demonstrate knowledge of automation using robotics for industrial applications.

**UNIT I: INTRODUCTION TO MICROPROCESSORS             (9 periods)**
**Introduction:** Number systems, codes.  Digital electronics: logic gates, combinational circuits design, flip-flops. Sequential logic circuits design: counters, shift registers.

**Introduction to 8085:** 8085 architecture, registers, ALU, bus systems, 8255 PPI, 8253 programmable timer, ADC and DAC, functional block diagram of 8085.

**UNIT II:  INTRODUCTION TO MICROCONTROLLERS             (8 periods)**
**The 8051 architecture:** Introduction, 8051 Microcontroller hardware, input/output ports and circuits, external memory, counter and timers, synchronous serial and asynchronous serial communication, interrupts and priorities.
**UNIT III: ASSEMBLY LANGUAGE PROGRAMMING AND APPLICATIONS  (8 periods)**
**Basic Assembly Language Programming Concepts**: Assembly language programming process, addressing modes, instruction set of 8051 microcontrollers, assembly language programming, and introduction to C programming.
**Applications:** Interfacing with keyboards, D/A and A/D conversions, serial data communication, programmable timers.
**UNIT IV: DIGITAL CONTROL                 (8 periods)**
Introduction to Digital Control: Sampling theorem, signal conversion and processing, Z-Transform, digital filters, implementation of digital algorithm
**UNIT V: AUTOMATION                 (12 periods)**
**Automation:** Need for Automation, Robot components, control system concepts, analysis, control of joints, adaptive and optimal control. End effectors, classification, mechanical, magnetic, vacuum, adhesive drive systems and controls, force analysis and gripper design. Direct and inverse kinematics for industrial robots.

**Total Periods: *45***

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. Michael D. Ciletti, M. Morris Mano, *Digital Design*, 4/e. Pearson Education, 2007.

2. Ramesh S. Gaonkar, *Microprocessors, Architecture, Programming and Applications with the 8085*, 5/e, Penram, 2011.

3. Thomas R. Kurfess, *Robotics And Automation Handbook*, CRC Press, 2004, ISBN 0-8493-1804-1

**REFERENCE BOOKS:**

1. Digital Electronics, *An Introduction to Theory and Practice*, William H. Gothmann, PHI Learning Private Limited, 1982.

2. John.F.Wakerly, *Microcomputer Architecture and Programming*, John Wiley and Sons 1981

3. Kenneth. J. Ayala, *The 8051 Microcontroller*, 3/e, Cengage Learning, 2004.

4. Benjamin C. Kuo, Digital Control Systems, Oxford University Press, 2nd Indian Edition, 2007.

5. Raj Kamal, *The Concepts and Features of Microcontrollers*, Wheeler Publishing, 2005.

6. Groover M.P. Weiss Mithell Nagel R.N., Odery N.G., "*Industrial Robotics, Technology, Programming and Applications*", McGraw Hill International Editions, 1986.

7. Klafter,"*Robotics Engineering*", PHI Pvt. Ltd., New Delhi.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | 1 | - | - | - | - | - | - | - | 3 | - | - |
| CO2 | 3 | - | | | 1 | - | - | - | - | - | - | - | 3 | - | - |
| CO3 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | - | - | - | 3 | - | - |
| CO4 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | - | - | - | 3 | - | - |
| CO5 | 3 | - | - | - | | 1 | - | - | - | - | - | - | 3 | - | - |
| Average | 3 | 2 | 1 | 1 | 1.5 | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 2 | 1 | 1 | 2 | 1 | | | | | | | 3 | | |

**Correlation Levels:** 3– High 2 - Medium 1– Low

## III B. Tech. – I Semester

## (19BT50315)SOFT COMPUTING TECHNIQUES IN MECHANICAL ENGINEERING

(Interdisciplinary elective – 1)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Introduction to Soft computing techniques; Genetic Algorithm; Fuzzy Logic; neural Network; Hybrid soft computing techniques; Application in Mechanical Engineering.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of soft computing techniques and their applications.

CO2. Apply the genetic algorithms and their applications in Mechanical Engineering.

CO3. Model the fuzzy systems.

CO4. Analyze various neural network architectures.

CO5. Apply the hybrid soft computing techniques in real life applications.

.

**DETAILED SYLLABUS:**

**UNIT I:  INTRODUCTION TO SOFT COMPUTING                    (08 periods)**
Evolution of Computing - Soft Computing Constituents – From Conventional AI Computational Intelligence - Machine Learning Basics
**UNIT II: GENETIC ALGORITHM                                       (10 periods)**
Introduction, Working cycle of a Genetic Algorithm, Basic operators and Terminologieslike individual, gene, encoding, fitness function and reproduction, Genetic modeling: Significance of genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems, JSPP (Job Shop Scheduling Problem), TSP (Travelling SalesmanProblem), Differences& similarities between GA & other traditional methods, Applications of GA.
**UNIT III: FUZZY LOGIC                                              (09 periods)**
Introduction, Crisp Sets, Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions- Fuzzy Rules and fuzzy Reasoning – Fuzzy Clustering, C-Means clustering, Entropy-based Fuzzy Clustering.
**UNIT IV: NEURAL NETWORKS                                        (09 periods)**
Introduction, Static Vs Dynamic Neural Networks, training of neural networks, Multi-Layer Feed-Forward Neural Network (MLFFNN), Radial Basis Function Network (RBFN), Self Organizing Map (SOP), Recurrent Neural Networks (RNN).
**UNIT V: HYBRID SOFT COMPUTING TECHNIQUES                   (09 periods)**
Working principle of Genetic-Fuzzy systems, Genetic-Neural system, Neuro-fuzzy hybrid systems based on Mamdani Approach, Takagi and Sugeno's approach.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. D. K. Pratihar, *Soft Computing*, Narosa Publications, Revised Edition, 2018
2. S, Rajasekaran& G.A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications*, PHI Publication, 1st Edition, 2009.

**REFERENCE BOOKS:**

1. S.N.Sivanandam, S.N.Deepa, *"Introduction To Genetic Algorithms",* Springer, 2007.
2. Bart Kosko, Neural Network & Fuzzy System, PHI Publication, 1st Edition, 2009.

**ADDITIONAL LEARNING RESOURCES:**
http://nptel.ac.in/courses/106106046/

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | 1 | | 2 | | | | | | | | 3 | | |
| **CO2** | 3 | 3 | | | 3 | | | | | | | | 3 | | |
| **CO3** | 3 | 3 | 3 | 1 | 1 | | | | | | | | 3 | | |
| **CO4** | 3 | 3 | 1 | | 1 | | | | | | | | 3 | | |
| **CO5** | 3 | 3 | 1 | | 3 | | | | | | | | 3 | | |
| **Average** | 3 | 2.6 | 1.5 | 1 | 2 | | | | | | | | 3 | | |
| **Correlation level** | 3 | 3 | 2 | 1 | 2 | | | | | | | | 3 | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT50331) **COMPUTER AIDED DESIGN AND MANUFACTURING LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:**
A Course on Computer Aided Engineering Drawing.
**COURSE DESCRIPTION:**
Fundamental Concepts of CAD and Simulation; 2D and 3D Part Modeling, Manual Part Programming, CNC Code Generation.
**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Develop part drawings for machine components using drafting software.

CO2.   Model the machine components using 3D modeling software.

CO3.   Develop part programming in CNC applications.

CO4.   Work independently or in teams to solve problems with effective communication

**SYLLABUS:**

**LIST OF EXPERIMENTS**

Any **twelve** experiments are to be conducted.

Exercises (2-D & 3-D) using design packages:

**Part Modeling :**

Development of part drawings for various components in the form of orthographic and isometric, Representation of dimensioning and tolerances scanning and plotting.

**List of exercises: (Minimum 5 exercises)**

1.  prepare the solid model1 of given figure with required dimensions in isometric representation.

2.  prepare the solid model2 of given figure with required dimensions in isometric representation.

3.  prepare the solid model3 of given figure with required dimensions in isometric representation.

4.  prepare the solid model4 of given figure with required dimensions in isometric representation.

5.  prepare the solid model5 of given figure with required dimensions in isometric representation.

6.  prepare the solid model6 of given figure with required dimensions in isometric representation.

7.  prepare the solid model7 of given figure with required dimensions in isometric representation.

**Assembly Modeling:** Generation of various 3D models through protrusion, revolve, shell sweep, Creation of various features, Study of parent child relation, Feature based and

Boolean based modeling surface and assembly modeling, Study of various standard translators, Design simple components.

**List of exercises: (Minimum 3 exercises)**

1. Develop the part drawing of Knuckle joint assembly
2. Develop the part drawing of Plumber block assembly
3. Develop the part drawing of Crank hook assembly
4. Develop the part drawing of connecting rod in the orthographic representation.
5. Develop the part drawing of revolving center
6. Development of the part drawing of footstep bearing

**CNC machines:**

**List of exercises: (Minimum 4 exercises)**

1. Simulation of CNC Lathe and Milling Manual Part Programs.
2. Simulation of simple components on CNC Lathe 1.
3. Simulation of simple components on CNC Lathe 2
4. Simulation of simple components on CNC Milling.
5. Simulation of simple components using CANNED CYCLE.

**CAD Packages:** SOLIDWORKS, CATIA, Unigraphics, Solid Edge, CREO.

**CAM Packages:** Master CAM, Sinu train.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | 3 | 2 | - | - | - | - | - | - | 3 | - | - |
| CO2 | 3 | 3 | 3 | 1 | 3 | 2 | - | - | - | - | - | | 3 | - | - |
| CO3 | 3 | 3 | 3 | 1 | 3 | 2 | - | - | - | - | - | - | 3 | - | - |
| CO4 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - |
| Average | 3 | 3 | 3 | 1 | 3 | 2 | | | 3 | 3 | | | 3 | | |
| Correlation level | 3 | 3 | 3 | 1 | 3 | 2 | | | 3 | 3 | | | 3 | | |

**Correlation Levels:       3– High        2 - Medium        1– Low**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | 0 | 0 | 2 | 1 |

**PRE-REQUISITES:**

Course on Thermal Engineering-I.

**COURSE DESCRIPTION:**

Calculating the performance parameters of 2-stroke and 4- stroke I.C. Engines; Heat balancing of an engine; Practicing the valve and port timing diagrams; Determining frictional power for single and multi- cylinder engines; Compressor performance. Assembly and disassembly of automobile models; Determining the Fuel properties; determining the performance of vapor compression refrigeration system, Air conditioning system and Water cooler.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the performance and emission characteristics of I.C Engines.

CO2. Analyze the Performance characteristics of reciprocating air compressor and determine volumetric and isothermal efficiency.

CO3. Estimate the performance of Refrigeration and air-conditioning systems to assess its coefficient of performance.

CO4. Calculate the calorific value of fuels using Bomb calorimeter & Junker's Gas Calorimeter and viscosity of fuels using saybolt&redwoodViscometer.

CO5. Demonstrate the knowledge on working of boilers, steam turbines, steam condensers and steam nozzles.

CO6. Work independently or in teams to solve problems with effective communication.

## LIST OF EXPERIMENTS

**Minimum TWELVE experiments are to be conducted.**

1. (a) Valve Timing Diagram using a model of 4–SDiesel, CI engine

   (b) Port timing diagram of a model of 2-S, SI engine

2. Morse Test on 4-S, 4-C, Petrol Engine using Hydraulic loading

3. Retardation Test on 4-S, 1-C, Diesel Engine using Electrical loading

4. Performance Test on 2-S, 1-C, Petrol Engine using Electrical Loading

5. Economic speed test on 2-S, 1-C, Petrol Engine using Electrical Loading

6. Performance Test on 4-S, 1-C diesel Engine using Mechanical Loading

7. Heat Balance Test on 4-S, 1-C diesel Engine using Mechanical Loading Performance Test Variable Compression Ratio Engine (VCR Engine)

8. Motoring Test on Variable Compression Ratio Engine (VCR Engine)

9. Performance Test on 2-Stage Reciprocating Air compressor Unit

10. Dismantling/Assembly of Engines to identify the parts and their position in an engine

11. Performance and emission characterization tests on Computerized 4-S, 1-C, C.I. engine using Eddy Current loading, Exhaust gas analyzer and smoke meter.

12. Performance test on vapour compression refrigeration system.

13. Experiments on Fuels:

   (a) Bomb calorimeter for Calorific Value of Solid and Liquid fuel

   (b) Junker's Gas Calorimeter for Calorific Value of gaseous fuel

   (c) Viscosity measurement using saybolt and redwood viscometer

14. Study of boilers, steam condensers, steam turbines and steam nozzles.

15. Study of vapour absorption refrigeration systems and psychrometric process.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | | - | 1 | 1 | - | - | - | - | - | - | 3 | - |
| CO2 | 3 | 3 | 1 | | - | 1 | 1 | - | - | - | - | - | - | 3 | - |
| CO3 | 3 | 3 | 1 | | - | 1 | 1 | - | - | - | - | - | - | 3 | - |
| CO4 | 3 | 3 | 1 | - | - | 1 | 1 | - | - | - | - | - | - | 3 | - |
| CO5 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | 3 | - |
| CO6 | | | | | | | | | 3 | 3 | | | | | |
| Average | 3 | 3 | 1 | 1 | 1 | 1 | 1 | | 3 | 3 | | | | 3 | |
| Correlation level | 3 | 3 | 1 | 1 | 1 | 1 | 1 | | 3 | 3 | | | | 3 | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## (19BT50333) **SOCIALLY RELEVANT PROJECT-1**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | - | 1 |

**PREREQUISITES: -**

**COURSE DESCRIPTION:**

Identification of topic for the socially relevant project; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the socially relevant project; Preparation of thesis and presentation.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Create/Design engineering systems or processes to solve complex societal problems using appropriate tools and techniques following relevant standards, codes, policies, regulations and latest developments.

CO2. Consider environment, sustainability, economics and project management in addressing societal problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on socially relevant project.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | - | - | - | 3 | | | |
| **CO2** | - | - | - | - | - | - | 3 | - | - | - | 3 | - | | | |
| **CO3** | - | - | - | - | - | - | - | - | 3 | 3 | - | - | | | |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| **Correlation level** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

# III B.Tech. I Semester

## (19BT503AC) FOUNDATIONS OF ENTREPRENEURSHIP

(Common to CE, ME, ECE, EEE & EIE)

(AUDIT COURSE)

| L | T | P | C |
|---|---|---|---|
| 2 | - | - | - |

**PRE-REQUISITES**: --

**COURSE DESCRIPTION:**

The nature and growth of entrepreneurship; Characteristics of an entrepreneur; Types of Entrepreneurs; Ethics and social responsibility of entrepreneurs; Generating ideas; Opportunity identification; Implementing and managing the venture; Principles of creativity and innovation; Methods of protecting innovation and creativity; Market research; Feasibility analysis; Sources of funding; Preparation of business plan; Start-Ups; Social Entrepreneurship; Rural entrepreneurship.

**COURSE OUTCOMES**:

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on personal attributes that enable the best use of entrepreneurial opportunities.
CO2. Apply suitable methods to protect creativity and innovation.
CO3. Design and prepare high impact strategic and business plans.
CO4. Analyze the major steps and requirements to convert an innovative idea into a successful start-up.
CO5. Develop an idea to create a business for social change by identifying social entrepreneurship opportunities.

### UNIT I: ENTREPRENEURIAL MINDSET (06 Periods)

The nature and growth of entrepreneurship, Entrepreneurship and Intrapreneurship, Characteristics of an entrepreneur, Types of Entrepreneurs, Women as an Entrepreneur, Factors that contribute to the success of entrepreneurs, Ethics and social responsibility of entrepreneurs.

### UNIT II: ENTREPRENEURIAL PROCESS (06 Periods)

Generating ideas, Opportunity identification, Business concepts, Resources (Financial, Physical and Human), Implementing and managing the venture, Harvesting the venture, Harvesting strategies:  Absorption of new concept into mainstream operations, Licensing of rights, Family succession, Liquidate (Shut down) venture, Selling the venture, Management Buy-Out (MBO).

### UNIT III: CREATIVITY AND INNOVATION (06 Periods)

Principles of creativity and innovation, Disruptive, incremental and open innovations, Nurturing and managing innovation, Methods of protecting innovation and creativity: Intellectual property rights, Branding, Trademarks, Patents, Copyrights, Registered design protection, Trade secrets.

**UNIT IV: NEW VENTURE PLANNING AND CREATION**         **(06 Periods)**

Market research (venture opportunity screening), Feasibility analysis, Start-up capital;

Sources of funding: equity financing, debt financing (loans, venture funding, angel funding), grants, gifts, bequests and financial statements, Introduction to the business plan, Preparation of business plan.

**UNIT V: Start-Ups and Social Entrepreneurship**         **(06 Periods)**

**Start-Ups:** Definition to start-up, Start-up activities, Promising start-ups, Venture-backed start-ups, Corporate-supported start-ups.

**Social Entrepreneurship:** Social enterprise-Need - Types - Characteristics and benefits of social enterprises, Rural entrepreneurship.

                                                          **Total Periods: 30**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Robert D. Hisrich, Mathew J. Manimala, Michael P. Peters, Dean A. Shepherd, *Entrepreneurship*, McGraw Hill Education (India) Private Limited, Eighth Edition, 2013.
2. Marc J Dollinger, *Entrepreneurship: Strategies and Resources*, Pearson, Third Edition, 2003.

**REFERENCE BOOKS:**

1. Vasant Desai, *Dynamics of Entrepreneurial Development and Management,* Himalaya Publ. House, 2004.
2. *Harvard Business Review on Entrepreneurship,* HBR Paper Back.
3. Thomas W. Zimmerer& Norman M. Scarborough, *Essential of Entrepreneurship and small business management,* PHI.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | - | - | - | - | 1 | - | 1 | - | - | 1 | - | | | |
| **CO2** | 3 | 2 | 1 | - | - | 1 | - | 1 | - | - | 1 | - | | | |
| **CO3** | 3 | 2 | 2 | - | - | 2 | - | 1 | - | - | - | - | | | |
| **CO4** | 3 | 3 | 1 | - | - | 2 | - | 1 | - | - | 3 | - | | | |
| **CO5** | 3 | 2 | 1 | - | - | 2 | - | 1 | - | - | 1 | - | | | |
| **Average** | 3 | 2.2 | 1.2 | | | 1.6 | | 1 | | | 1.5 | | | | |
| **Correlation level** | 3 | 2 | 1 | | | 2 | | 1 | | | 2 | | | | |

    **Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

## (19BT60301) **INDUSTRIAL ENGINEERING AND MANAGEMENT**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Management – Concept; Staffing, Leading and Controlling; Leading Effective Teams, Planning and Implementing Change; Allowances and Standard time calculations; Line balancing, Maintenance; Statistical Process Control.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:

CO1.  Demonstrate the knowledge on essentials of management theories and approaches by valuing ethics and social responsibility.

CO2.  Analyze organizational structures and formulate leadership strategies for organizational transformation.

CO3.  Apply work study techniques for uniform and enhanced production flow.

CO4.  Analyze maintenance and facility planning problems and solve anomalies in breakdown, availability and redundancy.

CO5.  Apply quality control tools and techniques for acceptance decisions, process adjustments and minimal rework by following quality standards, industry Acts and safety measures.

**DETAILED SYLLABUS:**

**UNIT I: ESSENTIALS OF MANAGEMENT** **(09 periods)**

Management – Concept, Process, Theories and Approaches; Management Roles and Skills Functions – Planning, Organizing, Staffing, Leading and Controlling; Decision Making – Concept, Process, Techniques and Tools; Business Ethics, Corporate Social Responsibility and Corporate Governance

**UNIT II: MANAGEMENT OF ORGANIZATIONAL BEHAVIOUR** **(09 periods)**

Leadership and management, Classic Motivational Theories, Situational Leadership, Effective Communication, Leading Effective Teams, Planning and Implementing Change, Leadership Strategies for Organizational Transformation.

**UNIT III: WORK STUDY** **(09 periods)**

Productivity, Method study – Steps, Charts and Diagrams, Principles of Motion economy; Work measurement – Time study – Rating, Allowances and Standard time calculations; Work sampling, Human Factors and Ergonomics.

**UNIT IV: FACILITIES PLANNING AND MAINTENANCE** **(09 periods)**

Types of Production, Plant Location and Layout, Line balancing, Maintenance – Breakdown, Preventive and Predictive; 5S and TPM; Reliability – Series, Parallel, Series-Parallel device configurations, Bath-tub curve, MTBF, MTTR, Availability and Redundancy.

**UNIT V: QUALITY ASSURANCE AND INDUSTRIAL SAFETY**      **(09 periods)**

Statistical Process Control – Control Charts for Variables and Attributes, Process Capability; Acceptance sampling – Sampling Plans, OC curve; ISO 9000 Standards and Total Quality Management, Benchmarking, Industrial Safety rules, Investigation and Analysis of Accidents, Indian Factories Act, Workmen Compensation Act and Industrial Disputes Act

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**

1. MartandTelsang, *Industrial Engineering and Production Management*, S. Chand, 2nd Edition, 2006

2. Kenneth H. Blanchard, Paul Hersey and Dewey E. Johnson, *Management of Organizational Behaviour*,  Pearson, 10th Edition, 2015

**REFERENCE BOOKS**

1. Harold Koontz, Heinz Weihrich, et al, *Essentials of Management*, McGraw Hill, 11th Edition, 2020

2. M I Khan and N A Siddiqui, *Industrial Engineering and Management*, New Age International, 1st Edition, 2018

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | | | | | 1 | | 1 | | | | | | | 3 |
| CO2 | 3 | 3 | 1 | | | 1 | | | | | | | | | 3 |
| CO3 | 3 | 1 | 1 | | | 1 | | | | | | | | | 3 |
| CO4 | 3 | 3 | 1 | | | 1 | | | | | | | | | 3 |
| CO5 | 3 | 2 | 1 | | 1 | 1 | | 1 | | | | | | | 3 |
| Average | 3 | 2.2 | 1 | | 1 | 1 | | 1 | | | | | | | 3 |
| Correlation level | 3 | 2 | 1 | | 1 | 1 | | 1 | | | | | | | 3 |

**Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

# III B. Tech. – II Semester

## (19BT60302) DESIGN OF MACHINE ELEMENTS

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Strength of Materials.

**COURSE DESCRIPTION:**

General considerations of design, design process; Manufacturing considerations, BIS codes of materials; Combined stresses; theories of failure; Fatigue; Stress concentration; Goodman's line, Soderberg's line; shafts; keys; sleeve or muff, and Flange couplings, Flexible couplings; sleeve and cotter joint, Knuckle joint, mechanical springs.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Design the machine elements subjected to combined and structural loads considering design standards.

CO2. Design the parameters of power transmitting elements such as shafts, keys, couplings and joints.

CO3. Design threaded joints under eccentric loading conditions and welded joints for residual stresses.

CO4. Design journal, ball and roller bearings for the given application.

CO5. Design the parameters of springs and spur gears for the given application.


**DETAILED SYLLABUS:**

### UNIT I: DESIGN FOR COMBINED & FLUCTUATING LOADS            (09 Periods)

Introduction to design, Types of design, General considerations of design, Design process; Manufacturing considerations in the design; BIS coding and Preferred numbers; Combined stresses, Various theories of failures.

Stress concentration, Notch sensitivity, Design for fluctuating stresses fatigue failure, Endurance limit, Estimation of Endurance strength - Goodman's line, Soderberg's line; Design of components for finite and infinite life.

### UNIT II: DESIGN OF SHAFTS, KEYS, COUPLINGS AND JOINTS         (09 periods)

**Shafts:** Shaft design - based on strength and Torsional rigidity, ASME code for shaft design.

**Keys:** Design of Keys – Sunk keys: Rectangular and Square keys and Applications of keys.

Couplings: Design of couplings - Sleeve or Muff, Protected type Flange couplings, Bush-pin type, Applications of couplings.

**Joints:** Sleeve and cotter joint, Knuckle joint;

**UNIT III: DESIGN OF THREADED AND WELDED JOINTS**          **(09 periods)**

**Threaded Joints**: Basic Types of screw fastenings - cap screws, set screws; Bolts of uniform strength, locking devices, I.S.O. metric screw threads, bolts under tension, eccentrically loaded bolted joints in shear, eccentric load parallel and perpendicular to the axis of bolts, and plane containing the bolts.

**Welded Joints**: Introduction, welding process, types of welded joints, working stresses in welds, Strength of welds, Special cases of fillet welds, Eccentric loads on welded connections, Design procedure.

**UNIT IV: BEARINGS**          **(09 periods)**

Journal bearing design, Ball and Roller Bearings, Static load, Dynamic load, Equivalent radial load, Design and Selection of ball and roller bearings.

**UNIT V: DESIGN OF MECHANICAL SPRINGS AND SPUR GEAR**          **(09 periods)**

Stress and deflections of helical springs, Design of helical springs, springs for fatigue loading, Energy storage capacity in helical springs, Concentric springs; Design procedure for spur gear.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. V. B. Bhandari, *Design of Machine Elements*, Tata McGrawHill, 3rd Edition, 2010.

2. R.S. Khurmi & J.K. Gupta, *Machine Design*, Eurasia Publishing House (pvt.) Ltd. 2005

**REFERENCE BOOKS:**

1. Joseph E. Shigely, *Mechanical Engineering Design*, TMH Publishers, 9th Edition, 2011.

2. T. Krishna Rao, *Design of Machine Elements* Vol-II, I K International, 1st Edition, 2008.

**Data Book:** Design data hand book for Mechanical Engineers in SI and Metric units by Balaveera Reddy and Mahadevan.N

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 3 | 2 | - | 2 | - | - | - | - | - | - | 3 | - | - |
| **CO2** | 3 | 3 | 3 | 2 | - | 2 | - | - | - | - | - | - | 3 | - | - |
| **CO3** | 3 | 3 | 3 | 2 | - | 2 | - | - | - | - | - | - | 3 | - | |
| **CO4** | 3 | 3 | 3 | 2 | - | 2 | - | - | - | - | - | - | 3 | - | |
| **CO5** | 3 | 3 | 3 | 2 | - | 2 | - | - | - | - | - | - | 3 | - | |
| **Average** | 3 | 3 | 3 | 2 | - | 2 | | | | | | - | 3 | - | |
| **Correlation level** | 3 | 3 | 3 | 2 | | 2 | | | | | | | 3 | | |

**Correlation Levels:**          **3– High          2 - Medium          1– Low**

## III B.Tech – II Semester

## (19BT60303) HEAT TRANSFER

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | **3** | **-** | | **3** |

**PRE-REQUISITES:**

Courses on Multi-Variable Calculus and Differential Equations, Engineering Thermodynamics and Fluid Mechanics and Hydraulic Machinery.

**COURSE DESCRIPTION:**

Modes of heat transfer; One-dimensional steady and transient conduction; Analysis of extended surfaces; Convection heat transfer; free and forced convection; boiling and condensation; Heat exchangers; radiation; Concept of black body; heat exchange between surfaces.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the principles of heat transfer in steady state conduction and determine the heat transfer characteristics.

CO2. Analyze the fins to increase heat transfer rate and Transient heat conduction process for heat transfer characteristics.

CO3. Analyze fluid flow systems and determine heat transfer characteristics in forced and free convection processes.

CO4. Design heat exchangers, boilers and condensers for the given heat transfer rates and determine heat transfer characteristics.

CO5. Apply the principles of radiation in the heat exchange between black and grey bodies and determine heat transfer characteristics.

**DETAILED SYLLABUS:**

**UNIT I:  CONDUCTION HEAT TRANSFER                           (09 periods)**

Basics of Heat Transfer, Modes and Mechanism of heat transfer, Conduction, convection and radiation, General differential equation of heat conduction - Cartesian, Cylindrical and Spherical Coordinates; One dimensional steady state heat conduction - Conduction through plane wall, cylinders and spherical systems; Composite systems, Critical thickness of insulation.

**UNIT II: EXTENDED SURFACES AND TRANSIENT HEAT CONDUCTION    (09 Periods)**

Extended surfaces, Types of fins, - Efficiency, Effectiveness and Temperature distribution on Long Fin, Fin with Insulated Tip and Short Fin; Introductions to unsteady heat conduction - Lumped heat analysis, Infinite and semi-infinite solids, use of Heisler's chart.

**UNIT III: CONVECTION HEAT TRANSFER                           (10 Periods)**

Boundary layer concepts - Hydrodynamic and thermal boundary layer theory, Dimensional analysis, Buckingham's π-theorem applied to forced and natural convection.

**Forced convection:** External flows - Flow over plates, cylinders and spheres; internal flows- flow through Horizontal pipe, annular pipe.

**Natural convection:** Flow over the vertical plate, horizontal plate, horizontal cylinders.

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## UNIT IV: HEAT EXCHANGERS AND PHASE CHANGE HEAT TRANSFER     (09 Periods)

**Heat Exchangers:** Classification of Heat Exchangers, Overall Heat Transfer Coefficient and Fouling Factor, Log Mean Temperature Difference (LMTD): parallel & counter flow, Correction factor, Effectiveness - NTU methods of analysis of heat exchangers.

**Boiling:** Pool Boiling Regimes, Determination of Heat Transfer Coefficient in Nucleate Boiling, Critical Heat Flux and Film Boiling.

**Condensation:** Film wise and Drop wise Condensation, Nusselt's Theory of Condensation on a Vertical Plate.

## UNIT V: RADIATION HEAT TRANSFER                              (08Periods)

 Fundamentals of Radiation, Emission Characteristics - Irradiation, Total and Monochromatic radiation, Laws of Radiation - Planck, Wien's displacement, Kirchhoff, Lambert's cosine, Stefan–Boltzmann, Heat Exchange between Two Black Bodies and Gray Bodies, Concepts of Shape Factor, Emissivity, Radiation Shields.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. R.C. Sachdeva, *Fundamentals of Engineering Heat and Mass Transfer*, New Age International, 5th Edition, 2017.

2.  R.K.Rajput, *Heat and Mass Transfer*, S.Chand & Company Ltd, 7th Edition, 2018.

**REFERENCE BOOKS:**

1. P.K.Nag, *Heat Transfer*, McGraw Hill Education, 3rd Edition, 2011.

2. Holman.J.P, *Heat Transfer*, TMH, 10th Edition, 2017.

3. Yunus Cengel, *Heat and Mass Transfer*, Mc Graw Hill Publications, 5th Edition, 2015.

4. C.P Kothandaraman and S.Subramanyan, *Heat and Mass Transfer data book*, New Age International, 9th Edition, 2018.

**Note: Heat Transfer Data Book mentioned in Reference No.4 is needed during**

   **Examinations.**

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | - | 1 | 1 | - | - | - | - | - | - | 3 | - |
| CO2 | 3 | 3 | 2 | 1 | - | 1 | 1 | - | - | - | - | - | - | 3 | - |
| CO3 | 3 | 3 | 2 | 1 | - | 1 | 1 | - | - | - | - | - | - | 3 | |
| CO4 | 3 | 3 | 3 | 1 | - | 1 | 1 | - | - | - | - | - | - | 3 | |
| CO5 | 3 | 3 | 2 | 1 | - | 1 | 1 | - | - | - | - | - | - | 3 | |
| Average | 3 | 3 | 2.1 | 1 | - | 1 | 1 | | | | | - | - | 3 | |
| Correlation level | 3 | 3 | 2 | 1 | | 1 | 1 | | | | | | | 3 | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

## (19BT60304) CASTING AND WELDING TECHNOLOGY

(Professional Elective - 2)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Manufacturing Technology

**COURSE DESCRIPTION:**

Introduction to materials and their manufacturing techniques; Casting methods; Design of pattern and dies; Gating design; Special casting and welding processes; Weld metal characterization; analyzing the properties of weldment; standards and codes followed in industry.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Design patterns, dies, gating systems and riser systems in casting metallurgy considering standards.

CO2. Demonstrate knowledge of modern molding, core making and special casting process.

CO3. Design weld joints in welding metallurgy considering standards.

CO4. Demonstrate knowledge of special welding processes.

CO5. Analyze casting and welding process involving advanced processes with environmental considerations.

**DETAILED SYLLABUS:**

**UNIT I: CASTING METALLURGY AND DESIGN**          **(10 periods)**

Casting metallurgy and design-Heat transfer between metal and mould-Solidification of pure metals and alloys-Shrinkage in cast metals-Feeding characteristics of Alloys; Progressive and directional solidification-Elements and types of gating systems; Pressurized and non-pressurized gating; design considerations of gating system; applications. Risers: types and Functions of risers; Computer Aided design for gating and riser systems.

**UNIT II: SPECIAL CASTING PROCESSES**          **(10 periods)**

Special Casting Processes: Investment casting processes; Continuous casting processes; Die casting- low pressure / Gravity, pressure and squeeze; Centrifugal Casting: Calculations of various parameters in centrifugal casting, die temperature, Rotational speeds, advantages, limitations and applications; Defects in various special casting processes.

**UNIT III: WELDING METALLURGY AND DESIGN**          **(9 periods)**

Welding metallurgy and design-Heat affected zone and its characteristics-Weldability of steels, Stainless steel, Aluminium and Titanium alloys-Hydrogen Embrittlement-Lamellar tearing - Residual Stress-Heat transfer and solidification-Analysis of stresses in welded structures - pre and post welding heat treatments-Weld joint design-Welding defects-testing of weldment.

**UNIT IV: SPECIAL WELDING PROCESSES** **(7 periods)**

Special welding processes-Friction Welding-Friction stir welding-Explosive Welding-Diffusion Bonding-High frequency Induction Welding-Ultrasonic Welding-Electron beam welding-Laser beam welding.

**UNIT V: RECENT ADVANCES IN CASTING AND WELDING** **(9 periods)**

Recent advances in casting and welding-Layout of mechanized foundry-sand reclamation-Material handling in foundry-Pollution control in Foundry-Recent trends in casting-Computer Aided design of Casting. Automation in welding-WeldingRobots-Overview of automation of welding in aerospace, nuclear, surface transport vehicles and underwater welding.Introduction to codes and standards, Welding procedure specification,Welding performance qualification.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Ravi B, "*Metal Casting: Computer Aided Design and Analysis*" Prentice Hall ,2005.

2. R S Parmer,"*Welding Engineering Technology*", Khanna publishers, 2nd Edition, 2008.

**REFERENCE BOOKS:**

1. John Campbell, "*Casting Practice*" Elsevier Science Publishing C0.,2004.

2. Richard L Little, "*Welding and Welding Technology*" Tata McGraw Hill, 2004.

3. ASM Hand Book "*Casting*", ASM International 1998

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | 1 | 1 | - | - | - | - | - | - | 3 | - | - |
| CO2 | 3 | | | | 1 | 1 | - | - | - | - | - | - | 3 | - | - |
| CO3 | 3 | 3 | 3 | 1 | | 1 | - | - | - | - | - | - | 3 | - | - |
| CO4 | 3 | | | | 1 | 1 | - | - | - | - | - | - | 3 | - | - |
| CO5 | 3 | 3 | | | 1 | 1 | 1 | | | | | | 3 | | |
| Average | 3 | 3 | 3 | 1 | 1 | 1 | 1 | - | - | - | - | - | 3 | - | - |
| Correlation level | 3 | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | 3 | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## (19BT60305)COMPOSITE MATERIALS

(Professional Elective – 2)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Basic Engineering Mechanics and Materials Science and Engineering

**COURSE DESCRIPTION:**

Composite materials and their classifications; various matrices and reinforcements; manufacturing process of various composites; analyzing the properties of composite materials.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of composite materials for various engineering applications.

CO2. Analyze the effect of fiber length, fiber orientation and concentration on composite properties.

CO3. Demonstrate knowledge of manufacturing processes of composites.

CO4. Analyze composites for appropriate joining and machining techniques.

CO5. Analyze the failure behavior during testing of composite materials.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO COMPOSITE MATERIALS            (9 periods)**

**Composite Materials:** Definition -Special Features of Composites - Drawbacks of Composites - Classification of Composite Materials: Particle Reinforced Composites - Dispersion Strengthened Composites - Fiber Reinforced Composites -Structural Composites, Processing techniques for Composite materials, Applications and Barriers of Composite Materials.

**UNIT II: RAW MATERIALS FOR COMPOSITE PRODUCTION       (9 periods)**

**Matrix Phase:** Types and Functions, **Reinforcements Phase:** Types and Functions, Effect of reinforcement (Fiber length, Fiber orientation and Concentration) on overall composite performance, Fabrics and its types, Prepegs and its types, Preforms and Honeycomb Materials, Molding compounds and its types.

**UNIT III: MANUFACTURING PROCESS OF COMPOSITES          (9 periods)**

**Manufacturing Process:** Basic Steps in a Composites Manufacturing Process.

**Manufacturing Processes for Thermoset Composites:** Prepegs Lay-Up Process, Wet Lay-Up Process, Spray-Up Process, Filament Winding Process, Pultrusion Process, Resin Transfer Molding Process, Compression Molding Process, Roll Wrapping Process, Injection Molding Process.

**Manufacturing Processes for Thermoplastic Composites:** Thermoplastic Tape Winding, Thermoplastic Pultrusion Process, Part Fabrication, Autoclave Processing, Diaphragm Forming Process, Injection Molding.

## UNIT IV: JOINING AND MACHINING OF COMPOSITES                    (9 periods)

**Joining**: Definition, principles, selection and design guidelines surface preparation, types, advantages, limitations and failures modes in adhesive joints, Mechanical joints: Principles, types, advantages, limitations, design parameters, failure modes

**Machining**: Objectives of Machining, Challenges during Machining of Composites, Failure Mode during Machining of Composites, Cutting tools, Types of machining operations.

## UNIT V: TESTING OF COMPOSITES                    (9 periods)

Testing of Composites: Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing; Non – Destructive testing.

**Total Periods: 45**

### TEXTBOOKS:

1. Sanjay K. Mazumdar, "*Composites Manufacturing - Materials, Product and Process Engineering*", CRC Press LLC, 1st edition, USA, 2002.

2. Deborah D. L. Chung, "*Composite Materials – Science & Applications*", 2nd edition, Springer Verlag, USA, 2009.

### REFERENCE BOOKS:

1. Daniel B. Miracle and Steven L. Donaldson, ASM Handbook, "*Composites*", ASTM International, Vol-21, 2001.

2. William. D. Callister, "*Materials Science and Engineering-An Introduction*", John Wiley and sons, 7th edition, USA, 2007.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | | - | - | - | 1 | - | - | - | - | - | - | 3 | - | - |
| CO2 | 3 | 3 | | | - | 1 | - | - | - | - | - | - | 3 | - | - |
| CO3 | 3 | | | - | | 1 | - | - | - | - | - | - | 3 | - | - |
| CO4 | 3 | 3 | | - | | 1 | - | - | - | - | - | - | 3 | - | - |
| CO5 | 3 | 3 | | | 1 | 1 | - | - | - | - | - | - | 3 | - | - |
| Average | 3 | 3 | | | 1 | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 3 | | | 1 | 1 | | | | | | | 3 | | |

**Correlation Levels:**          **3– High**          **2 - Medium**          **1– Low**

## (19BT60306) **GAS TURBINES AND JET PROPULSION**

(Professional Elective – 2)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | -- | 3 |

**PRE-REQUISITES:**

Courses on Engineering Thermodynamics and Thermal Engineering-I.

**COURSE DESCRIPTION:**

Jet propulsion gas turbine; engine types; performance; turbojet and turbofan engines; designs of the compressor; combustor and turbines; Jet and Rocket propulsions.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Analyze the gas turbine cycles using PV and TS diagrams and solve problems.

CO2.   Analyze gas turbines and Air compressors for performance characteristics.

CO3.   Analyze the combustion process in gas turbines and determine its performance characteristics.

CO4.   Apply the principles of Jet Propulsion and solve problems.

CO5.   Demonstrate the knowledge of rocket propulsion systems.

**DETAILED SYLLABUS:**

**UNIT I:  ANALYSIS OF GAS TURBINE CYCLES                    (09 periods)**

Development of gas turbine, Classification of gas turbines, Gas turbine vs. reciprocating I C engine, Gas turbine vs steam turbine, Applications of gas turbines, the basic cycle Analysis of simple gas turbine cycle, Effect of thermodynamic variables on the performance of simple gas turbine plant, Improvements in simple gas turbine cycle, Actual gas turbine cycle, Closed cycle gas turbine, Helium cooled, closed gas turbine for nuclear power plants, Total energy system incorporating gas turbine, Semi-closed cycle gas turbine, Gas turbine plant arrangement

**UNIT II: Gas TURBINES AND AIR COMPRESSOR                   (09 periods)**

Axial flow and radial flow turbines, impulse and reaction turbines, fundamental relations and velocity triangles, elementary vortex theory, limiting factors in turbine design, blade materials; blade attachments and blade cooling.

Centrifugal and Axial flow compressors, degree of reaction, design of impellers and Blading, vortex theory, elementary air-foil theory and cascade theory, performance characteristics.

**UNIT III: GAS TURBINE COMBUSTION CHAMBER                   (09 periods)**

Introduction, Requirements, Combustion process in gas turbine, Types of combustion chamber, Flow pattern in a combustion chamber, Performance and operating characteristics of combustion chambers, Fuel injection in combustion chamber, Effect of incomplete combustion.

## UNIT IV: JET PROPULSION                                        (09 periods)

Introduction, Thrust, Thrust vs thrust horsepower, Efficiencies, Airscrew, Turbojet, Thrust augmentation, Turboprop engine, Bypass and ducted fan engines, Regenerative ducted fan engine, Turboshaft engine, Ramjet, Pulsejet, Comparison of various propulsion devices. Aircraft launch and recovery systems (EMALS and AAG).

## UNIT V: ROCKET PROPULSION                                      (9 periods)

Introduction, classification of rockets, Principle of rocket propulsion, Analysis of an ideal chemical rocket, Optimum expansion ratio for rocket, The chemical rocket, Advantages of liquid propellant rockets over solid propellant rockets, Free radical Propulsion, Nuclear Propulsion, Ion propulsion, Plasma propulsion.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Mathur, M., and Sharma, R.P., "*Gas Turbines and Jet & Rocket Propulsion*", Standard Publishers, New Delhi, 2014.
2. Ganesan, V., *Gas Turbines* 3/e, Tata McGraw Hill Book Company, New Delhi, 2010

**REFERENCE BOOKS:**

1. Yahya. S.M., *Fundamental of compressible flow with Aircraft and Rocket Propulsion*", New Age International (p) Ltd., New Delhi, 2005.
2. Cohen.H., Rogers R.E.C and Sravanamutoo, "*Gas turbine theory*", Addison Wesley Ltd., 1987.
3. Rathakrishnan. E., "*Gas Dynamics*", Prentice Hall of India, New Delhi, 2001.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | | | 1 | | | | | | | | 3 | |
| CO2 | 3 | 3 | 1 | | | 1 | | | | | | | | 3 | |
| CO3 | 3 | 3 | 1 | | | 1 | | | | | | | | 3 | |
| CO4 | 3 | 3 | 1 | | | 1 | | | | | | | | 3 | |
| CO5 | 3 | | | | | 1 | | | | | | | | 3 | |
| Average | 3 | 3 | 1 | | | 1 | | | | | | | | 3 | |
| Correlation level | 3 | 3 | 1 | | | 1 | | | | | | | | 3 | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## (19BT60307) **INTERNAL COMBUSTION ENGINES**

(Professional Elective – 2)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

### PRE-REQUISITES:

A course on thermal Engineering-I

### COURSE DESCRIPTION:

Fuel air cycles and actual cycles of internal combustion engines; Combustion phenomena in spark ignition engine; Combustion phenomena in compression ignition engines; Engine friction and lubrication; Non conventional engine.

### COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of internal combustion engine systems.

CO2. Analyze fuel air cycles and actual cycles to find the various heat losses.

CO3. Analyze the combustion phenomenon in SI Engines for emissions and study the effect of variables on combustion phenomenon.

CO4. Analyze the combustion phenomenon in CI Engines for emissions and study the effect of variables on the combustion phenomenon.

CO5. Demonstrate the knowledge on advances in Internal Combustion Engines.

### DETAILED SYLLABUS:

### UNIT I: INTERNAL COMBUSTION ENGINE SYSTEMS: (9 periods)

I. C. ENGINES - Classification - Working principles; Engine systems –Fuel, Carburettor, Fuel Injection, Ignition, Cooling and Lubrication System; principle of wankle engine, principles of supercharging and turbocharging.

### UNIT II: FUEL AIR CYCLES AND ACTUAL CYCLES: (9 periods)

**Fuel Air Cycles:** Assumptions for fuel–air cycles, Reasons for variation of specific heats of gases, change of internal energy and enthalpy during a process with variable specific heats, isentropic expansion with variable specific heats, effect of variable specific heats dissociation, comparison of air standard and fuel air cycles,

**Actual Cycles:** Effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in Petrol and Diesel engines.

### UNIT III: COMBUSTION IN S.I. ENGINES (9 periods)

Stages of combustion in SI engines, combustion parameters, Flame front propagation, Factors influencing the flame speed, abnormal combustion, Phenomenon of knock in S.I engines, factors affecting knock in SI engine, Combustion chambers for SI Engines, Fuel Requirements and Fuel Rating, Emission from SI Engines and its control.

**UNIT IV: COMBUSTION IN C.I. ENGINES**            **(9 periods)**

Stages of combustion in C.I engines, combustion parameters, Factor affecting delay period; Phenomenon of knock in C.I engine, factors affecting knock in CI engine, comparison of knock in S.I and C.I engines, Combustion chambers for C.I engines, Fuel Requirements and Fuel Rating, Emission from CI Engines and its control.

**UNIT V: ADVANCED IC ENGINES**            **(9 periods)**

Introduction, Common Rail Direct Injection Engine, Dual fuel and Multi-Fuel engine, free piston engine, Gasoline Direct Injection Engine, Homogeneous Compression Ignition Engine, Lean burn Engine, Stratified engine, Variable Compression ratio engine and LHR engines.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. V. Ganesan, *I.C. Engines*, TMH, 3rd Edition, 2008.

2. R.K.Rajput, *Thermal Engineering*, Laxmi publications, 8th Edition, 2010

**REFERENCE BOOKS:**

1. M.L Mathur & R.P.Sharma, *Internal combustion engines*, Dhanpat Rai & Sons, 8th Edition, 2014.

2. Mahesh M Rathore, *Thermal Engineering*, Tata Mcgrawhill Education, 2010.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| CO2 | 3 | 3 | 1 | | | 1 | | | | | | | | 3 | |
| CO3 | 3 | 3 | 1 | | | 1 | 1 | | | | | | | 3 | |
| CO4 | 3 | 3 | 1 | | | 1 | 1 | | | | | | | 3 | |
| CO5 | 3 | 1 | | | | 1 | | | | | | | | 3 | |
| Average | 3 | 1.5 | 1 | | | | | | | | | | | 3 | |
| Correlation level | 3 | 2 | 1 | | | 1 | 1 | | | | | | | 3 | |

**Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

(19BT60308) **MECHANICAL VIBRATIONS**

(Professional Elective-2)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Kinematics of Machinery and Dynamics of Machinery

**COURSE DESCRIPTION:**

Basics of vibration; Analysis of two or more degrees of freedom; Multi-body mechanical systems; Undamped free vibrations; Damped free vibration; Forced vibrations; Basic concepts on engineering measurements; Spectrum analysis; signal processing; vibration control.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Calculate the vibration parameters of damped and undamped free SDOF systems.

CO2. Calculate the vibration parameters in forced vibrations.

CO3. Calculate the natural frequencies vibrations in two-degree freedom systems.

CO4. Analyze torsional vibrations and calculate vibration parameters.

CO5. Analyze vibrations using various methods involved to enhance productivity.

**DETAILED SYLLABUS:**

**UNIT I: SINGLE DEGREE OF FREEDOM SYSTEMS                    (09 Periods)**

**Fundamentals of vibration:** Elements of a vibratory system, S.H.M, degrees of freedom; modeling of a system; concept of linear and non-linear systems; equivalent spring; linear and torsional systems.

**Undamped free vibrations:** Natural frequency by equilibrium and energy methods for longitudinal and torsional vibrations.

**Damped free vibrations:** Different types of damping, equivalent viscous damping; free vibrations with viscous damping: overdamped, critically damped and under damped systems; initial conditions; logarithmic decrement; dry friction or coulomb damping, frequency and rate of decay of oscillations.

**UNIT II: FORCED VIBRATIONS                              (09 Periods)**
Constant harmonic excitation - steady state forced vibration, Impressed harmonic force, Impressed force due to unbalance; Motion excitation – amplitude, absolute, relative, Rotating with reciprocating unbalance; Transmissibility and Isolation – Force and Motion transmissibility; Damping – coulomb damping, Viscous damping.

## UNIT III: TWO DEGREE OF FREEDOM SYSTEMS                     (09 Periods)

Free vibrations of spring coupled systems - Natural frequencies and modes of vibration by the classical method of the spring-mass system; Forced vibration - Dynamic vibration absorber, longitudinal vibrations of bars.

## UNIT IV: TORSIONAL VIBRATIONS                     (09 Periods)

Introduction, Torsional system, Damped mass and distributed mass systems, Natural frequencies and mode shapes - Rayleigh's method, Holzer method, Stodola method.

## UNIT V: VIBRATION MEASUREMENTS                     (09 Periods)

Vibration measurement - process, classification of measuring instruments; Vibrometers-Stylus type, optical type, seismic instrument, simple potentiometer; capacitance pick-up-Active type and passive type pick-ups; Accelerometers- FFT Spectrum analyzer and its applications; Vibration monitoring technique.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. G.K.Groover, S.P. Nigam, *Mechanical Vibrations*, Nemchand & Brother's, 8th Edition 2008

2. V.P.Singh, *Mechanical Vibrations*, Dhanpat Rai & Co. Pvt. Ltd., 4th Edition, 2014.

3. S.S.Rao, *Mechanical Vibrations*, Pearson Publication. 4th Edition, 2003.

**REFERENCE BOOKS:**

1. 1.W.T. Thompson, *Theory of Vibration with Applications*, Prentice Hall, 5th Edition, 2008.

2. Sadhu Singh, *Mechanical vibrations and Noise control*, 13th Edition, Dhanpat Rai & Sons.

3. Meirovitch, *Elements of Vibration analysis*, McGraw Hill Education (India) Pvt. Ltd., 1st Edition 2013.

4. Timoshenko and Young, *Vibration Problems in Engineering*, Wolfe den Press

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| **CO2** | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| **CO3** | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| **CO4** | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| **CO5** | 3 | 3 | 1 | | 1 | 1 | | | | | | | 3 | | |
| **Average** | 3 | 3 | 1 | | 1 | 1 | | | | | | | 3 | | |
| **Correlation level** | 3 | 3 | 1 | | 1 | 1 | | | | | | | 3 | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

**(19BT60309) QUALITY MANAGEMENT AND RELIABILITY ENGINEERING**

(Professional Elective – 2)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | -- | -- | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Introduction to Quality, Quality Costs, Quality Circles, QC Tools, Statistical Quality Control, Control Charts, Acceptance Sampling Evaluation, Reliability, Types of Failures, Reliability Improvement.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on the concepts of standardization and bodies of standardization for improvement of quality.

CO2. Apply quality control codes, standards, and techniques in controlling the quality of a product/ process.

CO3. Analyze sampling plans for continuous quality in production.

CO4. Develop failure hazard models to improve reliability.

**DETAILED SYLLABUS:**

**UNIT I:  INTRODUCTION                                (9 Periods)**

Definition of Quality, Quality Control, Factors Affecting Quality, Stages of Evaluation, Quality Management System, Quality Standards, Need for Standardization, Tools for Continuous Improvement-Deming cycle, Poka-Yoke, and Kaizen; Quality related costs, contemporary quality engineering philosophy, Quality systems and international standards, Quality Circles-Concepts, Objectives and advantages, QC Tools, Introduction to Six Sigma Concept, Advantages.

**UNIT II: STATISTICAL QUALITY CONTROL                        (9 Periods)**

Introduction to SQC, Causes of Variation, Control Charts for Variables- $\overline{X}$ and R Charts; Interpretation of Control Charts, Control Charts for Attributes- P chart, C chart, U chart; Quality Rating System.

**UNIT III: ACCEPTANCE SAMPLING                        (9 periods)**

Acceptance Sampling Plans for Attributes- Types of Sampling Plans, Advantages and Disadvantages of Sampling Plans; Evaluation of Sampling Plans, OC Curve- Characteristics of OC Curve, Producer Risk and Consumer Risk, AOQ, AQL, ATI, ASN; Brief Introduction to Acceptance Sampling Plans for Continuous Production and Acceptance Sampling Plan for Variables.

**UNIT IV: CONCEPTS OF RELIABILITY** **(9 Periods)**

Quality and Reliability, Importance of Reliability, Reliability Data Collection, Failure Data Analysis- MTTF, MTBF, Failure Rate, Hazard Rate, Failure Rate Curve; Types of Failures- Hazard Models (Exponential and Weibull); System Reliability with Components in Series, in Parallel and Mixed configurations.

**UNIT V: RELIABILITY IMPROVEMENT** **(9 Periods)**

Active and Standby Redundancies, Fault Tree Analysis, Reliability Optimization, Maintainability and Availability and  Application of Reliability in Maintenance Strategies.

(**Total Periods: 45)**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Dale H Besterfield et al, *Total Quality Management*, Pearson Education,3rd edition, 2011.
2. L S Srinath, *Reliability engineering*, East west press, 4th edition, 2005.

**REFERENCE BOOKS:**

1. Howard Giltow, *Quality Management*,TataMcGrawhill, 3rd edition,2008.
2. Amitava Mitra, *Fundamentals of Quality Control and Improvement*, Wiley,3rd edition,2013.
3. Grant E.L, statistical Quality Control, McGraw Hill Education (India) Pvt. limited, 7th edition,2005.
4. Montgomery D. C. '*Introduction to Statistical Quality Control'* - John Wiley - 2010
5. Ebeling C., *An Introduction to Reliability and Maintainability Engineering,* Tata McGraw Hill Publishing Company Ltd. - 2004

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | | | | | 1 | | | | | | | | | 3 |
| **CO2** | 3 | 3 | 1 | | | 1 | | | | | | | | | 3 |
| **CO3** | 3 | 3 | 1 | | | 1 | | | | | | | | | 3 |
| **CO4** | 3 | 3 | 3 | | | 1 | 1 | | | | | | | | 3 |
| **Average** | 3 | 3 | 1.6 | | | 1 | 1 | | | | | | | | 3 |
| **Correlation level** | 3 | 3 | 2 | | | 1 | 1 | | | | | | | | 3 |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## III B. Tech. – II Semester

## (19BT60310) AUTOMOTIVE FUELS AND COMBUSTION

(Professional Elective – 3)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Thermal Engineering-I

**COURSE DESCRIPTION:**

Alternate fuels; Fuel production procedure; Effect on human health due to pollution caused by I.C engine; Needs of alternative fuel, Types of alternative fuel used in petrol and diesel engine.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of automotive fuels and their storage and handling systems.

CO2. Analyze the desirable characteristics of alternate fuels.

CO3. Analyze composition and characteristics of alternate fuels for enhancing the performance and controlling the emission.

CO4. Demonstrate the knowledge of automotive emission, emission control methods and emission standards.

**Detailed Syllabus**

### UNIT I: ATOMOTIVE FUELS                                    (9 periods)

Introduction, Classification of fuels, Solid Fuels - Origin of coal, Wood and Charcoal, Composition of coal, Properties of different grades of coal, Preparation and storage of coal, Coal washing, Briquetting; Liquid fuels - Introduction, Chemical structure of petroleum-Paraffin Series, Olefin series, Naphthalene series, Aromatic series, Production, composition, Petroleum refining; Gaseous fuels -Gasification of liquid fuel, Synthetic fuels.

### UNIT II: PROPERTIES OF ATOMOTIVE FUELS                    (9 periods)

Introduction, Desirable properties of IC engine fuel - Moisture Content, Particle Size and Size distribution, Bulk Specific gravity, Calorific value, Specific gravity, flash and fire point, pour point, metal content, ultimate analysis, proximate analysis, fly ash analysis, Hard grove Grindeability Index, Density, Viscosity, Aromatic Content, Sulphur content,  octane number and cetane number.

### UNIT III: ALCOHOLS AND VEGETABLE OILS AS ALTERNATE FUEL      (9 periods)

**Alcohols:** Introduction to alcohols, Production methods, Properties, use of alcohols in CI and SI engines, Reformulated gasoline for SI engine, Water Gasoline Mixture for SI engine, Alcohol for CI engine, Surface Ignition of Alcohols in  CI engine.

**Vegetable oil**: Introduction, Edible and Non Edible oils, Various methods of using Vegetable oil in CI engine, Biodiesel sources, Preparation of Biodiesel, Characteristics of CI engine with Biodiesel as fuel, Biodiesel oxidation stability, Blending, Preheating, emulsification.

### UNIT IV: HYDROGEN AND BIOGAS AS ALTERNATE FUEL            (9 periods)

Production methods of hydrogen, Hydrogen Engine, Combustive properties of hydrogen, Problems in hydrogen as fuel, Techniques of using hydrogen in SI and CI engines. Hydrogen storage – safety aspects of hydrogen fuel. Biogas-various production methods-properties, Use in SI and CI engine, Performance and emission characteristics.

**UNIT V:IC ENGINE EMISSIONS AND CONTROL** **(9 Periods)**

Engine Exhaust Emissions, Bharat stage emission standards (BSES), Euro norms, Flow in crevices, Leakage Past the exhaust valve, Valve overlap, Deposit on walls, Thermal Converters, Catalytic converters- Sulphur, Cold Start-Ups, CI engines-Particulate traps, Non-exhaust Emissions-Evaporative emissions, Emissions control Technique, Modern evaporative emission control system, Crankcase Blowby, Intake manifold return PCV System, EGR, SCR.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Ayhan Demirbas, '*Biodiesel A Realistic Fuel Alternative for Diesel Engines'*, Springer-Verlag London Limited, 2008.

2. Devaradjane. Dr. G., Kumaresan. Dr. M., "*Automobile Engineering*", AMK Publishers, 13th Edition, 2013.

**REFERENCE BOOKS:**

1. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, *The Biodiesel Handbook*, AOCS Press Champaign, Illinois 2005.

2. Richard L Bechtold P.E., *Alternative Fuels Guide book*, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | | | | | | | | | 3 | |
| CO2 | 3 | 3 | | | | 1 | 1 | | | | | | | 3 | |
| CO3 | 3 | 3 | | | | 1 | 1 | | | | | | | 3 | |
| CO4 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| Average | 3 | 2 | | | | 1 | 1 | | | | | | | 3 | |
| Correlation level | 3 | 2 | | | | 1 | 1 | | | | | | | 3 | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT60311) **DESIGN OF PRESSURE VESSELS AND PIPING SYSTEMS**

(Professional Elective–3)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Strength of Materials.

**COURSE DESCRIPTION:**

Material selection, Estimation of stresses; Formulation of fatigue models, Factor of safety; Design of Heads, Covers, Nozzle, Gasket & End closure; Buckling phenomenon, buckling problems and Design of piping layout.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1: Design cylindrical shells by applying conceptual knowledge of stresses in field problems and selection of materials.

CO2: Analyze safety factors to find fatigue stresses in cylindrical plates to meet ASME Boiler standards.

CO3: Design pressure vessel components such as end closures, bolted flanges and supports to meet the applications.

CO4: Design the pressure vessel cylinders for protection against buckling effects in thick-walled cylinders considering the standard solutions.

CO5: Design piping layout system consists of Tees, bends, bellows and valves to meet the piping ASME code standard requirements.

**DETAILED SYLLABUS:**

**UNIT I: DESIGN OF CYLINDRICAL SHELLS                (09 periods)**

Introduction to pressure vessels, Design Philosophy, Structural Integrity, material considerations, Stresses in pressure vessels, shrink fit stresses in built-up cylinders, auto-frettage of thick cylinders, thermal stresses and their significance, methods for determining stresses.

**Design of Cylindrical Shells:**  ASME equations - Thin shell equations - Thick shell equations.

**UNIT II: FATIGUE ASSESSMENT AND DISCONTINUITY STRESSES:      (09 periods)**

**Fatigue Assessment:** Introduction to theories of failure; Allowable stress limits in ASME Boiler & Pressure Vessel, Design for cyclic loading, Protection against fracture, S–N curves, Design curves, Cumulative damage. Fatigue, shock, high pressure, high temperature, irradiation, corrosion, and other hostile environments.

**Discontinuity Stresses** -Beams on elastic foundation, Cutouts and Reinforcements;Stress concentration in plate having circular hole due to bi-axial loading, excessive elastic deformation, plastic instability, brittle, rupture and creep. Design of nozzle.

## UNIT III: END CLOSURES, BOLTED FLANGES & SUPPORTS: (10 periods)

**End Closures** - Introduction to ASME equations for various types of heads – Hemispherical, flat, ellipsoidal, torispherical, and conical heads.

**Bolted Flanges** - Introduction to bolted flanges, RF and FF flanges - Gasket loading behaviour - Application of ASME equations for flange analysis and bolt design.

**Design of Supports:** Design of base plate and support lugs, Support skirts. Types of anchor bolt, its material and allowable stresses, Design for wind load- Design for seismic load- Theory of reinforcement - Design of cone cylinder intersections - Use of codes

## UNIT IV: DESIGN OF PRESSURE VESSELS FOR BUCKLING LOADS: (08 periods)

Introduction to Buckling, types of Buckling, Elastic Buckling of circular ring and cylinders under external pressure, Collapse of thick-walled cylinders or tubes under external pressure, Effect of supports on elastic Buckling of Cylinders, Design of circumferential stiffeners, Buckling under combined external pressure and axial loading.

## UNIT V: DESIGN OF PIPING LAYOUT (09 periods)

Introduction to Piping layout, Flow diagram, piping layout and piping stress analysis; Flexibility factor and stress intensification factor; Design of piping system as per B31.1 piping code.

Introduction to Piping components, bends, tees, bellows and valves.

**Design and analysis of piping systems** – Pipes and tubing under external and internal pressure –design of tube-sheets and tube seats, and use of post-weld heat treatment to affect residual stress in final rupture

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. John F. Harvey, "*Theory and Design of Pressure Vessels*", CBS Publishers and Distributors, 1987.
2. Somnath Chattopadhyay, *Pressure Vessels: Design and Practice*, 1st Edition, CRC Press, 2005.

**REFERENCE BOOKS:**

1. Henry H. Bedner, "*Pressure Vessels, Design Hand Book*", CBS publishers and Distributors, 1987.
2. William. J., Bees, "*Approximate Methods in the Design and Analysis of Pressure Vessels and Piping*", Pre ASME Pressure Vessels and Piping Conference, 1997.

**ADDITIONAL LEARNING RESOURCES:**

1. Stanley, M. Wales, "*Chemical process equipment, selection and Design*",Buterworths series in Chemical Engineering, 1988.
2. Pullarcot, Sunil Kumar, "*Practical Guide to Pressure Vessel Manufacturing*", CRC Press 2019.
3. Brownell L. E & Young. E. D, *Process equipment design*, Wiley Eastern Ltd., India,1959.
4. *ASME Pressure Vessel and Boiler code,* Section VIII Div 1, 2, and 3.
5. ASME B31.1-2016: Power Piping: ASME Code for Pressure Piping, B31, ANSI,2016.
6. Ellenberger P. '*Pressure Vessels: ASME Code Simplified'* , McGraw Hill Company , 8th Edition,2004.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | | 2 | | | | | | | 3 | | |
| CO2 | 3 | 3 | 2 | 1 | | 2 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 3 | 1 | | 2 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 3 | 1 | | 2 | | | | | | | 3 | | |
| CO5 | 3 | 3 | 3 | 1 | | 2 | | | | | | | 3 | | |
| Average | 3 | 3 | 2.8 | 1 | | 2 | | | | | | | 3 | | |
| Correlation level | 3 | 3 | 3 | 1 | | 2 | | | | | | | 3 | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT60312) **MECHANICAL BEHAVIOR OF MATERIALS**

(Professional Elective–3)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | -- | -- | 3 |

**PRE-REQUISITES:**

Courses on Material Science and Engineering and Design of Machine Elements

**COURSE DESCRIPTION:**

Elastic and plastic behavior of materials. Strengthening mechanisms, fatigue and its factor affecting, creep and fracture.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge on mechanism involved in elastic and plastic behavior of materials.

CO2. Apply strengthening mechanism for ferrous and non ferrous materials.

CO3. Analyze Fatigue behavior of components using S-N curve.

CO4. Analyze fractures and mechanics of fractures and determine its parameters.

CO5. Analyze the materials using creep tests for engineering applications.

**DETAILED SYLLABUS:**

**UNIT I: ELASTIC AND PLASTIC BEHAVIOUR                   (09 periods)**

Elastic behavior of materials, Hooke's law, plastic behavior, dislocation theory, Burger's vectors and dislocation loops, dislocations in the FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, dislocation climb, intersections of dislocations, Jogs, dislocation sources, multiplication of dislocations, dislocation pile-ups, Slip and twinning.

**UNIT II: STRENGTHENING MECHANISMS                   (09 periods)**

Elementary discussion of cold working, grain boundary strengthening. Solid solution strengthening, Martensitic strengthening, Precipitation strengthening, Particulate Strengthening, Dispersion strengthening, Fiber strengthening, Examples of above strengthening mechanisms from ferrous and non-ferrous systems, Yield point phenomenon, strain aging and dynamic strain ageing.

**UNIT III: FATIGUE BEHAVIOUR                   (09 periods)**

Fatigue: Stress cycles, S-N curves, Effect of mean stress, Factors affecting Fatigue, Structural changes accompanying fatigue, Cumulative damage, HCF / LCF, thermomechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines- Pari's Equation, Residual life prediction under Fatigue. Macro, Microstructural features of fatigue fracture.

## UNIT IV: FRACTURE AND FRACTURE MECHANICS                    (09 periods)

Types of fracture, Basic mechanisms of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, Determination of DBTT.

Fracture mechanics-Introduction, Modes of fracture, Stress intensity factor, Strain energy release rate, Fracture toughness and Determination of KIC, Introduction to COD, J integral.

## UNIT V: CREEP BEHAVIOUR AND TESTING                    (09 periods)

Creep curve, Stages in creep curve and explanation, Structural changes during creep, Creep mechanisms, Metallurgical factors affecting creep, High-temperature alloys, Stress rupture testing, Creep testing machines, Parametric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1. Dieter, G. E., *Mechanical Metallurgy*, McGraw-Hill Co., 3rd Edition, 2017.

2. Thomas H.Courtney, *Mechanical Behavior of Materials*", McGraw-Hilll, 2nd edition, 2019.

**REFERENCE BOOKS**:

1. Suryanarayana, A. V. K., *Testing of Metallic Materials*, Prentice Hall India, New Delhi.

2. Marc Andr'e Meyers and Krishan Kumar Chawla, "*Mechanical Behavior of Materials*" Cambridge University Press, 2009.

3. Prashant Kumar, *Elements of Fracture Mechanics*, McGraw-Hilll, 2009.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | - | - | - | - | - | - | - | - | 3 | - | - |
| CO2 | 3 | 1 | | | - | 1 | | - | - | - | - | - | 3 | - | - |
| CO3 | 3 | 3 | 1 | | - | 1 | | - | - | - | - | - | 3 | - | - |
| CO4 | 3 | 3 | 1 | | - | 1 | | - | - | - | - | - | 3 | - | - |
| CO5 | 3 | 3 | 1 | | - | 1 | | - | - | - | - | - | 3 | - | - |
| Average | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |

**Correlation Levels:**        **3– High**        **2 - Medium**        **1– Low**

(19BT60313) **NON TRADITIONAL MACHINING PROCESSESS**

(Professional Elective–3)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Engineering Workshop and Manufacturing Technology

**COURSE DESCRIPTION:**

The course details various non-conventional manufacturing processes. It consists of manufacturing processes classification and necessity of non-conventional manufacturing processes. Also details about the working principle, mechanism of material removal, sources of energy used for material removal, the setup/equipment and relative advantages and disadvantages.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Demonstrate knowledge of chemical energy based machining processes.

CO2.   Demonstrate knowledge of electrochemical energy-based machining processes.

CO3.   Demonstrate the knowledge of mechanical energy based machining process

CO4.   Demonstrate knowledge of electrical energy based machining processes.

CO5.   Demonstrate knowledge of thermal energy-based machining process.

**DETAILED SYLLABUS**

**UNIT I: CHEMICAL ENERGY BASED PROCESSES                   (9 periods)**

Need for non-traditional machining methods, Classification of modern machining processes, Comparative study of different processes, Considerations in process selection, Materials and its applications.

Chemical machining –Fundamentals - Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and Material removal rate - Applications.

**UNIT II: ELECTRO-CHEMICAL ENERGY BASED PROCESSES          (9 periods)**

Principles of ECM- Surface Roughness and Material removal rate- Process Parameters – Electro Chemical Grinding - Electro Chemical Honing – Electro Chemical Deburring-Applications.

**UNIT III: MECHANICAL ENERGY BASED PROCESSES          (9 periods)**

Basic principles, Types of abrasives - Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – Material removal mechanism - Applications.

## UNIT IV: ELECTRICAL ENERGY BASED PROCESSES (9 periods)

Electric Discharge Machining (EDM)- working Principle-Process Parameters-Surface Finish and Material Removal Rate- electrode / Tool – Power and control Circuits-Mechanics of metal removal in EDM, process parameters, Selection of tool electrode and dielectric fluids, Methods of surface finish and machining accuracy, Characteristics of spark eroded surface and machine tool selection, Wire EDM-principle & its applications.

## UNIT V: THERMAL ENERGY BASED PROCESSES (9 periods)

**ELECTRON BEAM MACHINING**: Generation and control of electron beam for machining, Theory of electron beam machining, Comparison of thermal and non-thermal processes, Applications, Advantages, Limitations.

**LASER BEAM MACHINING**: General principle and application of laser beam machining, Thermal features, Cutting speed and accuracy of cut, Laser drilling.

**PLASMA ARC MACHINING:** Principle, Metal removal mechanism, Process parameters, Accuracy and surface finish, Applications, Advantages and limitations.

**Total No. of Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Vijay.K. Jain, *"Advanced Machining Processes"*, Allied Publishers Pvt. Ltd., New Delhi, 2007

2. Pandey P.C. and Shan H.S, *"Modern Machining Processes"*, Tata McGraw-Hill, New Delhi, 2007.

**REFERENCE BOOKS:**

1. Benedict. G.F., *"Nontraditional Manufacturing Processes"*, Marcel Dekker Inc., New York, 1987.

2. Mc Geough, *"Advanced Methods of Machining"*, Chapman and Hall, London, 1998.

3. Paul De Garmo, J.T. Black, and Ronald. A. Kohser, "*Material and Processes in Manufacturing*", Prentice Hall of India Pvt. Ltd., 10thEdition, New Delhi, 2012.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | 1 | 1 | | | | | | 3 | | |
| CO2 | 3 | 1 | | | | 1 | 1 | | | | | | 3 | | |
| CO3 | 3 | 1 | | | | 1 | 1 | | | | | | 3 | | |
| CO4 | 3 | 1 | | | | 1 | 1 | | | | | | 3 | | |
| CO5 | 3 | 1 | | | | 1 | 1 | | | | | | 3 | | |
| Average | 3 | 1 | | | | 1 | 1 | | | | | | 3 | | |
| Correlation level | 3 | 1 | | | | 1 | 1 | | | | | | 3 | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## (19BT60314) **OPTIMIZATION TECHNIQUES**

(Professional Elective 3)

(common to CE & ME)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Differential equations and Multivariable calculus

**COURSE DESCRIPTION:**

Introduction to optimization; classical optimization techniques; classification of optimization problems; linear programming; Transshipment and Travelling salesman problem; non-linear programming; unconstrained non-linear programming; constrained non-linear programming; dynamic programming; Genetic Algorithm; Ant Colony Optimization.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:

CO1. Model and solve unconstrained optimization problems.

CO2. Apply LP TechniquesandConduct Sensitivity analysis for real lifeProblems

CO3. Apply Non-Linear Programmingtechniques for real-life problems.

CO4. Analyze various complex problems by using Dynamic programming approaches.

CO5. Model and solve complex problems using evolutionary algorithms to optimize the parameters.

**DETAILED SYLLABUS:**

**UNIT I: CLASSICAL OPTIMIZATION TECHNIQUES              (09 periods)**

Introduction, Engineering applications of optimization, Statement of an optimization problem, Design vector, Design constraints, Constraint surface, Objective function, Classification of optimization problems, Single variable optimization, Multivariable optimization without constraints, Multivariable optimization with equality constraints - Lagrange multipliers method; Multivariable optimization with inequality constraint - Kuhn Tucker conditions.

**UNIT II: LINEAR PROGRAMMING                          (09 periods)**

Introduction, Formulation, Primal Simplex method, Dual simplex method, Sensitivity Analysis, Goal programming

**UNIT III: NON-LINEAR PROGRAMMING                     (09 periods)**

One dimensional minimization methods, classification - Fibonacci method, quadratic interpolation method; classification of unconstrained minimization methods - Powell's method, steepest descent method (Cauchy's method); classification of constrained optimization techniques - interior and exterior penalty function methods.

**UNIT IV: DYNAMIC PROGRAMMING** (09 periods)

Multistage decision processes, Concept of sub-optimization and Principle of optimality, Computational procedure in dynamic programming - Calculus method, Tabular method; Linear Programming problem by dynamic programming approach, Applications - reliability problem, shortest path problem, and capital budgeting problem.

**UNIT V: EVOLUTIONARY OPTIMIZATION ALGORITHMS** (09 periods)

Introduction to Evolutionary optimization, genetic algorithm-Mathematical Modeling of Genetic algorithm, Ant Colony Optimization, Particle Swarm Optimization and differential evolution techniques.

**Total Periods:45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Singiresu S Rao, *Engineering Optimization: Theory and Practice*, New Age International, 3rdEdition, 2013.

2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, *Engineering Optimization: Methods and applications,* Wiley India Pvt. Ltd., 2nd Edition2006.

3. Dan Simon, *Evolutionary Optimization Algorithms*, John Wiley & Sons, 2013.

**REFERENCE BOOKS:**

1. C Mohan and Kusum Deep, *Optimization Techniques*, New Age International Publishers, 1st Edition, 2010.

2. Hamdy A. Taha, *Introduction to Operations Research*, PHI, 10th edition, 2017.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | | 3 |
| CO2 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | | 3 |
| CO3 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | | 3 |
| CO4 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | | 3 |
| CO5 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | | 3 |
| Average | 3 | 3 | 3 | 1 | | 1 | | | | | | | | | 3 |
| Correlation level | 3 | 3 | 3 | 1 | | 1 | | | | | | | | | 3 |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT60315) **REFRIGERATION AND AIR CONDITIONING**

((Professional Elective - 3)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Engineering Thermodynamics and Fluid Mechanics & Hydraulic Machinery

**COURSE DESCRIPTION:**

Refrigeration cycles; Application of thermodynamics; heat transfer to the refrigeration cycles; Analysis and design of various refrigeration systems; Study of components of the refrigeration system; refrigerants selection; Psychrometry; Heat gain and heat loss calculations. Air conditioning equipment; load calculations; heat pump circuits.

**COURSE OUTCOMES:** After successful completion of this course, the students will be able to:

CO1. Analyze the performance of air and vapour compression refrigeration systems and solve problems related to it.

CO2. Demonstrate the knowledge of desirable properties of refrigerants and constructional features of refrigeration equipment.

CO3. Demonstrate knowledge of constructional features and working of vapour absorption refrigeration systems, steam jet refrigeration systems and non-conventional refrigeration systems.

CO4. Design the air conditioning systems using psychrometric principles by considering various heat loads.

CO5. Demonstrate knowledge of comfort air conditioning, air conditioning equipment and heat pump circuits

**DETAILED SYLLABUS:**

**UNIT I: AIR AND VAPOR COMPRESSION REFRIGERATION SYSTEMS    (9 periods)**

**Air refrigeration cycle**: Introduction, open and dense air refrigeration cycle, Energy Efficiency Ratio (EER), BEE star rating Air refrigeration systems - Bell-Coleman cycle, applications; Aircraft air refrigeration systems: Need for aircraft refrigeration, simple air cooling system, simple air evaporative cooling system and bootstrap air cooling system;

**vapor compression refrigeration cycle:** Effect of liquid subcooling & superheating, the effect of evaporator and condenser pressures, Cascade refrigeration system.

**UNIT II: REFRIGERATION EQUIPMENT AND REFRIGERANTS        (9 periods)**

**Refrigeration equipment:** Introduction, working and applications of Compressors, Condensers, Evaporators, Expansion devices.

**Refrigerants:** Classification, properties, ASHRAE numbering system for refrigerants, selection of refrigerants, alternate refrigerants, impact of refrigerants on environment.

## UNIT III: VAPOUR ABSORPTION REFRIGERATION SYSTEM AND EMERGING TECHNOLOGIES                                                    (9 periods)

Classification, Working principle of NH3 – water system, Li Br – water (Two shells & four shells) system, Calculation of maximum COP, Electrolux refrigeration system.

**Steam jet refrigeration system:** Working principle, basic components.

**Non-conventional refrigeration system:** Principle and operation of Thermo-electric refrigerator, Thermoacoustic Refrigeration, Vortex tube.

## UNIT IV: DESIGN OF AIR CONDITIONING SYSTEMS                        (9 periods)

classification of air-conditioning systems, summer, winter and year-round air conditioning systems; Different Heat sources: Adiabatic mixing of two air streams, Bypass factor, Room Sensible Heat Factor (RSHF), Grand Sensible Heat Factor (GSHF), Effective Room Sensible Heat Factor (ERSHF); cooling load calculations, sensible heat load, latent heat load.

## UNIT V: COMFORT AIR CONDITION AND EQUIPMENTS                       (9 periods)

**Comfort Conditions:** need and requirements of comfort air conditioning, Thermal exchange of body with the environment, the concept of effective temperature, Comfort chart.

**Air Conditioning Equipment:** Introduction, working and applications of Humidifiers, Dehumidifiers; Air-filters, Fans, Blowers, Ducts**.**

**Heat pump:** Introduction, different heat pump circuits, air to air, water to air.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Domkundwar Arora Domkundwar, *A Course in Refrigeration and Air conditioning*, Dhanpat Rai publication, 8th Edition, 2018.

2. C.P Arora, *Refrigeration and Air Conditioning*, TMH, 8th Edition, 2017.

**REFERENCE BOOKS:**

1.  P.L.Ballaney, *Refrigeration and Air Conditioning*, Khanna Publications, 15th Edition, 2012.

2. Manohar Prasad, *Refrigeration and Air Conditioning*, New Age International, 3rd Edition, 2016

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | | | | 1 | 1 | | | | | | | 3 | |
| CO2 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| CO3 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| CO4 | 3 | 3 | 3 | 1 | | 1 | 1 | | | | | | | 3 | |
| CO5 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| Average | 3 | 1.8 | 3 | 1 | | 1 | 1 | | | | | | | 3 | |
| Correlation level | 3 | 2 | 3 | 1 | | 1 | 1 | | | | | | | 3 | |

**Correlation Levels:**       3– High       2 - Medium       1– Low

(19BT50408) **MICROELECTROMECHANICAL SYSTEMS**
(Inter Disciplinary Elective - 2)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**
A Course on Applied Physics.
**COURSE DESCRIPTION:**
Overview of Micro Electro Mechanical Systems (MEMS), working principles of microsensors and microactuators, materials, microfabrication processes, MEMS accelerometers, packaging of Microsystems and applications over different fields.
**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:
- CO1. Demonstrate MEMS Components like microsensors and microactuators.
- CO2. Understand working methodologies of MEMS accelerometers.
- CO3. Use microfabrication techniques and device packaging methods in manufacturing MEMS devices.
- CO4. Analyze various MEMS devices for engineering applications.

**DETAILED SYLLABUS:**
**UNIT I: INTRODUCTION TO MEMS AND MICROSYSTEMS           (09 Periods)**
Introduction to MEMS, Energy domains and transducers, sensors and actuators, Microsystems versus MEMS, miniaturization, MEMS materials.
**UNIT II:MICROSENSORS & ACTUATORS                        (09 Periods)**
**Microsensors:** Classification of physical sensors, Integrated, Intelligent or Smart sensors, Sensor Principles and Examples: Thermal sensors, Pressure, Flow, Inertial, Gyro sensors, Bio Sensors.
**Microactuators:** Electromagnetic and Thermal micro actuation, Mechanical design of microactuators, Microactuator examples, microvalves, micropumps, micromotors.
**UNIT III: MEMS ACCELEROMETERS                           (07 Periods)**
Micro accelerometers for MEMS, Temperature and Damping analysis, Piezoelective accelerometer, Piezoresistive accelerometer, Piezocapacitive accelerometer technology.
**UNIT IV**: **MEMS FABRICATION AND PACKAGING             (12 Periods)**
Review of Fabrication process-Photolithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapour deposition, deposition by Epitaxy, Czochralski process.
Micromachining technology of MEMS, Microstereolithography; Introduction to microsystem packaging, objectives and general considerations in packaging design, three levels of microsystem packaging.
**UNIT V:  MEMS APPLICATIONS                              (08 Periods)**
Applications of MEMS in the automotive industry, avionics and space applications and commercial applications, RF MEMS, optical MEMS, Introduction to Bio-MEMS and microfluidics.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOK:**
1. Tai-Ran Hsu, *MEMS & Microsystems, Design and Manufacture*, McGraw Hill Education (India) Pvt. Ltd., 27th reprint, 2018.

**REFERENCE BOOKS:**
1. G.K.Ananthasuresh, K.J.Vinoy, *Micro and Smart Systems*, New Delhi publication, 1st edition, 2011 Education (India) Pvt. Ltd.
2. Nitaigour Premchand Mahalik, *MEMS*, McGraw Hill Education (India) Pvt. Ltd., 11th reprint, 2016.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | - | | | |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | | | |
| CO3 | 3 | 2 | - | - | 3 | - | - | - | - | - | - | - | | | |
| CO4 | 3 | 3 | - | - | - | 3 | - | - | - | - | - | - | | | |
| Average | 3 | 2.3 | - | - | 3 | 3 | - | - | - | - | - | - | | | |
| Correlation level | 3 | 3 | - | - | 3 | 3 | - | - | - | - | - | - | | | |

**Correlation Levels:     3– High     2 - Medium     1– Low**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Appiled Physics and Engineering Metrology

**COURSE DESCRIPTION:**

Basic Principles of Measurement, Measurement of Displacement, Measurement of Temperature and Pressure, Measurement of Speed, Acceleration, Vibration, force, torque, Power, Stress, Strain, Level And Flow Measurement, Elements of Control systems

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge on methods and instruments used for the measurement of Displacement

CO2. Demonstrate the knowledge on methods and instruments used for the measurement of Temperature and Pressure

CO3. Demonstrate the knowledge on methods and instruments used for the measurement of Speed, Acceleration, Force, Torque and Power

CO4. Demonstrate the knowledge on stress and strain measurements Level and Flow measurements.

CO5. Demonstrate the knowledge of control systems.


**DETAILED SYLLABUS:**

**UNIT I**: **BASIC PRINCIPLES OF MEASUREMENT** (09 periods)

**Measurement**: Definition - Basic principles of measurement - Measurement systems, generalized configuration and functional descriptions of measuring instruments - examples. Dynamic performance characteristics - sources of error and uncertainty analysis, Classification and elimination of error.

**Measurement of Displacement**: Theory and construction of various transducers to measure displacement - Piezoelectric, Inductive, capacitance, resistance, ionization and Photoelectric transducers, Calibration procedures.

**UNIT II: MEASUREMENT OF TEMPERATURE AND PRESSURE** (09 periods)

**MEASUREMENT OF TEMPERATURE:** Classification - Ranges - Various Principles of measurement - Expansion, Electrical Resistance - Thermistor - Thermocouple - Pyrometers - Temperature Indicators.

**MEASUREMENT OF PRESSURE:** Units - classification - different principles used-Manometers, Piston, Bourdon pressure gauges, Bellows - Diaphragm gauges. Low-pressure measurement - Thermal. conductivity gauges - ionization pressure gauges, McLeod pressure gauge.

**UNIT III: SPEED, ACCELERATION, VIBRATION, FORCE, TORQUE AND POWER MEASUREMENT**     **(09 periods)**

**MEASUREMENT OF SPEED:** Mechanical Tachometers - Electrical tachometers - Stroboscope, Noncontact type of tachometer    .

**Measurement of Acceleration and Vibration**: Different simple instruments - Principles of Seismic instruments - Vibrometer and accelerometer.

**MEASUREMENT OF FORCE, TORQUE AND POWER**: Elastic force meters, load cells, Torsion meters, Dynamometers.

**UNIT IV: STRESS, STRAIN, LEVEL AND FLOW MEASUREMENT**     **(09 Periods)**

**STRESS & STRAIN MEASUREMENTS:** Various types - electrical strain gauge - gauge factor - method of usage of a resistance strain gauge for bending, compressive and tensile strains - usage for measuring torque, Strain gauge Rosettes.

**MEASUREMENT OF LEVEL:** Direct method - Indirect methods - capacitative, ultrasonic, magnetic, cryogenic fuel level indicators - Bubbler level indicators.

**FLOW MEASUREMENT:** Magnetic, Ultrasonic, Turbine flow meter, Hot wire anemometer Laser Doppler Anemometer (LDA).

**UNIT V: SYSTEMS AND THEIR REPRESENTATION**     **(09 periods)**

**ELEMENTS OF CONTROL SYSTEMS:** Basic elements in control systems – Open and closed-loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Synchros – AC and DC servomotors – Block diagram reduction techniques – Temperature, speed & position control system

                             **Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. D. S. Kumar, *Mechanical Measurements and Control*, Metropollitan Book, 5th edition, 2015.
2. S. Bhaskar, *Basic Principles Measurements*, Instrumentation and control systems, Anuradha Agencies, 2014.

**REFERENCE BOOKS:**

1. R.K. Jain, *Mechanical and Industrial Measurements*, Khance Publications, 12th edition, 2015.
2. Ernesto. Doebelin, *Measurement systems application and design*, Mc Grawhill Companies, 5th edition, 2003.
3. Bechwith, Marangoni, Lienhard, *Mechanical Measurements*, Pearson, 6th edition, 2006.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | - | - | 1 | 1 | - | - | - | - | - | - | - | 3 | - |
| CO2 | 3 | 2 | - | - | 1 | 1 | - | - | - | - | - | - | - | 3 | - |
| CO3 | 3 | 2 | - | - | 1 | 1 | - | - | - | - | - | - | - | 3 | - |
| CO4 | 3 | 2 | - | - | 1 | 1 | - | - | - | - | - | - | - | 3 | - |
| CO5 | 3 | 2 | - | - | 1 | 1 | - | - | - | - | - | - | - | 3 | - |
| Average | 3 | 2 | | | 1 | 1 | - | - | - | - | - | - | - | 3 | - |
| Correlation level | 3 | 2 | | | 1 | 1 | | | | | | | | 3 | |

**Correlation Levels:**     3– High     2 - Medium     1– Low

# III B. Tech. – II Semester

## (19BT60317) **HYDRAULICS AND PNEUMATICS**

### (Inter Disciplinary Elective - 2)

| Int. Marks | Ext.Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Fluid Mechanics and Hydraulic Machinery and Basic Electrical and Electronics Engineering

**COURSE DESCRIPTION:**

Basic fluid power system; Hydraulic components and its use; Hydraulic circuits and its application; Fundamentals of pneumatics; Pneumatic components and its use; Pneumatic circuits; Application; Design of hydraulic and pneumatic systems for various applications; Logic gates, PLC in Pneumatics.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Demonstrate the knowledge of basic components and mechanisms of fluid power systems.

CO2.  Analyze functional characteristics of valves and conditioners used in industrial applications.

CO3.  Design the pneumatic and hydraulic circuits for domestic and industrial problems.

CO4.  Apply suitable logic gates to control the fluid power system

**DETAILED SYLLABUS:**

**UNIT I : FUNDAMENTALSOF FLUID POWER**             **(08 Periods)**

Fluid power, Fluid power systems, Fluid power physics; **Pumps:** Pumps, pumping theory, pump classification: Rotary, Reciprocating pumps, gear pumps (internal and external Gear pumps) and piston pumps.

**Actuators:** Cylinders and their classification.

**Pressure Control Valves:** Relief valves, Pilot operated relief valve, Poppet relief valve, Pressure sequence valve, Pressure reducing valve, unloading valve, Counterbalance valve, Brake valve

**UNIT II: VALVES & CONDITIONERS**             **(08 Periods)**

**Directional control valves (DCVs):** Poppet valve, Spool valves, Check valves, Two-way Direction Control Valves, Four-way valves, Pilot operated DCV.

**Flow Control valves:** Classification of flow control valves, Flow control methods: Meter-in circuit, Meter-out circuit and Bleed-off circuit.

**Fluid Conditioner:** Filters, Heat exchangers, Reservoirs,

**Accessory Components:** Accumulators, Pressure switches, Pressure gauges, Flowmeters, manifolds, Pressure intensifiers.

## UNIT III: HYDRAULIC & PNEUMATICS                    (12 Periods)

Hydraulic Symbols: Flowlines, Reservoirs, Pumps, Directional Control Valves, Flow control valves, Pressure Control valves, Motors, Check valves, Cylinders, Filters, Heat exchanges and accumulator, Basic hydraulic circuits of single and double-acting cylinder circuit.

**Pneumatics:** Units, Fundamentals of air, Air compressors and its types,  Reservoirs or Air receiver, Safety relief valve, Pressure switches, Air dryers, Air distribution, Air filters, Air regulators,  Air lubricators.

## UNIT IV: PNEUMATIC ACTUATORS AND CIRCUITS           (10 Periods)

**Pneumatic actuators:** Actuators and Output devices, Direction Control Valves(DVC): 2/2 way valve, 3/2 –Way valve, 4/2-Way valve, 4/3- valve, 5/2 –way valve, and 5/3-way valve, Non-Return Valve(NRV), Flow control valves,  Mufflers.

**Circuits:** Control of single-acting cylinder, Manual controlled double-acting cylinder, Air pilot control of double-acting actuator, Semi-automatic control of a double-acting actuator.

## UNIT V: LOGIC CONTROLS IN FLUID POWER SYSTEMS       (07 Periods)

Position sensors, Backpressure sensors, Proximity sensors, Pneumatic limit valves, limit switches, pressure sensor, Switching elements - Pneumatic valve functions of AND, NOT, and OR GATE, Applications of Fluidics, Examples of Pneumatic Cylinder sequencing circuit using logic gates.PLC in fluid power applications (block diagram of PLC only)

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Srinivasan.R, *Hydraulic and Pneumatic controls*, McGraw Hill Education, 2nd Edition, 2006.

2. ShanmugaSundaram. K, *Hydraulic and Pneumatic Controls*, S. Chand & Co, 1st Edition, 2019

**REFERENCE BOOKS:**

1. Majumdar S. R., *Oil Hydraulics Systems Principles and Maintenance*, McGrawHill Education, 1st Edition, 2000.

2. Majumdar S.R., *Pneumatic systems–Principles and Maintenance*, McGraw Hill Education, 2nd Edition, 2001.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | - | 1 | - | - | - | - | - | - | 3 | - | - |
| **CO2** | 3 | 3 | 1 | - | - | 1 | - | - | - | - | - | - | 3 | - | - |
| **CO3** | 3 | 3 | 3 | 1 | - | 1 | - | - | - | - | - | - | 3 | - | - |
| **CO4** | 3 | 2 | | | - | 1 | - | - | - | - | - | - | 3 | - | - |
| **CO5** | 3 | 2.25 | 2 | 1 | - | 1 | - | - | - | - | - | - | 3 | - | - |
| **Average** | 3 | 2 | 2 | 1 | | 1 | | | | | | | 3 | | |
| **Correlation level** | | | | | | | | | | | | | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT60318) **INDUSTRIAL INTERNET OF THINGS**

(Inter Disciplinary Elective - 2)

(Common to ME, CSE & CSSE)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:-**

**COURSE DESCRIPTION:**

Introduction to the Industrial Internet; IIoT Reference Architecture; Design of Industrial Internet Systems; Modern Communication Protocols, Wireless Communication Technologies, The Access Network, Access Networks Connecting, Defining Industry 4.0, Introducing the Smart Factory, Smart Factories in Action, IOT – A Market Perspective, Technical Design constraints.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the functional, informational, and operational characteristics of IoT and IIOT architectures.

CO2. Design industrial internet systems encompassing access network technology and protocols.

CO3. Apply design principles, characteristics, and building blocks of Industry 4.0. for innovative manufacturing applications.

CO4. Demonstrate knowledge of IoT market perspective and Security issues in smart manufacturing.

CO5. Apply real-world design constraints for solving problems encountered in smart manufacturing.

**DETAILED SYLLABUS:**

**UNIT I: IoT and IIoT Reference Architecture (09 Periods)**

**Introduction**: Introduction to the Internet of Things (IoT). Architecture, Enabling Technologies, Applications.

**IIoT Reference Architecture**: Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

**UNIT II: Design of Industrial Internet Systems and Access Network Technology & Protocols (09 Periods)**

**Design of Industrial Internet Systems:** The Concept of the IIoT, The Proximity Network, WSNEdge Node, Legacy Industrial Protocols, Modern Communication Protocols, WirelessCommunication Technologies, Proximity Network Communication Protocols, Gateways.

**Access Network Technology and Protocols**: The Access Network, AccessNetworks Connecting Remote Edge Networks.

**UNIT III: Industry 4.0 and Smart Factories**                              **(09 Periods)**

**Industry 4.0:** Defining Industry 4.0, Four Main Characteristics of Industry 4.0, TheValue Chain, Industry 4.0 Design Principles, Building Blocks of Industry 4.0, smart manufacturing.

**Smart Factories:** Introducing the Smart Factory, Smart Factories in Action, Importance of SmartManufacturing, Real-World Smart Factories - GE's Brilliant Factory, Airbus: Smart Tools and smart Apps, Siemens' Amberg Electronics Plant (EWA), Industry 4.0: The Way Forward

**UNIT IV: IoT Market perspective and security issues in manufacturing**

**(09 Periods)**

**IoT Market perspective:** M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, emerging industrial structures for IoT, The international driven global value chain and global information monopolies.

**Security issues in manufacturing:** PLCs and DCS, Securing the OT, Network Level: Potential Security Issues, System Level: Potential Security Issues, Identity Access Management

**UNIT V: Real-World IoT Design Constraints and Industrial Automation**

**(09 Periods)**

**Real-World IoT Design Constraints-** Introduction, Technical Design constraints-hardware components, Data representation and visualization, Interaction and remote control.

**Industrial Automation-** Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things,

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*
**TEXTBOOKS**:

1. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress Publications, 2016.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "*From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*", Academic Press,1st Edition, 2014.

**REFERENCE BOOKS**:

1. Giacomo Veneri and Antonio Capasso, *Hands-on Industrial Internet of Things: Createapowerful Industrial IoT infrastructure using Industry 4.0*, Ingram Academic Services, 2018.
2. Vijay Madisetti and Arshdeep Bahga, *Internet of Things A Hands-On- Approach*, Orient Blackswan Private Limited, 2015.
3. Francis da Costa, *Rethinking the Internet of Things: A Scalable Approach to Connecting Everything*", 1stedition, Apress Publications, 2014.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | | | | | |
| CO3 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | | | | | |
| CO4 | 3 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | |
| CO5 | 3 | 3 | 3 | 1 | 1 | 1 | | | | | | | | | |
| Average | 3 | 2.6 | 1.8 | 1 | 1 | 1 | | | | | | | | | |
| Correlation level | 3 | 3 | 2 | 1 | 1 | 1 | | | | | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

**(19BT60319) MACHINERY FAULT DIAGNOSIS AND SIGNAL PROCESSING**

(Inter Disciplinary Elective–2)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Basic Engineering Mechanics, Kinematics of Machinery and Dynamics of Machinery.

**COURSE DESCRIPTION:**

Introduction to Condition Based Maintenance, Types and Benefits of Vibration Analysis; Basic Signal Processing Techniques- visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring; Fault Detection- Vibration Criteria- Use of Frequency Spectra- CPB Spectrum; Diagnostic Techniques- Gear Diagnostics techniques- Bearing Diagnostics; Vibration Monitoring- vibration data collection,  instruments, measurement location, time-domain analysis, frequency domain analysis.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Apply maintenance and condition monitoring techniques to machines.

CO2.   Apply signal processing techniques to components of machines.

CO3.   Analyze and correct the Machinery faults using fault Trending and Prognostics tools.

CO4.   Analyze machine elements using various Diagnostic Techniques

CO5.   Analyze characteristics of vibration using suitable monitoring techniques.

**DETAILED SYLLABUS**

**UNIT I: CONDITION BASED MAINTENANCE                           (09 Periods)**

Introduction, Maintenance Strategies, Condition Monitoring Methods- Vibration Analysis- Oil Analysis- Performance Analysis- Thermography; Types and Benefits of Vibration Analysis; Vibration Transducers- Absolute vs Relative Vibration Measurement -Proximity Probes - Velocity Transducers – Accelerometers -Dual Vibration Probes -Laser Vibrometers; Torsional Vibration Transducers- Shaft encoders- Torsional Laser Vibrometers; Condition Monitoring - Basic Problems.

**UNIT II: SIGNAL PROCESSING TECHNIQUES                         (09 Periods)**

Basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring.Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic/random signal separation, Time-frequency analysis.

## UNIT III: FAULT DETECTION                                 (09 Periods)

Introduction, Rotating Machines - Vibration Criteria- Use of Frequency Spectra- CPB Spectrum Comparison; Reciprocating Machines- Vibration Criteria for Reciprocating Machines- Time-Frequency Diagrams- Torsional Vibration; Fault Trending and Prognostics- Trend Analysis- Trending of Simple Parameters- Trending of Impulsiveness; Determination of Spall Size in Bearings; Advanced Prognostics- Data-Driven Models- Hybrid Models.

## UNIT IV: DIAGNOSTIC TECHNIQUES                            (09 Periods)

Harmonic and Sideband Cursors; Minimum Entropy Deconvolution; Gear Diagnostics- Techniques Based on the TSA- Transmission Error as a Diagnostic Tool- Separation of Spalls and Cracks- Diagnostics of Gears with Varying Speed and Load; Rolling Element Bearing Diagnostics- Signal Models for Bearing Faults- A Semi-automated Bearing Diagnostic Procedure; Reciprocating Machine and IC Engine Diagnostics- Time-Frequency Methods- Cylinder Pressure Identification.

## UNIT V: VIBRATION MONITORING                              (09 Periods)

Vibration Monitoring Introduction, vibration data collection, techniques, instruments, measurement location, time-domain analysis, frequency domain analysis, time-frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration analysis. Vibration signals from rotating and reciprocating machines – signal classification, signals generated by rotating machines, signals generated by reciprocating machines.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. Robert Bond Randall, *Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications*, John Wiley & Sons Ltd., 2011 DOI:10.1002/9780470977668
2. R.A.Collacot, *Mechanical Fault Diagnosis*, Chapman and Hall Ltd., 1977.
3. R.C.Mishra, K.Pathak, *Maintenance Engineering and Management*, Prentice Hall of India Pvt. Ltd., 2002.

### REFERENCES MATERIALS / BOOKS:

1. Dr. K.Balaveera Reddy, *ISTE Summer School on Machinery Diagnostics and Preventive Maintenance*, KREC, Surathkal, 1995.
2. John S.Mitchell, *Introduction to Machinery Analysis and Monitoring*, PennWell Books, 1993.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | | | 1 | | | | | | | 3 | | |
| CO2 | 3 | 2 | 1 | | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| CO5 | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |
| Average | 3 | 2.6 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | 3 | | |

**Correlation Levels:**        **3– High**        **2 - Medium**        **1– Low**

## (19BT60320) MECHATRONICS

(Interdisciplinary Elective - 2)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Basic Electrical and Electronics Engineering, kinematics of machinery

**COURSE DESCRIPTION:**

Mechatronics system; Sensors; Transducers; Pneumatic and hydraulic actuation system, Mechanical  and electrical actuation systems**,** signal conditioning and process controllers

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Design mechatronic systems considering components, control systems and ethics as design constraints.

CO2.  Demonstrate the knowledge of hydraulic, pneumatic actuation systems used in automation circuits.

CO3.  Demonstrate the knowledge of mechanical and electrical actuation systems

CO4.  Demonstrate the knowledge of sensors and transducers to monitor and control the behavior of a process.

CO5.  Demonstrate the knowledge of signal conditioning and process controllers used in mechatronics.

**DETAILED SYLLABUS:**

**UNIT I: MECHATRONICS SYSTEMS                                          (07 periods)**

Definition, Elements of mechatronics System, Difference between     Traditional and mechatronics system, Measurement systems, Control systems, Examples of Automatic control systems: Examples - Automatic car parking gate system, Washing machine, Automatic Camera, Pick and Place Robot arm, Advantages and Disadvantages of mechatronics systems. Mechatronics approach to design,  Ethics as a design constraint.

**UNIT II: PNEUMATIC AND HYDRAULIC ACTUATION SYSTEMS          (09 Periods)**

Actuation systems, Pneumatic and hydraulic systems, Directional control valves, pressure control valves, Cylinders, Process control valves, Rotary actuators

**UNIT III:  MECHANICAL  AND ELECTRICAL ACTUATION SYSTEMS        (09 Periods)**

**Mechanical Actuation systems-**Mechanical Systems, Types of motion, Kinematic chains, CAMS, Gear Trains, Ratchet and Pawl, belt and Chain drives, bearings.

**Electrical Actuation systems** - Switches, Solenoids, Relays, DC motors, AC motors, Stepper motors.

**UNIT IV:  SENSORS AND TRANSDUCERS                                      (09 periods)**

**Sensors:** Introduction, Types of and sensors and transducers, Performance terminology: Range, span, error, accuracy, sensitivity, hysteresis error, non-linear error, repeatability,

stability and resolution. Static and dynamic Characteristics; Displacement sensors-Potentiometer, Strain gauge, Linear Variable Differential Transformer; Position sensors- Hall effect sensor, Optical Encoder; Proximity- Inductive, Capacitive; Acceleration-Piezoelectric accelerometer; Temperature- Bimetallic strips, Resistance Temperature Detectors (RTD); Light sensors- photo diodes, photo electric transducer; Selection of Sensors.

## UNIT V: SIGNAL CONDITIONING AND PROCESS CONTROLLERS    (11 Periods)

**Signal conditioning -** Operation Amplifiers: Inverting and non-inverting amplifier, Filtering: Ideal filter characteristic, Low Pass, High Pass, Band pass, Band stop filters and notch filter, Bridge circuits, Analog to digital converter, Digital to analog Converter, Data Acquisition System.

**Process Controller -** Principles, Two position controller, Proportional (P) controllers, Integral (I) controllers, Derivative (D) controllers; Composite controller Modes – Proportional Integral (PI), Proportional Derivative (PD), Three mode controller (PID); Selection of controllers, Syllabus

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*
**TEXTBOOKS:**

1. K.P.Ramachandran, *Mechatronics Integrated Mechanical Electronic Systems*, Wiley, 2012.
2. W. Bolton, *Mechatronics Electronics Control systems in Mechanical and Electrical Engineering*, Pearson, 4th edition, 2005.

**REFERENCE BOOKS:**

1. N.P. Mahalik, *Mechatronics Principles Concepts and Applications*, McGraw Hill Education (India) Private Limited, 2012.

2. Devdas Shetty, *Richard, Mechatronic System Design*, Cengage Learning, 2nd edition, 2012.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | | | 1 | | 3 | | | | | 3 | | |
| CO2 | 3 | 1 | | | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 1 | | | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 1 | | | | 1 | | | | | | | 3 | | |
| CO5 | 3 | 1 | | | | 1 | | | | | | | 3 | | |
| Average | 3 | 1.4 | 3 | | | 1 | | 3 | | | | | 3 | | |
| Correlation level | 3 | 1 | 3 | | | 1 | | 3 | | | | | 3 | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

## (19BT61531)**INTERNET OF THINGS LAB**

### (Common to CE, ME, CSE, CSSE & IT)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | 1 | 2 | 2 |

**PRE-REQUISITES:-**

**COURSE DESCRIPTION:**

Setting up IoT work-flow, Programming with Python, Micro-controller programming using Arduino, Building IoT Applications using Raspberry Pi, IoT Cloud Infrastructure.

**COURSE OUTCOMES:**

*After successful completion of this course, the students will be able to:*

CO1. Design an interface to embedded systems using real-time sensors with Arduino and Raspberry Pi.

CO2. Develop applications to capture the data generated by sensors and send to cloud.

CO3. Develop real time applications using NodeMCU and BLYNK.

CO4. Design applications to push sensor data to cloud using MQTT protocol.

CO5. Work independently and in team to solve problems with effective communication.

**THEORY COMPONENT:** **(10 Periods)**

Arduino IDE, 7-segment display, Servo motor, ultrasonic sensor, LCD, Flame sensor, gas sensor, Humidity & temperature sensors, MQTT protocols, ECG System, Raspberry Pi, Home security system with camera, PIR sensor, light sensor, motion detector, NodeMCU, BLYNK, cloud

**LIST OF EXPERIMENTS:**

1. (a) Design and Simulate LED 7-Segment Display interfacing with Arduino.

   (b) Design and Simulate Servo motor interfacing with Arduino.

2. (a) Design and Simulate ultrasonic sensor and LCD interfacing with Arduino.

   (b) Design and Simulate Flame Sensor interfacing with Arduino.

3. Design and Implement to capture Gas Sensor and send sensor data to cloud from your NodeMCU device using Arduino IDE.

4. Design and Implementation of Humidity and Temperature Monitoring Using Arduino and upload data to cloud using MQTT.

5. Design and Implementation of an IoT ECG (Electrocardiogram) System to record hearts electrical activity.

6. Design and Simulate controlling an LED 7-Segment Display with Raspberry Pi.

7. Design and implementation of Raspberry Pi Home Security System with Camera and PIR Sensor with Email Notifications.

8. Design and Implement to upload Light sensor (TSL) data to cloud through Raspberry Pi.

9. Design and Implementation of Motion Detector with NodeMCU and BLYNK.

10. Design and Implementation of Fire notification IoT system with BLYNK.

**REFERENCE BOOKS:**

1. Adrian McEwen and Hakin Cassimally, *Designing the Internet of Things,* Wiley India.

2. Simon Monk, *Programming Aurdino,* Second Edition, McGraw-Hill Education**,**2016.

3. Matt Richardson and Shawn Wallace, *Getting Started with Raspberry Pi*, O'Reilly, 2014.

4. Rahul Dubey, *An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications* , Cengage Learning India Pvt. Ltd,2019

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 2 | - | 3 | - | - | 2 | 2 | - | - | - | - | - | - | - | - |
| **CO2** | 2 | - | 2 | - | - | 2 | 3 | - | - | - | - | - | - | - | - |
| **CO3** | 1 | 3 | 2 | - | 1 | 1 | 1 | - | - | - | - | - | - | - | - |
| **CO4** | 1 | 2 | 2 | - | 3 | 1 | 1 | 1 | - | - | - | - | - | - | - |
| **CO5** | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - |
| **Average** | 1.5 | 2.5 | 2.2 | - | 2 | 1.5 | 1.7 | 1 | 3 | 3 | - | - | - | - | - |
| **Correlation level** | **2** | **3** | **2** | | **2** | **2** | **2** | **1** | **3** | **3** | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT60331) **HEAT TRANSFER LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | - | 3 | 1.5 |

**PRE-REQUISITES:**

A course on Engineering Thermodynamics and Fluid Mechanics and hydraulics Machinery

**COURSE DESCRIPTION:**

Experimental studies on mechanisms of heat transfer; Film wise and drop wise condensation; Steady and unsteady flow; Effectiveness of heat exchanger; thermal conductivity; emissivity; Stefan - Boltzmann constant.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the conduction heat transfer process by performing experiments on composite systems, metal rod and transient heat conduction systems and determine the heat transfer characteristics.

CO2. Analyze the convection heat transfer process by performing experiments on Pin Fin, Horizontal tube and vertical tube systems and calculate heat transfer characteristics.

CO3. Analyze the heat exchangers, boilers and condensers for heat transfer rates by performing experiments and determine the heat transfer characteristics.

CO4. Analyze the radiation heat transfer process by performing experiments on black bodies and gray bodies and determine heat transfer characteristics.

CO5. Demonstrate the knowledge of the heat transfer process in heat pipes and simulation of heat flow systems.

CO6. Work independently or in teams to solve problems with effective communication

**DETAILED SYLLABUS:**

**LIST OF EXPERIMENTS:**

1. Determination of Thermal conductivity of metal rod using thermal conductivity Apparatus.

2. Determination of Thermal conductivity of insulating powder material through concentric sphere apparatus.

3. Determination of Thermal conductivity of insulating material by lagged pipe apparatus.

4. Determination of Overall heat transfer co-efficient through Composite Slab Apparatus.

5. Determination of Temperature distribution and heat transfer rate in Transient heat conduction mode using the Transient heat conduction apparatus.

6. Determination of Convective Heat transfer coefficient in natural convection using natural convection apparatus.

7. Determination of Convective Heat transfer coefficient in forced convection using forced convection apparatus.

8. Determination of Temperature distribution, efficiency and effectiveness of Pin- Fin using pin-fin Apparatus.

9. Determination of overall heat transfer coefficient of Parallel and counter flow heat exchanger using Parallel and counter flow heat exchanger Apparatus.

10. Determination of Critical heat flux using the Critical Heat flux apparatus.

11. Determination of Heat transfer in drop and film-wise condensation using drop and film wise condensation apparatus.

12. Determination of Stefan Boltzmann constant using the Stefan Boltzmann Apparatus.

13. Determination of Emissivity of a gray body using the Emissivity apparatus.

14. Study of two-phase heat flow in heat pipes.

15. Study of simulation of heat flow systems using simulation tools.


**NOTE: Student shall perform a minimum of twelve experiments**


1. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age International, 5th Edition, 2017.
2. SVEC19 Heat transfer Manual


## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | 3 | |
| CO2 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | 3 | |
| CO3 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | 3 | |
| CO4 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | 3 | |
| CO5 | 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | | 3 | |
| CO6 | | | | | | | | | 3 | 3 | | | | | |
| Average | 3 | 3 | 1 | 1 | 1 | 1 | | | 3 | 3 | | | | 3 | |
| Correlation level | 3 | 3 | 1 | 1 | 1 | 1 | | | 3 | 3 | | | | 3 | |

**Correlation Levels:       3– High       2 - Medium       1– Low**

# III B.Tech. - II semester

## (19BT60332) **SOCIALLY RELEVANT PROJECT-2**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | - | 1 |

**PREREQUISITES:** -

**COURSE DESCRIPTION:**
Identification of topic for the socially relevant project; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the socially relevant project; Preparation of thesis and presentation.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Create/Design engineering systems or processes to solve complex societal problems using appropriate tools and techniques following relevant standards, codes, policies, regulations and latest developments.

CO2. Consider the environment, sustainability, economics and project management in addressing societal problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on the socially relevant project.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | - | - | | 3 | | | |
| **CO2** | - | - | - | - | - | - | 3 | - | - | - | 3 | - | | | |
| **CO3** | - | - | - | - | - | - | - | - | 3 | 3 | | - | | | |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |
| **Correlation level** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT5MC01) **UNIVERSAL HUMAN VALUES**

(Mandatory Course)

(Common to CE, ME, EEE, ECE & EIE)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | - | 40 | 2 | - | - | - |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:** Process for Value Education; Harmony in the Human Being - Harmony in Myself!; Harmony in Family and Society- Human Relationship; Harmony in the Nature and Existence – Coexistence; Implications of Holistic Understanding of Harmony on Professional Ethics.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand Values and skills for sustained happiness and prosperity.

CO2. Analyse realistic implications of a Holistic understanding of ethical human conduct, trustful and mutually fulfilling human behaviour.

CO3. Apply holistic approach in personal life and profession through a positive understanding of the Human reality and existence.

**DETAILED SYLLABUS:**

**UNIT I: VALUE EDUCATION** (6 Periods)

Human Values-Introduction; Self-Exploration - Natural Acceptance; Human Aspirations-Right understanding- the current scenario: understanding and living in harmony.

**UNIT II: HUMAN BEING AND SELF** (6 Periods)

Understanding human being - I' and the material 'Body'; needs of Self ('I') and 'Body'-happiness and physical facility; Body as an instrument of 'I' - characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body.

**UNIT III: FAMILY, THE SOCIETY AND THE NATIONS** (6 Periods)

Values in human relationship (nine universal values) - foundational values of relationship; Difference between intention and competence; Difference between respect and differentiation; harmony in the society; Universal harmonious order in society.

**UNIT IV: HARMONY WITH THE NATURE** (6 Periods)

Harmony in the Nature; Interconnectedness and mutual fulfilment - the four orders of nature - Recyclability and Self-regulation; Existence as Co-existence; Holistic perception of harmony and existence.

**UNIT V: HARMONY WITH PROFESSIONAL ETHICS** (6 Periods)

Acceptance of human values; Ethical Human Conduct; Basis for Humanistic Education; Competence in professional ethics; Case studies: Holistic technologies, Management Models and Production Systems; Socially and ecologically responsible engineers, technologists and managers - enriching institutions and organizations.

**Total Periods: 30**

***Topics for self-study are provided in the lesson plan.***

**TEXTBOOKS:**
1. R R Gaur, R Sangal, G P Bagaria, Human Values and Professional Ethics, Excel Books, New Delhi, 2010

**REFERENCE BOOKS:**

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidya Prakashan, Amarkantak, 1999.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 2 | - | - | - | - | 3 | 2 | - | - | - | - | - | | | |
| **CO2** | 3 | - | - | - | - | 3 | 3 | - | - | - | - | - | | | |
| **CO3** | 3 | - | - | - | - | 3 | 3 | 2 | - | - | - | - | | | |
| **Average** | 2.6 | | | | | 3 | 2.6 | 2 | | | | | | | |
| **Correlation level** | 3 | | | | | 3 | 3 | 2 | | | | | | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## IV B.Tech. - I Semester

**(**19BT6HS01**) PRINCIPLES OF BUSINESS ECONOMICS AND ACCOUNTANCY**
(Common to CE, ME, CSE, CSSE & IT)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITE: --**

**COURSE DESCRIPTION**:
Business economics and demand analysis; theory of production and cost analysis; markets and pricing; principles of accounting and capital; final accounts and tally ERP 9.0

**COURSE OUTCOMES**:

After successful completion of this course, the students will be able to:

CO1. Demonstrate Knowledge in concepts, principles and significance of Business Economics, Financial accounting and Tally ERP 9.0

CO2. Demonstrate analytical skills in managerial decision making of an organization by applying theories of Economics

CO3. Develop effective communication in Business and Accounting transactions.

CO4. Ascertain the profitability and soundness of an organization.

CO5. Preparing Financial Statements

**DETAILED SYLLABUS:**

**UNIT I: BUSINESS ECONOMICS AND DEMAND ANALYSIS             (9 periods)**

Definition - Nature and Scope of Business Economics - **Demand:** Determinants of demand – Demand function - Law of demand, assumptions and exceptions - Elasticity of demand – Types of elasticity of demand - Demand forecasting and methods of demand forecasting.

**UNIT II: THEORY OF PRODUCTION AND COST ANALYSIS             (9 periods)**

**Production Function:** Input-output relationship - Law of Variable proportion- Isoquants and Isocosts

**Cost Concepts:** Total, Average and Marginal Cost **-** Fixed vs. Variable costs – Opportunity Costs Vs Outlay Costs– Separable Costs Vs Joint Costs, Urgent Costs Vs Postponable Costs- Avoidable Costs Vs Unavoidable Costs

**Break Even Analysis (BEA)** – Assumptions, Merits and demerits - Determination of Break Even Point (Simple problems).

**UNIT III: MARKETS AND PRICING                             (9 periods)**

**Market Structure:** Types of Markets - Features of perfect competition - Monopoly and monopolistic competition - Price and Output determination in perfect competition, monopoly and monopolistic Markets.

**Pricing:** Objectives and policies of pricing – Sealed bid pricing - Marginal cost pricing - Cost plus pricing - Going rate pricing – penetration Pricing –skimming Pricing - Block pricing – Peak load pricing - Cross subsidization.

## UNIT IV: PRINCIPLES OF ACCOUNTING & CAPITAL                (9 periods)

**Accountancy:** Introduction – Concepts – Conventions – Double Entry Book Keeping - Journal – Ledger - Trial Balance (Simple problems).
**Capital:** Significance - Types of capital – Sources of Capital.

## UNIT V: FINAL ACCOUNTS & TALLY ERP 9.0                (9 periods)

**Introduction to Final Accounts** - Trading account - Profit and Loss account and Balance Sheet with simple adjustments (Simple problems)
**Tally ERP 9.0:** Introduction – Create a company – Create ledger – Posting vouchers – Advantages of Tally.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. H L Ahuja, *Business Economics (Thirteenth edition)*, S Chand Publishing, Jan 2016.
2. Larry M. Walther, *Financial Accounting,* Create Space Independent Publishing Platform, July 2017.

**REFERENCE BOOKS:**

1. Joseph G.Nellis and David Parker, *Principles of Business Economics*, Pearson Education Canada, 2nd edition, 2016.
2. S.P. Jain and K.L. Narang, *Financial Accounting*, Kalyani Publishers, Ludhiana, 12th edition, 2018.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | - | - | - | - | - | - | - | 2 | - | - | | | |
| **CO2** | - | 3 | - | - | - | - | - | - | - | 2 | - | - | | | |
| **CO3** | - | 1 | - | - | - | - | - | - | - | - | 3 | - | | | |
| **CO4** | 1 | 2 | - | - | - | - | - | - | - | - | - | 3 | | | |
| **CO5** | - | 1 | - | - | - | - | - | - | - | 3 | - | 2 | | | |
| **Average** | 2 | 1.6 | | | | | | | | 1.3 | 3 | 2.5 | | | |
| **Correlation level** | 2 | 2 | | | | | | | | 1 | 3 | 3 | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT70301) **DESIGN OF TRANSMISSION SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Strength of Materials and Design of Machine Elements.

**COURSE DESCRIPTION:**

Helical, Bevel, Worm Gears; Stress analysis of gears; Gearbox, Gear train; Working of the gearbox and Gear train; Functions of Various gearbox and gear train; Hydraulic controls for Automatic transmission system; Hydrostatic, Hydrodynamic, Hydrokinetic drives; Construction of drives; Working of drives and their performance; Automatic transmission system; intelligent electronic control systems.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Design Helical, Bevel and worm gears using strength and wear equations for power transmitting applications.

CO2.   Design gearbox and determine speeds for machine tools applications.

CO3.   Design gear trains for automatic transmission.

CO4.   Analyze the performance of Hydrostatic, Hydrodynamic and Hydrokinetic drives and determine the performance parameters.

CO5.   Analyze functional characteristics of automatic transmission systems with intelligent electronic control and hydraulic clutch activation systems.

**DETAILED SYLLABUS:**

**UNIT I: HELICAL, BEVEL AND WORM GEARS:**                           **(9 Periods)**

Parallel Helical Gears - Kinematics, Tooth proportions, Force analysis, Stresses in Helical gear; Design of helical gear; Crossed Helical gears; Straight Bevel gears – Kinematics, Force analysis, Stresses in straight bevel gear tooth,  Design of bevel gear; Worm gearing – Kinematics, Forces, Friction and Efficiencies, Stresses in worm gear tooth.

**UNIT II: GEAR BOX:**                                        **(9 Periods)**

Need for a gearbox in an automobile and types of Gearboxes – Construction and working of Sliding mesh, Constant mesh gearbox, Epi-cyclic gearbox , overdrive torque converter, ray diagrams, Synchromesh gearbox and principle of synchronizers; Design of multi-speed gearboxes for machine tools.

**UNIT III: GEAR TRAINS :**                                   **(8 Periods)**

Construction and Working Principle of Epi-cyclic gear train, Planetary gearbox, Ford T Model gearbox, Wilson gearbox, Cotal electromagnetic transmission and Automatic overdrive. Gear ratios for Wilson gearbox and Automatic Overdrive. Hydraulic control system for Automatic transmission.

**UNIT IV: HYDROSTATIC, HYDRODYNAMIC AND HYDROKINETIC DRIVES :**

**(10 Periods)**

**Hydrostatic drives:** Introduction to hydrostatic drives, Working principle, types, Advantages and limitations of Hydrostatic drives, Comparison of hydrostatic drive with hydrodynamic drive, Construction and working of Janny Hydrostatic drive.

**Hydrodynamic and Hydrokinetic drives:** Introduction to fluid coupling, Fluid coupling – Construction, Principle of operation and Performance characteristics, Drag torque and various drag reducing devices of fluid coupling, Problems on design and torque capacity of fluid coupling, Construction and working of Torque converter, converter coupling, Multistage torque converter, and Polyphase torque converter - Performance characteristic of multistage and poly phase torque converters.

**UNIT V:  AUTOMATIC TRANSMISSION:**                          **(9 Periods)**

Layout of Automatic transmission system, construction and working of Turbo glide transmission, Power glide transmission, ECT- intelligent transmission, Automatic transmission with intelligent electronic control systems, Hydraulic clutch actuation for Automatic transmission. Chevrolet "Turboglide" Transmission, Continuously Variable

Transmission (CVT) – Types – Operations of a typical CVT.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "*Mechanical Engineering Design*", 11th Edition, Tata McGraw-Hill, 2020.

2. Harald Naunheimer , Bernd Bertsche , Joachim Ryborz , Wolfgang Novak "*Automotive Transmission: Fundamentals, Selection, Design and Application*", 2nd Edition, Springer, 2011.

**REFERENCE BOOKS:**
1. Robert L. Norton, "*Machine Design"- an integrated approach*, (5th Edition) Pearson publisher, 2000.

2. Bhandari V, *Design of Machine Elements*, 5th Edition, Tata McGraw-Hill Book Co, 2020.

3. Judge A. W., "*Modern Transmission*", 3rd ed., Chapman & Hall Std., London, 1989.

4. CDX Automotive, "*Fundamentals of Automotive Technology, Principles and practice*", Jones &Barlett Publishers, 2013.

5. Newton Steeds & Garrot, "*Motor Vehicles*", SAE International and Butterworth Heinemann, 2001.

6. Malisa, "*Hand Book of Gear Design*", Tata Mc Graw Hill, International Edition, 2000.

7.  Mahadevan, k, Reddy, K. Balaveera, "*Design Data Handbook for Mechanical Engineering in SI and Metric Units*", CBS; 4th edition,2019.

**Data Book:** Design data hand book for Mechanical Engineers in SI and Metric units by Balaveera Reddy and Mahadevan.N

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |
| CO2 | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 2 | 1 | | 1 | | | | | | | 3 | | |
| CO5 | 3 | 3 | 2 | 1 | | 1 | | | | | | | 3 | | |
| Average | 3 | 3 | 2.6 | 1 | | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 3 | 3 | 1 | | 1 | | | | | | | 3 | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT70302) **OPERATIONS MANAGEMENT**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITE:**

A course on Operations Research

**COURSE DESCRIPTION:**

Introduction to Operations Management, Services as a part of operations management; Regression and correlation methods; Material Requirements Planning Logic; Capacity Requirements Planning; Scheduling of Job Shops; Operational Control issues in Mass Production systems; Continuous improvement Process.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:

CO1. Apply operations strategy through strategic means, measures and decisions for attaining operational excellence.

CO2. Model demand forecasting problems and develop accurate forecasts.

CO3. Apply aggregate production planning techniques to order optimal material quantities.

CO4. Apply operation scheduling and control issues for smooth production.

CO5. Demonstrate lean management strategies for creating a stable workflow based on actual customer demand.

**DETAILED SYLLABUS:**

**UNIT I: OPERATIONS STRATEGY                           (08 periods)**

Introduction to Operations Management, Services as a part of operations management, Relevance of Operations Strategy, Strategy formulation process, Measures of operational excellence, Options for strategic decisions in operations, World-class manufacturing practices, Emerging trends and implications for operations

**UNIT II: DEMAND FORECASTING                           (09 periods)**

Forecasting techniques- causal and time series models, moving average, exponential smoothing, trend and seasonality; Regression and correlation methods; Accuracy of forecasts, Application and control of forecasts.

**UNIT III: AGGREGATE PRODUCTION PLANNING                 (10 periods)**

Need for Aggregate Production Planning, Alternatives for managing demand and supply, Strategies for Aggregate Production Planning, Master Production Scheduling, Material Requirements Planning Logic, Capacity Requirements Planning, Distribution Requirements Planning, Enterprise Resource Planning and Supply Chain Management.

**UNIT IV:OPERATIONS SCHEDULING                          (09 periods)**

Need for Scheduling, Scheduling rules and performance criteria, Scheduling of Flow Shops – Johnson's rule; Scheduling of Job Shops, Operational Control issues in Mass Production systems, Operations Planning and Control based on Theory of Constraints.

**UNIT V:LEAN MANAGEMENT** **(09 periods)**

Philosophy of Lean Management, Elements of JIT Manufacturing, Production Planning and Control in JIT, Continuous improvement Process, Organizational challenges in Lean Management, Six-Sigma approach to Quality Control, Six-Sigma Methodology, and Lean Six-Sigma

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. B.Mahadevan, *Operations Management*, Pearson education, 3rd edition, 2014.

2. Lee J Krajewski, M K Malhotraand Larry P Ritzman, *Operations management – Processes and Supply Chains*, 12th edition, 2019.

**REFERENCE BOOKS:**

1. Monks J.G., *Operations Management*, Schaums outline series, McGrawHill, 2nd edition, 2020.

2. R Pannerselvam, *Production and Operations Management*, PHI learning, 3rd edition, 2012.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 1 | | | 1 | | | | | 1 | | | | 3 |
| **CO2** | 3 | 3 | 2 | 1 | | 1 | | | | | 1 | | | | 3 |
| **CO3** | 3 | 3 | 1 | | | 1 | | | | | 1 | | | | 3 |
| **CO4** | 3 | 3 | 1 | | | 1 | | | | | 1 | | | | 3 |
| **CO5** | 3 | | | | | 1 | | | | | 1 | | | | 3 |
| **Average** | 3 | 3 | 1.25 | | | 1 | | | | | 1 | | | | 3 |
| **Correlation level** | 3 | 3 | 1 | 3 | | 1 | | | | | 1 | | | | 3 |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

# IV B. Tech. I-Semester

## (19BT70303) COMPUTATIONAL FLUID DYNAMICS

### (Professional Elective – 4)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | 1 | - | 3 |

**PRE-REQUISITES:**

Courses on Multi-Variable Calculus and Differential Equations, Fluid Mechanics and Hydrulics Machinery and Heat Transfer.

**COURSE DESCRIPTION:**

Introduction to Computational Fluid Dynamics(CFD); Various Numerical methods; Solution methods for governing equations; Finite difference method and its application to heat transfer problems; Errors and stability analysis; Finite Volume method; Study flow analysis; Simple CFD techniques.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

- CO1. Apply governing equations of fluid dynamics for solving fluid mechanics and heat transfer problems.
- CO2. Apply Discretization Techniques to solve the algebraic equation of Grids With Appropriate Transformation.
- CO3. Analyze numerical models of the Fluid Flow and Heat transfer phenomenon using finite difference method as discretization and grid generation techniques for Parabolic Partial Differential Equations.
- CO4. Analyze numerical models of the Fluid Flow and Heat transfer phenomenon using finite difference method as discretization and grid generation techniques for elliptic and hyperbolic equations.
- CO5. Analyze mathematical models of fluid dynamics using the Finite volume approach.

**DETAILED SYLLABS:**

**UNIT I: GOVERNING EQUATIONS**           **(9 periods)**

Introduction, applications of CFD in diverse fields, Governing equations of fluid dynamics – Continuity, Momentum and energy equations; Generic differential and integral form for governing equations, Initial and Boundary conditions, Differences between Finite element method, Finite difference method and Finite volume method, Classification of partial differential equations – Hyperbolic, Parabolic, Elliptic and Mixed types; Applications and relevance.

**UNIT II: DISCRETIZATION TECHNIQUES**       **(9 periods)**

**Basic Aspects of Discretization:** Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points.

**Grids With Appropriate Transformation:** General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.

### UNIT III:    FINITE DIFFERENCE FORMULATIONS                    **(9 periods)**

**Parabolic Partial Differential Equations:** Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.

**Stability Analysis:** Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion.

### UNIT IV: ELLIPTIC AND HYPERBOLIC EQUATIONS                    **(9 periods)**

**Elliptic Equations:** Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods.

**Hyperbolic Equations:** Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order TVD schemes, introduction to modern tools.

### UNIT V: FINITE VOLUME METHOD                    **(9 periods)**

Introduction, Finding the flux at the interface, Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and MacCormack Method; Upwind Method in Finite Volume methods -  Flux Splitting Method Steger and Warming, Vanleer, Roe's Method and finding Roe's Averages; Numerical procedure for SIMPLE algorithm, Boundary conditions for the pressure correction method; Stream function, Vorticity method, introduction to modern tools.

                                                              **Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*
**TEXTBOOKS:**

1. John. D. Anderson, *Computational Fluid Dynamics, the Basics with Applications*, Mc Graw Hill.6th Edition, 1995.

2. Hoffman, K.A., and Chiang, S.T., *Computational Fluid Dynamics, Vol. I, II and III*, Engineering Education System, Kansas, USA, 2000.

**REFERENCE BOOKS:**

1. Tapan K. Sengupta, *Fundamentals of Computational Fluid Dynamics*, 1st Edition, Universities Press, 2004.

2. Suhas V. Patankar, *Numerical Heat Transfer and Fluid Flow*, 1st Edition, CRC, 1980.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | | | | | | | | | | 3 | |
| CO2 | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | |
| CO3 | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | |
| CO4 | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | |
| CO5 | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | |
| Average | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | |
| Correlation level | 3 | 3 | 2 | 1 | 1 | | | | | | | | | 3 | |

            **Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT70304) **FINITE ELEMENT METHOD**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Design of Machine Elements and Heat Transfer.

**COURSE DESCRIPTION:**

Discretization; Formulation of finite element expression; Finite Element approach to solve 1-D problems; beams; trusses; CST problems; Heat transfer problems and Dynamic analysis problems.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply FEM techniques and approaches for solving One-dimensional field problems.

CO2. Analyze element stiffness matrices and shape functions for formulation of mathematical models to find stresses in trusses and beams.

CO3. Analyze CST element andaxi-symmetric element for formulationof mathematic models and solve by using Finite Element Methods.

CO4. Analyzeiso-parametric elements and heat transfer problems for formulations mathematic models and solve  byusing Finite Element Methods.

CO5. Analyze Lumped mass matrix and Eigen vectorsfor formulation of models and solve vibration analysis problems.

**DETAILED SYLLABUS:**

**UNIT I:  INTRODUCTION  TO FINITE ELEMENT METHOD**            **(09 periods)**

Introduction to Finite Element Method for solving field problems, Stress and Equilibrium, Strain - Displacement relations, Stress-strain relations,

**One-dimensional finite element method**: Bar elements, Finite element modelling, coordinates and shape functions, Element matrices, assembling of global stiffness matrix and load vector, Principle of minimum potential energy, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element.

**UNIT II: TRUSSES  & BEAMS**                                         **(09 periods)**

**Trusses:** Plane trusses, local and global coordinate systems, formulation for direction cosines, Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, and temperature effects.

**Beams:** Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.

## UNIT III: TWO-DIMENSIONAL & AXI-SYMMETRIC MODELS          (09 periods)

**Two-dimensional problems:** Basic concepts of plane stress and plane strain, stiffness matrix of Constant Strain Triangle (CST) element, finite element solution of plane stress problems.

**Axi-symmetric model:** Finite element modelling of axi-symmetric solids subjected to axi-symmetric loading with triangular elements.

## UNIT IV: ISO-PARAMETRIC FORMULATION & HEAT TRANSFER ANALYSIS

                                                            (11 periods)

**Iso-parametric formulation:** Sub parametric, super parametric and iso-parametric elements, 2 dimensional 4 noded iso-parametric elements, numerical integration.

**Heat transfer problems:** One-dimensional finite element formulation of heat transfer with conduction, convection and Heat transfer through fins, Two-dimensional finite element formulation.

## UNIT V: DYNAMIC ANALYSIS                               (07 periods)

Introduction to dynamic considerations, Hamilton's principle, Dynamics of spring mass system, consistent mass matrix, Formulation of FEM model, element matrices, One-dimensional bar, truss, CST elements, Lumped mass matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar and beam element. List of FEM software packages.

                                                     **Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Tirupati R. Chandrupatla& Ashok D. Belegundu, *Introduction to Finite Elements in Engineering*, PHI learning, 3rd Edition, 2011

2. Daryl L. Logan, *First course in the Finite Element Method*, Cengage Learning, 4th Edition 2007

**REFERENCE BOOKS:**

1. S. S. Rao, *Finite Element Methods in Engineering*, Elsevier, 5th Edition, 2012.

2. J. N. Reddy, *An Introduction to Finite Element Method*, Tata Mc Graw-Hill, 3rd Edition, 2005.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | | | 1 | | | | | | | 3 | 3 | |
| CO2 | 3 | 3 | 2 | | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 2 | | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 2 | | | 1 | | | | | | | 3 | | |
| CO5 | 3 | 3 | 2 | | 1 | 1 | | | | | | | 3 | 3 | |
| Average | 3 | 3 | 2 | | | 1 | | | | | | | 3 | 3 | |
| Correlation level | 3 | 3 | 2 | | 1 | 1 | | | | | | | 3 | 3 | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

## IV B. Tech. – I Semester
### (19BT70305) MATERIAL PROCESSING TECHNIQUES
### (Professional Elective-4)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Materials Science and Engineering , Manufacturing Technology**,** Metal Cutting and Machine Tools.

**COURSE DESCRIPTION:**

Metal forming and its types; Micromachining and its measuring techniques; fundamentals of laser and its applications; advanced welding processes and testing; advanced finishing processes.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge on advances in metal forming processes, process parameters and their techniques.

CO2. Demonstrate knowledge of micro-machining process and its measuring techniques.

CO3. Analyze the functional characteristics of laser processing for diverse applications.

CO4. Demonstrate the knowledge of advanced welding process and tests to enhance the quality of welds

CO5. Apply appropriate finishing techniques and explore the mechanisms involved.

**DETAILED SYLLABUS:**

**UNIT I: ADVANCES IN METAL FORMING                         (9 periods)**

Conventional processes-High Energy Rate Forming techniques-Explosive forming, Electro-hydraulic forming, Magnetic pulse forming, Superplastic forming, Rubber forming, Flow forming - Principles and process parameters- Advantages -Limitations and Applications. Overviews of powder metal forming technique-Advantages- Applications-Powder performs forging- Hot and cold Isostatic pressing- Powder rolling-Tooling and process parameters.

**UNIT II: MICRO-MACHINING                                    (9 periods)**

Introduction to micromachining technologies, Micro electro discharge Machining: Principles of micro-EDM, Micro-EDM by Die-sinking and WEDG, Micro-WEDM, Micro-WEDG, Micro-ECM, Principles of micro-turning, Micro-drilling and Micro-milling, Micro grinding, Hybrid micro-machining method, On-line measurement by machine vision and integrated probe, Measuring Techniques in micro-machining, Surface integrity and other related measurements.

**UNIT III: LASER MATERIALS PROCESSING                      (9 periods)**

Fundamentals of industrial lasers - Laser materials interaction theories - Laser processing for various industries such as metals, non-metals, photovoltaic, bio-medical applications. Laser optics- Heat flow theory, Pulsed lasers, Pulsed laser heating, Laser cutting, Laser welding, Laser surface modifications. Diffusion Modelling, Laser cladding, Laser texturing, Laser bending, Laser safety and Laser micromachining.

## UNIT IV:ADVANCED FABRICATION PROCESSES                (9 periods)

Introduction, Advancements in Fabrication Techniques -Thermit welding, Electro slag welding, Electron beam welding, laser beam welding, forge welding, friction welding, diffusion welding, explosion welding, ultrasonic metal welding, destructive & non-destructive testing of welds.

## UNIT V: ADVANCED FINE FINISHING PROCESS            (9 periods)

Abrasive Flow Machining; Magnetic Abrasive Finishing; Magneto-Rheological Abrasive Finishing: Principle, Process equipment; Analysis and modelling of finishing mechanism; Parametric analysis; Applications.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. M P Groover, "*Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, John Wiley & Sons,3rdEdition, India, 2007.
2. Pandey, P.C., and Shan, H.S., "*Modern Machining Processes*", Tata McGraw-Hill Education, New Edition, UK, 2017.

**REFERENCE BOOKS:**

1.SeropeKalpakjian, "*Manufacturing Processes for Engineering Materials*", Pearson Education, 5th Edition, UK, 2017.

2.PeterSchaaf, "*Laser Processing of Materials: Fundamentals, Applications and Developments*", Springer Publishers, 1st Edition, USA, 2010.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | | | - | - | - | - | - | 3 | | |
| CO2 | 3 | 1 | | | | - | | - | - | - | - | - | 3 | | |
| CO3 | 3 | 3 | | | | - | | - | - | - | - | - | 3 | | |
| CO4 | 3 | 1 | | | | - | | - | - | - | - | - | 3 | | |
| CO5 | 3 | 2 | | | 1 | - | | - | - | - | - | - | 3 | | |
| Average | 3 | 1.6 | | | 1 | - | | - | - | - | - | - | 3 | | |
| Correlation level | 3 | 2 | | | 1 | - | | - | - | - | - | - | 3 | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BT70306) **POWER PLANT ENGINEERING**

(Professional Elective-4)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|-----------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Courses on Thermal Engineering-II and Heat transfer.

**COURSE DESCRIPTION:**

Energy sources; Types of Power Plants; Thermal power plant; Study of various systems of thermal power plant; Combustion and Firing Methods; Diesel Power plant; Gas Turbine Power Plants; Hydroelectric power plants andNuclear power plants; Power generation and recovery systems; Various conventional and non-conventional sources of energy with power plant economics.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge on construction and working principles of various subsystems and pollution control methods in thermal power plants.

CO2. Demonstrate knowledge on various components, working principles and Performance improvements in diesel and gas power plants.

CO3. Demonstrate the knowledge of hydroelectric power plant and nuclear power Plant and their pollution control methods.

CO4. Demonstrate the knowledge of working principles of non-conventional power generation units and direct energy conversion systems.

CO5. Calculate the cost of power generation for various power plants using different types of tariff systems

**DETAILED SYLLABUS:**

**UNIT I: THERMAL POWER PLANT**            **(09 Periods)**

Introduction to the sources of energy, Plant layout, selection of site for power plant, coal handling systems, Overfeed and underfeed stoker principles, Traveling grate stokers, Spreader

stokers, Multi retort stokers, Pulverized fuel firing – Pulverizedfuel handling, Pulverizing mills, Pulverized fuel burners; Ash handling systems, Dust collectors.Thermal Power plant pollution.

**UNIT II:  DIESEL ENGINE AND GAS TURBINE POWER PLANTS**      **(9 periods)**

**Diesel Power Plant:** Essential components of a diesel powerplant, Operation of the diesel power plant, Plant layout with auxiliaries.

**Gas Turbine Plant:** Requirements, Functions, Classification, Construction, and Layout with auxiliaries.

**UNIT III: HYDROELECTRIC AND NUCLEAR POWER PLANTS**      **(9 periods)**

**Hydro-Electric Power Plant:** Selection of site for power plant, Typical layouts, Elements of plant, Classification of dams, Spillways, Surge tank, Draft tube, Classification of Hydroelectric

power plants, Hydrology, Hydrological cycle, Hydrographs;

**Nuclear Power Plants:** Requirements, Functions, Nuclear fuel, Breeding and Fertile materials, Nuclear reactor, Reactoroperation, Types Of Reactors - Pressurized water reactor, Boiling water reactor, Sodium-Graphite reactor, Fast breeder reactor, Homogeneous reactor, Gas-cooled reactor; Nuclear power plant pollution.

## UNIT IV: NON CONVENTIONAL POWER GENERATION ANDDIRECT ENERGY CONVERSION SYSTEMS                                                    (9 periods)

**Non-Conventional Power Generation:** Solar, Wind, Tidal, Ocean energy conversion, Geothermal, and biogas power plants.

**Direct energy conversion systems:** Thermoelectric conversion system, Thermionic conversion system, Photovoltaic power systems, Magneto Hydrodynamic systems, Electrostaticmechanical generators, Electro gas-dynamic generators, and fuel cells.

## UNIT V: POWER PLANT ECONOMICS                                        (9 periods)

Load curves, Load duration curve, Definitions of connected load, Maximum demand, Demand factor, Load factor, Plant capacity factor, Plant use factor, Diversity factor, Cost Analysis.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. R.K.Rajput, *A textbook of Power Plant Engineering*, LaxmiPublications, 3rd edition, 2014.

2. Arora and S. Domkundwar, *A Course in Power Plant Engineering*, Dhanpat Rai and Co, 3rd Edition, 2012.

**REFERENCE BOOKS:**

1. P.K.Nag, *Power Plant Engineering*, TMH, 2nd edition, 2006.

2. K.K Ramalingam, *Power Plant Engineering*, ScitechPublishers, 2nd edition, 2010.

3. Dr.P.C Sharma, *Power Plant Engineering*, Sk Kataria andsons publishers, 8th Edition, 2011.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| CO2 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| CO3 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| CO4 | 3 | 1 | | | | 1 | 1 | | | | | | | 3 | |
| CO5 | 3 | 2 | | | | 1 | | | | | | | | 3 | |
| Average | 3 | 1.2 | | | | 1 | | | | | 1 | | | 3 | |
| Correlation level | 3 | 1 | | | | 1 | 1 | | | | 1 | | | 3 | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

*(*19BT70307*)* **SUPPLY CHAIN MANAGEMENT**

(Professional Elective - 4)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Fundamentals of Supply Chain Management; Supply Chain Decisions; Achieving Strategic fit; Drivers and Metrics of Supply Chain; Inventory management in a supply chain; Supply chain integration; Distribution Resources Planning; Bullwhip Effect; Role of information technology in SCM; Designing and planning transportation networks through infrastructure and strategies; International and Contemporary issues in SCM; Demand and Supply planning; Mass customization; Global issues and Outsourcing problems; Supply Chain Operations ReferenceModel; Third-party logistics; Retailer-Supplier Partnership; Emerging trends in SCM.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of the supply chain and supply chain management concepts.

CO2. Analyze and provide strategies for inventory management in SCM

CO3. Develop appropriate and customized strategies and policies for managing the supply chain by leveraging information.

CO4. Design and plan efficient and responsive transportation networks.

CO5. Demonstrate knowledge on international and contemporary issues in managing supply chains effectively and efficiently

**DETAILED SYLLABUS**

**UNIT I: INTRODUCTION TO SCM** **(08 Periods)**

Supply Chain - Definition, Objectives; Global optimization, Importance of Supply Chain Decisions, Decision Phases in a Supply Chain, SCM- objectives, Competitive and Supply Chain Strategies, Achieving Strategic fit, Obstacles to achieve strategic fit, Supply Chain Drivers and Metrics

**UNIT II: INVENTORY MANAGEMENT IN SCM** **(09 Periods)**

Role of cycle inventory and safety inventory in a supply chain, Economic lot size model, Effect of demand uncertainty, Risk pooling, centralized and decentralized system, Managing inventory in the supply chain, Distribution Channel Management, Distribution Resource Planning (DRP).

**UNIT III: VALUE OF INFORMATION** **(09 Periods)**

Bullwhip effect, Information and supply chain technology, Supply chain integration- Push, Pull and push-pull system; Demand-driven strategies, Role of Information Technology in

SCM - Impact of the Internet on SCM; Decision support systems for SCM - Goals, Standardization and Infrastructure.

## UNIT IV: DESIGNING AND PLANNING TRANSPORTATION NETWORKS (09Periods)

The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and Policies, Design options for a transportation network, Trade-offs in transportation design, Third-party logistics and Tailored transportation.

## UNIT V: INTERNATIONAL& CONTEMPORARY ISSUES IN SCM          (09Periods)

Sales and Operations Planning, Mass customization, Global issues and Outsourcing problems, Aligning the Supply Chain with Business Strategy – Supply Chain Operations Reference (SCOR) Model, Retailer-Supplier Partnership, Collaborative Planning, Forecasting and Replenishment (CPFR), Vendor Managed Inventory, Distributors integration, Emerging trends in SCM.

**Total Periods: 45**

**TEXTBOOKS:**

1. Sunil Chopra & Peter Meindl, *Supply Chain Management - Strategy, Planning & Operation*, 6thEdition, Pearson Education Asia, 2016.

2. Janat Shah, *Supply Chain Management:Text and Cases*, 2ndEdition, Pearson Education, 2016.

**REFERENCE BOOKS:**

1. Thomas E Vollman and Clay Whybark D, *Manufacturing Planning and Control for Supply Chain Management*, Fifth Edition,Tata McGraw Hill, New Delhi, 2005

2. Simchi – Levi Davi, Kaminsky Philip and Simchi-Levi Edith, *Designing and  Managing the Supply Chain*,Third Edition Tata McGraw Hill, New Delhi, 2007.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | | | | | 1 | | | | | 3 | | | | 3 |
| CO2 | 3 | 3 | 1 | | | 1 | | | | | 3 | | | | 3 |
| CO3 | 3 | 3 | 3 | | 1 | 1 | | | | | 3 | | | | 3 |
| CO4 | 3 | 3 | 3 | | | 1 | | | | | 3 | | | | 3 |
| CO5 | 3 | | | | | 1 | | | | | 3 | | | | 3 |
| Average | 3 | 3 | 2.3 | 3 | 1 | 1 | | | | | 3 | | | | 3 |
| Correlation level | 3 | 3 | 3 | 3 | 1 | 1 | | | | | 3 | | | | 3 |

**Correlation Levels:          3– High          2 - Medium          1– Low**

(19BT70308) **SUSTAINABLE MANUFACTURING**

(Professional Elective-4)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**-

**COURSE DESCRIPTION:**

Concept of sustainability; metrics of green manufacturing; economic and social dimensions of sustainability; Principles of green manufacturing; Principles of green manufacturing; Green supply chain

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of sustainable manufacturing tools and techniques for sustainable product development

CO2. Apply sustainability assessment tools and techniques to infuse and manage the sustainability of a product.

CO3. Analyze the environmental impact of a product through its life cycle encompassing extraction and processing of the raw materials, manufacturing, distribution, use, recycling, and final disposal.

CO4. Demonstrate the knowledge of green manufacturing techniques for renewal of production processes and the establishment of environmentally-friendly operations within the manufacturing field

CO5. Demonstrate the knowledge of sustainability assessment and green supply chain in infusing sustainability.

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**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO SUSTAINABLE MANUFACTURING        (9 periods)**

Concept of sustainability, manufacturing, operations, processes, practices, Resources in manufacturing, five Ms, system approach to manufacturing, environmental, economic and social dimensions of sustainability, Environmental Impact of Manufacturing, Strategies for Green Manufacturing, Metrics for Green Manufacturing, Metrics Development Methodologies.

**UNIT II: TOOLS AND TECHNIQUES                              (9 periods)**

Principles of green manufacturing and its efficiency, Green manufacturing and sustainability, System model architecture and module, Design and planning, control or tools for green manufacturing (Qualitative Analysis), Consumption Analysis, Life Cycle Analysis, Efficiency, Sustainability tools). Standards for green manufacturing (ISO 14000 and OHSAS 18000), Waste stream mapping and application, Design for the environment and for sustainability – Discuss the Product Life Cycle of manufactured goods.

**UNIT III: LIFE CYCLE ANALYSIS                              (9 periods)**

Remanufacture and disposal, tools for LCA, Concept of design for recycling, Green manufacturing Lean models, value analysis, carbon footprint, analysis for carbon footprint

Green manufacturing- sustainability framework, Green manufacturing techniques- factors affecting sustainability.

## UNIT IV: GREEN MANUFACTURING TECHNIQUES                    (9 periods)

Dry and near-dry machining, edible oil-based cutting fluids Green manufacturing techniques: cryogenic machining for eco-efficiency Green manufacturing, Lean manufacturing, Lean techniques for green manufacturing, Waste assessment and strategies for waste reduction in green manufacturing.

## UNIT V: SUSTAINABILITY ASSESSMENT AND GREEN SUPPLY CHAIN    (9 periods)

Methods to infuse sustainability in early product design phases, concept models and various approaches in assessment, product sustainability and risk/benefit assessment, Green supply chain- techniques and implementation, Logistics management, Green Supply Chain as Product Life Cycle Management

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. G.Atkinson, S.Dietz, E.Neumayer, *Hand book of Sustainable Manufacturing* ‖. Edward Elgar Publishing Limited,2007.

2. Klemes, J., 2011. Sustainability in the process industry. McGraw-Hill.2011

3. M.Karpagam, Geetha Jaikumar, *Green Management* , Ane Books Pvt.Ltd.2010

### REFERENCE BOOKS:

1.  M.K. Ghosh Roy, *Design for Environment: A guide to sustainable Product Development Sustainable Development*, Ane Books Pvt.Ltd,2009.

2. Dornfeld, D.A. ed., *Green manufacturing: fundamentals and applications*. Springer Science & Business Media,2012.

3. Ashby, M. F. *Materials and the environment: eco-informed material choice*. Elsevier, 2012.

4.  D. Rodick, *Industrial Development for the 21st century, sustainable development perspective*s, UN New York, 2007

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | 1 | 2 | - | - | - | - | - | 3 | - | - |
| CO2 | 3 | 2 | 1 | | - | 1 | 2 | - | - | - | - | - | 3 | - | - |
| CO3 | 3 | 2 | 1 | 1 | - | 1 | 2 | - | - | - | - | - | 3 | - | - |
| CO4 | 3 | - | - | - | - | 1 | 2 | - | - | - | - | - | 3 | - | - |
| CO5 | 3 | - | - | - | - | 1 | 2 | - | - | - | - | - | 3 | - | - |
| Average | 3 | 2 | 2 | 1 | - | 1 | 2 | - | - | - | - | - | 3 | - | - |
| Correlation level | 3 | 2 | 2 | 1 | | 1 | 2 | | | | | | 3 | | |

**Correlation Levels:**        **3– High**        **2 - Medium**        **1– Low**

(19BT70309) **CRYOGENICS**

(Program Elective-5)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Thermal Engineering-II

**COURSE DESCRIPTION:**

Necessity of Low temperature, Multi-stage refrigeration, Cascade system, Applications of low temperature, Properties of cryogenic fluids, Liquefaction of air, hydrogen and helium, gas separation and gas purification systems, **Low-**temperature insulation, Storage systems and Cryogenic fluid transfer systems

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Demonstrate the knowledge of cryogenic systems for low temperature applications.

CO2.   Analyze the properties of cryogenic fluids for low temperature application.

CO3.   Analyze the various refrigeration and liquefaction systems for low temperature application.

CO4.   Analyze the various gas separation and gas purification systems for low temperature application.

CO5.   Demonstrate the knowledge of cryogenic insulation for suitable storage and handling systems.

**DETAILED SYLLABUS**

**UNIT I: CRYOGENIC SYSTEMS                                                   (09 periods)**

Introduction to Cryogenic Systems, Cryogenics – Definition, Historical development, Necessity of Low temperature, Limitations of vapour compression system for the production of low temperature, Multi stage refrigeration system - Cascade system.

Applications of Cryogenics: Applications in space, Food Processing, super conductivity, Electrical Power, Cryobiology, Medicine-Cryosurgery, Electronics and Cutting Tool Industry.

**UNIT II: PROPERTIES OF CRYOGENIC FLUIDS                        (09 periods)**

Effects on the properties of metals - Low Temperature properties of Engineering Materials-Mechanical properties, Thermal properties, Super conductivity and Super fluidity, Electric and magnetic properties

T-S diagram of a cryogen; Properties of cryogenic fluids - Liquid Methane, Liquid Neon, Liquid Nitrogen, Liquid Oxygen, Liquid Argon, Liquid Air, Liquid hydrogen and helium.

**UNIT III: REFRIGERATION AND LIQUEFICATION                      (09 periods)**

Manufacture of Dry ice, Joule's Thomson effect, Liquefication of air - Linde system, Claude system, Cascaded System, Liquefaction of neon, Hydrogen and Helium, Stirling Cycle Cryo

Coolers, Gifford Mcmahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator.

## UNIT IV: GAS SEPARATION AND GAS PURIFICATION SYSTEMS (09 periods)

The thermodynamically ideal separation system properties of mixtures, Principles of gas separation, air separation systems, Hydrogen, Argon, Helium air separation systems, Gas purification methods.

## UNIT V: LOW TEMPERATURE INSULATION (09 periods)

Types of Insulation - Reflective insulation, Evacuated powders, Rigid foams; Super insulation; Dewar vessels; Hazards in cryogenic engineering. Cryogenic fluid transfer systems. Transfer through un-insulated lines, vacuum insulated lines, porous insulated lines etc.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. Randal F.Barron*, Cryogenic systems*, McGraw Hill, 2nd  edition, 1986

2. Klaus D.Timmerhaus and Thomas M.Flynn, *Cryogenic Process Engineering*, Plenum Press, New York, 1989.

### REFERENCE BOOKS:

1. Traugott H.K. Frederking and S.W.K. Yuan, *Cryogenics - Low Temperature Engineering and Applied Sciences*, Yutopian Enterprises, 2005.
2. A. R. Jha, *Cryogenic Technology and Applications*, Butterworth-Heinemann, 2005

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | | 1 | | | | | | | 3 | |
| CO2 | 3 | 3 | | | | | 1 | | | | | | | 3 | |
| CO3 | 3 | 3 | | | | | 1 | | | | | | | 3 | |
| CO4 | 3 | 3 | | | | | 1 | | | | | | | 3 | |
| CO5 | 3 | 1 | | | | | 1 | | | | | | | 3 | |
| Average | 3 | 2.2 | | | | | 1 | | | | | | | 3 | |
| Correlation level | 3 | 2 | | | | | 1 | | | | | | | 3 | |

**Correlation Levels:      3– High       2 - Medium       1– Low**

## IV B. Tech. – I Semester

### (19BT70310) DESIGN OF AUTOMOTIVE COMPONENTS

(Professional Elective – 5)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Strength of Materials and Design of Machine Elements.

**COURSE DESCRIPTION:**

Design of cylinder, piston, connecting rod, crankshaft, Center and overhung cranks; Clutch applications in automobile, Working of Fluid Coupling; Propeller Shaft; Differential and Axles; Types of lubrication, Performance parameters of bearings; Classification of brakes; Hydraulic, Pneumatic Brakes and Power Brakes, Anti-Lock Brake system; Performance of gearbox in vehicles, traction and tractive effort calculations; design of three and four-speed gearbox; Types of Front Axle;

**COURSE OUTCOMES:** After successful completion of this course, the students will be able to:

- CO1. DesignCylinder, Piston, connecting rod, crankshaft and Center and overhung cranks for automobile vehicles considering safety standards.
- CO2. Design Power drive lines and calculate performance parameters.
- CO3. DesignBearings and Brakessystems for automobile vehicles considering safety standards.
- CO4. Design gearbox for automobile vehicles and calculate its performance characteristics.
- CO5. Design front axle and steering linkages and determine optimum dimensions and proportions for steering linkages ensuring minimum error in steering

**DETAILED SYLLABUS:**

**UNIT I: DESIGN OF IC ENGINE PARTS:**                              (9 Periods)

Introduction to I.C engine parts, design of cylinder, design of piston, piston rings, piston pin; Connecting rod, Working Principle and Essential loads on the connecting rod; Crankshaft, Working Principle and design of Crankshaft, determination of loads at centre and overhung cranks.

**UNIT II: POWER DRIVE LINE:**                              (9 Periods)

Introduction to Clutch - Types and Construction, Fluid Coupling, Transmissions, design details of roller and sprag type of clutches - Manual, Semi and Automotive Transmission, Continuously Variable Transmission, Overdrives, Torque Converter, Propeller Shaft, Differential and Axles, Front and All Wheel Drive Vehicles.

**UNIT III: DESIGN OF BEARINGS AND BRAKING SYSTEMS :**                 (9 Periods)

Introduction to Lubrication, Viscosity, Classification; Introduction to Bearings, Hydrodynamic & Hydrostatic Lubrication, Pressure distribution - eccentricity and minimum film thickness, Thick & Thin film lubrication, Bearing materials, choice of bearings, determination of loads at kingpin bearings, wheel spindle bearings.

Braking Systems - Hydraulic, Pneumatic Brakes and Power Brakes; Anti-Lock Brake system.

**UNITIV: DESIGN OF GEAR BOX:** (8 Periods)

Introduction to gearbox, Performance of vehicle, total resistance to motion, Forces and Couples, traction and tractive effort, acceleration, calculation of gear ratio, design of three speed gearbox, design of four speed gear boxes.

**UNIT V: DESIGN OF FRONT AXLE AND STEERING:** (10 Periods)

Types of Front Axle, Analysis of loads, moments and stresses at different sections of the front axle; Differential and Axles, Front and All Wheel Drive Vehicles. Steering Geometry and Types, Steering Linkages, Power Assisted Steering; Determination of optimum dimensions and proportions for steering linkages ensuring minimum error in steering.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Bhandari V, *Design of Machine Elements*, 5th Edition, Tata McGraw-Hill Book Co, 2020.

2. Harald Naunheimer , Bernd Bertsche , Joachim Ryborz , Wolfgang Novak *"Automotive Transmission: Fundamentals, Selection, Design and Application"*, 2nd Edition, Springer, 2011.

**REFERENCE BOOKS:**
1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "*Mechanical Engineering Design*", 11th Edition, Tata McGraw-Hill, 2020.

2. Judge A. W., "*Modern Transmission*", 3rd ed., Chapman & Hall Std., London, 1989.

3. CDX Automotive, "*Fundamentals of Automotive Technology*, Principles and practice", Jones &Barlett Publishers, 2013.

4. Newton Steeds & Garrot, "*Motor Vehicles*", SAE International and Butterworth Heinemann, 2001.

5. Mahadevan, k, Reddy, K. Balaveera, "*Design Data Handbook for Mechanical Engineering in SI and Metric Units*", CBS; 4th edition,2019.

**Data Book:** Design data hand book for Mechanical Engineers in SI and Metric units by Balaveera Reddy and Mahadevan.N

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | |
| CO2 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | |
| CO3 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | |
| CO4 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | |
| CO5 | 3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | |
| Average | 3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | |
| Correlation level | 3 | 3 | 3 | 1 | | 1 | | | | | | | | 3 | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

(19BT70311) **PROJECT MANAGEMENT**

(Professional Elective -5)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on industrial Engineering and Management.

**COURSE DESCRIPTION:**

Project Characteristics; Project Selection; Economics; Feasibility Assessment and Evaluation;Project integration; Project Implementation; Agile project management; Scrum framework; Project scope management; Project time and cost management; Organizational and Work Breakdown;Scheduling; Budgeting; Project Control; Project Auditing; Financing for projects; Project investment evaluation.

**COURSE OUTCOMES:**

After completion of this course, a successful student will be able to:

CO1. Demonstrate knowledge of project characteristics, selection, and various stages of a project.

CO2. Apply project implementation strategies involving resource constraints to manage and execute projects in a hassle-free manner.

CO3. Apply information systems to monitor, control and execute the projects effectively.

CO4. Analyze projects for auditing and appraisal with appropriate procedures considering technical, financial, and socio-economic issues.

CO5. Apply project financing concepts and tools to the financing decisions.

**DETAILED SYLLABUS:**

**UNIT I: PROJECT SELECTION AND PLANNING**          **(9 periods)**

Project identification and formulation; Needs analysis: Resource surveys, Market research; Identification of investment opportunities; Feasibility analysis: Technical feasibility; Technology forecasting: Choice of technology, Techno economic analysis, Appropriate technology; Project environment: Nature, and Characteristics of projects; Projects screening: Project selection, Project portfolio process; Project life cycle; Work content: Work breakdown structure; Systems integration; Interface coordination; Social Cost-Benefit Analysis.

**UNIT II: PROJECT IMPLEMENTATION**          **(9 periods)**

Estimating Project Budgets; Process of cost estimation; Project Scheduling tools; Developing Project Plan (Baseline); Project cash flow analysis; Project scheduling with resource constraints: Resource Leveling and Resource Allocation; Project Execution and Administration; Project contracting: Contract pricing, project time monitoring and cost monitoring, Project overruns; Agile project management, Scrum framework.

## UNIT III: MONITORING AND INFORMATION SYSTEMS (9 periods)

Information needs and the reporting process; computerized project management information system; Earned value analysis; Planning- Monitoring-Controlling cycle; Project control: types of control processes, design of control systems, control of change and scope.

## UNIT IV: PROJECT APPRAISAL AND PROJECT AUDITING (9 periods)

Project Appraisal: Objectives, essentials of a project methodology, Market appraisal, Technical appraisal, Financial appraisal, Socio-economic appraisal, Management appraisal; Post-Project analysis: Construction and use of audit report, Project audit life cycle, Essentials of audit and evaluation, Varieties of project termination, the termination process.

## UNIT V: PROJECT FINANCING (9 periods)

Rationale of Project Financing; Essential elements of project financing; Analysis of project viability and risk management; Ownership and Financial Structuring; Legal Documentation; Project financing in India and abroad: Source, schemes, and various incentives for new projects.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Prasanna Chandra, *Projects: Planning, Analysis, Selection, Financing, Implementation and Review*, McGraw Hill Education(India) Private Limited, 8th edition, 2014.

2. Jack R. Meredith, and Samuel J. Mantel Jr., *Project Management - A Managerial Approach*, Wiley India Pvt. Ltd.,New Delhi, 8th Edition, 2012.

**REFERENCE BOOKS:**

1. Harold Kerzner, *Project Management - A Systems Approach to Planning*, Scheduling and Controlling, Wiley India Pvt. Ltd., New Delhi, 10th Edition, 2013.

2. Larry Richman, *Project Management: Step-by-Step*, PHI Learning Private Limited, 2011.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | 1 | | | | | 3 | | | | 3 |
| CO2 | 3 | 2 | 1 | | | 1 | | | | | 3 | | | | 3 |
| CO3 | 3 | 2 | 1 | | 1 | 1 | | | | | 3 | | | | 3 |
| CO4 | 3 | 3 | 1 | | | 1 | | | | | 3 | | | | 3 |
| CO5 | 3 | 2 | 1 | | | 1 | | | | | 3 | | | | 3 |
| Average | 3 | 2 | 1 | | 1 | 1 | | | | | 3 | | | | 3 |
| Correlation level | 3 | 2 | 1 | | 1 | 1 | | | | | 3 | | | | 3 |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## IV B. Tech. – I Semester

## (19BT70312) **RAPID PROTOTYPING**

(Program Elective-5)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Computer Aided Design and Manufacturing.

**COURSE DESCRIPTION:**

History of RP systems; Stereo; Datafiles and machine details; Solid Ground Curing; LOM, DMLS, Principle of operation, Machine details; Applications; Thermal jet printer; Indirect Rapid tooling, Direct Tooling; Quick cast process; Rapid Tool; Software For RP; STL files; Rapid manufacturing process optimization; Vacuum Casting, Surface digitizing; data transfer to solid models, Reverse Engineering.

**COURSE OUTCOMES: :**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the working of different RPT techniques for producing various products.

CO2. Analyze the functional characteristics of sterolithography systems, SLS and FDM for complex applications.

CO3. Analyze the functional characteristics of SGC, LOM and concept modelers for complex engineering applications.

CO4. Demonstrate the knowledge on rapid tooling to manufacture intricate components.

CO5. Apply software tools for rapid prototyping and reverse engineering concepts in production for Industrial applications.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTALS OF RAPID PROTOTYPING          (9 periods)**

Definition, Types of prototypes, Classification of RP Systems, Need for the compression in product Development, History of RP systems, Applications survey, Development of RP industry.

**UNIT II: STEREOLITHOGRAPHY SYSTEMS, SLS AND FDM          (9 periods)**

Stereolithography: Principle; Process parameters; Process details; Data preparation; Data files and machine details; Application.

Selective laser sintering: Machine types, Operating principle, Process parameters, Data preparation for SLS, Applications.

Fused deposition modeling: Principle, Process parameters, Path generation, Applications

## UNIT III: SOLID GROUND CURING (SGC), LOM AND CONCEPT MODELERS

**(9 periods)**

SGC: Principle, Machine details, Applications.

Laminated Object Manufacturing: Principle, LOM materials, Process details, Application.

Concept modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer, GenisysXs printer HP system – 5, Object Quadra systems.

## UNIT IV:  RAPID TOOLING                                      **(9 periods)**

Laminate tooling- soft Tooling and Hard tooling.

Indirect Rapid tooling, Silicon rubber tolling, Aluminium filled epoxy tooling, Spray metal tooling, Cast kirksite, 3D Keltool.

Direct Rapid Tooling - Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, Prometal, Sand casting tooling, DMLS

## UNIT V: SOFTWARE FOR RAPID PROTOTYPING AND REVERSE ENGINEERING

**(9 periods)**

STL files, Overview of Solid view, Magics, Magic communicator, Internet based software, Rapid Manufacturing Process Optimization.

**Allied processes:** Vacuum casting, Surface digitizing, Surface generation from point cloud, Surface modification, Data transfer to solid models.

**Reverse Engineering**: Capturing and reading the scan data, Align point clouds and simplify data, Polygon meshing and editing, Defining surface boundaries, applying nurbs, Exporting data, Reverse engineering update.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Paul F. Jacobs, *Stereo lithography and other RP and MTechnologies*, SME, New York, 3rdedition, 1996.
2. Frank W. Liou, *Rapid Prototyping and Engineering Applications*, CRC Press Taylor and Francis Group, New York,Special Indian Edition, 2011.

**REFERENCE BOOKS:**

1. C. K. Chua, K. F. Leong, C. S. Lim, *Rapid Prototyping -Principles and Applications*, Yesdee publications Pvt. Ltd.,Mumbai, India, 2nd edition, 2010.

2. Hari Prasad, K.S. Badarinarayan, *Rapid Prototyping andTooling*, SIP PageTuners, Bangalore, 1stEdition, 2013.

3. Fiham D.T, Dinjoy S. S, *Rapid Manufacturing*, Verlog, London, 4th edition, 2002.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | | | | | 1 | - | - | - | - | - | - | 3 | | |
| **CO2** | 3 | 2 | 1 | | | 1 | - | - | - | - | - | | 3 | | |
| **CO3** | 3 | 2 | 1 | | | 1 | - | - | - | - | - | - | 3 | | |
| **CO4** | 3 | - | - | - | - | 1 | - | - | - | - | - | - | 3 | | |
| **CO5** | 3 | 2 | | | 1 | 1 | | | | | | | 3 | | |
| **Average** | 3 | 2 | 1 | | 1 | 1 | | | | | | | 3 | | |
| **Correlation level** | 3 | 2 | 1 | | 1 | 1 | | | | | | | 3 | | |

**Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

## (19BT70313) **SURFACE ENGINEERING**

(Professional Elective-5)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Materials Science and Engineering, Strength of Materials and Engineering Metrology.

**COURSE DESCRIPTION:**

Mechanisms of wear; Metal cleaning; Techniques for surface modification or deposition of protective coatings; Rationale behind employing coatings; Quality assurance & testing.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Demonstrate knowledge of surface engineering processes.
CO2.   Analyze functional and operational characteristics of thermal spraying and electrodeposited coatings for different applications.
CO3.   Analyze functional and operational characteristics of hot dip and diffusion coatings for engineering applications.
CO4.   Analyze functional and operational characteristics of non-metallic and conversion coatings for different surfaces.
CO5.   Apply testing procedures for qualitative assessment of different coating.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO SURFACE ENGINEERING                    (10 periods)**

Importance and necessity of surface engineering, past, present and future scenario of surface engineering, classification of the surface engineering process, substrates and their pretreatments; coating characteristics: coating thickness, continuity, hardness, adhesion, porosity, and bond strength, General cleaning process for ferrous and non-ferrous metals, selection of cleaning process, alkaline cleaning, emulsion cleaning, ultrasonic cleaning and abrasive bath cleaning.

**UNIT II: THERMAL SPRAYING AND ELECTRODEPOSITED COATINGS     (9 periods)**

Thermal spraying materials, characteristics of thermal spray process, Spray fused coatings, principles of electroplating, properties and applications of electrodeposits, Principles of Non aqueous and electroless deposition, Plasma spraying, flame spraying, detonation spray coating.

**UNIT III: HOT DIP COATING AND DIFFUSION COATING          (9 periods)**

Surface preparation, Batch coating and continuous coating process, coating properties and applications, principles of cementation, cladding-vacuum deposition, sprayed metal coating, structure of diffusion coatings, Chemical vapour deposition (CVD), Physical vapour deposition (PVD),Thin film Characterization techniques- Scanning Electron Microscopy and Energy dispersive X-ray analysis

## UNIT IV: NON-METALLIC COATING OXIDE AND CONVERSION COATINGS

**(9 periods)**

Plating coating, lacquers, rubbers and elastomers, vitreous enamels, anodizing Chromating, application to aluminium, magnesium, tin, zinc, cadmium, copper and silver, Phosphating primers.

## UNIT V: TESTING AND SELECTION OF COATINGS      **(8 periods)**

Quality assurance, the quality plan, design testing and inspection, thickness and porosity measurement, selection of coatings, Industrial applications of engineering coatings, Performance assessment of engineered surfaces- wear and corrosion.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. S. Grainger, *Engineering Coatings-design and application*, Jaico Publishing House,

   2nd  Edition, 1998.

2. D.R. Gabe, *Principles of Metals surface treatment and protection*, Pergamon,

   2nd Edition, 2014.

3. K.G Budinski, Surface Engineering for wear resistance, Prentice Hall, 1998.

**REFERENCE BOOKS:**

1. N.V Parthasarathy, Electroplating Handbooks, Prentice Hall, 1989.

2. Niku-Lavi, *Advances in surface treatment*, Pergamon, 1984.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | | 1 | | | | | | | 3 | | |
| CO2 | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| CO4 | 3 | 3 | 1 | | | 1 | | | | | | | 3 | | |
| CO5 | 3 | 1 | | | | 1 | | | | | | | | | |
| Average | 3 | 2.2 | 1 | | | 1 | | | | | | | 3 | | |
| Correlation level | 3 | 2 | 1 | | | 1 | | | | | | | 3 | | |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

## (19BT70314) **HYBRID AND ELECTRIC VEHICLES**

(Professional Elective – 5)

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Thermal Engineering-I.

**COURSE DESCRIPTION:**

History of hybrid and electric vehicles; Drive trains; Configuration and control of electric components; Types of energy storage devices;Sizing the drive systems; Energy management strategies in hybrid and electric vehicles.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Analyze the performance characteristics of transmission systems in hybrid and electric vehicles (HEVs).

CO2.  Demonstrate the knowledge of electric propulsion incorporated in HEVs.

CO3.  Analyze the dimensional features of drive systems for optimal matching of the electric machine and the internal combustion engine.

CO4.  Analyze and select the energy storage devices of hybrid and electric vehicles for the given applications.

CO5.  Demonstrate knowledge of the energy management strategies and implementation issues in hybrid and electric vehicles.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO TRANSMISSION SYSTEMS                (9 periods)**

**Introduction:** History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Comparison of transmission systems, Impact of modern drive trains on energy supplies.

**Drive Trains for Hybrid and Electric Vehicles:** Basic concept of traction, Types of drive–train topologies, power flow control, fuel efficiency analysis.

**UNIT II: ELECTRIC PROPULSION UNIT                          (9 periods)**

Introduction to electric components used in hybrid and electric vehicles, Configuration and control - DC motor drives, induction motor drives, permanent magnet motor drives, switch reluctance motor drives, drive system efficiency.

**UNIT III: SIZING THE DRIVE SYSTEM                          (9 periods)**

Matching the electric machine and the internal combustion engine, Sizing the propulsion motor, Sizing the power electronics, Selecting the energy storage technology, Supporting subsystems.

**UNIT IV: ENERGY STORAGE** (9 periods)

Introduction to energy storage, Requirements in hybrid and electric vehicles, Types of energy storage and its analysis - Battery based, Fuel cell-based, Super capacitor-based, Flywheel based, Hybridization of different energy storage devices.

**UNIT V: Energy Management Strategies** (9 periods)

Introduction to Energy Management Strategies used in hybrid and electric vehicles, Classification of different Energy Management Strategies, Comparison of different Energy Management Strategies, Implementation issues of Energy Management Strategies.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. IqbalHussain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.

2. MehrdadEhsani, YimiGao, Sebastain E, Gay, Ali Emadi, *Modern Hybrid Electric and Fuel cell Vehicles: Fundamentals Theory and Design*, CRC Press, 2004.

**REFERENCE BOOKS:**

1. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.

2. Tom Denton, *Electric and Hybrid Vehicles*, Routledge, 2016.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 1 | | | | 1 | | | | | | | 3 | |
| CO2 | 3 | | | | | | 1 | | | | | | | 3 | |
| CO3 | 3 | 3 | 1 | | | | 1 | | | | | | | 3 | |
| CO4 | 3 | 3 | 1 | | | | 1 | | | | | | | 3 | |
| CO5 | 3 | | | | | | 1 | | | | | | | 3 | |
| Average | 3 | 3 | 1 | | | | 1 | | | | | | | 3 | |
| Correlation level | 3 | 3 | 1 | | | | 1 | | | | | | | 3 | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## (19BT70331) INDUSTRIAL AUTOMATION AND ROBOTICS LAB

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:**

A course on Computer Aided Design and Manufacturing

**COURSE DESCRIPTION:**

This laboratory is intended to provide hands-on experience on industrial robotics, manufacturing automation, mobile robotics, and dynamics and control of field robots. The students experiment with various automation systems, learn to program, implement planning and control algorithms.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply different motion commands of various configurations of robot and perform different tasks relative to its degrees of freedom using programming.

CO2. Design various combinations of gripper design with the robot configuration suitable for industrial applications.

CO3. Develop a virtual robot in the Robot simulation software, which will perform all the functions of a 3R Manipulator in real-time.

CO4. Demonstrate the knowledge of automation process, robotic end effectors and robotic arm configurations.

CO5. Work independently or in teams to solve problems with effective communication

**List of Exercises/List of Experiments: (9)**

1. Demonstration of robot configuration

2. Demonstration of robot with 2 dof, 3 dof, 4 dof etc.

3. Design/modeling of any two different types of grippers.

4. Two assignments on programming the robot for applications

5. Two programming exercises for robots

6. Exercise on welding robot in robot simulation software

7. Exercise on pick and place robot in robot simulation software

8. Exercise on robotic simulation software

9. Two case studies of applications in industry

10. Study of automation processes such as Distribution station, Testing station, Pick and place, Fluidicmuscle press, and Storing.

11. Study of PLC on Automation production system

12. Study of robotic end effectors, robotic arm and its configurations.

13. Design and testing of hydraulic circuits

14. Design and testing of pneumatic circuits

15. Simulation of basic hydraulic and pneumatic circuits

**SOFTWARE/Tools used:**

**.**Offline robot programming software

. Aristo Robotic Simulation Software

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 1 | 3 | 1 | - | - | - | - | - | - | 3 | | |
| CO2 | 3 | 2 | 2 | 1 | 3 | 1 | - | - | - | - | - | | 3 | | |
| CO3 | 3 | 2 | 2 | 1 | 3 | 1 | - | - | - | - | - | - | 3 | | |
| CO4 | 3 | 2 | | | 3 | 1 | | | | | | | 3 | | |
| CO5 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | | |
| Average | 3 | 2 | 2 | 1 | 3 | 1 | | | 3 | 3 | | | 3 | | |
| Correlation level | 3 | 2 | 2 | 1 | 3 | 1 | | | 3 | 3 | | | 3 | | |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

## (19BT70332) **SIMULATION AND ANALYSIS LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | -- | -- | 2 | 1 |

**PRE-REQUISITES:**

Courses on Computer aided design and manufacturing lab, Computer Aided Machine Drawing.

**COURSE DESCRIPTION:**

Fundamental Concepts of geometric modeling; Analysis of Simple Structural, Thermal and CFD problems.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Develop 3D solid model parts of mechanical systems and assemble the parts using CAD software.

CO2. Analyze the simulation models and structural problems in mechanical engineering to calculate stress and strains destitutions using FEM software.

CO3. Analyze the simulation models and thermal problems in mechanical engineering to calculate temperature distribution using FEM and CFD software.

CO4. Analyze and simulate mechanical engineering systems using simulation software.

CO5. Work independently or in teams to solve problems with effective communication

**LIST OF EXPERIMENTS**

Minimum **TEN** experiments should be conducted.

**Structural Analysis:**

1. Simulate the stress concentration phenomena on a flat plate with central hole under the application of tensile load.

2. Determination of deflection and stresses in 2D trusses and beams.

3. Determination of deflections component and principal and Von-Mises stresses in simple 3D plane and axisymmetric components.

**Thermal Analysis:** 2D problem with conduction and convection boundary conditions.

4. Conductive heat transfer Analysis of plane and axisymmetric components.

5. Convective heat transfer Analysis of 2D components.

6. Harmonic, transient and spectrum analysis of simple systems.

**CFD Analysis:**

7. Simple fluid flow and heat transfer problems.

8. Modeling Periodic flow and heat transfer.

9. Modeling external compressible flows.

10. Modeling transient compressible flows.

11. Modeling radiation and natural convection.

**Simulation:**

12. Simulation cam and follower mechanism

13. Simulate air conditioning systems

14. Simulation of heat transfer and fluid flow systems

**Note: Any Two Software Packages from each of the modules:**

**CAD Packages:** SOLIDWORKS, CATIA, Unigraphics, Solid Edge, CREO.

**Analysis Packages:** HyperMesh, ANSYS, CFD, STAR-CD, Autodesk A360.

**Simulation Packages:** Matlab, SciLab, C language.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 1 | 3 | 1 | | | | | | | 3 | | |
| CO2 | 3 | 3 | 3 | 1 | 3 | 1 | | | | | | | 3 | | |
| CO3 | 3 | 3 | 3 | 1 | 3 | 1 | | | | | | | | 3 | |
| CO4 | 3 | 3 | 3 | 1 | 3 | 1 | | | | | | | 3 | | |
| CO5 | | | | | | | | | 3 | 3 | | | | | |
| Average | 3 | 3 | 3 | 1 | 3 | 1 | | | 3 | 3 | | | 3 | | |
| Correlation level | 3 | 3 | 3 | 1 | 3 | 1 | | | 3 | 3 | | | 3 | 3 | |

**Correlation Levels:**      **3– High**      **2 - Medium**      **1– Low**

# IV B.Tech. - I semester

## (19BT70333) INTERNSHIP

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| - | 100 | 100 | - | - | - | 2 |

**PREREQUISITES:** -

**COURSE DESCRIPTION:**

Expose students to the industrial environment; Create competent professionals for the industry; sharpen the real time technical / managerial skills required at the job; Gain professional experience and understand engineer's responsibilities and ethics; Familiarize with latest equipment, materials and technologies; Gain exposure to technical report writing; Gain exposure to corporate working culture.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze latest equipment, materials and technologies that are used in industry to solve complex engineering problems following relevant standards, codes, policies and regulations.

CO2. Analyze safety, health, societal, environmental, sustainability, economical and managerial factors considered in the industry in solving complex engineering problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on practicing engineering.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | - | 3 | 3 | - | - | 3 | - | - | - | 3 | 3 | 3 | 3 |
| **CO2** | - | 3 | - | - | - | 3 | 3 | - | - | - | 3 | - | 3 | 3 | 3 |
| **CO3** | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - |
| **Average** | 3 | 3 | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Correlation level** | 3 | 3 | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Correlation Levels:**     **3– High**     **2 - Medium**     **1– Low**

(19BT703AC) **MATLAB FOR MECHANICAL ENGINEERS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on any programming for problem solving and Basic Engineering Mechanics.

**COURSE DESCRIPTION:**

Basics of MATLAB; Functions for plotting; Programming in MATLAB; Application of MATLAB code in Engineering Mechanics and Mechanical Vibrations.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the syntax, built-in functions, mathematical operations of MATLAB.

CO2. Analyze the given data through visualization.

CO3. Analyzesyntax for preparingMATLAB script and function files.

CO4. Develop MATLAB code for solving engineering Mechanics problems.

CO5. Develop MATLAB code for solving mechanical Vibrations problems.

**DETAILED SYLLABUS:**

**UNIT I:  BASICS OF MATLAB**                                    **(06 periods)**

Arithmetic operations with scalars, display formats, math built-in functions, Arrays, Mathematical operations with arrays**.**

**UNIT II: PLOTING**                                             **(06 periods)**

Plot of given data, plot of a function, multiple graphs in the same plot, multiple plots in the same page.

**UNIT III: PROGRAMMING IN MATLAB**                              **(06 periods)**

Conditional statements, the switch-case statement, Loops, Nested loops, Nested conditional statements,   break and continue commands, User defined Functions and Function files.

**UNIT IV: MATLAB APPLICATION IN ENGINEERING MECHANICS**         **(06 periods)**

Preparing MATLAB codes for Resultant and equilibrium force of coplanar force system, non-coplanar force system, friction  problems, virtual work, kinematics of rigid body in plane motion, moment of inertia, work and energy,

**UNIT V: MATLAB APPLICATION IN MECHANICAL VIBRATIONS**          **(06 periods)**

Preparing MATLAB codes for Free and forced vibration of Single Degree of Freedom Systems, free vibration of damped system, modal analysis for undamped system

**Total Periods: 30**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Rao V. Dukkipati, *MATLAB: An Introduction with Application*, New Age International Publishers, Second edition, 2010

2. Amos Gilat, *MATLAB: An Introduction with Applications*, John Wiley & Sons, Fourth Edition.

**REFERENCE BOOKS:**

1. Rudra Pratap. Getting Started With MATLAB, Oxford University Press. Seventh edition, 2019

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | | 2 | | | | | | | | 3 | | |
| CO2 | 3 | 3 | | | 2 | | | | | 1 | | | 3 | | |
| CO3 | 3 | 3 | | | 3 | | | | | 1 | | | 3 | | |
| CO4 | 3 | 3 | 3 | 1 | 3 | | | | | 1 | | | 3 | | |
| CO5 | 3 | 3 | 3 | 1 | 3 | | | | | 1 | | | 3 | | |
| Average | 3 | 2.6 | 3 | 1 | 2.6 | | | | | 1 | | | 3 | | |
| Correlation level | 3 | 3 | 3 | 1 | 3 | | | | | 1 | | | 3 | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

# IV B.Tech. - II semester

## (19BT80331) PROJECT WORK

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 100 | 100 | 200 | | - | - | - | 10 |

**PREREQUISITES:** -

**COURSE DESCRIPTION:**

Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Preparation of thesis and presentation.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Create/Design mechanical engineering systems or processes to solve complex mechanical engineering and allied problems using appropriate tools and techniques following relevant standards, codes, policies, regulations and latest developments.

CO2. Consider society, health, safety, environment, sustainability, economics and project management in solving complex mechanical engineering and allied problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on mechanical engineering systems or processes.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | - | - | - | 3 | 3 | 3 | 3 |
| **CO2** | - | - | - | - | - | - | 3 | - | - | - | 3 | - | 3 | 3 | 3 |
| **CO3** | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - | - |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Correlation level** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Correlation Levels:** **3– High** **2 - Medium** **1– Low**

# HONORS DEGREE
# IN
# MECHANICAL ENGINEERING

## (SVEC-19 Regulations)

# HONORS DEGREE IN MECHANICAL ENGINEERING

## (SVEC-19 Regulations)

| Semester | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I Semester (2 Theory) | 19BH50301 | Computer Integrated Manufacturing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH50302 | CNC Programming | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH50303 | Introduction to Mechanical systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| III B.Tech. II Semester (2 Theory) | 19BH60301 | Principles of Industrial Automation | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH60302 | Principles of Robotics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH60303 | Robot Kinematics and Dynamics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| IV B.Tech. I Semester (2 Theory) | 19BH70301 | Applied and Industrial Robotics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH70302 | Robot Programming | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BH70303 | Sensors and Vision Systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Honors degree. It is the responsibility of the student to acquire/complete the prerequisite before taking the respective course.

(19BH50301) **COMPUTER INTEGRATED MANUFACTURING**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Introduction to CIM, CAD/CAM, product life cycle, Fundamentals of NC and CNC, Group Technology AND FMS, Computer Aided Planning Systems, Adaptive control systems

**COURSE OUTCOMES:** After successful completion of this course, the students will be able to:

CO1. Apply the principles of Computer integrated manufacturing to control and foster the production process.

CO2. Analyze the architecture of numerical control and apply the Numerical control programming techniques for the machining process.

CO3. Analyze different part families through grouping and construe different machine cell designs and flexible manufacturing systems.

CO4. Demonstrate different approaches and techniques for computer aided process planning in automation.

CO5. Demonstrate knowledge of Adaptive control systems for different applications.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTALS OF CIM** (09 Periods)

Introduction to Manufacturing; CIM - Types, Manufacturing Systems, CIM Definition, CIM wheel, CIM components, Evolution of CIM - Development of computers, needs of CIM, Benefits of CIM, CIM Hardware & Software, Fundamentals of CAD / CAM, Product cycle.

**UNIT II: FUNDAMENTALS OF NC AND CNC** (09 Periods)

**Numerical control machines**: Introduction, basic components of an NC system, the NC procedure, NC coordinate system, NC motion control system, application of numerical control and Economics of Numerical control.

**Computer controls in NC:** Principle of CNC, types of CNC machine tools, programming and applications of CNC machine tools, Direct Numerical control (DNC), Database and DBMS-requirement, features and architecture of DBMS.

**UNIT III: GROUP TECHNOLOGY AND FMS** (09 Periods)

**Group Technology**: Group Technology - Part families, Parts classification and coding, Production flow analysis, Composite part concept, Machine cell design and Benefits of GT.

**Flexible Manufacturing Systems**: FMS - Components of FMS, FMS Work stations, Material Handling Systems, Computer Control system, FMS layout configurations and Benefits of FMS.

## UNIT IV: COMPUTER AIDED PLANNING SYSTEMS                    (09 Periods)

Computer aided planning systems - Approaches to Computer aided Process Planning (CAPP), Generative and Retrieval CAPP systems, Benefits of CAPP, Material Requirement Planning (MRP), Mechanism of MRP, Benefits of Capacity Planning.

## UNIT V: ADAPTIVE CONTROL SYSTEMS                            (09 Periods)

Adaptive control machining system - Adaptive control optimization system, Adaptive control constraint system, Applications to machining processes, Computer process monitoring, Hierarchical structure of computers in manufacturing, and computer process control.

**Total No. of Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Mikel.P.Groover, *Automation, Production systems and Computer Integrated Manufacturing Systems*, Pearson Education; 4th Edition,2016.

2. P.N.Rao, *CAD/CAM: Principles and Applications,* McGraw Hill Education*, 3rd edition, 2017.*

**REFERENCE BOOKS:**

1. Radhakrishnan and Subramanian, *CAD/CAM/CIM*, New Age International Pvt Ltd, 4th Edition, 2018.

2. M. Groover, *CAD/CAM*, Pearson Education; 1st Edition, 2003.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | | - | 1 | 1 | | - | - | - | - | - | | | |
| CO2 | 3 | 3 | 1 | - | 1 | 1 | - | - | - | - | - | - | | | |
| CO3 | 3 | 3 | 1 | - | 1 | 1 | - | - | - | - | - | - | | | |
| CO4 | 3 | 1 | | - | 1 | 1 | - | - | - | - | - | - | | | |
| CO5 | 3 | 1 | | - | 1 | 1 | | - | - | - | - | - | | | |
| Average | 3 | 1.8 | 1 | | 1 | 1 | - | - | - | - | - | - | | | |
| Correlation level | 3 | 2 | 1 | | 1 | 1 | | | | | | | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Fundamentals of NC And CNC Machines, CNC Machine Elements, CNC Machine Structure and Machining Centers, Machining Centers, Adaptive Control Systems and Drives, DNC Systems and Adaptive Control, Feedback Devices, Fundamentals of CNC Programming, CNC Part Programming, CNC Turning and Milling Programming, CNC Turning, CNC Milling.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:
- CO1. Demonstrate the knowledge of numerical controls & computerized numerical control of a manufacturing system.
- CO2. Demonstrate the knowledge of constructional and functional features of machines and their support systems.
- CO3. Analyze CNC machines with the knowledge of Adaptive control systems and drive systems considering societal needs.
- CO4. Apply CNC coding used in CNC programming for a given operation.
- CO5. Apply CNC programming for basic Turning and Milling Operations.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTALS OF NC and CNC MACHINES                    (09 Periods)**
**NC machines:** Fundamentals of numerical control, advantage of NC systems, classification of NC systems, point to point, NC and CNC, incremental and absolute, open and closed loop systems, features of NC Machine tools, interpolations.
**CNC Machines**: CNC machine elements, principle of operation of CNC, features of CNC, classification of CNC systems, Advantages of CNC system, Application of CNC systems.

**UNIT II: CNC MACHINE STRUCTURE AND MACHINING CENTERS        (09 Periods)**
**CNC Machine Structure:** Guideways, feed drives, spindles, spindle bearings, slide ways - Friction, Antifriction and types of guideways; Recirculating ball screw; Torque transmission elements - gears, timing belts, flexible couplings and bearings.
**Machining centers**: Features, Auto Tool Changer (ATC) & Automatic Pallet Changer (APC).

**UNIT III: ADAPTIVE CONTROL SYSTEMS AND DRIVES                 (09 Periods)**
**DNC Systems and Adaptive Control**: Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, adaptive control with constraints.
**Feedback devices** – Open loop and closed loop control systems, positional feedback, velocity feedback devices.
**Drives:** spindle drives-DC shunt motor, 3 phase induction motor, Feed drives-stepper motors, servo principle, DC and AC servo motors.

**UNIT IV: CNC PROGRAMMING**                                                   **(09 Periods)**

**CNC PART PROGRAMMING**: Coordinate systems- structure of part program, Types of interpolation, Methods of CNC part programming, Part Program Terminology-G and M Codes, Machine and work piece datum, absolute and incremental programming, tool offset and tool nose radius compensation, fixed cycles, subroutines in part programming, computer-aided part programming, CNC controllers (FANUC and SINUMERIC),

**UNIT V: CNC TURNING AND MILLING PROGRAMMING**             **(09 Periods)**

**CNC Turning**: Basic programs on Turning, Facing, Drilling, Threading, Taper Turning, Boring, reaming, and tapping

**CNC Milling**: Basic programs on Face Milling, End Milling, Drilling, Chamfering, Boring, Reaming, Tapping, Sinking.

Features of typical CAM packages: Master CAM, Edge CAM, Siemens NX CAM.

                                                          **Total Periods:45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**
1. Mike Mattson, *CNC Programming: Principles & Applications: Principles and Applications*, Delmar; 1st edition, 2013.
2. Yorem Koren, *Computer Control of Manufacturing Systems*, Mc Graw Hill Book Co, 2017.
3. P. Radhakrishnan, *Computer Numerical Control (CNC) Machines*, New Central Book Agency; 1st edition,2013

**REFERENCE BOOKS:**
1. M. Adithan and B.S. Pable, *CNC Machines*, New Age, Third edition, 2018.
2. Mikell P. Groover, *Automation, Production Systems and Computer-Integrated Manufacturing*, Pearson Education; Fourth edition, 2016.
3. J.S. Narang, *CNC Machines And Automation*, Dhanpat Rai & Co. (P) Limited, 2016.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | | - | 1 | 1 | | - | - | - | - | - | | | |
| **CO2** | 3 | 1 | | - | 1 | 1 | - | - | - | - | - | - | | | |
| **CO3** | 3 | 3 | | - | 1 | 1 | - | - | - | - | - | - | | | |
| **CO4** | 3 | 3 | | - | 1 | 1 | - | - | - | - | - | - | | | |
| **CO5** | 3 | 1 | | - | 1 | 1 | | - | - | - | - | - | | | |
| **Average** | 3 | 1.8 | | | 1 | 1 | | - | - | - | - | - | | | |
| **Correlation level** | **3** | **2** | | | **1** | **1** | | | | | | | | | |

    **Correlation Levels:**         **3– High**         **2 - Medium**         **1– Low**

(19BH50303) **INTRODUCTION TO MECHANICAL SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Statics of rigid bodies; Laws of mechanics; Force couple system; Equilibrium of rigid bodies; Supports and reactions forces; Moment and couple and their representation; Dynamics of rigid bodies; Motion of rigid bodies; Energy equations; Frictional forces; Robotics and automation; Configuration and anatomy of robots; End effectors; Robotic drive and control systems; Actuators.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:
- CO1. Analyze the mechanical behavior of a rigid body and components of forces involved in it.
- CO2. Analyze conditions of equilibrium applied over a rigid body in different dimensions and compute its moments and couples.
- CO3. Analyze the dynamic behavior of a rigid body and its condition of motion.
- CO4. Demonstrate knowledge of robots and its components.
- CO5. Analyze the functional characteristics of robot drives, actuators and controls for configurations.

**DETAILED SYLLABUS:**

**UNIT I: STATICS** **(09 Periods)**
Introduction, Units and Dimensions, Laws of Mechanics, Force Characteristics, System of forces, Lami's theorem, Parallelogram and triangular Law of forces, Statics of rigid bodies in two dimensions, force couple system.

**UNIT II: EQUILIBRIUM OF RIGID BODIES** **(09 Periods)**
Free body diagram, Types of supports, Action and reaction forces, Moments and Couples, Moment of a force about a point and about an axis, Vectorial representation of moments and couples, Varignon's theorem, Equilibrium of Rigid bodies in two dimensions.

**UNIT III: RIGID BODY DYNAMICS** **(09 Periods)**
Displacements, Velocity and acceleration, their relationship, Relative motion, Curvilinear motion, Newton's laws of motion, Work Energy Equation; Friction force – Laws of sliding friction, Equilibrium analysis of simple systems with sliding friction.

**UNIT IV: ROBOTICS** **(09 Periods)**
Robotics and programmable automation, Law of robotics, Anatomy, Configuration of robots, Robot end effectors-classification, force analysis, active and passive grippers.

**UNIT V: ROBOTIC DRIVES, ACTUATORS & CONTROLS** **(09 Periods)**
Functions of Drive Systems, General Types of Fluids, Classification of fluid power systems, Components of hydraulic fluid power systems, components of pneumatic systems, Pump Classification, Introduction to Pneumatic Systems, Electrical Drives, D.C. Motors and Transfer Functions, A.C. Motors, Piezoelectric Actuators, Stepper Motor, Drive Mechanisms.

**Total Periods: 45**

***Topics for self-study are provided in the lesson plan.***

**TEXTBOOKS:**

1. Beer F.P, Johnston Jr.E.R, *Vector Mechanics for Engineers Statics and Dynamics,* McGraw Hill Education, 11th Edition, 2017.
2. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta *"Industrial Robotics (SIE): Technology, Programming and Applications*, McGraw Hill Education India, 2012
3. 3.S.R. Deb and S.Deb *"Robotic Technology and Flexible Automation"* McGraw Hill Education India. Second Edition, 2012.
4. 4.Khushdeep goyal, Deepak Bhandari*, Industrial automation and robotics*, Katson books, 2013.

**REFERENCES:**

1. Hibbeller R.C, Ashok Gupta "*Engineering Mechanics Statics and Dynamics*", Pearson Education, 11th Edition, 2009.
2. Bhavikatti S.S "*Engineering Mechanics*", 7th Edition, New Age International (P) Limited Publishers, 2019.
3. Young D H, Timashenko S "*Engineering Mechanics*", Tata McGraw-Hill., 2006
4. S K Saha *"Introduction to Robotics",* 2nd Edition, McGraw Hill Education India, 2014.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | | | |
| **CO2** | 3 | 3 | 1 | | - | | - | - | - | - | - | - | | | |
| **CO3** | 3 | 3 | 1 | | - | | - | - | - | - | - | - | | | |
| **CO4** | 3 | 2 | 1 | | - | | - | - | - | - | - | - | | | |
| **CO5** | 3 | 3 | 1 | | - | | - | - | - | - | - | - | | | |
| **Average** | **3** | **2.6** | **1** | | | | | | | | | | | | |
| **Correlation level** | **3** | **3** | **1** | | | | | | | | | | | | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

## (19BH60301) **PRINCIPLES OF INDUSTRIAL AUTOMATION**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Introduction to automation, Types of automation systems, Fluid power and fluid power systems, Assembly automation equipment, Material handling, transfer and assembly equipment, Types of automated assembly machines, Programmable Logic Controllers, PLC hardware components, Microprocessors and Microcontrollers, Feedback devices.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of automation and its different applications.

CO2. Analyze functional characteristics of power systems for industrial applications.

CO3. Demonstrate knowledge of assembly automation equipment and its related components.

CO4. Demonstrate the knowledge of programming logic controller units for industrial applications.

CO5. Demonstrate the knowledge of microprocessors and microcontrollers in integrating mechanical systems with computer and electronic systems.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO AUTOMATION**                    (09 Periods)

History, Elements of Automation, Types of Automation systems, Applications of Automation, Goals of Automation, Low cost automation, Hierarchical levels in industrial automation systems.

**UNIT II: FLUID POWER AND FLUID POWER SYSTEMS**           (09 Periods)

Introduction to fluid power- Classification of fluid power systems, comparison of electrical, hydraulic and Pneumatic systems; Basic circuit diagram of Hydraulic fluid power and pneumatic power systems, Components of Hydraulic fluid power systems, Components of Pneumatic power system, Logic Gates, Truth tables and Boolean algebra.

**UNIT III: ASSEMBLY AUTOMATION EQUIPMENT**                (09 Periods)

**Material Handling**: Principles of Material Handling, Material handling equipment- Wheel conveyor, Gravity Roller Conveyor, Chain conveyor, Flat belt conveyor, Magnetic belt conveyor, bucket conveyor, Vibrating conveyor, screw conveyor, vertical lift conveyor, trolley conveyor, sortation conveyor, cranes and Hoists, storage equipment, AS/RS, AGV.

**Transfer and assembly equipment:** Introduction to feeder units, Cycled transfer equipment and non-cycled transfer equipment.

**Automated assembly machines:** Dial indexing machine, In-line machine, and floating work platform machines.

## UNIT IV: PROGRAMMABLE LOGIC CONTROLLERS (09 Periods)

**Programmable Logic Controllers (PLC):** Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Applications.

**PLC hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, Typical Discrete I/O Module Specifications, Typical Analog I/O Module Specifications, The Central Processing Unit (CPU), Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).

## UNIT V: MICROPROCESSORS AND MICROCONTROLLERS (09 Periods)

Evolution of microprocessors and microcontrollers; Architectures of microprocessors and microcontrollers; Integration of mechanical systems with computer and electronic systems (Mechatronic systems).

**Feedback devices:** LVDT, Linear/Rotary encoders, absolute encoders, resolvers and potentiometers, Fundamentals of  SCADA and Data Acquisition Systems.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Khushdeep Goyal, *Industrial Automation and Robotics*,  S.K.Kataria& Sons, 4th Edition, 2013.

2. Frank. D.Petruzella*, Programmable Logic Controllers,* Tata McGraw-Hill Education, 4thEdition, 2011.

**REFERENCE BOOKS:**

1. M.P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Fourth edition, PHI Learning, 2016.

2. Geoffrey Boothroyd, Assembly Automation and Product design, Taylor and Francis Publishers, Second edition 2005.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | | | - | - | 1 | | - | - | - | - | - | | | |
| **CO2** | 3 | 3 | 1 | - | 1 | 1 | - | - | - | - | - | - | | | |
| **CO3** | 3 | 2 | | - | 1 | 1 | - | - | - | - | - | - | | | |
| **CO4** | 3 | 2 | 1 | - | - | 1 | - | - | - | - | - | - | | | |
| **CO5** | 3 | 2 | 1 | - | | 1 | | - | - | - | - | - | | | |
| **Average** | 3 | 2.2 | 1 | | 1 | 1 | | - | - | - | - | - | | | |
| **Correlation level** | **3** | **2** | **1** | | **1** | **1** | | | | | | | | | |

**Correlation Levels:**          3– High          2 - Medium          1– Low

## III B.Tech. II Semester

### (19BH60302) **PRINCIPLES OF ROBOTICS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Brief history - Robot – Definition, Various robot manipulators – Linear and angular velocities, tactile, proximity and range sensors, End Effectors and robot economics

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of robotics, its specifications, functions and different applications.
CO2. Demonstrate knowledge of various robot manipulators
CO3. Demonstrate knowledge of sensors, work cells and programming languages.
CO4. Analyze functional characteristics of robot end effectors through design considerations.
CO5. Analyze the economic aspects of robots by considering different safety parameters.

**DETAILED SYLLABUS:**

**UNIT I: BASIC CONCEPTS** **(9 periods)**

Brief history, Robot - Definition, Anatomy; Co-ordinate Systems, Work Envelope types and Classification, Robotic Specifications, Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load, Robot Parts and their Function; Need for Robots, Applications.

**UNIT II: ROBOT MANIPULATORS** **(9 periods)**

Various robot manipulators, Linear and angular velocities, Manipulator Jacobian, Prismatic and rotary joints, Robotic Inverse, Wrist and arm singularity.

**UNIT III: ROBOT SENSORS** **(9 periods)**

Desirable features of Sensors; Tactile, proximity and range sensors; Uses of sensors in robotics; work cell; Introduction to Programming languages.

**UNIT IV: ROBOT END EFFECTORS** **(9 periods)**

End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

**UNIT V: IMPLEMENTATION AND ROBOT ECONOMICS** **(9 periods)**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

**Total Periods: 45**

***Topics for self-study are provided in the lesson plan.***

**TEXTBOOKS:**

1. R.K.Mittal and I.J.Nagrath, *Robotics and Control*, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, *Industrial Robotics*, McGraw-Hill Singapore, 1996.

**REFERENCE BOOKS**:

1. JohnJ.Craig ,*Introduction to Robotics Mechanics and Control*, Pearson Education, Third edition,  2009.
2. Ashitava Ghoshal, *Robotics-Fundamental Concepts and Analysis*, Oxford University Press, Sixth impression, 2010.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | | - | - | 1 | | - | - | - | - | | | | |
| **CO2** | 3 | 1 | | - | 1 | 1 | - | - | - | - | - | | | | |
| **CO3** | 3 | 1 | 1 | - | 1 | 1 | - | - | - | - | - | | | | |
| **CO4** | 3 | 3 | 2 | - | - | 1 | - | - | - | - | - | | | | |
| **CO5** | 3 | 3 | 1 | - | | 1 | | - | - | - | 1 | | | | |
| **Average** | 3 | 1.8 | 1.3 | | 1 | 1 | | - | - | - | 1 | | | | |
| **Correlation level** | **3** | **2** | **1** | | **1** | **1** | | | | | **1** | | | | |

**Correlation Levels:**         **3– High**         **2 - Medium**         **1– Low**

## (19BH60303) **ROBOT KINEMATICS AND DYNAMICS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Robot Manipulation, Robot Classification, Robot Specifications, Direct Kinematics, Inverse Kinematics, Manipulator Differential Motion and Statics, Manipulator Jacobian, Dynamic Modeling,

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Demonstrate the knowledge of robot manipulation and control for industrial applications

CO2.  Analyze forward and Inverse kinematics for different robot schemes.

CO3.  Analyze manipulator differential motion and statics for different robot schemes

CO4.  Develop dynamic models for robots using Langrangian mechanics, Lagrange–Euler formulation, Newton–Euler formulation and other techniques.

**DETAILED SYLLABUS:**

**UNIT I: ROBOT MANIPULATION                                    (9 Periods)**

Automation and robots; Robot anatomy; Robot Classification; Manipulation and control; Applications; Robot Specifications-Number of axes, Capacity and speed, Reach and stroke, Tool orientation, Repeatability, precision and accuracy, Operating environment.

**UNIT II: DIRECT KINEMATICS                                    (9 Periods)**

Dot and cross products; coordinate frames; Rotations; Homogeneous coordinates; link coordinates; D-H Representation; The ARM equation; Schematic diagram of four, five and six axis articulated robot.

**UNIT III: INVERSE KINEMATICS                                    (9 Periods)**

Manipulator workspace; Solvability of inverse kinematic model; Existence of solutions; Multiple solutions, Solution techniques; Closed form solution; The inverse kinematics problem; General properties of solutions; Tool configuration; Inverse kinematics of four axis SCARA robot and six axis articulated robot.

**UNIT IV: MANIPULATOR DIFFERENTIAL MOTION AND STATICS        (9 Periods)**

Linear and angular velocity of a rigid body; Relationships between transformation; Mapping, Velocity vector; Velocity propagation along links; Manipulator Jacobian; Jacobian inverse; Jacobian singularities; Static analysis.

**UNIT V: DYNAMIC MODELING:                                   (9 Periods)**

Langrangian mechanics; Two degrees of freedom manipulator–Dynamic model, Lagrange – Euler formulation, Newton–Euler formulation; Comparison of Lagrange–Euler formulation and Newton–Euler formulation; Inverse dynamics.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Robert J. Schilling, *Fundamentals of Robotics Analysis and Control,* PHI Learning, 2011.

2. R.K.Mittal and Nagrath*, Robotics and Control, TMH, 2017.*

**REFERENCE BOOKS:**

1. Niku S B, Introduction to Robotics, Analysis, Systems, Applications, Prentice Hall, Second edition 2006.

2. Geoffrey Boothroyd, Assembly Automation and Product design, Taylor and Francis Publishers, Second edition 2005.

**CO-PO-PSO Mapping Table :**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | | | | | 1 | | | | | | | | | |
| CO2 | 3 | 2 | 1 | 1 | | 1 | | | | | | | | | |
| CO3 | 3 | 2 | 1 | 1 | | 1 | | | | | | | | | |
| CO4 | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| CO5 | 3 | 2.3 | 1 | 1 | | 1 | | | | | | | | | |
| Average | 3 | 3 | 1 | 1 | | 1 | | | | | | | | | |
| Correlation level | | | | | | | | | | | | | | | |

**Correlation Levels:        3– High        2 - Medium        1– Low**

(19BH70301) **APPLIED AND INDUSTRIAL ROBOTICS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

General considerations in Robot material handling, material transfer application, machine loading and unloading, CNC machine tool loading; repeatability, maximum working envelop, kinematic and state values. Robot safety Considerations, Factors affecting robot safety measures; Cooperative manipulation; field robots and robots in health care

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Demonstrate knowledge of robotic material handling and assembly systems.

CO2.   Demonstrate the knowledge of expert systems in robotic performance testing and safety

CO3.   Demonstrate knowledge of various cooperative and SWARM robots and their applications.

CO4.   Analyze robotic configurations and specifications for field and service applications.

CO5.   Demonstrate the core concepts of robots in medical applications.

**DETAILED SYLLABUS:**

**UNIT I**:  **ROBOT MATERIAL HANDLING**                                        **(10 periods)**

General considerations in Robot material handling, material transfer application, machine loading and unloading, CNC machine tool loading, Robot centered cell Assembly and parts presentation methods, Assembly operation, Compliance and the Remote center compliance (RCC) Device, Assembly system configurations, Adaptable programmable assembly system, Designing for robotic assembly, Inspection automation - vision inspection system, robot - manipulated inspection.

**UNIT II: EXPERT SYSTEMS**                                                           **(09 periods)**

Factors influencing the choice of a robot, Robot performance testing - Path/point accuracy and repeatability, Maximum working envelop, Kinematic and State values. Robot safety Considerations, Factors affecting robot safety measures, Safety features built into the industrial robot, Safety barriers and other devices.

**UNIT III: COOPERATIVE AND SWARM ROBOTS**                            **(07 periods)**

Cooperative manipulation, Challenges in cooperative manipulation- Case studies for Cooperative manipulation for Industrial and Service applications; Introduction to swarm Robots, Comparison with other multi-agent systems, challenges and benefits of swarm systems- Algorithms for swarm Robots, application, case study of swarm Robots.

## UNIT IV: FIELD ROBOTS                                          (10 periods)

Forestry, Robot locomotion, Forestry automation, Broadacre Applications- Automatic guidance, sowing, weeding, spraying and broad-acre harvesting; Horticulture, Picking of fruits, Robot milking, Sheep shearing, Slaughtering, livestock inspection, Robots in construction, Future directions; Robots for hazardous applications, Enabling technologies- Search and Rescue robotics: Disaster characteristics-Impact on Robots, Robots actually used at disaster, Promising robots, open issues – Case studies; Cleaning Robots, lawn moving Robots- Smart appliances and smart homes.

## UNIT V: ROBOTS IN HEALTH CARE                                  (09 periods)

Medical robotics, Core concepts, Technology- Medical robotic systems, Research areas and applications; Rehabilitation and Health care robotics- Overview, physical therapy

and training Robots; Robotic aid for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, *Industrial Robotics Technology, Programming and Applications*, Mc Graw Hill Book company, 4th edition, 2016.

2. Bernard Hodges, *Industrial Robotics*, Second Edition, Jaico Publishing House, 1993.

### REFERENCE BOOKS

1. Yangsheng Xu Huihuan Qian Xinyu Wu, *Household and Service Robots*, ElsevierLtd, 2015.

2. Aleksandar Lazinica, -*Mobile Robots Towards New Applications*, Advanced Robotic Systems International, 2006.

3. L Marques,A de Almeida,Mo Tokhi,GSVirk, -*Advances in Mobile Robotics*, World Scientific Publishing Co. Pte. Ltd. 2008.

4. Bruno Siciliano, OussamaKhatib, -*Springer Handbook of Robotics*, Springer-Verlag Berlin Heidelberg, 2008.

### CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 1 | 1 | | | 1 | | | | | | | | | |
| CO2 | 3 | 1 | 1 | | | 2 | | | | | | | | | |
| CO3 | 3 | 1 | | | | 1 | | | | | | | | | |
| CO4 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | | | | | |
| CO5 | 3 | | | 1 | 1 | 1 | | | | | | | | | |
| Average | 3 | 1.5 | 1.3 | 1 | 1 | 1.2 | | | | | | | | | |
| Correlation level | 3 | 2 | 1 | 1 | 1 | 1 | | | | | | | | | |

**Correlation Levels:         3– High         2 - Medium         1– Low**

(19BH70302) **ROBOTIC PROGRAMMING**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Robotic programming; Robotic software functions; Program planning; Modes of programming; Commands for motion control; Lead through robotic programming; Textual robotic programming; End effectors and sensors commands; Program control and subroutines; VAL II Programming; AML Programming;

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of basic planning schemes involved in the development of robotic programming.

CO2. Develop Programmes for robots based on the techniques of pendent and command control.

CO3. Demonstrate the knowledge of robotic languages for operations and control.

CO4. Develop Programs for robots on VAL II platform with complete command-based control.

CO5. Develop Programs for robots on AML platform with complete command-based control.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTALS OF ROBOT PROGRAMMING**         **(09 Periods)**

Robot software functions - coordinate systems, Position control, Oher control functions, sub-routines, Planning of robotic programming using flowcharting - examples.

**UNIT II: METHODS OF ROBOT PROGRAMMING**         **(09 Periods)**

Online programming, off-line programming advantages of off-line programming; lead through methods - powered lead through, manual lead through, Teach pendant; Robot program as a path in space, defining position in space, motion interpolation, WAIT, SIGNAL and DELAY commands, Branching capabilities and Limitations of lead through methods.

**UNIT III:ROBOT LANGUAGES**         **(09 Periods)**

Textual robot Languages, first-generation and Second-generation languages, Structure of a robot language - Operating Systems, Elements and Functions, Constants, Variables and Other data objects, Motion commands, Points in workspace, End effectors and sensor commands, Computations and operations, Program control and subroutines, Communications and Data processing.

## UNIT IV: VARIABLE ASSEMBLY LANGUAGE                    (09 Periods)

Variable Assembly Language II - Introduction, Monitor commands, motion command, Hand Control, Configuration control, interlock commands, INPUT/OUTPUT Controls, Program Control, Examples

## UNIT V: A MANUFACTURING LANGUAGE                      (09 Periods)

A Manufacturing Language(AML) - Introduction, AML statements, Constant and Variables, Program control statements, motion commands, Sensor commands; Grip sensing capabilities, Data processing, Examples.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, *Industrial Robotics Technology, Programming and Applications*, McGraw Hill Book company, 1986

2. Bernard Hodges, *Industrial Robotic*, Jaico Publishing House, 2nd Edition, 1993.
3. S.R. Deb and S.Deb *Robotic Technology and Flexible Automation,* Second Edition McGraw Hill Education India., 2012

**REFERENCES:**

1. JJ Craig, *Introduction to Robotic Mechanics and Control*, Pearson, 3rd edition, 2004.
2. Fu, Lee and Gonzalez, *Robotics, control vision and intelligence*, McGraw Hill International, 2nd edition, 1987.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | 1 | | 1 | 1 | | | | | | | | | |
| **CO2** | 3 | 2 | 3 | | 1 | 1 | | | | | | | | | |
| **CO3** | 3 | 1 | 1 | | 1 | 1 | | | | | | | | | |
| **CO4** | 3 | 2 | 3 | | 1 | 1 | | | | | | | | | |
| **CO5** | 3 | 2 | 3 | | 1 | 1 | | | | | | | | | |
| **Average** | 3 | 1.6 | 2.2 | | 1 | 1 | | | | | | | | | |
| **Correlation level** | 3 | 2 | 2 | | 1 | 1 | | | | | | | | | |

**Correlation Levels:**          **3– High**          **2 - Medium**          **1– Low**

# IV B.Tech. – I Semester

## (19BH70303) SENSORS AND MACHINE VISION SYSTEMS

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Vison systems; Components of vision systems; Elements of visual perception; Low level vison; Filters; Higher level visions; Boundary and regional description; Sensors in robots; Different sensing variables; Robotic control; Robotic operating System; OpenCV;

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of vision system components and  image interfaces.

CO2. Demonstrate the knowledge of image representations and filters for low level vision system.

CO3. Demonstrate the knowledge of higher level vision for industrial applications.

CO4. Analyze functional characteristics of sensors incorporated in a robot system.

CO5. Demonstrate the knowledge on robotic operating system and vision system for robotic simulation.

**DETAILED SYLLABUS:**

### UNIT I: VISION SYSTEM                                         (09 Periods)

Basic Components, Elements of visual perception: structure of the human eye, image formation in the eye – pinhole cameras - colour cameras – Image formation model – Imaging components and illumination techniques-Picture coding–Basic relationship between pixels -Camera-Computer interfaces.

### UNIT II: LOW-LEVEL VISION                                    (09 Periods)

Image representation–Gray level transformations, Histogram, Image subtraction, Image averaging – Filters: Smoothing spatial filters, sharpening spatial filters, smoothing frequency domain filters, sharpening frequency domain filters-Edge detection.

### UNIT III:  HIGHER LEVELVISION:                               (09 Periods)

Segmentation-Edge linking and Boundary Detection, Thresholding, Region-oriented segmentation, the use of motion Description: Boundary Descriptors, Regional Descriptors, Recognition: Decision-Theoretic methods, structural methods.

### UNIT IV: SENSORS IN ROBOTICS                                 (09 Periods)

Position sensors - optical, non-optical, Velocity sensors, Accelerometers, Proximity Sensors - Contact, non-contact, Range Sensing, touch and Slip Sensors, Force and Torque Sensors. Different sensing variables - smell, Heat or Temperature, Humidity, Light, Speech or Voice recognition Systems, Telepresence and related technologies, robot control through vision

## UNIT V: ROBOT VISION (09 Periods)

Robotic Operating System (ROS) -Introduction, Real and Simulated Robots; Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV – The CV_bridge Package.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. K.S.Fu, R.C.Gonzalez, CSG.Lee, *-Robotics control, sensing, vision and Intelligence‖,* McGraw Hill EducationPvt.Ltd.,2017.

2. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin,*Robotics Engineering: An Integrated Approach*, PHI Learning, New Delhi, 2009.

**REFERENCE BOOKS:**

1. Damian M.Lyons, *Cluster Computing for Robotics and Computer Vision,* World Scientific, Singapore, 2011.

2. Rafael C.Gonzalez, Richard E.Woods, StevenL. Eddins, *Digital Image Processing using MATLAB* ,2nd edition, Tata McGrawHill, 2010.

3. Carsten Steger, Markus Ulrich, Christian Wiedemann, *-Machine Vision Algorithms and Applications*, WILEY-VCH, Weinheim,2008.

4. Kenneth Dawson-Howe, *-A Practical Introduction to Computer Vision with OpenCV*, Wiley, Singapore, 2nd edition, 2013.

## CO-PO-PSO Mapping Table :

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CO1** | 3 | 1 | | | | 1 | | | | | | | | | |
| **CO2** | 3 | 1 | | | | 1 | | | | | | | | | |
| **CO3** | 3 | 1 | | | | 1 | | | | | | | | | |
| **CO4** | 3 | 3 | 2 | 1 | 1 | 1 | | | | | | | | | |
| **CO5** | 3 | 1 | | 1 | 1 | 1 | | | | | | | | | |
| **Average** | 3 | 2 | 2 | 1 | 1 | 1 | | | | | | | | | |
| **Correlation level** | 3 | 2 | 2 | 1 | 1 | 1 | | | | | | | | | |

**Correlation Levels:**       **3– High**       **2 - Medium**       **1– Low**

# MINOR DEGREE

## (SVEC-19 Regulations)

**Offering Department:** Computer Science and Engineering

**Students of Eligible Branches:** ECE, EEE, EIE, ME and CE

## COURSE STRUCTURE

| Year & Semester | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem (2 Theory + 1 Lab) | 19BM50501 | Artificial Intelligence | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50502 | Soft Computing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50503 | Python for Data Science | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50531 | Python for Data Science Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| III B.Tech. II-Sem (2 Theory + 1 Lab) | 19BM60501 | Data Science | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60502 | Nature Inspired Algorithms | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60503 | Machine Learning | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60531 | Machine Learning Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| IV B.Tech. I-Sem (1 Theory + 1 Lab) | 19BM70501 | Deep Learning | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70531 | Deep Learning Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

(19BM50501) **ARTIFICIAL INTELLIGENCE**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Introduction to artificial intelligence, Designing intelligent agents, Solving general purpose problems, Search in complex environments, Probabilistic reasoning, Represent knowledge and reason under uncertainty, Robotics, Ethics and safety in AI.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Architect intelligent agents using artificial intelligence techniques and principles.

CO2.  Analyze and interpret the problem, identify suitable solutions using heuristic functions, optimization algorithms and search algorithms.

CO3.  Select and apply appropriate knowledge representation to build Bayesian network models to reason under uncertainty.

CO4.  Investigate robot hardware and frameworks for intelligent robotic perception.

CO5.  Demonstrate knowledge on ethical implications of intelligent machines for providing privacy, trust, security and safety.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE          (10 periods)**

Foundations of artificial intelligence, History of artificial intelligence, State of the art, Risks and benefits of AI, Intelligent agents – Agents and environments, The concept of rationality, Structure of agents.

**UNIT II: PROBLEM SOLVING BY SEARCHING                  (09 periods)**

Problem solving agents, Search algorithms, Uninformed search strategies, Informed search strategies – Greedy best-first search, A* search; Heuristic functions.

**UNIT III: SEARCH IN COMPLEX ENVIRONMENTS               (09 periods)**

Local search algorithms and optimization problems – Hill-climbing search, Simulated annealing, Local beam search, Evolutionary algorithms; Optimal decisions in games – The minimax search algorithm, Optimal decisions in multiplayer games, Alpha-Beta pruning, Move ordering; Monte Carlo tree search.

**UNIT IV: PROBABILISTIC REASONING                       (09 periods)**

Representing Knowledge in an uncertain domain, Semantics of Bayesian networks, Probabilistic reasoning over time – Time and uncertainty, Inference in temporal models, Hidden Markov models, Kalman Filter.

**UNIT V: ROBOTICS, ETHICS AND SAFETY IN AI**                              **(08 periods)**

**Robotics:** Robots, Robot hardware, Robotic perception, Alternative robotic frameworks, Application domains.

**Ethics and Safety in AI:** Limits of AI, Ethics of AI – Surveillance, security and privacy, Fairness and bias, Trust and transparency, AI safety.

*Total Periods: 45*

*Topics for self-study are provided in the lesson plan*

**TEXTBOOK:**

1. Stuart Russell, Peter Norvig, *Artificial Intelligence: A Modern Approach*, Prentice Hall, 4th Edition, 2020.

**REFERENCE BOOKS:**

1. Stephen Lucci, Danny Kopec, *Artificial Intelligence in the 21st Century*, Mercury Learning and Information, 3rd Edition, 2018.

2. Rich, Knight, Nair, *Artificial intelligence*, Tata McGraw Hill, 3rd Edition, 2009.

3. Deepak Khemani, *A First Course in Artificial Intelligence*, McGraw Hill, 2017.

4. Saroj Kaushik, *Artificial Intelligence,* Cengage Learning, 2011.

**ADDITIONAL RESOURCES:**

- https://searchenterpriseai.techtarget.com/definition/AI-Artificial-Intelligence

- http://aima.cs.berkeley.edu/

- https://ai.google/education/

- https://www.coursera.org/courses?query=artificial%20intelligence

- https://www.edureka.co/blog/artificial-intelligence-with-python/

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Soft computing technique concepts, Supervised learning networks, Unsupervised learning networks, Genetic algorithms, Fuzzy logic, Hybrid soft computing techniques and applications.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Investigate soft computing techniques for solving computational problems.

CO2. Design efficient neural architectures to model patterns for a given learning problem.

CO3. Investigate and solve optimization problems using genetic algorithms.

CO4. Apply fuzzy logic and reasoning to handle uncertainty in engineering problems.

CO5. Develop intelligent solutions using hybrid soft computing techniques to solve problems of multidisciplinary domains.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO SOFT COMPUTING AND SUPERVISED LEARNING NETWORKS (10 periods)**

**Introduction to Soft Computing:** Neural networks, Application scope of neural networks, Fuzzy logic, Genetic algorithm, Hybrid systems, Soft computing.

**Artificial Neural Networks:** Fundamentals, Basic Models, Terminologies, Linear Separability, Hebb network.

**Supervised Learning Networks:** Perceptron Networks- Theory, Perceptron learning rule, Architecture, Flowchart for training process, Perceptron training algorithm for single and multiple output classes, Perceptron network testing algorithm; Back-Propagation Network - Theory, Architecture, Flow chart for training process, Training algorithm, Learning factors of back-propagation network, Testing algorithm for back-propagation network.

**UNIT II: UNSUPERVISED LEARNING NETWORKS (8 periods)**

Fixed weight competitive nets – Maxnet, Mexican Hat Net, Hamming network; Kohonen self-organizing feature maps – Theory, Architecture, Flowchart, Training algorithm; Learning vector quantization – Theory, Architecture, Flowchart, Training algorithm, Variants; Counterpropagation networks – Theory, Full counterpropagation Net, Forward-only counterpropagation Net; Adaptive resonance theory network – Fundamental architecture, Fundamental operating principle, Fundamental algorithm.

## UNIT III: GENETIC ALGORITHMS                          (9 periods)

Genetic algorithms - Biological background, Traditional optimization and search techniques, Genetic algorithm and search space, Genetic algorithms vs. traditional algorithms, Basic terminologies in genetic algorithm, Simple GA, General genetic algorithm, Operators in genetic algorithm, Stopping condition for genetic algorithm flow, Constraints in genetic algorithm, Problem solving using genetic algorithm, Adaptive genetic algorithms, Hybrid genetic algorithms, Advantages and limitations of genetic algorithm, Applications of genetic algorithm.

## UNIT IV: FUZZY LOGIC                                   (11 periods)

Introduction to fuzzy logic, Classical sets, Fuzzy sets, Membership function – Features, Fuzzification, Methods of membership value assignments; Fuzzy arithmetic and measures – Fuzzy arithmetic, Extension principle, Fuzzy measures, Measures of fuzziness, Fuzzy integrals; Fuzzy rule base and approximation reasoning - Truth values and tables in fuzzy logic, Fuzzy propositions, Formation of rules, Compound rules, Aggregation of fuzzy rules, Fuzzy reasoning, Fuzzy inference systems, Overview of fuzzy expert system; Fuzzy decision making, Fuzzy logic control systems.

## UNIT V: HYBRID SOFT COMPUTING TECHNIQUES AND APPLICATIONS  (7 periods)

**Hybrid Soft Computing Techniques:** Genetic neuro hybrid systems, Genetic fuzzy hybrid and fuzzy genetic hybrid systems.

**Applications of Soft Computing:** Optimization of traveling salesman problem using genetic algorithm approach, Genetic algorithm-based internet search technique, Soft computing-based hybrid fuzzy controllers, Soft computing-based rocket engine control.


***Total Periods: 45***

***Topics for self-study are provided in the lesson plan***


**TEXTBOOK:**

1. S. N. Sivanandam and S. N. Deepa, *Principles of Soft Computing*, Wiley, 3rd Edition, 2019.


**REFERENCE BOOKS:**

1. S. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms:* Synthesis and Applications, PHI Learning Private Ltd, 2011.

2. Udit Chakraborty, Samir Roy, *Soft Computing: Neuro-Fuzzy and Genetic Algorithms,* Pearson, 2013.

3. Saroj Kaushik, Sunita Tewari, *Soft Computing: Fundamentals, Techniques and Applications*, McGraw Hill, 2018.


**ADDITIONAL LEARNING RESOURCES:**

- https://nptel.ac.in/courses/106105173/

(19BM50503) **PYTHON FOR DATA SCIENCE**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Basics of Data Science, Computation using NumPy, Data exploration using Pandas, Data transformation, Plotting and visualization using Matplotlib, Time series analysis.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on the concepts of data science to perform mathematical computations using efficient storage and data handling methods in NumPy.

CO2. Apply data preparation and exploration methods using Pandas to perform data manipulation.

CO3. Create data visualization using charts, plots and histograms to identify trends, patterns and outliers in data using Matplotlib and Seaborn.

CO4. Develop methods to analyze and interpret time series data to extract meaningful statistics.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION (10 periods)**

Basic terminologies of data science, Types of data, Five steps of data science, The NumPy ndarray, Fast element-wise array functions, Array-oriented programming with arrays, File input and output with arrays, Linear algebra, Pseudorandom number generation.

**UNIT II: DATA EXPLORATION WITH PANDAS (10 periods)**

Process of exploring data, Pandas data structures – Series, Data frame, Index objects; Essential functionality, Summarizing and computing descriptive statistics, Data loading, storage, and file formats – Reading and writing data in text format, Reading text files in pieces, Writing data to text format; Reading Microsoft Excel files.

**UNIT III: DATA CLEANING AND PREPARATION (8 periods)**

Handling missing data – Filtering out missing data, Filling in missing data; Data transformation – Removing duplicates, Transforming data using a function or mapping, Replacing values, Renaming axis indexes, Discretization and binning, Detecting and filtering outliers, Permutation and random sampling, Computing indicator/dummy variables; String manipulation – String object methods, Regular expressions, Vectorized string functions in Pandas.

**UNIT IV: DATA VISUALIZATION WITH MATPLOTLIB (8 periods)**

Plotting with Matplotlib – Figures and subplots, Colors, markers and line styles, Ticks, labels and legends, Annotations and drawing on a subplot, Saving plots to file; Plotting with Pandas and Seaborn – Line plots, Bar plots, Histograms and density plots, Scatter plots, Facet grids and categorical data.

**UNIT V: TIME SERIES ANALYSIS**                                    **(9 periods)**

Date and time data types and tools, Time series basics, Date ranges, frequencies, and shifting, Time zone handling, Periods and period arithmetic, Resampling and frequency conversion, Moving window functions.


*Total Periods: 45*

*Topics for self-study are provided in the lesson plan*


**TEXTBOOK:**

1. Wes McKinney, *Python for Data Analysis*, O'Reilly, 2nd Edition, 2017.


**REFERENCE BOOKS:**

1. Sinan Ozdemir, *Principles of Data Science*, Packt Publishers, 2nd Edition, 2018.

2. John Paul Mueller, Luca Massaron, Python for Data Science for Dummies, 2nd Edition, Wiley, 2015.

3. Rachel Schutt, Cathy O'Neil, *Doing Data Science: Straight Talk from the Frontline*, O'Reilly, 2014.


**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs60/preview

- https://towardsdatascience.com/

- https://www.w3schools.com/datascience/

- https://github.com/jakevdp/PythonDataScienceHandbook

- https://www.kaggle.com

**III B. Tech. – I Semester**

(19BM50531) **PYTHON FOR DATA SCIENCE LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:** A Course on "Python for Data Science"

**COURSE DESCRIPTION:**

Hands on practice on the concepts of data science using Python - Computations using NumPy, Data manipulation using Pandas, Data cleaning and preparation, Data visualization using Matplotlib and Seaborn, Time series analysis.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate efficient storage and data handling methods in NumPy to perform mathematical computations vital for data science.

CO2. Apply data preparation and data exploration methods using Pandas to perform data manipulation.

CO3. Create data visualization using charts, plots and histograms to identify trends, patterns and outliers in data importing Matplotlib and Seaborn.

CO4. Develop methods to analyze and interpret time series data to extract meaningful statistics.

CO5. Work independently to solve problems with effective communication.

**LIST OF EXERCISES:**

1. Array Computations using NumPy

   a) Perform arithmetic operations using array.

   b) Perform slicing and indexing on multi-dimensional arrays.

   c) Perform computations on multi-dimensional array using universal functions (ufunc).

   d) Compute arithmetic mean, standard deviation, variance, percentile, minimum and maximum, cumulative sum and product using statistical functions in NumPy.

   e) Perform set theory operations such as union, intersection, symmetric difference and fetching unique values.

2. Linear Algebra and Random Number generation using linalg and random module in NumPy

   a) Compute dot product, vector product and inner product of two arrays.

   b) Perform matrix operations such as multiplication, determinant, sum of diagonal elements and inverse.

   c) Compute eigenvalues, eigenvectors and singular value decomposition for a square matrix.

d) Generate random samples from uniform, normal, binomial, chi-square and Gaussian distributions using numpy.random functions.

e) Implement a single random walk with 1000 steps using random module and extract the statistics like minimum and maximum value along the walk's trajectory.

3. Data Manipulation using pandas

   a) Create DataFrame from List, Dict, List of Dicts, Dicts of Series and perform operations such as column selection, addition, deletion and row selection, addition and deletion.

   b) Create a DataFrame and perform descriptive statistics functions such as sum, mean, median, mode, standard deviation, skewness, kurtosis, cumulative sum, cumulative product and percent changes.

   c) Implement the computation of correlation and covariance by considering the DataFrames of stock prices and volumes obtained from Yahoo Finance! Using pandas-datareader package.

4. Working with different data formats using pandas

   a) Perform reading and writing data in text format using read_csv and read_table considering any online dataset in delimited format (CSV).

   b) Perform reading and writing of Microsoft Excel Files (xslx) using read_excel.

5. Data Cleaning and Preparation

   a) Perform data cleaning by creating a DataFrame and identifying missing data using NA(Not Available) handling methods, filter out missing data using dropna function, fill the missing data using fillna function and remove duplicates using duplicated and drop_duplicates functions.

   b) Perform data transformation by modifying set of values using map and replace method and create transformed version of original dataset without modification using rename method.

   c) Create a DataFrame with normally distributed data using random sampling and detect possible outliers.

6. Perform Data Visualization with Matplotlib and Seaborn considering online dataset for processing.

   a) Create a Line Plot by setting the title, axis labels, ticks, ticklabels, annotations on subplots and save to a file.

   b) Create Bar Plots using Series and DataFrame index.

      i) Create bar plots with a DataFrame to group the values in each row together in a group in bars side by side for each value.

      ii) Create stacked bar plots from a DataFrame.

   c) Create Histogram to display the value frequency and Density Plot to generate continuous probability distribution function for observed data.

   d) Create Scatter Plot and examine the relationship between two one-dimensional data series.

   e) Create Box plots to visualize data with many categorical variables.

7.    Time Series Analysis

   a) Create time series using datetime object in pandas indexed by timestamps.

   b) Use pandas.date_range to generate a DatetimeIndex with an indicated length.

   c) Perform period arithmetic such as adding and subtracting integers from periods and construct range of periods using period_range function.

   d) Convert Series and DataFrame objects indexed by timestamps to periods with the to_period method.

   e) Perform resampling, downsampling and upsampling for the time series.

**REFERENCE BOOKS**:

1. Wes McKinney, *Python for Data Analysis*, O'Reilly, 2nd Edition,2017.

2. John Paul Mueller, Luca Massaron, Python for Data Science For Dummies, 2nd Edition, Wiley, 2015.

**SOFTWARE/TOOLS:**

- Python 3.8

- Python Libraries – NumPy, Pandas, Matplotlib,

- Anaconda Framework

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs60/preview

- https://towardsdatascience.com/

- https://www.w3schools.com/datascience/

- https://github.com/jakevdp/PythonDataScienceHandbook

- https://www.kaggle.com

(19BM60501) **DATA SCIENCE**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Concepts of data science, Extracting meaning from data, The dimensionality problem, Plotting with pandas and seaborn, Probability distributions, Time series analysis, Predictive modeling.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on the concepts of data science to perform data analysis.

CO2. Develop methods to extract meaning from data using feature selection techniques.

CO3. Create data visualization using charts, plots and histograms to identify trends, patterns and outliers in data using Matplotlib and Seaborn.

CO4. Develop distribution functions to analyze and interpret data to extract meaningful statistics.

CO5. Design and develop predictive models for a given problem to support prediction and forecasting.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION** (9 periods)

Definition of data science, Skills for data science, Tools for data science, Data types, Data collections, Data preprocessing, Data analysis and data analytics, Descriptive analysis, Diagnostic analytics, Predictive analytics, Prescriptive analytics, Exploratory analysis, Mechanistic analysis.

**UNIT II: DATA EXTRACTION** (9 periods)

Extracting meaning from data – Feature selection, User retention, Filters, Wrappers, Entropy, Decision tree algorithm; Random forests, The dimensionality problem, Single value decomposition, Principal component analysis.

**UNIT III: DATA VISUALIZATION** (8 periods)

A Brief matplotlib API primer, Plotting with Pandas and Seaborn – Line plots, Bar plots, Histograms and density plots, Scatter plots, Facet grids and Categorical data; Other Python visualization tools.

**UNIT IV: STATISTICAL THINKING** (11 periods)

Distributions – Representing and plotting histograms, Outliers, Summarizing distributions, Variance, Reporting results; Probability mass function – Plotting PMFs, Other visualizations, The class size paradox, Data frame indexing; Cumulative distribution functions - Limits of PMFs, Representing CDFs, Percentile based statistics, Random numbers, Comparing

percentile ranks; Modeling distributions - Exponential distribution, Normal distribution, Lognormal distribution.

**UNIT V: TIME SERIES ANALYSIS AND PREDICTIVE MODELING          (8 periods)**

Time series analysis – Importing and cleaning, Plotting, Moving averages, Missing values, Serial correlation, Autocorrelation; Predictive modeling – Overview, Evaluating predictive models, Building predictive model solutions, Sentiment analysis.

*Total Periods: 45*

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Chirag Shah, *A Hands-on Introduction to Data Science*, Cambridge University Press, 2020.

2. Alen B. Downey, *Think Stats: Exploratory Data Analysis*, O'Reilly, 2nd Edition, 2014.

**REFERENCE BOOKS:**

1. Wes McKinney, *Python for Data Analysis*, O'Reilly, 2nd Edition, 2017.

2. Ofer Mendelevitch, Casey Stella, Douglas Eadline, *Practical Data science with Hadoop and Spark: Designing and Building Effective Analytics at Scale*, Addison Wesley, 2017.

3. Rachel Schutt, Cathy O'Neil, *Doing Data Science: Straight Talk from the Frontline*, O'Reilly, 2014.

4. Jake VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data*, O'Reilly, 2017.

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs60/preview

- https://towardsdatascience.com/

- https://www.w3schools.com/datascience/

- https://github.com/jakevdp/PythonDataScienceHandbook

- https://www.kaggle.com

(19BM60502) **NATURE INSPIRED ALGORITHMS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on "Differential Equations and Multivariable Calculus"

**COURSE DESCRIPTION:**

Optimization, Classical optimization techniques, Nature inspired algorithms, Genetic algorithm, Particle swarm optimization, Ant colony optimization, Bee colony optimization, Cuckoo search algorithm, Firefly algorithm, Bat algorithm, Gray wolf optimization, Elephant herding optimization, Applications of nature inspired algorithms.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on optimization and classical optimization techniques to find optimal solutions for a given problem.

CO2. Analyze the key components and mathematical aspects of nature inspired algorithms.

CO3. Design efficient solutions for optimization problems using nature inspired algorithms.

CO4. Investigate the applications of nature inspired algorithms to solve wide range of optimization problems.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO OPTIMIZATION** (9 periods)

**Introduction to Optimization:** Fundamentals of optimization, Types of optimization problems, Examples of optimization, Formulation of optimization problems, Classification of optimization algorithms, Traveling salesman problem, Knapsack problem.

**Classical Optimization Techniques:** Mathematical model of optimization, Linear programming – Simplex method, Revised simplex method, Kamarkar's method, Duality theorem, Decomposition principle, Transportation problem; Nonlinear Programming – Quadratic programming, Geometric programming; Dynamic programming, Integer programming, Stochastic programming, Lagrange multiplier method.

**UNIT II: NATURE INSPIRED ALGORITHMS AND GENETIC ALGORITHM** (8 periods)

**Nature Inspired Algorithms:** Traditional vs nature inspired algorithms, Bioinspired algorithms, Swarm intelligence, Metaheuristics, Diversification and intensification, No free lunch theorem, Parameter tuning and control, Algorithm.

**Genetic Algorithm:** Basics, Genetic operators, Example of GA, Algorithm, Schema theory, Prisoner's dilemma problem, Variants and hybrids of GA.

## UNIT III:  PARTICLE SWARM, ANT COLONY, BEE COLONY AND CUCKOO SEARCH OPTIMIZATION ALGORITHMS                                            (10 periods)

**Particle Swarm Optimization:** Swarm behavior, Algorithm, Variants of algorithm.

**Ant Colony Optimization:** Ant colony characteristics, Ant colony optimization – Travelling salesman problem, algorithm; Variants of algorithm.

**Bee Colony Optimization:** Honey bee characteristics, Algorithm, Variants of algorithm.

**Cuckoo Search Algorithm:** Cuckoo bird behavior, Levy flights, Algorithm, Variants of algorithm.

## UNIT IV: FIREFLY, BAT, GRAY WOLF AND ELEPHANT HERDING OPTIMIZATION ALGORITHMS                                                              (9 periods)

**Firefly Algorithm:** Firefly behavior and characteristics, Algorithm, Variants and applications.

**Bat Algorithm:** Behavior of bats in nature, Algorithm, Variants and applications.

**Gray Wolf Optimization:** Gray wolf characteristics, Gray wolf optimization, Variants and applications.

**Elephant Herding Optimization:** Elephant herding behavior, Algorithm, Pseudocode, Variants of the algorithm.

## UNIT V: APPLICATIONS OF NATURE INSPIRED ALGORITHMS          (9 periods)

Image processing, Classification, clustering and feature selection, Traveling salesman problem, Vehicle routing, Scheduling, Software testing, Deep belief networks, Swarm robots, Data mining and deep learning – Clustering, Support vector machines, Artificial neural networks, Optimizers for machine learning, Deep learning.


*Total Periods: 45*

*Topics for self-study are provided in lesson plan*


**TEXTBOOKS:**

1. A. Vasuki, *Nature-Inspired Optimization Algorithms,* CRC Press, 2020.

2. Xin-She Yang, *Nature-Inspired Optimization Algorithms,* Elsevier, 2nd Edition, 2020*.*


**REFERENCE BOOKS:**

1. Xin-She Yang, Xing-Shi He, *Mathematical Foundations of Nature-Inspired Algorithms*, Springer, 2019.

2. George Lindfield, John Penny, *Introduction to Nature-Inspired Optimization,* Elsevier, 2017.


**ADDITIONAL LEARNING RESOURCES:**

- Xin-She Yang, *Nature-Inspired Computation and Swarm Intelligence: Algorithms, Theory and Applications,* Elsevier, 2020.

- Hema Banati, Shikha Mehta, Parmeet Kaur, *Nature-Inspired Algorithms for Big Data Frameworks*, IGI Global, 2019.

(19BM60503) **MACHINE LEARNING**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Concept learning, General to specific ordering, Decision tree learning, Support vector machine, Artificial neural networks, Multilayer neural networks, Bayesian learning, Instance based learning, reinforcement learning.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the concept learning algorithms to automatically infer a general description for a given learning problem.

CO2. Analyze the underlying mathematical models within machine learning algorithms and learning tasks.

CO3. Evaluate and apply suitable machine learning algorithms for various types of learning tasks.

CO4. Design efficient neural architectures to model patterns for a given learning problem.

CO5. Select and apply machine learning algorithms to solve societal problems such as face recognition, text classification.

**DETAILED SYLLABUS:**

**UNIT I:  CONCEPT LEARNING AND GENERAL-TO-SPECIFIC ORDERING  (9 periods)**

Well-posed learning problems, Designing a learning system, Perspectives and issues in machine learning, Concept learning task, Concept learning as search, FIND-S, Version spaces and candidate elimination algorithm, Inductive bias.

**UNIT II: DECISION TREE LEARNING AND KERNEL MACHINES         (9 periods)**

**Decision Tree Learning:** Decision tree representation, Problems for decision tree learning, Decision tree learning algorithm, Hypothesis space search, Inductive bias in decision tree learning, Issues in decision tree learning.

**Kernel Machines**: Support vector machines – SVMs for regression, SVMs for classification, Choosing C, A probabilistic interpretation of SVMs.

**UNIT III: ARTIFICIAL NEURAL NETWORKS                          (9 periods)**

Neural network representations, Appropriate problems for neural network learning, Perceptrons, Multilayer networks and Backpropagation algorithm, Convergence and local minima, Representational power of feedforward networks, Hypothesis space search and inductive bias, Hidden layer representations, Generalization, Overfitting, Stopping criterion, An Example - Face Recognition.

**UNIT IV: BAYESIAN LEARNING** **(10 periods)**

Bayes theorem and concept learning, Maximum likelihood and least-squared error hypothesis, Maximum likelihood hypotheses for predicting probabilities, Minimum Description Length principle, Bayes optimal classifier, Gibbs algorithm, Naive Bayes classifier, An Example – Learning to classify text; Bayesian belief networks, EM Algorithm.

**UNIT V: INSTANCE BASED LEARNING AND REINFORCEMENT LEARNING (8 periods)**

**Instance Based Learning:** k-Nearest Neighbor learning, Locally weighted regression, Radial basis functions, Case-based reasoning.

**Reinforcement Learning:** The learning task, Q-learning, Nondeterministic rewards and actions, Temporal difference learning, Generalizing from examples, Relationship to dynamic programming.

*Total Periods: 45*

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS**:

1. Tom M. Mitchell, *Machine Learning*, McGraw Hill, 2013.

2. Kevin P. Murphy, *Machine Learning*: *A Probabilistic Perspective*, MIT Press, 2012.

**REFERENCE BOOKS**:

1. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press, 4th Edition, 2020.

2. Shai Shalev Shwartz, Shai Ben David, *Understanding Machine Learning: From Theory to Algorithms,* Cambridge University Press, 2014.

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs52/preview

- https://www.udemy.com/course/machinelearning/

(19BM60531) **MACHINE LEARNING LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

Courses on "Programming for Problem Solving", "Machine Learning"

**COURSE DESCRIPTION:**

Implementation of Back propagation algorithm, Decision tree learning, Neural networks, k-NN from scratch algorithm, Naïve Bayes classifier, Radial basis function neural network, SVM based classifier, Maximum likelihood estimation using statistical techniques.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the given problem and identify appropriate machine learning technique to provide an intelligent solution.

CO2. Design and implement machine learning solutions for classification, regression, and clustering problems.

CO3. Develop intelligent solutions to solve societal problems related to computer vision, information security, healthcare and other areas.

CO4. Work independently to solve problems with effective communication.

**LIST OF EXERCISES:**

1. Solve classification problem by constructing a feedforward neural network using Backpropagation algorithm. (Wheat Seed Data)

2. Implement ID3 (information gain) algorithm for decision tree learning for transforming continuous variables into discrete variables.

3. Explore the problem of overfitting in decision tree and develop solution using pruning technique.

4. Build a neural network that will read the image of a digit and correctly identify the number.

5. Implement k-NN algorithm to solve classification problem.

6. Use Naïve Bayes classifier to solve the credit card fraud detection problem over a skewed dataset.

7. Design and implement a radial basis function neural network to solve function approximation or regression problem.

8. Compare and analyze the performance of optimal Bayes classifier and Naïve Bayes using simulated Gaussian Data.

9. Train an SVM based classifier to predict whether the cancer is malignant or benign.

10. Solve the stock price forecasting problem using statistical techniques – Maximum Likelihood estimation after understanding the distribution of the data.

**REFERENCE BOOKS**:

1. Sebastian Raschka, Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 3rd Edition, 2019.
2. Aurelien Geron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 2nd Edition, O'Reilly, 2019.

**SOFTWARE/TOOLS:**

- Python
- Scikit-learn/Keras/TensorFlow

**ADDITIONAL LEARNING RESOURCES:**

- https://www.coursera.org/learn/machine-learning
- https://nptel.ac.in/courses/106106202/

# IV B. Tech. – I Semester

## (19BM70501) **DEEP LEARNING**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on "Machine Learning"

**COURSE DESCRIPTION:**

Overview of machine learning; Fundamentals of deep learning; Modern approaches in deep learning; Feedforward neural network architectures; Deep learning Models and Applications.

**COURSE OUTCOMES:**

*After successful completion of this course, the students will be able to:*

CO1. Analyze a neural network by applying the basics of mathematics and machine learning.

CO2. Analyze the data using multilayer perceptron and backpropagation algorithms.

CO3. Apply regularization and optimization techniques to improve the performance of Deep neural networks.

CO4. Identify appropriate deep learning model for text, multimedia, and biological data analysis.

CO5. Compare deep neural networks and deep learning models to infer the suitable learning algorithm on large scale data.

CO6. Develop a model for domain specific applications by applying various network models in deep learning.


**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION** **(9 Periods)**

Historical Trends in Deep Learning – Machine Learning basics - Learning algorithms: Supervised and Unsupervised Training - Linear Algebra for Machine Learning - Testing - Cross Validation - Dimensionality Reduction - Over fitting /Under Fitting - Hyper parameters and validation sets - Estimators – Bias – Variance - Loss Function- Regularization.

**UNIT II: NEURAL NETWORKS** **(9 Periods)**

Biological Neuron – Idea of Computational units - Linear Perceptron - Perceptron Learning Algorithm - Convergence theorem for Perceptron Learning Algorithm - Linear Separability - Multilayer perceptron – Backpropagation.

**UNIT III: MODERN PRACTICES IN DEEP NETWORKS** **(10 Periods)**

Introductions to Simple DNN - Platform for Deep Learning - Deep Learning Software Libraries - Deep Feed forward networks – Gradient-Based Learning - Architecture Design – Various Activation Functions, ReLU, Sigmoid – Error Functions - Regularization methods for Deep Learning - Early Stopping - Drop Out - Optimization methods for Neural Networks- Adagrad, Adam.

**UNIT IV: DEEP LEARNING MODELS** **(9 Periods)**

Convolutional Neural Networks (CNNs): CNN Fundamentals – Architectures – Pooling – Visualization – Sequence Modeling: Recurrent Neural Networks (RNN) - Long-Short Term Memory (LSTM) – Bidirectional LSTMs-Bidirectional RNNs -Deep Unsupervised Learning: Autoencoders – Auto Encoder Applications -Deep Boltzmann Machine (DBM).

**UNIT V: CASE STUDY AND APPLICATIONS** **(8 Periods)**

Application Case Study - Handwritten digits recognition using deep learning - LSTM with Keras – Sentiment Analysis – Image Dimensionality Reduction using Encoders LSTM with Keras – Alexnet – VGGnet.

*Total Periods: 45*

*Topics for self-study are provided in the lesson plan*

**TEXTBOOK:**

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, 4th Edition, MIT Press, 2016.

**REFERENCE BOOKS:**

1. Kevin P. Murphy, "*Machine Learning: A Probabilistic Perspective*", MITPress,2012.

2. Michael A. Nielsen, *Neural Networks and Deep Learning, Determination* Press, 2015.

3. Deng & Yu, *Deep Learning: Methods and Applications*, Now Publishers, 2013.

**ADDITIONAL RESOURCES:**

1. https://www.youtube.com/watch?reload=9&v=aPfkYu_qiF4

2. http://www.deeplearning.net/tutorial/

3. https://www.guru99.com/deep-learning-tutorial.html

4. https://www.coursera.org/courses?query=deep%20learning

# IV B. Tech. – I Semester

## (19BM70531) **DEEP LEARNING LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

## PRE-REQUISITES:

A Course on "Deep Learning"

## COURSE DESCRIPTION:

Implementation of deep learning architectures, Modern approaches in deep learning, Feedforward neural network architectures, Deep learning models and applications.

## COURSE OUTCOMES:

After successful completion of this course, the students will able to:

CO1. Identify optimal hyperparameter values and appropriate architecture for a given problem and data using optimization techniques.

CO2. Analyze the characteristics of the given data and perform necessary pre-processing tasks to structure the data using Python libraries.

CO3. Utilize Python machine learning libraries and packages for building deep neural architectures to solve AI problems.

CO4. Work independently to solve problems with effective communication.

## LIST OF EXERCISES:

1. Perform splitting of data for training, testing, and validation using k-fold cross validation.

2. Construct and implement multi-layer feed forward neural network for hand written digit classification problem.

3. Implement a binary and multi class image classification using Convolution Neural Network.

4. Perform hyper parameter tuning using Bayesian optimization technique for a Convolution Neural Network.

5. Analyze the effectiveness of various optimization algorithms with an image classification problem.

6. Solve the overfitting problem in a neural architecture using DropOut technique.

7. Study the efficiency of the transfer learning approach for a classification problem on the following architectures; VGG-16, Alexnet, and Inception-V3.

8. Solve a seq2seq problem (machine translation) using LSTM Recurrent Neural Architecture.

9. Solve a time series forecasting (stock prediction) using LSTM RNN.

10. Implement the image dimensionality reduction problem using a AutoEncoder architecture.

**REFERENCE BOOKS:**

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning,* MIT Press, 2016.

2. S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka, *Deep Learning Using Python*, Wiley, 2019.

3. François Chollet, *Deep Learning with Python*, Manning Publications, 2017.

4. Jojo Moolayil, *Learn Keras for Deep Neural Networks: A Fast-Track Approach to Modern Deep Learning with Python*, Apress, 2018.

**SOFTWARE/TOOLS:**

- Environment: Google CoLab
- Programming Language: Python 3.8
- Machine Learning Library: Tensor Flow 2.1 and Keras

**ADDITIONAL LEARNING RESOURCES:**

- Bharath Ramsundar, Reza Bosagh Zadeh, *TensorFlow for Deep Learning,* O'reilly, 2018.

- https://www.coursera.org/professional-certificates/tensorflow-in-practice

- https://www.coursera.org/learn/introduction-tensorflow

**Offering Department:** INFORMATION TECHNOLOGY

**Students of Eligible Branches:** CSE, CSSE, ECE, EEE, EIE, ME and CE

## COURSE STRUCTURE

| Year & Semester | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem (2 Theory + 1 Lab) | 19BM51201 | Embedded System Design and Architecture | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM51202 | IoT Architecture and Protocols | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM51203 | Sensor Technologies | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM51231 | Sensors based IoT Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| III B.Tech. II-Sem (2 Theory + 1 Lab) | 19BM61201 | Cloud Storage and Computing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM61202 | Privacy and Security in IoT | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM61203 | Software Defined Networks for IoT | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM61231 | IoT Application Development Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| IV B.Tech. I-Sem (1 Theory + 1 Lab) | 19BM71201 | Advanced IoT | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM71202 | Big Data Analytics for IoT | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM71231 | Advanced IoT Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**--

**COURSE DESCRIPTION:**

Concepts of Embedded systems and its computing; The programming of 8051; The Embedded C and Applications; Applications of RTOS and Embedded Software Development Tools; The ARM and SHARC Processor's Architectures.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on Fundamental concepts of Embedded Systems in Real-time.
CO2. Demonstrate programming skills using 8051.
CO3. Develop the Embedded Systems applications.
CO4. Demonstrate knowledge on RTOS concepts and Embedded Software Development Tools through RTOS.
CO5. Demonstrate knowledge on advanced processors architecture such as ARM and SHARC and the bus protocols such as I2C and CAN bus.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO EMBEDDED COMPUTING                (08 periods)**

Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, complex systems and microprocessor, classification, major application areas, the embedded system design process, formalisms for system design, design examples

**UNIT II: THE 8051 ARCHITECTURE                          (09 periods)**

Introduction, 8051 Micro controller Hardware, Input/output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/output, Interrupts. The Assembly Language Programming Process, Instructions of 8051 Programming Tools and Techniques, Simple Programs.

**UNIT III: INTRODUCTION TO EMBEDDED C AND APPLICATIONS       (10 periods)**

Embedded systems programming in C, binding and running embedded C program in Keil IDE, dissecting the program, building the hardware. Basic techniques for reading and writing from I/O port pins, LED interfacing, interfacing with keyboards, displays, D/A and A/D conversions, using embedded C interfacing.

**UNIT IV: INTRODUCTION TO REAL – TIME OPERATING SYSTEMS       (10 periods)**

Tasks and Task States, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer Functions, Events, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Interrupt Routines in an RTOS Environment.

**EMBEDDED SOFTWARE DEVELOPMENT TOOLS:** Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded Software into the Target System; Debugging Techniques: Testing on Host Machine.

**UNIT V: INTRODUCTION TO ADVANCED ARCHITECTURES**            **(08 periods)**

ARM and SHARC, Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus.

**Total Periods: 45**

*Topics for self-study are provided in lesson plan*

**TEXTBOOKS:**

1. Wayne Wolf, *Principles of Embedded Computing System Design*, 2nd Edition, Elsevier, 2014.

2. Kenneth J. Ayala, *The 8051 Microcontroller*, Thomson, 2nd Edition, 2016.

**REFERENCE BOOKS:**

1. David E. Simon, *An Embedded Software Primer*, Pearson Education, 2009.

2. Dr. KVKKPrasad, *Embedded/Real-Time Systems: Concepts, Design And Programming*, Black Book, DreamTech Press, 2003.

**ADDITIONAL LEARNING RESOURCES:**

**Web References:**

1. https://www.smartzworld.com/notes/embedded-systems-es/

2. http://notes.specworld.in/embedded-systems-es/

3. http://education.uandistar.net/jntu-study-materials

4. http://www.nptelvideos.in/2012/11/embedded-systems.html

**E-TextBooks:**

1. https://www.scribd.com/doc/233633895/Intro-to-Embedded-Systems-by-Shibu-Kv

2. http://www.ee.eng.cmu.ac.th/~demo/think/_DXJSq9r3TvL.pdf

3. https://www.scribd.com/doc/55232437/Embedded-Systems-Raj-Kamal

4. https://docs.google.com/file/d/0B6Cytl4eS_ahUS1LTkVXb1hxa00/edit

# III B. Tech. – I Semester

## (19BM51202) **IoT ARCHITECTURE AND PROTOCOLS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

M2M to IoT An Architectural Overview and M2M and IoT Technology Fundamentals, IoT Architecture State of the Art, IoT Reference Architecture and Real-World Design Constraints, IoT Data Link Layer & Network Layer Protocols, Session Layer Protocols and Application Layer Protocols, Security in IoT Protocols and Case studies.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on architecture and technology of M2M to IoT.

CO2. Demonstrate knowledge on IoT architectures and identify design constraints of IoT.

CO3. Select suitable protocols of data link and network layer protocols for different applications of IoT.

CO4. Identify appropriate protocols of session and application layer protocols for different applications of IoT.

CO5. Evaluate security issues and challenges during implementation of real world models.

**DETAILED SYLLABUS:**

**UNIT-I:** (9 Periods)

**M2M TO IoT AN ARCHITECTURAL OVERVIEW:** Building architecture, Main design principles and needed capabilities, An IoT architecture outline, Standards considerations.

**M2M AND IoT TECHNOLOGY FUNDAMENTALS**: Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a service (XaaS), M2M and IoT analytics, Knowledge management.

**UNIT II:** (9 Periods)

**IoT ARCHITECTURE STATE OF THE ART**: Introduction, State of the art, Architecture Reference Model- Reference model and architecture, IoT reference model.

**IoT REFERENCE ARCHITECTURE**: Functional view, Functional view, Deployment and operational view, Other relevant architectural views

**REAL-WORLD DESIGN CONSTRAINTS**: Technical design constraints hardware is popular again, Data representation and visualization, Interaction and remote control

**UNIT III:** (9 Periods)

**IoT DATA LINK LAYER:** IEEE 802.15.4, IEEE 802.11ah, LoRaWAN, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy; **Network Layer Encapsulation Protocols:** 6LoWPAN, 6TiSCH, 6Lo;

**NETWORK LAYER ROUTING PROTOCOLS:** RPL, CORPL, CARP.

**UNIT IV:** (10 Periods)

**SESSION LAYER PROTOCOLS:** MQTT, AMQP, CoAP, XMPP, DDS;

**APPLICATION LAYER PROTOCOLS:** SCADA, Generic Web-Based Protocol.

**UNIT V:** (8 Periods)

**SECURITY IN IoT PROTOCOLS:** MAC 802.15.4, 6LoWPAN, RPL, IoT Challenges

**CASE STUDIES:** Smart Metering, Smart House, Smart Cities

**Total Periods: 45**

*Topics for self-study are provided in lesson plan*

**TEXTBOOKS:**

1. Jan Holler and Vlasios Tsiatsis, *From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence,* Elsevier, 2014.

2. David Hanes and Gonzalo Salgueiro, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things,* Cisco Press, 2017

**REFERENCE BOOKS:**

1. Peter Waher, *Learning Internet of Things*, PACKT publishing, 2015.

2. Olivier Hersent and David Boswarthick, *The Internet of Things Key Applications and Protocols*, John Wiley & Sons Ltd Publication, 2012.

**ADDITIONAL LEARNING RESOURCE:**
1. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES**:

A course on Physics.

**COURSE DESCRIPTION**:

Sensor fundamentals and characteristics, Optical Sources and Detectors; Intensity Polarization and Interferometric Sensors, Phase sensor, Strain, Force, Torque and Pressure sensors; Position, Direction, Displacement and Level sensors, Velocity and Acceleration sensors, Electromagnetic velocity sensor, Light and Sound Sensors; Flow, Temperature and Acoustic sensors; Wearable Sensors.

**COURSE OUTCOMES**:

After successful completion of this course, the student will be able to:

CO1. Demonstrate knowledge on the characteristics of Sensors and principles of Optical Sources and Detectors.

CO2. Apply the principles of Intensity Polarization, Interferometric, Phase, Strain, Force, Torque and Pressure sensors in Sensor applications.

CO3. Apply the principles of Position, Direction, Displacement, Level, Velocity and Acceleration, Electromagnetic velocity, Sound and Light Sensors in Sensor applications.

CO4.  Analyze the principles of Flow, Temperature and Acoustic sensors to build Sensor applications.

CO5.  Analyze the principles of Wearable Sensors and identify suitable sensors for real time applications.

**DETAILED SYLLABUS:**

**UNIT-I:**                                                                      **(9 Periods)**

**SENSOR FUNDAMENTALS AND CHARACTERISTICS**: Sensor Classification, Performance and Types, Error Analysis characteristics,

**OPTICAL SOURCES AND DETECTORS**: Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.

**UNIT-II:**                                                                     **(9 Periods)**

**INTENSITY POLARIZATION AND INTERFEROMETRIC SENSORS**: Intensity sensor, Microbending concept, Interferometers, Mach Zehnder, Michelson, FabryPerot and Sagnac.

**PHASE SENSOR**: Phase detection, Polarization maintaining fibers.

**STRAIN, FORCE, TORQUE AND PRESSURE SENSORS**: Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors.

**UNIT-III:** (9 Periods)

**POSITION, DIRECTION, DISPLACEMENT AND LEVEL SENSORS**: Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magneto strictive sensors.

Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor.

**VELOCITY AND ACCELERATION SENSORS**:

Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, rotor, monolithic and optical gyroscopes.

**UNIT-IV:** (9 Periods)

**FLOW SENSORS:** pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. microflow sensor, coriolis mass flow and drag flow sensor.

**TEMPERATURE SENSORS**: thermoresistive, thermoelectric, semiconductor and optical. Piezoelectric temperature sensor.

**ACOUSTIC SENSORS:** microphones-resistive, capacitive, piezoelectric, fiber optic, solid state electrect microphone.

**UNIT-V: WEARABLE SENSORS** (9 Periods)

From fibers to textile sensors - Interlaced network -Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors and other applications. FBG sensor in Intelligent Clothing and Biomechanics.

**Total Periods: 45**

*Topics for self-study are provided in lesson plan*

**TEXTBOOKS:**

1. J. Fraden, *Handbook of Modern Sensors: Physical, Designs, and Applications*, AIP Press, 2004.

2. D. Patranabis, *Sensors and Transducers*, PHI Publication, 2nd Edition, 2014.

**REFERENCE BOOKS**:

1. Patranabis D, *Principles of Industrial Instrumentation*, Tata McGrawHill, End edition, 1997

2. Ganesh S. Hegde, *Mechatronics*, Published by University Science Press,2008.

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Hands-on experience on connecting IoT devices using Sensors, Arduino/Raspberry Pi, Bread Board.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Identify different types of Sensors and study their functionality in IoT

CO2. Demonstrate skills in connecting peripherals to Arduino/Raspberry Pi for data exchange.

CO3. Develop a Cloud platform to upload and analyze any sensor data

CO4. Demonstrate skills in connecting GSM, GPS, Gateways to micro controllers and perform Data Management in IoT.

CO5. Build a complete working IoT system involving prototyping, programming and data analysis.

CO6. Work independently or in teams to solve problems with effective communication.

**LIST OF EXPERIMENTS:**

1. Study of Different types of Sensors and Introduction to Arduino platform and programming.

2. Interfacing Arduino to Zigbee module.

3. Interfacing Arduino to GSM module and Bluetooth Module.

4. Introduction to Raspberry PI platform and python programming.

5. Interfacing sensors to Raspberry PI.

6. Communicate between Arduino and Raspberry PI using any wireless medium.

7. Log Data using Raspberry PI and upload to the cloud platform.

8. Design an IoT based system.

**REFERENCE BOOKS:**

1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things- A hands on approach*, 1st edition, VPI publications, 2014.
2. Adrian McEwen, Hakin Cassimally, *Designing the Internet of Things*, Wiley India, 2013
3. Massimo Banzi and Michael Shiloh, *Getting Started with Arduino*, 3rd Edition, Maker Media, 2015
4. Getting Started with Raspberry pi, Matt Richardson & Shawn Wallace, O'Reilly, 2014.

## (19BM61201) CLOUD STORAGE AND COMPUTING

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Introduction to Cloud Computing, Data Storage Networking fundamentals, Cloud Services and Platforms, Cloud Application Design.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate basic concepts and terminologies of Cloud Computing, Cloud-based Services and Applications.

CO2. Demonstrate Cloud, Virtualization and Data Storage Networking concepts.

CO3. Analyze Cloud Services, Platforms and Applications.

CO4. Apply different Cloud Services and Platforms to construct Cloud applications.

CO5. Design Cloud applications as per societal needs through different design approaches.

**DETAILED SYLLABUS**

**UNIT I: INTRODUCTION TO CLOUD COMPUTING                 (9 Periods)**

Introduction, Characteristics of Cloud Computing. Cloud Models, Cloud Services Examples, Cloud-based Services and Applications.

**UNIT-II:                                                           (9 Periods)**

**CLOUD CONCEPTS AND TECHNOLOGIES:** Virtualization, Load Balancing, Scalability and Elasticity, Deployment, Replication, Monitoring, Software Defined Networking, Network Function Virtualization, MapReduce, Identity and Access Management, Service Level Agreements and Billing.

**DATA STORAGE FUNDAMENTALS**: Server and I/O Architectures, Storage Hierarchy, From Bits to Bytes, Disk Storage Fundamentals, Initiators and Targets, How Data Is Written to and Read from a Storage Device, Storage Sharing vs. Data Sharing, Different Types of Storage.

**UNIT III: CLOUD SERVICES AND PLATFORM -I                 (9 Periods)**

Amazon Elastic Compute Cloud, Google Compute Engine, Windows Azure Virtual Machines, Amazon Simple Storage Service, Google Cloud Storage, Windows Azure Storage, Amazon Relational Data Store, Amazon DynamoDB, Google Cloud SQL, Google Cloud Datastore, Windows Azure SQL Database and Windows Azure Table Service.

**UNIT IV: CLOUD SERVICES AND PLATFORM -II                 (9 Periods)**

Application Runtimes and Framework, Queuing Services, Email Services, Notification Services, Media Services, Amazon CloudFront, Windows Azure Content Delivery Network,

Amazon Elastic MapReduce, Google MapReduce Service, Google BigQuery, Amazon Elastic Beanstalk and Amazon CloudFormation.

**UNIT V: CLOUD APPLICATION DESIGN**            **(9 Periods)**

Introduction, Design Considerations for Cloud Applications, Reference Architectures for Cloud Applications, Cloud Application Design Methodologies and Data Storage Approaches.

                                                  **Total Periods: 45**

*Topics for self-study are provided in lesson plan*

**TEXTBOOKS:**

1. ArshdeepBahga and Vijay Madisetti, *Cloud Computing – A Hands-on Approach,* Universities Press (India) Private Limited, 2014.

*2.* Greg Schulz, *Cloud and VirtualData StorageNetworking,* CRC PressTaylor & Francis Group, 2012.

**REFERENCE BOOKS:**

1. Barrie Sosinsky, *Cloud Computing Bible,* Wiley India Pvt Ltd, 2011 (Reprint 2017).

2. Thomas Erl and RicardoPuttini, *Cloud Computing- Concepts, Technology and Architecture,* Pearson, 2014 (Seventh Impression 2017).

**ADDITIONAL LEARNING RESOURCES:**

1. "Exploring the Google Toolkit", https://code.google.com/, drafted on 21 June, 2021.

2. "Understanding Amazon Web Services", https://aws.amazon.com/, drafted on 21 June, 2021.

(19BM61202) **PRIVACY AND SECURITY IN IoT**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Internet of Things Lab.

**COURSE DESCRIPTION:**

Introduction of IoT; Securing The Internet Of Things; Cryptographic Fundamentals for IoT; Identity & Access Management Solutions for IoT; Privacy Preservation And Trust Models for IoT; Cloud Security for IoT;

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on Security issues of IoT.

CO2. Apply Cryptographic Principles for IoT Security.

CO3. Identify suitable Access Management Solutions for IoT.

CO4. Apply Privacy Preservation and Trust Models for IoT.

CO5. Demonstrate knowledge on Cloud Security for IoT.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION: SECURING THE INTERNET OF THINGS       (9 periods)**

Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications; Security Architecture in the Internet of Things, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT; Vulnerabilities, Secrecy and Secret-Key Capacity, Authentication/Authorization for Smart Devices; Transport Encryption; Attack & Fault trees

**UNIT II: CRYPTOGRAPHIC FUNDAMENTALS FOR IoT               (9 periods)**

Cryptographic primitives and its role in IoT, Encryption and Decryption, Hashes, Digital Signatures, Random number generation, Cipher suites, key management fundamentals, cryptographic controls built into IoT messaging and communication protocols, IoT Node Authentication.

**UNIT III: IDENTITY & ACCESS MANAGEMENT SOLUTIONS FOR IoT     (9 periods)**

Identity lifecycle, authentication credentials, IoT IAM infrastructure; Authorization with Publish/Subscribe schemes; access control.

**UNIT IV: PRIVACY PRESERVATION AND TRUST MODELS FOR IoT       (9 periods)**

Concerns in data dissemination, Lightweight and robust schemes for Privacy protection, Trust and Trust models for IoT, self-organizing Things, Preventing unauthorized access

**UNIT V: CLOUD SECURITY FOR IoT** (9 periods)

Cloud services and IoT - offerings related to IoT from cloud service providers, Cloud IoT security controls; An enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing.

**Total Periods: *45***

*Topics for self-study are provided in lesson plan*

**TEXTBOOK:**

1. Brian Russell, Drew Van Duren, *Practical Internet of Things Security*, Kindle Edition, 2016.

**REFERENCE BOOK:**

1. Fei Hu, *Security and Privacy in Internet of Things (IoTs)- Models, Algorithms, and Implementations*, CRC Press, 1st Edition, 2016

**ADDITIONAL LEARNING RESOURCES:**

1. https://www.fortinet.com/resources/cyberglossary/iot-security

## (19BM61203) SOFTWARE DEFINED NETWORKS FOR IoT

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Internet of Things Lab.

**COURSE DESCRIPTION:**

Packet Switching Terminology, Traditional Switch architecture, Fundamental Characteristics of SDN, SDN Controller, SDN Applications, SDN in the data center**,** Use Cases in the Data Center, Scope of the Internet of Things, SDN for IoT.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on characteristics of Data center and Network Technologies.

CO2. Demonstrate skills on Operating and performing Data flow in Software Defined Networks

CO3. Identify suitable Data Center topologies for virtualized environment.

CO4. Apply Software defined Networks concepts for the Internet of Things

CO5. Apply suitable addressing schemes and routing protocols to achieve QoS in SDN based IoT.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO SOFTWARE DEFINED NETWORKS          (9 Periods)**

Basic Packet-Switching Terminology, The Modern Data Center, Traditional Switch architecture, Autonomous and Dynamic Forwarding Tables, Evolution of Switches and Control Planes ,SDN Implications for Research and Innovation, Data Center Innovation, Data Center Needs, The Evolution of Networking Technology, Forerunners of SDN, Software Defined Networking is Born, Sustaining SDN Interoperability, Open Source Contributions, Legacy Mechanisms Evolve Toward SDN, Network Virtualization.

**UNIT II: FUNDAMENTAL CHARACTERISTICS OF SDN          (9 Periods)**

SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods, OpenFlow, OpenFlow Limitations, Potential Drawbacks of Open SDN,SDN via APIs, SDN via Hypervisor-Based Overlays, SDN via Opening Up the Device, Network Functions Virtualization, Alternatives Overlap and Ranking. Real-World Data Center Implementations, applications and SDN features.

**UNIT III: SDN IN THE DATA CENTER          (9 Periods)**

Data Center Definition, Data Center Demands, Tunneling Technologies for the Data Center, Path Technologies in the Data Center, Ethernet Fabrics in the Data Center, SDN Use Cases in the Data Center, Open SDN versus Overlays in the Data Center.

**UNIT IV: THE INTERNET OF THINGS** (9 Periods)

Scope of the Internet of Things, Key Features of IoT Data, Technical requests for Openstack as a IoT-Cloud Platform, Feature of Message Broking, IoT architecture in NTT DATA, IoT architecture on Openstack, Endpoint-Aware Service Function Chaining, Service function chaining for the IoT data plane, Mobile Network Slicing for IoT, Introduction to IoTivity.

**UNIT V: SDN for IoT**: (9 Periods)

SDN based IoT, IoT Host Management System Architecture, Network Topology, Experiment Environment, Host Address collection, Host blocking, Host address translation, Dynamic QoS Routing Algorithm in SDN, SDN based Dynamic QoS Routing Framework, Mobility Support in SDN IoT networks, SDN and Cloud based Forest Fire Detection System using IoT devices.

**Total Periods: *45***

**Topics for self-study are provided in lesson plan**

**TEXTBOOKS:**

1. Paul Goransson and Chuck Balck, *Software Defined Networks -A comprehensive Approach*, 1st Edition, 2014.

2. Sunyoung Han, Software Defined Network for Internet of Things, Chulalongkorn University, Thailand, 2016.

**REFERENCE BOOKS:**

1. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, Addison-Wesley, 2015.

2. Jim Doherty, SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization, Pearson, 2017.

## (19BM61231) **IoT APPLICATION DEVELOPMENT LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

A course on Internet of Things Lab.

**COURSE DESCRIPTION:**

Hands-on practice on Internet of Things (IoT); Usage of Sensors, Arduino microcontroller and Raspberry Pi microprocessor; Development of IoT Applications for societal needs; IoT with Cloud environments.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate hands-on experience on IoT.

CO2. Use Sensors, Arduino microcontroller and Raspberry Pi microprocessor for the development of IoT applications.

CO3. Analyze the user requirements for the development of IoT applications.

CO4. Develop IoT applications to solve societal problems using cloud environment.

CO5. Work independently or in teams to solve problems with effective communication.

**LIST OF EXPERIMENTS:**

1. Develop an IoT application to control servo motor using Arduino/Raspberry Pi.

2. Develop an IoT application using Arduino/Raspberry Pi for fire alarm.

3. Develop an IoT application to measure temperature, humidity, light and distance using Arduino/Raspberry Pi.

4. Develop an IoT application to control home appliances using a smart phone.

5. Develop an IoT application to measure soil moisture, air and water quality using Arduino/Raspberry Pi.

6. Develop an IoT application to control and monitor Street lights using Arduino/Raspberry Pi.

7. Develop an IoT application to detect obstacles using Arduino/Raspberry Pi.

8. Develop an IoT application using Arduino/Raspberry Pi to monitor heartbeat, blood pressure, etc. of a person and to upload health information to thingspeak cloud.

9. Develop an Alexa based Home Automation System using IoT.

**REFERENCE BOOKS:**

1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things( A hands on approach),* 1st Edition, VPI Publications, 2014.

2. Adrian McEwen and Hakin Cassimally, *Designing the Internet of Things,* Wiley India.

3. Massimo Banzi and Michael Shiloh*, Getting Started with Arduino*, Third Edition, Maker Media.

4. Matt Richardson and Shawn Wallace, *Getting Started with Raspberry Pi*, O'Reilly, 2014.

**(19BM71201) ADVANCED IoT**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Internet of Things Lab.

**COURSE DESCRIPTION:**

Introduction to the Industrial Internet; Industrial Internet Use-Cases; Technical and Business Innovators of the Industrial Internet; IIoT Reference Architecture, Designing Industrial Internet Systems; Examining the Access Network Technology & Protocols; Examining the Middleware Transport Protocols; Middleware Software Patterns; Middleware Industrial Internet of Things Platforms; IIoT WAN Technologies and Protocols; Securing the Industrial Internet; Introducing Industry 4.0; Smart Factories.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Demonstrate knowledge on IIoT Concepts, applications, Technical requirements.

CO2.   Design and develop IIoT applications, using different architectures and protocols.

CO3.   Identify suitable middleware Transport Protocols, and Software Patterns to design APIs and Platforms.

CO4.   Demonstrate knowledge on WAN Technologies& Protocols and security management in IIoT.

CO5.   Demonstrate knowledge on Industry 4.0 and smart factories

**DETAILED SYLLABUS:**

**UNIT-I:** (9 Periods)

**INTRODUCTION TO THE INDUSTRIAL INTERNET**: What is IIoT, Key IIoT Technologies Catalysts and Precursors of the IIoT, Innovation and the IIoT, Key Opportunities and Benefits, The Digital and Human Workforce.

**INDUSTRIAL INTERNET USE-CASES**: Healthcare, Oil and Gas Industry, Smart Office, Logistics and the Industrial Internet, Retail

**THE TECHNICAL AND BUSINESS INNOVATORS OF THE INDUSTRIAL INTERNET**: Miniaturization, Cyber Physical Systems (CPS), Wireless Technology, IP Mobility, Network Functionality Virtualization(NFV), Network Virtualization, The Cloud and Fog, Big Data and Analytics, M2M Learning and Artificial Intelligence, Augmented Reality, 3D Printing, People versus Automation

**UNIT-II:** (9 Periods)

**IIoT REFERENCE ARCHITECTURE**: The IIC Industrial Internet Reference Architecture, Industrial Internet Architecture Framework (IIAF), Architectural Topology, The Three-Tier Topology, Connectivity, Key System Characteristics, Data Management.

**DESIGNING INDUSTRIAL INTERNET SYSTEMS:** The Concept of the IIoT, The Proximity Network, WSN

Edge Node, Legacy Industrial Protocols, Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, Gateways

**EXAMINING THE ACCESS NETWORK TECHNOLOGY AND PROTOCOLS**: The Access Network, Access Networks Connecting Remote Edge Networks

**UNIT-III:** (9 Periods)

**EXAMINING THE MIDDLEWARE TRANSPORT PROTOCOLS**: TCP/IP, UDP, Reliable Transport Protocol (RTP), CoAP (Constrained Application Protocol).

**MIDDLEWARE SOFTWARE PATTERNS**: Publish/Subscribe Pattern: MQTT, XMPP, AMQP, DDS, Delay Tolerant Networks (DTN).

**SOFTWARE DESIGN CONCEPTS**: API (Application Programming Interface), API: A Technical Perspective, Web Services.

**MIDDLEWARE INDUSTRIAL INTERNET OF THINGS PLATFORMS**: Middleware Architecture, IIoT Middleware Platforms.

**UNIT-IV:** (9 Periods)

**IIoT WAN TECHNOLOGIES AND PROTOCOLS:** IIoT Device Low-Power WAN Optimized Technologies for M2M, Low Power Wi-Fi, LTE Category-M, Weightless, Millimeter Radio.

**SECURING THE INDUSTRIAL INTERNET:** Security in Manufacturing: PLCs and DCS, Securing the OT, Network Level: Potential Security Issues, System Level: Potential Security Issues, Identity Access Management

**UNIT-V:** (9 Periods)

**INTRODUCING INDUSTRY 4.0:** Defining Industry 4.0, Four Main Characteristics of Industry 4.0, The Value Chain, Industry 4.0 Design Principles, Building Blocks of Industry 4.0, Smart Manufacturing.

**SMART FACTORIES:** Introducing the Smart Factory, Smart Factories in Action, Importance of Smart Manufacturing, Real-World Smart Factories - GE's Brilliant Factory, Airbus: Smart Tools and Smart Apps, Siemens' Amberg Electronics Plant (EWA), Industry 4.0: The Way Forward

**Total Periods: *45***

*Topics for self-study are provided in lesson plan*

**TEXTBOOK**:

1. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress Publications, 2016.

**REFERENCE BOOKS**:

1. Giacomo Veneri and Antonio Capasso, *Hands-on Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0*, Ingram Academic Services, 2018.
2. Vijay Madisetti and Arshdeep Bahga, *Internet of Things A Hands-On- Approach*, Orient Blackswan Private Limited, 2015.
3. Francis daCosta, *Rethinking the Internet of Things: A Scalable Approach to Connecting Everything*", 1st edition, Apress Publications, 2014.

(19BM71202) **BIG DATA ANALYTICS FOR IoT**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | 1 | - | 4 |

**PRE-REQUISITES:**

A course on Internet of Things Lab.

**COURSE DESCRIPTION:**

The course provides introduction to IoT Analytics and Big Data Analytics, Sensors And Tools of IoT Analytics, Services of IoT, Big Data Storage Systems for IoT, Case Studies and Applications of IoT

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Use Analytical Architecture and its exploration in Data Analytics for IoT

CO2. Analyze and Visualize the Sensor data for IoT.

CO3. Apply Advanced Analytical Architectures as a service for IoT.

CO4. Analyze Big data storage systems in IoT.

CO5. Develop Real Time solutions for given societal problems.


**DETAILED SYLLABUS:**

**UNIT I**: **INTRODUCING IoT ANALYTICS** **(9 periods)**

**Introduction:** IoT Data and BigData, Challenges of IoT Analytics Applications, IoT Analytics Lifecycle and Techniques. **IoT, Cloud and Big Data Integration for IoT Analytics:** Cloud-based IoT Platform, Data Analytics for the IoT, Data Collection Using Low-power, Long-range Radios, WAZIUP Software Platform, iKaaS Software Platform.

**UNIT II:  SENSORS AND TOOLS OF IoT ANALYTICS** **(9 periods)**

**Sensors:** Architecture for Social and Physical Sensors, Local Event Retrieval, Using Sensor Metadata Streams to Identify Topics of Local Events in the City, Venue Recommendation. **Development Tools for IoT Analytics Applications:** VITAL Development Environment, Tools for IoT Semantic Analytics**,** Development Examples: Predict the Footfall!, Find a Bike!

**UNIT III: IoT ANALYTICS AS A SERVICE** **(9 periods)**

Architecture for IoT Analytics-as-a-Service, Sensing-as-a-Service Infrastructure Anatomy, Scheduling, Metering and Service Delivery, Sensing-as-a-Service Examples, From Sensing-as-a-Service to IoT-Analytics-as-a-Service, Data Collection to Deployment and Operationalization, Ethical IoT.

**UNIT IV: BIG DATA STORAGE SYSTEMS AND CASE STUDIES FOR IoT** **(9 periods)**

**Perspectives and Challenges:** Big data analytics for IoT, Data Storage and Access for IoT, Dynamic-Data Handling in Big Data Storage Systems, Heterogeneous Datasets in IoT Big Data, Semantic Analytics for Big Data. **Case Studies**: Data Analytics in Smart Buildings, Internet-of-Things Analytics for Smart Cities.

**UNIT V: APPLICATIONS OF IoT AND BIG DATA SOLUTIONS          (9 Periods)**

**IoTBDs Applications:** Smart Transportation**,** Smart Healthcare, Smart Grid, Smart Inventory System, Smart Manufacturing, Smart Retail, Smart agriculture**, Big Data Management Solutions for IoT**: Case Study – Connected Car.

**Total Periods: 45**

*Topics for self-study are provided in lesson plan*

**TEXTBOOKS:**

1. John Soldatos, *Building Blocks for IoT Analytics*, River Publishers, 2017.
2. Pethuru Raj, T. Poongodi, Balamurugan Balusamy, and Manju Khari*, Internet of Things and Big Data Analytics Integrated Platforms and Industry Use Cases*, 1st edition, CRC Press, 2020.

**REFERENCE BOOKS:**

1. Hwaiyu Geng, P.E., *Internet of Things and Data Analytics Handbook*, Wiley Publishing, 2017.
2. Dey. N, Hassanien A.E, Bhatt C, Ashour A.S, Satapathy S.C, *Data Analytics: Internet of Things and Big Data Analytics Toward Next-Generation Intelligence*, Springer, 2018.

**ADDITIONAL LEARNING RESOURCES:**

1. https://www.tutorialspoint.com/excel_data_analysis/data_analysis_overview.html
2. https://data-flair.training/blogs/data-analytics-tutorial/
3. https://pythonprogramming.net/data-analysis-tutorials/

## (19BM71231) **ADVANCED IoT LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|:---:|:---:|:---:|---|:---:|:---:|:---:|:---:|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

A course on Internet of Things Lab.

**COURSE DESCRIPTION:**

Hands-on practice on Internet of Things (IoT); IBM Bluemix; Amazon AWS cloud; Google Firebase; Git hub IoT packages; Python IoT libraries for the development of IoT applications.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Demonstrate hands-on experience on IoT.

CO2.   Use IBM Bluemix, Amazon AWS cloud, Google Firebase, Git hub IoT packages and Python libraries for the development of IoT applications.

CO3.   Analyze the user requirements for the development of IoT applications.

CO4.   Develop IoT applications to solve societal problems using cloud environment.

CO5.   Work independently or in teams to solve problems with effective communication.


**LIST OF EXPERIMENTS:**

1. Study of AT89S52 Ultra Development Kit with Development Tool /Environment of Kiel Software for Microcontroller programming

2. Familiarize with Intel Galileo Gen2 board and understand the procedure of creation and compilation of C source code.

3. Study of IoT Data Logging using Beaglebone Black and Thingspeak.

4. Turn your smartphone into an IoT device using the IBM Watson IoT Platform cloud-hosted service.

5. Controlling home light using WiFi Node MCU, and Relay module

6. Develop an application using the Google Firebase NodeMCU ESP8266

    a) Connecting Arduino Node-MCU with Google Firebase

    b) Control Led Using Firebase Console

    c) Control Led with Android App using Firebase database

7. Develop an application using the Google Firebase for controlling LED and Android App with NodeMCU

8. Configuring IOT Based DHT Sensor using AWS

9. Design and develop Alexa based Home Automation System using AWS.

**REFERENCE BOOKS:**

1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things( A hands on approach),* 1ˢᵗ Edition, VPI Publications, 2014.

2. Adrian McEwen and Hakin Cassimally, *Designing the Internet of Things,* Wiley India.

3. Massimo Banzi and Michael Shiloh*, Getting Started with Arduino*, 3ʳᵈ Edition, Maker Media.

**ADDITIONAL LEARNING RESOURCES:**

1. https://aws.amazon.com/iot-core/getting-started/

2. https://www.balena.io/docs/learn/develop/integrations/bluemix/

3. https://github.com/thingsboard

4. https://www.javatpoint.com/iot-internet-of-things

**Offering Department:**  COMPUTER SCIENCE AND SYSTEMS ENGINEERING

**Students of Eligible Branches:** ECE, EEE, EIE, ME and CE

## COURSE STRUCTURE

| Year & Semester | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem<br><br>(2 Theory + 1 Lab) | 19BM51501 | Computer Networks | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM51502 | Ad hoc and wireless Sensor Networks | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM51503 | Operating Systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM51531 | Computer Networks Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| III B.Tech. II-Sem<br><br>(2 Theory + 1 Lab) | 19BM61501 | Cloud Computing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM61502 | Modern Cryptography | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM61503 | Cyber security | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM61531 | Modern Cryptography Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| IV B.Tech. I-Sem<br>(1 Theory + 1 Lab) | 19BM71501 | IoT Security | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM71502 | Information Security | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM71531 | Information Security Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Introduction to computer networks; Protocols of physical layer, data link layer, medium access control sub layer, network layer, transport layer, application layer.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the types of network topologies, layers and protocols.

CO2. Evaluate subnetting and routing algorithms for finding optimal paths in networks.

CO3. Solve problems related to flow control, error control and congestion control in data transmission.

CO4. Assess the impact of wired and wireless networks in the context of network protocols Like DNS, SMTP, HTTP, and FTP.

CO5. Apply ethical principles and standards for developing network-based solutions.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION AND PHYSICAL LAYER                    (9 Periods)**

Network hardware, Network software, Reference models - OSI, TCP/IP; Example networks – Internet; Wireless LANs - 802.11.

**Physical Layer** - Guided transmission media, Wireless transmission, Switching - Circuit switching, Packet switching.

**UNIT II: DATA LINK LAYER AND MEDIUM ACCESS CONTROL SUBLAYER**

**(9 Periods)**

**Data Link Layer**: Data link layer design issues, Error detection and correction - CRC, Hamming codes; Elementary data link protocols, Sliding window protocols.

**Medium Access Control Sub layer**: ALOHA, Carrier sense multiple access protocols, Collision free protocols, Ethernet, Data link layer switching - Repeaters, Hubs, Bridges, Switches, Routers, Gateways.

**UNIT III: NETWORK LAYER                                      (9 Periods)**

Network layer design issues, Routing algorithms - Shortest path algorithm, Flooding, Distance vector routing, Link state routing, Hierarchical routing, Broadcast routing, Multicast routing, Anycast routing; Congestion control algorithms, Network layer in the internet - The IP version 4 protocol, IP addresses, IP version 6, Internet control protocols, OSPF, BGP.

**UNIT IV: TRANSPORT LAYER                                    (9 Periods)**

UDP – Segment header, Remote procedure call, Real-time transport protocols; TCP – service model, Protocol, Segment header, Connection establishment, Connection release, Sliding window, Timer management, Congestion control.

**UNIT V: APPLICATION LAYER** **(9 Periods)**

Domain Name System (DNS) - Name space, Domain resource records, Name servers; Electronic mail - Architecture and services, User agent, Message formats, Message transfer, Final delivery; The World Wide Web - Architectural overview, HTTP, FTP.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOK(S):**

1. Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, Pearson, 5th Edition, 2015.

**REFERENCE BOOKS:**

1. Behrouz A. Forouzan, *Data Communications and Networking*, McGraw Hill, 5th Edition, 2013.

2. James F. Kurose and Keith W. Ross, *Computer Networking: A Top-Down Approach*, Pearson, 7th Edition, 2017.

**ADDITIONAL LEARNING RESOURCES:**

- https://www.cisco.com/c/en/us/solutions/small-business/resourcecenter/networking/networking-basics.html

- https://memberfiles.freewebs.com/00/88/103568800/documents/Data.And.Computer.Communications.8e.WilliamStallings.pdf

(19BM51502) **AD HOC AND WIRELESS SENSOR NETWORKS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:-**

**COURSE DESCRIPTION:**

Ad hoc Wireless Networks, Medium Access Control Protocols for Ad hoc Wireless Networks, Routing Protocols for Ad hoc Wireless Networks, Wireless Sensor Networks, Medium Access Control Protocols for WSN's.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Investigate ad hoc and wireless sensor networks to improve the network performance.

CO2. Analyze the issues in MAC, routing protocols in Ad hoc wireless networks.

CO3. Apply routing protocols of MAC Layer in sensor networks to provide networking solutions.

CO4. Follow norms and standards in engineering practice to solve ad hoc and wireless sensor network problems.

**DETAILED SYLLABUS:**

**UNIT I:  AD HOC WIRELESS NETWORKS                    (8 periods)**

Fundamentals of wireless communication technology, the electromagnetic spectrum, Radio propagation mechanisms, Characteristics of the wireless channel, Applications, Issues, Ad hoc wireless Internet.

**UNIT II: MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS        (8 periods)**

Issues in designing a MAC protocol, Classification of MAC protocols, Contention based protocols, Contention based protocols with reservation mechanisms, and Contention based protocols with scheduling mechanisms.

**UNIT III: ROUTING PROTOCOLS FOR AD HOC WIRELESS NETWORKS   (9 periods)**

Issues in designing routing and transport layer protocol for Ad hoc networks, Classification of routing protocols, Table driven routing protocols, On demand routing protocols, Hybrid routing protocols.

**UNIT IV: WIRELESS SENSOR NETWORKS                    (9 periods)**

Vision of ambient intelligence, Application examples, Types of applications, Challenges of WSN's, Why are sensor networks different, Enabling technologies, Hardware components, Energy consumption of sensor nodes.

**UNIT V: MEDIUM ACCESS CONTROL PROTOCOLS FOR WIRELESS SENSOR NETWORKS** **(11 periods)**

Fundamentals of MAC protocols, Low duty cycle protocols and wake up concepts, Contention based protocols, Schedule based protocols, IEEE 802.15.4 MAC protocol, 802.11 and Bluetooth, Case study on tele healthcare – Introduction, MASN hardware design, Reliable MASN communication protocols, MASN software design, Integration of RFID and wearable sensors.

**Total Periods: 45**

*Topics for self-study are provided in lesson plan*

**TEXTBOOKS**:

1. C. Siva Ram Murthy, B.S. Manoj, *Ad Hoc Wireless Networks: Architectures and Protocols*, Pearson, 2012.

2. Holger Karl and Andreas Willig, *Protocols and Architectures for Wireless Sensor Networks*, Wiley, 2017.

**REFERENCE BOOKS**:

1. Fei Hu and Xiaojun Cao, *Wireless Sensor Networks: Principles and Practice*, CRC Press, 2010.

2. Yi Qian, Peter Muller and Hsiao–Hwa Chen, *Security in Wireless Networks and Systems*, Wiley, 2011.

**ADDITIONAL LEARNING RESOURCES:**

- https://www.tyndall.ie/wireless-sensor-networks-2
- https://www.elprocus.com/introduction-to-wireless-sensor-networks-types-and-applications/
- https://www.analog.com/en/design-center/landing-pages/002/apm/wsn-solution-2014.html

(19BM51503) **OPERATING SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Operating Systems Operations; Process Scheduling; Process Synchronization, Deadlocks; Paging and Segmentation, Disk Scheduling; File Concepts, I/O Interface; Concepts of Protection and Security.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze performance of CPU scheduling algorithms.

CO2. Design solutions for process synchronization problems by using semaphores and monitors.

CO3. Devise solutions for deadlocks using deadlock handling mechanisms.

CO4. Solve memory management problems using page replacement and disk scheduling algorithms.

CO5. Identify efficient file allocation methods for optimal disk utilization.
CO6. Analyze services of I/O subsystems and mechanisms of security & protection.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO OPERATING SYSTEM AND PROCESS MANAGEMENT**
**(8 periods)**
**Introduction:** Definition, Operating System Structure and Services, System Calls.
**Process Management:** Process Scheduling, Process Control Block, Inter Process Communication, Threads, Multithreading Models, CPU Scheduling Criteria, Scheduling Algorithms, Multiprocessor Scheduling.
**UNIT II: PROCESS SYNCHRONIZATION AND DEADLOCKS          (10 periods)**
**Process Synchronization:** Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Synchronization Problems, Monitors.
**Deadlocks:** System Model, Deadlock characterization, Methods for handling deadlocks, Prevention, Detection, Avoidance, Recovery from deadlock.
**UNIT III: MEMORY MANAGEMENT AND SECONDARY STORAGE          (10 periods)**
**Memory Management:** Swapping, Contiguous Allocation, Paging, Segmentation, Segmentation with Paging.
**Virtual Memory:** Demand Paging, Page Replacement Algorithms, Copy-on-Write, Thrashing.
**Secondary Storage Structure:** Overview of Mass Storage Structure, Disk Structure, Disk Scheduling, Disk Management.
**UNIT IV: File and I/O Systems          (8 periods)**
**File System:** File concept, Access Methods, Directory Structure, File System Structure, i-node, File System Implementation, Directory Implementation, Allocation Methods.
**I/O System:** I/O Hardware, Application I/O Interface, Kernel I/O subsystem

**UNIT V: PROTECTION AND SECURITY** **(9 periods)**

**Protection:** Goals, Principles, Domain of Protection, Access Matrix, Implementation of Access Matrix, Access Control, Revocation of Access Rights.

**Security:** Security Problem, Program Threats, System and Network Threats, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks, Computer-Security Classifications.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS**:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, *Operating System Concepts*, Wiley India Edition, 9th Edition, 2016.

**REFERENCE BOOKS**:

1. William Stallings, *Operating Systems, Internals and Design Principles*, Pearson Education, 7th Edition, 2013.
2. Andrew S. Tanenbaum, *Modern Operating Systems*, PHI, 3rd Edition, 2009.

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** Course on computer networks

**COURSE DESCRIPTION**:

Hands on practice with NS3; Packet Tracer network simulation tools; Simulation of network topologies; ARP protocol; CSMA/CD protocol; Distance Vector/Link State Routing protocols; Transmission errors; Sliding window protocol; TCP; UDP.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply mathematical foundations to solve computational problems in computer networks.

CO2. Select and apply network simulation tools like NS3, Packet Tracer to simulate networking protocols.

CO3. Simulate and analyze network topologies, network protocols to provide efficient networking solutions.

CO4. Work independently and communicate effectively in oral and written forms.

**LIST OF EXERCISES:**

1.  a)  Study of network devices and network IP in detail.

    b)  Simulate a peer to peer topology of a computer network.

    c)  Simulate IPv4 addressing in a computer network (give IP Address of different classes in given Network id).

Exercises on Packet Tracer Simulator Tool:

2.  Introduction to Packet Tracer

3.  a)  Study of basic network commands and network configuration commands.

    i) ping      ii) nslookup     iii) netstat      iv) ifconfig

    b)  Create a network topology and configure a network topology with four PCs, two switches, and two routers.

Exercises on NS3 Simulator Tool:

4.  a)  Introduction to NS3 tool.

    b)  Create a network with three nodes namely 0, 1 and 2. Establish a TCP connection between node 0 and node 2 such that node 0 will send TCP packets to node 2 via node 1.

5. a) Create a simple topology of two nodes (Node1, Node2) separated by a point-to-point link. Setup a UDP Client on one Node1 and a UDP Server on Node2. Consider a fixed data rate Rate1.

    i) Measure end to end throughput whilst varying the latency of the link.

    ii) Add another client application to Node1 and a server instance to Node2. What do you need to configure to ensure that there is no conflict?

    iii) Repeat step 3 with the extra client and server application instances. Show screenshots of pcap traces which indicate that delivery is made to the appropriate server instance.

  b) Simulate a Local Area Network. Consider a local area network formed by nodes 3, 4, and 5. This LAN communicates with the external world through a router denoted by node 2. There are two servers connected to the router and represented by nodes 0 and 1. Node 0 is running an application over TCP, which is accessed by node 4. Node 1 is running an application on UDP, which is accessed by node 5. Analyze the trace file.

6. Simulate link errors. Presence of link errors cause one or more packets to be retransmitted. Consider the following topology.



Node #2 act as a router. Any traffic to or from the LAN passes through it. Consider node #1 running a FTP server, and node #5 is downloading a file of size 4 MB. However, the link between node #2 and #3 is fault. It drops packets with a fixed probability of 0.2. Implement a link error model to reflect this. Try different values of the simulation time to ensure that the file has been entirely transferred. Has the plot of bytes received a linear curve or non-linear? Why?

7. Simulate Address Resolution Protocol (ARP) to associate a logical address with a physical address and Reverse Address Resolution Protocol (RARP) allows a host to discover its Internet address when it knows only its physical address.

8. Simulate packet transmission over a CSMA/CD based LAN with NS3. Consider the LAN with seven nodes to be an isolated one i.e. not connected to the Internet. Node #0 in the LAN acts as a UDP traffic source, and node #6 is the destination node. Assume CBR traffic to be flowing between the nodes. The simulation lasts for 25 seconds. In Ethernet a packet is broadcasted in the shared medium, and only the destination node accepts the packet. Other nodes simply drop it. What should be the number of hops a packet from node #0 to node # 6 travel? Verify this from the "Hop Count" plot.

9. a) UDP uses a simple connectionless communication model with a minimum of protocol mechanism. The implementation provides checksums for data integrity, and port numbers for addressing different functions at the source and destination of the datagram. Simulate half duplex chat User Datagram Protocol.

b) TCP model supports a full bidirectional TCP with connection setup and close logic. Simulate full duplex chat Transmission Control Protocol.

10 a) In a typical FTP session, the user is sitting in front of one host (the local host) and wants to transfer files to or from a remote host. Implement File Transfer Protocol

to move files between local and remote file systems.

b) Sliding window protocol supports reliable and efficient transmission between nodes and it also obtains higher throughput than that of stop-n-wait protocol. Simulate sliding window protocol normal operation and timeout operations.

11 Configure the following network to find shortest path between R2 LAN to R3 LAN using Distance Vector / Link State Routing Protocol.
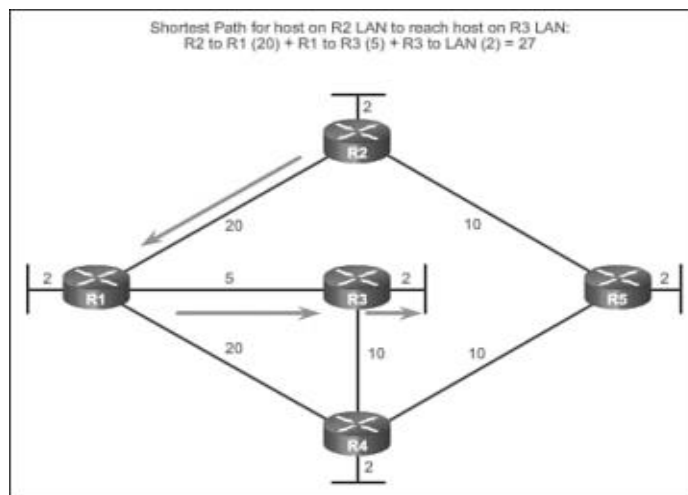


**REFERENCE BOOKS**:

1. Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, Pearson, 5th Edition, 2015.

2. A. Jesin, *Packet Tracer Network Simulator*,Packt Publishing, 2014.

3. Jack L. Burbank, *An Introduction to Network Simulator 3,* Wiley, 2018.

**Software/Tools used:**

- Network simulator tools - NS3, Packet Tracer

- Virtual Labs (Computer Networks Lab – http://vlabs.iitb.ac.in/vlabs-dev/labs_local/ computer-networks/ labs/explist.php)

- Virtual Labs (Advanced Network Technologies Virtual Lab - http://vlabs.iitkgp.ernet.in/ant)

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Fundamental Cloud Computing and Virtualization; Understanding Cloud Models and Architectures; Understanding Cloud Services, Applications and Capacity Planning; Exploring Platform as a Service (PaaS); Exploring Infrastructure as a Service (IaaS).

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on basic concepts and terminologies of Cloud Computing and Virtualization.

CO2. Select appropriate Cloud deployment models, Service models and Architectures in Cloud Application development.

CO3. Analyze Cloud services, Applications and Capacity Planning.

CO4. Apply different PaaS application frameworks to construct Cloud applications.

CO5. Develop web applications through Google, Microsoft and Amazon web services as per societal needs.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTAL CLOUD COMPUTING AND VIRTUALIZATION     (10 periods)**

**Cloud Computing:** Origin and influences, Basic concepts and terminology, Goals and benefits, Risks and challenges, Roles and boundaries and Cloud characteristics.

**Introduction to Virtualization:** Characteristics, Taxonomy of virtualization technologies, Pros and cons of virtualization, Virtualization Technologies: Xen**,** VMware and Hyper-V.

**UNIT II: UNDERSTANDING CLOUD MODELS AND ARCHITECTURES     (8 periods)**

**Cloud Models:** NIST model, Cloud Cube model, Deployment models: Public, Private, Hybrid and Community; Service models: IaaS, PaaS and SaaS.

**Understanding Cloud Architecture:** Exploring the Cloud Computing Stack: Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications; Connecting to the Cloud: The Jolicloud Netbook OS and Chromium OS - The Browser as an Operating System.

**UNIT III: UNDERSTANDING CLOUD SERVICES, APPLICATIONS AND CAPACITY**

**PLANNING                                                       (9 periods)**

**Understanding Cloud Services and Applications** Infrastructure as a Service (IaaS): IaaS workloads, Pods, aggregation, and silos; Platform as a Service (PaaS), Software as a Service (SaaS): SaaS characteristics, Open SaaS and SOA, Salesforce.com and CRM SaaS; Identity as a Service (IDaaS): Identity, Networked identity service classes, Identity system codes of conduct, IDaaS interoperability; Compliance as a Service (CaaS).

**Capacity Planning**: Defining Baseline and Metrics: Baseline measurements, System metrics, Load Testing, Resource ceilings, Server and instance types; Network Capacity and Scaling.

## UNIT IV: EXPLORING PLATFORM AS A SERVICE (PaaS)          (10 periods)

**PaaS Application Frameworks:** Drupal, Eccentex AppBase 3.0, Long Jump, Square space, WaveMaker and Wolf Frameworks.

**Exploring Platform as a Service using Google Web Services:** Surveying the Google Application Portfolio, Google Toolkit and Working with the Google App Engine.

**Exploring Platform as a Service using Microsoft Cloud Services:** Exploring Microsoft Cloud Services, Defining the Windows Azure Platform, Windows Live: Windows Live Essentials, Windows Live Home and Windows Live for Mobile.

## UNIT V: EXPLORING INFRASTRUCTURE AS A SERVICE (IaaS)          (8 periods)

Understanding Amazon Web Services, Amazon Web Service Components and Services, Working with the Elastic Compute Cloud (EC2): Amazon Machine Images, Pricing models, System images and software, Creating an account and instance on EC2; Working with Amazon Storage Systems: Amazon Simple Storage System (S3), Amazon Elastic Block Store (EBS) and CloudFront; Understanding Amazon Database Services: Amazon SimpleDB, Amazon Relational Database Service (RDS) and Choosing a database for AWS.

**Total Periods: 45**

*Topics for Self-study are provided in the Lesson Plan.*

**TEXTBOOKS:**

1. Barrie Sosinsky, *Cloud Computing Bible,* Wiley India Pvt Ltd, 2011 (Reprint 2017).

2. Thomas Erl and RicardoPuttini, *Cloud Computing- Concepts, Technology and Architecture,* Pearson, 2014 (Seventh Impression 2017).

**REFERENCE BOOKS:**

1. Rajkumar Buyya, Christian Vecchiloa and S Thamarai Selvi, *Mastering Cloud Computing*, McGraw Hill Education, 2013 (Reprint 2017).

2. George Reese, *Cloud Application and Architectures*, O'Relly, 2009 (Reprint 2017).

**ADDITIONAL LEARNING RESOURCES:**

1. "Exploring the Google Toolkit", https://code.google.com/, drafted on 23 December, 2019.

2. "Understanding Amazon Web Services", https://aws.amazon.com/, drafted on 23 December, 2019.

3. "Exploring Microsoft Cloud Services", https://www.microsoft.com/windowsazure, drafted on 23 December, 2019.

# III B. TECH. - II SEMESTER

## (19BM61502) **MODERN CRYPTOGRAPHY**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

**COURSE DESCRIPTION:**

Cryptographic protocols; Encryption techniques for confidentiality; Mathematics of symmetric and asymmetric algorithms; Hash functions for integrity; digital signature schemes.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply cryptographic protocols to ensure authentication in network systems.

CO2. Analyze the efficiency of cryptographic techniques based on security attacks.

CO3. Choose suitable key management scheme for efficient key exchange between the authenticated parties.

CO4. Implement algorithms using information, complexity, and number theories for ensuring the security requirements-CIA.

CO5. Evaluate Message Digest and Secure Hash Algorithms using hash functions for data Integrity.

CO6. Analyze well known digital signature algorithms for securing communication.

**DETAILED SYLLABUS:**

**UNIT I: FOUNDATIONS OF CRYPTOGRAPHY (8 Periods)**

**Foundations of Cryptography:** Steganography, Substitution ciphers and Transposition Ciphers, One Time Pads. **Protocol Building Blocks:** Introduction to protocols, communications using symmetric Cryptography, One-Way Hash Functions, Communications Using Public-Key Cryptography, Digital Signatures with Encryption, Random and Pseudo-Random-Sequence Generation, **Basic Protocols**: Key Exchange, Authentication and key Exchange.

**UNIT II: CRYPTOGRAPHIC TECHNIQUES (8 Periods)**

**Cryptographic Techniques:** Key Management, Electronic Codebook Mode, Block Replay, Cipher Block Chaining Mode, Stream Ciphers, Self-Synchronizing Stream Ciphers, Cipher-Feedback Mode, Synchronous Stream Ciphers, Output-Feedback Mode, Counter Mode, Choosing a Cipher Mode, Interleaving, Block Ciphers versus Stream Ciphers.

**UNIT III: MATHEMATICS FOR CRYPTOGRAPHIC ALGORITHMS (12 Periods)**

**Mathematics for Cryptographic Algorithms:** Mathematical background: Information Theory, Complexity Theory, Number Theory, Factoring, Prime Number Generation, Discrete Logarithms in a Finite Field, Data **Encryption** Standard (DES), DES decryption, Security of DES, DES variants, Public Key Algorithms: RSA, Pholig-Hellman, RABIN, Elliptic Curve Cryptosystems.

**UNIT IV: HASH FUNCTIONS** (8 Periods)

**Hash Functions:** One Way Hash Functions, Snefru hash function, N- Hash, MD4, MD5, Secure Hash Algorithm (SHA), Security of SHA, One Way Hash Functions Using Symmetric Block Algorithms, Using Public-Key Algorithms, Message Authentication Codes (MAC).

**UNIT V: DIGITAL SIGNATURES** (9 Periods)

**Digital Signatures:** Digital Signature Algorithm (DSA), Security of DSA, Discrete Logarithm Signature Schemes, Ongchnorr-Shamir, SCHNORR authentication and signature scheme, Diffie-Hellman Key exchange, Station-to-Station Protocol, Shamir's Three-Pass Protocol.

**Total Periods 45**

*Topics for self-study are provided in lesson plan*

**TEXTBOOKS:**

1. Bruce Schneier, "*Applied Cryptography: Protocols, Algorithms and Source Code in C*", John Wiley and Sons, New York, 2009.

**REFERENCE BOOKS:**

1. Alfred J Menezes, Paul C van Oorschot and Scott A.Vanstone, "*Handbook of Applied Cryptography*", CRC Press, New York, 2010.

2. Wenbo Mao, "*Modern Cryptography Theory and Practice*", Pearson Education, 2004

**ADDITIONAL LEARNING RESOURCES:**

https://www.coursera.org/specializations/applied-crypto

https://www.udacity.com/course/applied-cryptography--cs387

https://www.classcentral.com/course/udacity-applied-cryptography-326

https://www.classcentral.com/course/udacity-applied-cryptography-326

https://wiki.openssl.org/index.php/Command_Line_Utilities

https://www.sslshopper.com/article-most-common-openssl-commands.html

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

**COURSE DESCRIPTION:**

Cybercrime, Cyberoffenses, Phishing, Identity theft, Cybercrime in mobile and wireless devices, Organizational measures for handling mobile devices, Security implications on using mobile devices, Tools and methods used in cybercrime, Forensics of computer and handheld devices, Real-life examples of cybercrime.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze methods of cybercrime, cyberoffenses to maintain cybersecurity.

CO2. Investigate tools used for cybercrime to protect computational assets.

CO3. Apply appropriate authentication mechanisms to reduce attacks on mobile and wireless devices.

CO4. Use appropriate cyberforensics tools and techniques to maintain cybersecurity.

CO5. Recognize the need for cybersecurity and practice ethics to protect privacy, property rights in cyberspace.

**DETAILED SYLLABUS:**

**UNIT I: CYBERCRIME** **(8 periods)**

Cybercrime and information security, Cybercriminals, Classifications of cybercrimes, Need for Cyberlaws in Indian context, Legal perspectives of cybercrime, Indian perspective of cybercrimes, Cybercrime and the Indian ITA 2000, Positive aspects andweak areas of ITA 2000, Amendments made in Indian ITA 2000 for admissibility of e-records, Amendments to the Indian IT Act, Global perspective on cybercrimes, Intellectual property in cyberspace, Ethical dimension of cybercrimes.

**UNIT II: CYBEROFFENSES** **(11 periods)**

Categories of cybercrime, How criminals plan the attacks, Social engineering, Cyberstalking, Cybercafe and cybercrimes, Botnets, Attack vector, Cloud computing, Phishing – Methods, Techniques, Spear phishing, Phishing scams, Phishing toolkits, Spy phishing, Countermeasures; Identity Theft – Personally identifiable information, Types, Techniques, Countermeasures, Effacing online identity.

**UNIT III: CYBERCRIME IN MOBILE AND WIRELESS DEVICES** **(7 periods)**

Proliferation of mobile and wireless devices, Trends in mobility, Credit card frauds in mobile and wireless computing era, Security challenges posed by mobile devices, Registry settings for mobile devices, Authentication service security, Attacks on mobile/cell phones, Security implications of mobile devices for organizations, Organizational measures for handling mobile devices related security issues.

## UNIT IV: TOOLS AND METHODS USED IN CYBERCRIME                    (10 periods)

Proxy servers and anonymizers, Password cracking, Keyloggers and spywares, Virus and worms, Trojan horses and backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow, Attacks on wireless networks.

## UNIT V: CYBERFORENSICS, CYBERCRIMEIN REAL-WORLD          (9 periods)

**Forensics of Computer and Handheld Devices:** Cyberforensics, Cyberforensics and digital evidence, Forensics analysis of e-mail, Forensics and social networking sites, Forensics of handheld devices – Smartphone forensics, EnCase, Device Seizure, MOBILedit.

**Cybercrime examples, mini-cases, online scams:** Real-life examples - Official website of Maharashtra Government hacked, Indian banks lose millions of rupees, Game source code stolen; Mini-cases - Indian Case of online gambling, Indian case of intellectual property crime;Online scams - Cheque cashing scam, Charity scams.


**Total Periods: 45**

*Topics for self-study are provided in lesson plan*


### TEXTBOOK:

1. Nina Godbole, SunitBelapure, *Cyber Security*: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley, 2013.


### REFERENCE BOOKS:

1. Nilakshi Jain, Ramesh Menon, *Cyber Security and Cyber Laws*, Wiley, 2020.

2. Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short, *Cybersecurity Essentials*, 1st Edition, Sybex, 2018.

3. ErdalOzkaya,*Cybersecurity: The Beginner's Guide*, 1st Edition,Packt Publishing, 2019.


### ADDITIONAL LEARNING RESOURCES:

• Yuri Diogenes, ErdalOzkaya, *Cybersecurity: Attack and Defense Strategies*, 2nd Edition, Packt Publishing, 2019.

• http://www.ignou.ac.in/upload/Announcement/programmedetails.pdf

• Alessandro Parisi, *Hands-On Artificial Intelligence for Cybersecurity*, Packt Publishing, 2019.

## (19BM61531) MODERN CRYPTOGRAPHY LAB

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **50** | **50** | **100** | | **-** | **-** | **2** | **1** |

**PRE-REQUISITES:** Course on Modern Cryptography

**COURSE DESCRIPTION:**
Mono-alphabetic Ciphers; Poly-alphabetic Ciphers; Block modes; Block ciphers; Public Key Algorithms, Message Digest Algorithms, Diffie-Hellman Key Exchange; SHA; Digital Signature Standards.

**COURSE OUTCOMES**

*After successful completion of this course, the students will be able to:*

CO1. Analyze attack resiliency of classical encryption algorithms to provide security.

CO2. Develop block cipher modes of operations and stream ciphers to achieve confidentiality in network systems.

CO3. Analyze the strength of RSA using cryptanalysis.

CO4. Use Key Exchange algorithm to ensure security primitives.

CO5. Implement different Message digest algorithms and DSS to achieve authentication.

CO6. Work independently or communicate effectively in oral and written forms.

**LIST OF PROGRAMMING EXERCISES:**

1. Implement the following monoalphabetic Ciphers and analyze its attack resiliency.

   a. Shift Cipher

   b. Affine cipher

2. Implement the following Poly-alphabetic Ciphers and analyze its attack resiliency.

   a. Hill cipher

   b. Vigenere

3. Implement the following block cipher modes and analyze the role of Initialization Vector (IV)

   a. counter mode

   b. Output Feedback mode

4. Write a program to implement the Data Encryption Standard (DES).

5. Implement a stream cipher algorithm with running key generator.

6. Write a program to Implement RSA algorithm.

7. Write a program to find prime factors of a given large number and analyze the time complexity.

8. Write a program to determine the message digest of a given message using the SHA-1 algorithm.

9. Write a program to implement Diffie-Hellman Key Exchange mechanism.

10. Write a program to implement Digital Signature Standard.

**REFERENCE BOOKS:**
1. William Stallings, *Cryptography and Network Security: Principles and Practice*, Pearson Education, 7th Edition, 2017.
2. Douglas R. Stinson, *Cryptography: Theory and Practice*, CRC Press, 3rd Edition, 2005.

**ADDITIONAL LEARNING RESOURCES:**
https://www.classcentral.com/course/udacity-applied-cryptography-326
https://www.classcentral.com/course/udacity-applied-cryptography-326
https://wiki.openssl.org/index.php/Command_Line_Utilities
https://www.sslshopper.com/article-most-common-openssl-commands.html

## IV B. Tech. – I Semester

### (19BM71501) **IoT SECURITY**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Securing the Internet of Things; Cryptographic Fundamentals for IoT; Identity & Access Management Solutions for IoT; Mitigating IoT Privacy Concerns; Cloud Security for IoT

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze Attacks, threats and vulnerabilities to secure IoT devices.

CO2. Design IoT messaging and communication protocols using Cryptographic primitives

CO3. Apply authentication credentials and Identity Access Management infrastructure to manage IoT

CO4. Analyze privacy concerns in IoT devices by using PIA

CO5. Examine IoT threats in the cloud for effective utilization of cloud services

CO6. Analyze different cloud service providers to IoT computing

**DETAILED SYLLABUS:**

**UNIT I: SECURING THE INTERNET OF THINGS**                   **(9 periods)**

Security Requirements in IoT Architecture - Security in Enabling Technologies -Security Concerns in IoT Applications. Security Architecture in the Internet of Things -Security Requirements in IoT - Insufficient Authentication/Authorization – Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity -Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees

**UNIT II: Cryptographic Fundamentals for IoT**                   **(9 periods)**

Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes –Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – Zigbee, Bluetooth-LE, Near Field Communication (NFC).

**UNIT III: Identity & Access Management Solutions for IoT**          **(9 periods)**

Identity lifecycle – authentication credentials– passwords, Symmetric keys, certificates, Biometrics, IoTIAM infrastructure Authorization and Access controls within publish/Subscribe protocols, access controls within communication protocols

**UNIT IV: Mitigating IoT Privacy Concerns**                   **(9 periods)**

Privacy challenges introduced by IoT- A complex sharing environment- wearable's, smart homes, Guiding to perform an IoT PIA-Authorities, characterizing collected information, use of collected information, Security, Notice, Data retention Information sharing, redress, auditing and accountability

**UNIT V: Cloud Security for IoT** **(9 periods)**

Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – An enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing

**Total Periods: *45***

*Topics for self-study are provided in lesson plan*

**TEXTBOOK:**

1. Practical Internet of Things Security: Design a security framework for an Internet connected ecosystem, Brian Russell and Drew Van Duren, 2nd Edition 2016.

**REFERENCE BOOKS:**

1. Security and Privacy in Internet of Things (IoTs): Models, Algorithms,and Implementations, Fei Hu, CRC Press2016.
2. Securing the Internet of Things Elsevier

## (19BM71502) **INFORMATION SECURITY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:  -**

**COURSE DESCRIPTION:**
Computer security; Need of Security; Access Control; Security policies; Software vulnerabilities; Secure Electronic transactions; Secure socket layer; transport layer security; Privacy.

**COURSE OUTCOMES:**
After successful completion of this course, the students will be able to:
- CO1. Apply the security requirements like confidentiality, integrity, and availability to secure network assets from threats and attacks.
- CO2. Analyze virus, malicious software and worms for detecting distributed Daniel of service attacks.
- CO3. Apply handshaking, alert and change cipher spec protocols and Coding function to secure SSL and TLS.
- CO4. Apply PGP model and canonical forms to secure E-Mail data at transport layer.
- CO5. Design firewall to secure the system by applying various intrusion detection systems.
- CO6. Apply privacy techniques to protect information in the network.

**DETAILED SYLLABUS:**
**UNIT I: INTRODUCTION                                                (08 Periods)**
Computer Security Concepts, the OSI Security Architecture, Security Attacks, Security Mechanism, Standards.
**Malicious Software:** Types of Malicious Software, Viruses, Worms, Distributed Denial of Service Attacks.

**UNIT II: SECURITY AT TRANSPORT LAYER: SSL & TLS          (09 Periods)**
Web Security Consideration, Secure Socket Layer and Transport Layer Security, Transport Layer Security, HTTPS, Secure Shell.

**Wireless Network Security:** IEEE 802.11 Wireless LAN Overview, IEEE 802.11i LAN Security, Wireless Application Protocol Overview, Wireless Transport Layer Security, WAP end-to-end Security

**UNIT III: SECURITY AT APPLICATION LAYER: PGP AND S/MIME        (08 Periods)**
Pretty Good Privacy, S/MIME, Domainkeys Identified Mail

**IP Security:** IP Security Overview, IP Security Policy, IP Security Architecture, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange.

**UNIT IV: INTRUDERS AND FIREWALLS                              (08 Periods)**
**Intrusion Detection System:** Intruders, Intrusion Detection, Password Management.

**Firewalls:** The Need for Firewalls, Firewall Characteristics, Types of Firewalls, Firewall Basing, Firewall location and configuration.

**UNIT V: PRIVACY** **(09 Periods)**
Evade Traffic analysis, Tunnel SSH through Tor, Encrypt you file seamlessly, Guard against Phishing, Use the web with fewer passwords, Encrypt your E-mail with Thunderbird, Encrypt you E-mail in Mac OS X

**Total Periods: 45**

*Topics for self-study are provided in lesson plan*.

**TEXTBOOKS:**
1. William Stallings "*Network Security Essentials (Applications and Standards)*", 4th Edition, Pearson Education 2011.
2. Andrew Lockhart "*Information security Hacks (Tips and Tools for protecting your privacy)*",O,ReillyMedia publisher, 2nd Edition, 2004.

**REFERENCE BOOKS:**
1. Behrousz A Forouzan, D Mukhopadhyay, "*Cryptography and network Security*", 1st Edition, McGraw Hill,2010.
2. CharlieKaufman, Radia Perlman and Mike Speciner, *Network Security – Private Communication in a Public World,*2nd Edition, Pearson/PHI.

**ADDITIONAL RESOURCES:**
1. http://www.inf.ufsc.br/~bosco.sobral/ensino/ine5680/material-cripto-seg/2014 1/Stallings/Stallings_Cryptography_and_Network_Security.pdf.
2. http://www.ijcsmc.com/docs/papers/January2015/V4I1201544.pdf.
3. http://nptel.ac.in/syllabus/106105031/.

# IV B. TECH. – I SEMESTER

## (19BM71531) **INFORMATION SECURITY LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** Course on Information Security

**COURSE DESCRIPTION:**

Windows Firewall Security Features, Introduction to wireshark tool, Pretty Good Privacy (PGP), Intrusion Detection System, SSL Certificate, and TSL.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the tools and techniques to ensure the information security and privacy for network applications.

CO2. Analyze SSL Certificate and encryption in web applications for security.

CO3. Analyze SSL and TLS protocols to secure TCP connections.

CO4. Implement IP Packet filtering for blocking in-bound packets.

CO5. Work independently or communicate effectively in oral and written forms.


**List of Exercises/List of Experiments:**

1. Find the Packet Information using Wireshark on our network.

2. Simulate traffic analyzing using wireshark.

3. Study of SSL (HTTPS) over HTTP to secure TCP connections.

4. Simulate Transport Layer Security protocol.

5. Create a simple web application and deploy it in Apache tomcat server and secure it using SSL certificates.

6. Simulate Pretty Good Privacy security protocol for email messages and individual files.

7. Simulate IP Packet filtering at host system in user Network.

8. Study windows firewall security features on the system allotted to you.

9. Create firewalls using ip tables in linux.


**REFERENCE BOOKS/LABORATORY MANUALS**:

1. Computer Security: Principles and Practices, William Stallings and Lawrie Brown, Pearson Education, ISBN 13-9780134794396

2. Computer Security: Art and Science, by Matt Bishop, Pearson Education, ISBN:9788177584257

**SOFTWARE/Tools used:**

- Windows Fire Wall
- PGP
- SSL
- Tomcat 7.0.104
- Snort
- Java
- Wireshark

**ADDITIONAL LEARNING RESOURCES:**

https://www.cengage.com/resource_uploads/downloads/1111138214_259146.pdf
https://www.cmu.edu/iso/aware/presentation/tepperphd.pdf
https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-12r1.pdf
https://www.cs.unibo.it/babaoglu/courses/security/resources/documents/intro-to-crypto.pdf
http://www.cs.kent.edu/~mallouzi/ccn%20Spring%202014/

# MINOR DEGREE IN
## VLSI AND EMBEDDED SYSTEMS

**Offering Department:** ELECTRONICS AND COMMUNICATION ENGINEERING

**Students of Eligible Branches:** CSE, CSSE, IT, EEE, EIE, ME and CE

## COURSE STRUCTURE

| Year & Semester | Course code | Course title | Contact Periods per week | | | | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | C | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem (2 Theory + 1 Lab) | 19BM50401 | Switching Theory and Logic Design | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM50402 | VLSI Design | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM50403 | Microcontrollers | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM50431 | Digital design Lab | - | - | 2 | 1 | 40 | 60 | 100 |
| III B.Tech. II-Sem. (2 Theory + 1 Lab) | 19BM60401 | ARM and AVR Microcontrollers | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM60402 | Testing and Testability | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM60403 | Low Power CMOS VLSI Design | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM60404 | Microprocessors and Microcontrollers | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM60431 | VLSI  Lab | - | - | 2 | 1 | 40 | 60 | 100 |
| IV B.Tech. I-Sem. (1 Theory + 1 Lab) | 19BM70401 | Embedded Systems | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM70402 | Real Time Systems | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM70403 | System-on-Chip Design and verification | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM70431 | Embedded Systems Lab | - | - | 2 | 1 | 40 | 60 | 100 |

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

## (19BM50401) SWITCHING THEORY AND LOGIC DESIGN

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**
Number system and Boolean algebra; Minimization; Analysis and synthesis of digital circuits; Asynchronous Sequential Logic & Programmable Memories.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of Boolean Algebra, various number systems and Logic gates to implement Digital Circuits.

CO2. Design subsystem by Analyzing combinational & sequential logic circuits for providing optimal solutions

CO3. Develop Asynchronous sequential logic and programmable memories for societal needs.

CO4. Design various programmable logic arrays using logic gates

**DETAILED SYLLABUS:**

**UNIT I: NUMBER SYSTEMS AND BOOLEAN ALGEBRA** (10 Periods)

Digital systems, Binary Numbers, Number base conversions, Complements of numbers, Signed binary numbers, Binary codes, Error detection and correction codes. Boolean Algebra-Basic definition, Basic theorems and properties, Boolean Functions, Canonical & Standard forms, logic operations & Logic gates.

**UNIT II: GATE LEVEL MINIMIZATION** (8 Periods)

The map method, four variable, Five variable K-map, POS & SOP Simplification, Don't care conditions, NAND & NOR Implementation, Other two level Implementation, Ex-or Function, Tabular Method- Simplification of Boolean function using tabulation Method.

**UNIT III: COMBINATIONAL LOGIC DESIGN** (9 Periods)

Combinational circuits, Analysis & Design procedure, Binary Adder-Sub tractor, Decimal Adder, Binary Multiplier, Magnitude comparator, Decoder, Encoders, Multiplexers and De-Multiplexers.

**UNIT IV: SEQUENTIAL LOGIC DESIGN** (11 Periods)

Sequential Circuits, Latches, Flip-Flops, Analysis of Clocked sequential circuits, State Reduction & Assignment, Design procedure, Introduction to Registers-Universal Shift Registers, Introduction to Counters, Ripple Counters-Binary and BCD Ripple Counter , Synchronous counters-Binary, Up-Down Binary Counter and BCD Counter and Other counters-Ring Counter, Johnson Counter.

**UNIT V: ASYNCHRONOUS SEQUENTIAL LOGIC AND PROGRAMMABLE MEMORIES**
**(7 Periods)**

Introduction, Analysis procedure, Design Procedure-Primitive Flow Table, Reduction of State and Flow Tables-Implication Table and Implied States, Hazards, ROM, PLA, PAL.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOK**:

1. M. Morris Mano, Michael D. Ciletti, *Digital Design With an Introduction to the Verilog HDL*, Pearson,5th edition, 2017.

**REFERENCE BOOKS**:

1. A. Anand Kumar, *Switching Theory and Logic Design*, PHI Learning Private Limited, 3rd edition, India, 2017.
2. Charles H. Roth, Jr. and Larry L. Kinney, *Fundamentals of Logic Design*, Cengage Learning, 7th edition, 2015

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Switching Theory and Logic Design/Digital Logic Design.

**COURSE DESCRIPTION:**

Logic Families; CMOS Technology; Stick Diagrams and Layouts; Subsystem design; Programmable Interconnect structures; Memories.

**COURSE OUTCOMES**:

After successful completion of this course, the students will be able to:

CO1.  Analyze logic families, steady state and dynamic characteristics of CMOS, to improve performance characteristics of digital ICs.

CO2.  Analyze electrical properties of MOS circuits for VLSI/ULSI chip fabrication.

CO3.  Develop stick diagrams and layouts of CMOS circuits for miniaturization by analyzing gate delays and scaling effects.

CO4.  Design subsystems for High speed digital electronics to compensate tradeoff among area, speed and power requirements.


**DETAILED SYLLABUS:**

**UNIT I: DIGITAL LOGIC FAMILIES                                (8 Periods)**

Introduction to logic families, RTL, DTL, Transistor-Transistor logic, Emitter Coupled Logic, $I^2L$, CMOS logic, CMOS steady state and dynamic electrical behavior.

**UNIT II: FABRICATION AND ELECTRICAL PROPERTIES OF MOS        (10 Periods)**

Fabrication Process for NMOS and CMOS technology, Basic Electrical Properties of MOS: $I_{ds}$ – $V_{ds}$ relationships, Second order effects of MOSFETs-Latch up, Hot carrier Effects, channel length modulation, Threshold Voltage $V_T$, $g_m$, $g_{ds}$ and $\omega_0$; Pass Transistor, NMOS inverter, Pull up to pull down ratio for an NMOS inverter, CMOS Inverter

**UNIT III: CMOS CIRCUIT DESIGN PROCESS                       (10 Periods)**

VLSI design flow, MOS layers, stick diagrams, NMOS design style, CMOS design style, lambda based design rules, layouts for inverters, sheet resistance, capacitances of layers, Gate delays, Delay estimation, Scaling, Limitations of Scaling.

**UNIT IV: SUBSYSTEM DESIGN - I                                (08 Periods)**

Adders – Transmission based Adder, Carry look-ahead adder, Manchester carry chain adder, Carry Skip Adder, Carry Select Adder; Barrel Shifter, Multipliers – Array Multiplier, Booth Multiplier; ALUs.

## UNIT V: SUBSYSTEM DESIGN - II                              (09 Periods)

Counters- Synchronous and Asynchronous Counter; High Density Memory Elements - Design Approach, FPGAs, Programmable Interconnect structures - Fusible links, Antifuse

via link, UV Erasable, Electrically Erasable; CPLDs, Cell based Design Methodology.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Kamran Eshraghian, Douglas A. Pucknell and sholeh Eshraghian, *Essentials of VLSI Circuits and Systems*, PHI, 2005.

2. Morris Mano, *Digital Design*, Prentice Hall, 3rd Edition, 2003 .

**REFERENCE BOOKS:**

1. John F.Wakerly, *Digital Design Principles & Practices*, Pearson Education Asia, 4th Edition, 2008.

2. John M. Rabaey, *Digital Integrated Circuits: A Design Perspective*, PHI, 2nd Edition, 2003.

## UNIT V: PIC - INTERFACING (8 Periods)

Interfacing of PIC18 to LCD – 4bit and 8 bit modes, DC motor & PWM, ADC Characteristics & interfacing, Sensor interfacing, Serial & Parallel DAC interfacing.

**TEXT BOOKS:**

1. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, "PIC Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Education, 1st Edition, 2008.

2. Kenneth J. Ayala, "The 8051 microcontroller", Cengage learning, 3rd edition, 2004.

**REFERENCE BOOKS:**

1. Mazidi, Mazidi and Mckinlay, "The 8051 microcontroller and embedded systems", Pearson Education, 2nd Edition, 2007.

2. John B. Peatman, "Design with PIC microcontrollers", Pearson Education, 1st Edition, 2002.

3. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2nd Edition, 2012.

**ONLINE LEARNING RESOURCES:**

1. https://nptel.ac.in/courses/108/105/108105102/

2. https://www.electronicshub.org/microcontrollers-tutorial/

## UNIT V:  PIC INTERFACING                                           (8 Periods)

7 segment LED and LCD interfacing, keyboard interfacing, interfacing ADC, DAC,

Interfacing DC motor, stepper motor, PWM using CCP.


**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*


**TEXTBOOKS:**

1. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D, *The 8051 Microcontroller and Embedded Systems-using assembly and C,* PHI, 2006/ Pearson New International Edition 2014

2. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny causey, *PIC Microcontroller and Embedded Systems: Using C and PIC18*, Pearson Education, 2015.


**REFERENCE BOOKS:**

1. Kenneth J. Ayala, *The 8051 Microcontroller-Architecture, Programming & Applications,* 3rd  Edition, Cengage learning, June 2007.

2. Ramesh S. Gaonkar, *Fundamentals of Microcontrollers and Applications in Embedded Systems (With PIC18 Microcontroller Family),* Penram International, 2010.

3. M Rafiquzzaman, *Microcontroller Theory And Applications With The PIC, Wiley India Publications, March 2014*


**ADDITIONAL LEARNING RESOURCES:**

1. http://crystal.uta.edu/~zaruba/CSE3442/

2. https://owd.tcnj.edu/~hernande/ELC343/

3. http://www.ciebookstore.com/Content/Images/uploaded/PIC18-Study-Guide-CIE.pdf

## (19BM50431) **DIGITAL DESIGN LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

Courses on Switching Theory and Logic Design/Digital Logic Design & Electronic Devices and Circuits.

**COURSE DESCRIPTION:**

Design and verification of Digital Circuits, PCB Design of Electronic Circuits.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Design and Realize various Digital applications by using ICs for societal needs.

CO2. Implement Electronic Circuits using Passive and Active elements for specified applications.

CO3. Analyze performance parameters for PCB designed circuits using a simulation tool.

CO4. Work independently and in teams to solve problems with effective Communication.

**LIST OF EXERCISES/LIST OF EXPERIMENTS:**

**Part-A: Realize the Following in Hardware**

(Minimum **Six** Experiments are to be conducted)

1. Realize gates using NAND & NOR gates.

2. Optimize and Realize a given Boolean Function.

3. Design and Realize BCD to Excess-3 Code Converter.

4. Design and Realize Adder and Subtractor using Multiplexer based on logic gates/ IC74153.

5. Design and Realize a BCD to 7-Segment Decoder using Logic Gates/ ICs.

6. Design and Realize a Hexadecimal to Binary Encoder using IC74148 and IC74157.

7. Design and Realize a Sequence Generator using IC7495.

8. Design and Realize Asynchronous and Synchronous counters using IC7476 (JK-Flip Flop).

**Part-B: PCB Layout Design of Electronic Circuits using TINAPRO/ eSIM-KiCAD/ TinyCAD/ Fritzing Software**

*(Minimum **Four** Experiments are to be conducted)*

1. RC Filter.
2. Half Wave Precision Rectifier.
3. Zener Regulator.
4. Diode Clamper.
5. Transistor as a Switch.
6. CMOS Inverter.

**REFERENCE BOOKS/LABORATORY MANUALS**:

1. John F. Wakerly, *Digital Design Principles & Practices*, Pearson Education Asia, 4thEdition, 2008.

**SOFTWARE/Tools used:**

TINAPRO/ eSIM-KiCAD/ TinyCAD PCB Design Tool.

**ADDITIONAL LEARNING RESOURCES:**

1. http://vlabs.iitb.ac.in/vlabsdev/vlab_bootcamp/bootcamp/cool_developers/index.html - Virtual labs for digital circuits
2. https://nptel.ac.in/courses/108/108/108108031/
3. https://swayam.gov.in/nd2_aic20_sp59/preview

# III B. Tech. – II Semester

## (19BM60401) ARM AND AVR CONTROLLERS

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Switching Theory and Logic Design/Digital Logic Design, & Microcontrollers

**COURSE DESCRIPTION:**

ARM Architecture; ARM Instruction Set; ARM Programming; AVR Architecture; AVR Programming in Assembly Language & C

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze ARM Architectures and Instruction Set to develop fundamental Programs .

CO2. Develop efficient ARM based Prototypes by analyzing modes of ARM operation to program ARM Cortex M3 at Assembly and high levels.

CO3. Realize efficient Embedded Systems with an understanding of limitations by evaluating architectural features of AVR Family Microcontrollers .

CO4. Apply Programming techniques at Assembly and High Level to develop industry standard microcontroller based systems.

**DETAILED SYLLABUS:**

**UNIT I: Introduction to ARM Architecture                                    (9 Periods)**

Introduction to ARM family of processors and controllers, Architecture of ARM Cortex M3, Cortex M3 fundamentals, registers, Operation modes, ARM Instruction Set: Data transfer, Data Processing Call & Branch, Bit Manipulation, Pseudo Instructions and other useful instructions in Cortex M3, ARM Assembly Language Programming.

**UNIT II: Thumb Programming & other ARM features            (9 Periods)**

Thumb Instruction Set, ARM Mode & Thumb mode Programming, ARM Programming in C. Memory system, memory map, Memory system attributes, ARM Pipeline, Exception types, Cortex M3 Processor applications.

**UNIT III: INTRODUCTION to AVR MICROCONTROLLER            (9 Periods)**

Overview of AVR family, AVR Microcontroller architecture, status register, Special function registers, RAM, ROM & EEPROM space, On-Chip peripherals, ATmega32 pin configuration & function of each pin, Fuse bits of AVR.

**UNIT IV: AVR ASSEMBLY LANGUAGE PROGRAMMING            (10 Periods)**

AVR data types and assembler directives, Addressing modes of AVR, Data transfer, Arithmetic, Logic and Compare, Rotate and Shift, Branch and Call instructions, AVR studio setup for assembly language programming, AVR I/O Port Programming, Time delay loop, Look-up table, Bit addressability, MACROs, Intel HEX file.

**UNIT V: AVR PROGRAMMIN IN  C**                                     **(8 Periods)**

AVR Data types, AVR I/O port programming, Timer programming, Input capture and Wave Generator, PWM programming External Interrupt programming, ADC programming, EEPROM programming.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Joseph Yiu, *The Definitive Guide to the ARM Cortex-M3 & M4*, Elsevier, 3$^{rd}$ Edition, January 2014.
2. Muhammad Ali Mazidi, SarmadNaimi and SepehrNaimi*, The AVR Microcontroller and Embedded Systems Using Assembly and C*, Pearson Education, January 2014.

**REFERENCE BOOKS:**

1. Ramesh Gaonkar, *Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)*, Penram International, First edition,2010
2. Andrew Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing  and Optimizing System Software (The Morgan Kaufmann Series in Computer Architecture and Design), October 2004.
3. AVR ATmega32 data sheet

(19BM60402)**TESTING AND TESTABILITY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on VLSI Design.

**COURSE DESCRIPTION:**

Need for Testing, Types of Testing, Fault Modeling, Test Methods for evaluation, Test Generation Algorithms, Delay Tests, IDDQ Tests, Ad-Hoc DFT Methods, Scan Based Designs, Built-In Self Test.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand the importance of Testing, fault models and related theorems.

CO2. Analyze various test methods, combinational and sequential circuit test generation Algorithms for Functional Verification of Digital Circuits.

CO3. Analyze delay test algorithms and IDDQ test algorithms for at-speed testing of CMOS Integrated Circuits.

CO4. Understand the concepts and architectures for Built-In Self Testto satisfy industry specifications.

**DETAILED SYLLABUS:**

**UNIT I**: **INTRODUCTION TO TESTING** **(09 Periods)**

Role of Testing, VLSI Technology Trends Affecting Testing, Types of Testing, Test Economics, Yield, Fault Modeling, Fault Equivalence, Fault Collapsing, Fault Dominance and Checkpoint Theorem.

**UNIT II: TEST METHODS** **(10 Periods)**

Simulation for Design Verification and Test Evaluation, Algorithms for Fault Simulation – Serial, Parallel, Deductive, Concurrent Fault Simulations; Fault Sampling.

**UNIT III: COMBINATIONAL AND SEQUENTIAL CIRCUIT TEST GENERATION**

**(11 Periods)**

ATPG Algorithms – D-Algorithm, PODEM, FAN; Test Compaction, Time Frame Expansion Method – Nine-Value Algorithm; Simulation Based Sequential ATPG - CONTEST Algorithm.

**UNIT IV: DELAY AND IDDQ TESTS** **(06 Periods)**

Delay Test – Path-Delay Test, Transition Faults, At-Speed Testing; IDDQ Test –Limitations, Delta IDDQ Testing, IDDQ Built-in Current Testing.

**UNIT V: DESIGN FOR TESTABILITY** **(09 Periods)**

Ad-Hoc DFT Methods, Full Scan Design, Partial Scan Design, Random Logic BIST – Test-per-Clock and Test-per-Scan BIST Systems; Boundary Scan Standard – TAP Controller and Port.

**Total Periods: *45***

**TEXTBOOK:**

1. Michael L. Bushnell, Vishwani D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Pulishers, Springer US, New York, 2006.

**REFERENCE BOOKS:**

1. Miron Abramovici, Melvin A. Breur, Arthur D.Friedman, "Digital Systems Testing and Testable Design", Wiley, Jaico Publishing House, 1st Edition, 2001.

2. Alfred L. Crouch, "Design for Test for Digital ICs & Embedded Core Systems", Pearson Education, 1st Reprint Edition, 2007.

3. Robert J.Feugate, Jr., Steven M.Mclntyre, "Introduction to VLSI Testing", Prentice Hall, 1st Illustrated Edition,1998.

**ADDITIONAL LEARNING RESOURCES:**

1. https://www.classcentral.com/course/swayam-digital-vlsi-testing-7956

## (19BM60403) **LOW POWER CMOS VLSI DESIGN**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on VLSI Design.

**COURSE DESCRIPTION:**

Basic Principles; Methodologies and techniques of CMOS Circuit Designs; Need For Low Power VLSI Design; Principles Of Low Power Circuit Design; Simulation Analysis of Low Power; Logic and Circuit Analysis; Special Techniques and Advanced Techniques Of Low Power Design; Performance Management in Architecture or System level.

**COURSE OUTCOMES**:

After successful completion of this course, the students will be able to

CO1. Demonstrate low power design requirements for CMOS VLSI circuits.

CO2. Analyze and estimate power at Logic and Circuit abstraction levels of digital systems.

CO3. Develop alternate circuits and logic for analysis of low power circuits.

CO4. Apply special and advanced low power techniques at circuit, architecture and system levels to develop CMOS devices.

**DETAILED SYLLABUS:**

**UNIT I: BASICS OF LOW POWER DESIGN** **(07 Periods)**

Needs For Low Power VLSI Chips, Charging And Discharging Capacitances, Short Circuit Current in CMOS, CMOS Leakage Current, Static Current, Basic Principles Of Low Power Design, Low Power Figure Of Merits, Low Power VLSI Design Limits.

**UNIT II: POWER ANALYSIS AND ESTIMATION** **(10 Periods)**

Spice Circuit Simulation, Discrete Transistor Modeling and Analysis, Gate Level Logic Simulation, Architecture Level Analysis, Data Correlation Analysis, Monte Carlo Simulation.

**UNIT III: LOW POWER CIRCUITS** **(11 Periods)**

**Circuit Analysis:** Transistor and Gate Sizing, Equivalent Pin Ordering, Network Restructuring and Reorganization, Special latches and Flip flops.

**Logic Analysis:** Gate Reorganization, Signal Gating, Logic Encoding, State Machine Encoding, Pre computation Logic.

**UNIT IV: SPECIAL TECHNIQUES** **(08 Periods)**

Power Reduction in Clock Networks, CMOS Floating Node, Low Power Bus, Delay Balancing,Low Power Techniques for SRAM.

**UNIT V:  ARCHITECTURE, SYSTEM & ADVANCED TECHNIQUES          (09 Periods)**

Power and Performance Management, Switching Activity Reduction, Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuit.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOK:**

1. Gary Yeap, *Practical Low-Power Digital VLSI Design*, Springer Publication, 2012.

**REFERENCE BOOKS:**

1. A.P.Chandrakasan, R.W.Broadersen, *Low Power Digital CMOS Design*, Kluwer, Springer US, 2012.

2. Kaushik Roy, Sharat Prasad, *Low-Power CMOS VLSI Circuit Design*, Wiley Student Edition, 2009.

**ADDITIONAL LEARNING RESOURCES:**

https://nptel.ac.in/courses/106/105/106105034/

https://nptel.ac.in/courses/117/101/117101004/

(19BM60404) **MICROPROCESSORS AND MICROCONTROLLERS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Switching Theory and Logic Design/Digital Logic Design.

**COURSE DESCRIPTION:**

Architecture, Instruction set and programming of 8086; Programmable interfacing devices - architecture and programming; Interfacing Memory and I/O devices with 8086; 8051 Microcontroller - Architecture, programming, interrupts and applications.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze Architectural features and Instruction Set of 8086 for computing applications.

CO2. Analyze Techniques for Interfacing various peripherals to realize Microcomputer based systems

CO3. Analyze Architectural features and Instruction Set of 8051 for control applications.

CO4. Design various embedded applications programming 8051 on-chip Resources and by interfacing various peripherals.

**DETAILED SYLLABUS:**

**UNIT I: 8086 ARCHITECTURE AND PROGRAMMING**　　　　　　　**(10 Periods)**
Microprocessor Evolution, Review of Intel 8085, 8086 internal Architecture - register organization, memory segmentation, memory organization; Introduction to programming the 8086 - Assembler directives, addressing modes, instruction set, simple programs, procedures and macros;

**UNIT II: 8086 INTERFACING AND INTERRUPTS**　　　　　　　**(08 Periods)**
Pin description, minimum & maximum mode operation of 8086, timing diagram. Interfacing memory (RAM and EPROM) to 8086. 8086 Interrupts - types and interrupt responses, Interrupt vector table, priority of interrupts; 8259 priority interrupt controller - architecture, system connections and cascading, initialization of 8529;

**UNIT III: PROGRAMMABLE DATA COMMUNICATION DEVICES**　　　**(11 Periods)**
Introduction to serial and parallel communication, methods of parallel data transfer. 8255 PPI - Internal architecture and system connections, operational modes and initialization, interfacing stepper motor, ADC, DAC, Optical Shaft Encoder; Methods of serial data transfer, 8251 USART - architecture and its initialization, sending and receiving characters; Serial communication standard - RS232C, USB; Architecture and operation of 8257 DMA controller.

**UNIT IV: MICROCONTROLLERS AND PROGRAMMING**　　　　　　**(08 Periods)**
Microcontroller Vs. General purpose microprocessor, 8051/8052 Microcontroller – architecture, features, register organization, pin diagram, internal and external memories & their interfacing, instruction set, addressing modes, simple programs;

**UNIT V: 8051 INTERFACING**                                              **(08 Periods)**

Timer/Counters – Registers, modes and programming; Serial communication – registers, programming 8051 for serial communication; Interrupts – registers, programming; 8051 applications – Interfacing key board, LEDs and LCD;

**Total Periods: 45**

***Topics for self-study are provided in the lesson plan.***

**TEXTBOOKS:**

1. Douglas V. Hall, *Microprocessors and Interfacing: Programming and Hardware,* Tata McGraw-Hill, revised 2nd Edition, 2006.
2. Muhammad Ali Mazidi and Janice Gillispie Mazidi, *The 8051 Microcontroller and Embedded Systems,* Prentice Hall of India, 2000.

**REFERENCE BOOKS:**

1. A.K. Ray and K.M. Bhurchandi, *Advanced Microprocessors and Peripherals-Architecture, Programming and Interfacing,* Tata McGraw Hill, 2002 reprint.
2. Kenneth J. Ayala, *The 8051 microcontroller, Thomson Delmar learning,* 3rd Edition, 2004.

## III B. Tech. – II Semester

(19BM60431) **VLSI LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:**

A course on Switching Theory and Logic Design/ Digital Logic Design.

**COURSE DESCRIPTION**:

Design and verification of various combinational & sequential digital circuits through source code.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze simplification methods in logic circuits and perform desired logical operations optimally using logic gates.

CO2. Design combinational circuits to perform arithmetic operations, data encoding and decoding, Multiplexing and Demultiplexing for engineering applications.

CO3. Design sequential circuits for realizing counters and registers using flip-flops.

CO4. Develop source code for Advanced Digital Design and perform functional verification.

CO5. Work independently or in teams to solve problems with effective Communication.

**LIST OF EXERCISES/LIST OF EXPERIMENTS:**

**Part-A: Basic Digital Design**

*(Minimum **SEVEN** experiments are to be conducted)*

Develop the source code for the following circuits and their test bench for verification. Also perform simulation, synthesis for given specifications.

1. Buffer and basic gates.

2. Flip flops - RS, D, JK, T.

3. Adders and Subtractors.

4. 8-3 Encoder.

5. 3-8 Decoders.

6. 8x1 Multiplexer and 2x4 Demultiplexer.

7. Arithmetic and Logic Unit.

8. Synchronous &Asynchronous counter.

9. 4 Bit Comparator

**Part-B: Advanced Digital Design (FPGA Implementation)**

*(Minimum **THREE** Experiments are to be conducted)*

1. Write Verilog code for the design of 8-bit
   i. Carry Ripple Adder
   ii. Carry Look Ahead adder
   iii. Carry Save Adder

2. Write Verilog Code for the design of 8-bit
   i. Array Multiplier (Signed and Unsigned)
   ii. Booth Multiplier (Radix-4)
3. Write Verilog code for the design of 4/8-bit
   i. Universal Shift Register
   ii. Parity Generator

4. Write Verilog code for the design of 4/8-bit

   i. Pseudo Random  Pattern Generator
   ii. LFSR

5. Design a Mealy and Moore Sequence Detector using Verilog to detect Sequence.

   Eg. 11101 (with and without overlap) any sequence can be specified


**Note:** (For the experiments listed above, students can make the following flow of study

   -RTL synthesis

   -creation of power Analysis

   -use of I/O constrains)


**REFERENCE BOOKS/LABORATORY MANUALS**:

1. M. Morris Mano, Digital Design, Pearson Education, 5th edition, 2013.

2. Charles H. Roth, Fundamentals of Logic Design, Thomson Publications, 5th edition, 2004.

3. John F. Wakerly, Digital Design Principles & Practices, Pearson Education Asia, 4th Edition, 2008.

4. Stephen Brown and ZvonkoVramesic, Fundamentals of Digital Logic with VHDL Design, McGraw Hill, 2nd Edition, 2005.


**SOFTWARE/Tools used:**

CADENCE/SYNOPSYS/MENTOR GRAPHICS/TANNER or any other equivalent Tool FPGA/CPLD Boards with Xilinx or any other equivalent

**ADDITIONAL LEARNING RESOURCES:**

1. http://www.vlab.co.in

2. https://swayam.gov.in

## IV B. Tech. – I Semester

### (19BM70401) **EMBEDDED SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on Microcontrollers/Microprocessors and Microcontrollers.

**COURSE DESCRIPTION:**

MSP430 Architecture; Instruction Set; Programming; On-Chip Resources; Communication with peripherals; Embedded system design approaches.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze MSP430 Architecture, Instruction Set, Addressing modes to develop programs for various control applications using Assembly and Embedded C.

CO2. Solve Problems by analyzing MSP430 On Chip Resources such as Timer, Clock System, Low Power Modes/techniques and Interrupt Structure.

CO3. Realize Mixed Signal Processing and Networking Applications, by analyzing on-Chip Resources such as Comparator, ADC, Temperature Sensor, PWM and Communication Peripherals.

CO4. Analyze Language, IDE Support, Processor IC & Design Technologies, and System Modeling Techniques to capture behavior of Embedded Prototype using suitable model.


**DETAILED SYLLABUS:**

**UNIT I: ARCHITECTURE OF MSP430                    (09 periods)**

Embedded Systems – Introduction, MSP430 - Anatomy of microcontroller, Memory, Software, Pin out (MSP430G2553), Functional Block diagram, Memory, CPU, and Memory mapped input and output, Clock generator; Exceptions- Interrupts and Resets.

**UNIT II: PROGRAMMING MSP430                    (09 periods)**
Development Environment, Aspects of C for Embedded Systems, Assembly Language, Register Organization, Addressing Modes, Constant Generator and Emulated Instructions, Instruction Set, Example programs- Light LEDs, Read input from a switch; Automatic Control-Flashing light by delay, use of subroutines and Functions; Basic Clock System, Interrupts and Low Power Modes.

**UNIT III: TIMERS AND MIXED SIGNAL SYSTEMS                    (09 periods)**

Timers - Watchdog Timer, RTC, Timer A, Measurement in capture mode, PWM generation; Mixed Signal Systems- Comparator A, ADC10 SAADC –Architecture, operation- Single Conversion, Temperature Sensor on ADC10, DTC in ADC10; ADC12 – Comparison with ADC10.

**UNIT IV: COMMUNICATION PERIPHERALS & PROTOCOLS                    (09 periods)**

MSP430 Communication Interfaces- USART,USCI, USI;

Communication Protocols- SPI, Inter-integrated Circuit Bus, USB, CAN

**UNIT V:  EMBEDDED SYSTEM DESIGN**                                    **(09 periods)**

Processor Technology, IC Technology, Design Technology, Tradeoffs.

Model VS.Language, System Modelling – Data Flow Model, FSM, FSMD, HCFSM, PSM, Concurrent Process Model & implementation.

**Total Periods: *45***


*Topics for self-study are provided in the lesson plan.*


**TEXTBOOKS:**

1.  John H. Davies, *MSP430 Microcontroller Basics*, Newnes Publications, 1stEdition, 2008.

2.  Santanu Chattopadyay, Embedded System Design, PHI, 2010.

3.  Frank Vahid, Tony D. Givargis, *Embedded System Design – A Unified Hardware/Software Introduction,* John Wiley, January 2006


**REFERENCE BOOKS:**

1.  Chris Nagy, *Embedded Systems Design using the TI MSP30 Series*, Newnes Publications, October 2003.

2.  JorgeonStaunstrup, Wayne Wolf, *Hardware/Software Co-design Principles and Practice*, Springer 2009.

3.  Patrick R Schamont, *A Practical Introduction to Hardware/Software Co-design, Springer publications*, January 2010

# IV B. Tech. – I Semester

## (19BM70402) REAL TIME SYSTEMS

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Microcontrollers/ Microprocessors and Microcontrollers & Embedded Systems.

**COURSE DESCRIPTION:**

Real Time Systems Modeling; Scheduling Approaches; Multiprocessor and Distributed Scheduling Algorithms; Fault Tolerant Systems; Real Time Operating Systems.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Analyze Real Time System Characterization, Workload and Resource management algorithms and apply suitable techniques to model hard and soft real time systems.

CO2.  Solve scheduling problems and apply suitable techniques in constrained RT systems by Surveying various Real Time scheduling approaches for uniprocessor, Multiprocessor and distributed environments.

CO3.  Evaluate appropriate Fault tolerant techniques and apply them to design fail safe RT systems.

CO4.  Implement Efficient Real Time Systems porting suitable operating system on to hardware by Investigating POSSIX standard Kernel structure, services and Kernel objects.

**DETAILED SYLLABUS:**

**UNIT I: MODELING OF REAL TIME SYSTEMS                    (9 Periods)**

Hard Vs Soft Real Time Systems,  A Reference Model of Real Time Systems- Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency. Functional Parameters, Resource Parameters of Jobs and Parameters of Resources, Scheduling hierarchy.

**UNIT II: APPROACHES TO REAL TIME SCHEDULING             (9 Periods)**

Clock Driven, Weighted Round Robin, Priority Driven, Dynamic Vs Static Systems, Effective Release Times and Dead Lines, Optimality and Non-optimality of EDF and LST algorithms, Challenges in Validating Timing Constraints in Priority Driven Systems, Offline Vs Online Scheduling.

**UNIT III: SCHEDULING REAL TIME TASKS IN MULTIPROCESSOR AND DISTRIBUTED SYSTEMS                                     (9 Periods)**

Multiprocessor task allocation, Dynamic allocation of tasks, Fault tolerant scheduling of tasks, Clocks in distributed Real Time Systems, Centralized clock distribution, Distributed clock synchronization.

**UNIT IV: FAULT TOLERANCE TECHNIQUES**                              **(9 Periods)**

Introduction, Failures- Causes, Types, Detection. Fault and Error Containment, Redundancy- Hardware, Software, Time, Integrated Failure Handling.

**UNIT V: OPERATING SYSTEMS**                                       **(9 Periods)**

Overview- Threads and Tasks, the Kernel. Time Services and Scheduling Mechanisms, Basic Operating System Functions- Communication and Synchronization, Event Notification and Software Interrupt Memory Management, I/O and Networking. Processor Reserves and Resource Kernel, Capabilities of Commercial Real Time Operating Systems.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Jane W.S. Liu, "Real Time Systems", Pearson Education, 1st Edition, 2006.

2. Rajib Mall, "Real Time Systems-Theory and Practice", Pearson Education India, 1st Edition, Nov.2012.

3. C. M. Krishna, Kang G Shin, "Real Time Systems", MCgraw-Hill Series, Dec. 1996.

**REFERENCE BOOKS:**

1. Phillip A. Laplante and Seppo J. Ovaska, "Real-Time Systems Design and Analysis: Tools for the Practitioner", Wiley-IEEE Press, 4th edition, Nov. 2011.

2. Hermann Kopetz, "Real-Time Systems: Design Principles for Distributed Embedded Applications ", Springer; 2nd Edition, 2011.

(19BM70403) **SYSTEM-ON-CHIP DESIGN AND VERIFICATION**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A Course on VLSI Design.

**COURSE DESCRIPTION:**

System on Chip Design (SOC) Process; System level Design Issues; Test Strategies; Macro Design and Verification; Reusable Macros; System on Chip Verification; Communication Architectures for SoCs.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate various SoC Design aspects and issues in low power and high speed Implementations.

CO2. Analyze the Macro Design Process to solve issues in usage of hard macros and Develop reusable macros for system integration.

CO3. Analyze verification methods at system level, block level and Hardware/Software Co-verification to reduce the test time.

*CO4.* Apply various communication architectures to design energy efficient systems.

**DETAILED SYLLABUS:**

**UNIT I**: **SYSTEM ON CHIP DESIGN PROCESS**                    (08 Periods)

A canonical SoC Design, SoC Design flow- waterfall vs spiral, top down vs Bottom up. Specification requirement, Types of Specification, System Design process, System level design issues - Soft IP Vs Hard IP, Design for timing closure - Logic design issues, Verification strategy, Onchip buses and interfaces, Design for Low Power, Manufacturing test strategies.

**UNIT II: MACRO DESIGN PROCESS**                    (07 Periods)

Overview of IP Design, planning and Specification, Macro Design and Verification, Soft Macro Productization, Developing hard macros - Design issues for hard macros, Model Development for Hard Macros. System Integration with reusable Macros.

**UNIT III: SoC VERIFICATION - I**                    (12 Periods)

Technology Challenges, Verification technology options, Verification methodology, Testbench Creation, Testbench Migration, Verification languages, Verification IP Reuse, Verification approaches, Verification and Device Test, Verification plans, Bluetooth SoC. System level verification – System Design, System Verification.

Block level verification – IP Blocks, Block Details of Bluetooth SoC, Lint Checking, Formal Model Checking, Functional Verification/Simulation, Protocol Checking, Directed Random Testing, Code Coverage Analysis

## UNIT IV – SoC Verification - II                                    (12 Periods)

Hardware/Software Co-verification- HW/SW Co-verification Environment, Emulation, soft or virtual Prototypes, Co-verification, UART Co-verification, Rapid Prototype Systems, Software Testing. Static netlist verification, Physical Verification and Design Signoff, Introduction to VMM (Verification Methodology Manual), OVM(Open Verification Methodology) and UVM (Universal Verification Methodology).

## UNIT V: DESIGN OF COMMUNICATION ARCHITECTURES FOR SoCs  (06 Periods)

On chip communication architectures, System level analysis for designing communication, Design space exploration, Adaptive communication architectures- Communication architecture tuners. Communication architectures for energy/battery efficient systems. Introduction to bus functional models and bus functional model based verification.

**Total Periods: *45***

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1.  Michael Keating, Pierre Bricaud, "Reuse Methodology manual for System On A Chip Designs", Kluwer Academic Publishers, Springer US, 3rd Edition, 2007.

2.  Prakash Rashinkar, Peter Paterson and Leena Singh, "SoC Verification Methodology and Techniques", Kluwer Academic Publishers, Springer US, 2013.

3.  A.A. Jerraya, W.Wolf, "Multiprocessor Systems-on-chips", M K Publishers, Elsevier Science, 2005.

**REFERENCE BOOKS:**

1.  William K. Lam, "Hardware Design Verification: Simulation and Formal Method based Approaches", Prentice Hall, 1st Edition, 2005.

2.  Farzed Nekoogar, Faranak Nekoogar, "From ASICs to SOCs: A Practical Approach", China Machine Press, 2006.

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

A Course on Microcontrollers.

**COURSE DESCRIPTION:**

Familiarization using IDE – CCS, Energia; Instruction Set usage; GPIO – programming; Watchdog timer; Timer, ADC, Comparator – Programming; Low Power Modes demonstration; PWM generation – Speed Control of DC Motor; Networking MSPs.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze MSP430 Architecture, Instruction Set and Demonstrate Competence in developing programs using Assembly and Embedded C.

CO2. Solve various Problems using CCS and Energia IDE effectively by evaluating various on-chip resources.

CO3. Develop programs to realize control applications such as Speed control of DC Motor, Reading Ambient Temperature by investigating various interfacing techniques.

CO4. Survey usage of MSP430 for Mixed Signal Processing and IOT Applications to establish communication deploying various protocols.

CO5. Work independently and in teams to solve problems with effective Communication.

**LIST OF EXERCISES/LIST OF EXPERIMENTS:**

*(Minimum Ten Experiments to be done)*

1. Introduction to MSP430 launch pad and Programming Environment.

2. Practice on usage of Instruction Set

3. Read input from switch and Automatic control/flash LED (software delay).

4. Interrupts programming example using GPIO.

5. Configure watchdog timer in watchdog & interval mode.

6. Configure timer block for signal generation (with given frequency).

7. Read Temperature of MSP430 with the help of ADC.

8. Test various Power Down modes in MSP430.

9. Generation of Pulse Width Modulation.

10. Use Comparator to compare the signal threshold level.

11. Speed Control of DC Motor

12. Master slave communication between MSPs using SPI.

13. Networking MSPs using Wi-Fi.

**REFERENCE BOOKS/LABORATORY MANUALS**:

1. John H Davies, *MSP430 Microcontrollers Basics*, Newnes Publishers, 1stEdition, 2008.
2. C P Ravikumar, *MSP430 Microcontrollers in Embedded System Projects*, Elite Publishing House , 1stEdition, 2012.

**SOFTWARE/Tools used:**

Code Composer Studio Version 6, Energia, MSP430 launch pads, Wi-Fi booster pack.

# MINOR DEGREE IN

## POWER SYSTEMS AND DRIVES

**Offering Department:** ELECTRICAL AND ELECTRONICS ENGINEERING

**Students of Eligible Branches:** CSE, CSSE, IT, ECE, EIE, ME and CE

## COURSE STRUCTURE

| Year & Semester | Course Code | Course Title | Contact Periods per week | | | | Credits (C) | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem (2 Theory + 1 Lab) | 19BM50201 | Electrical Engineering Materials | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50202 | Electricity Safety and Practices | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50203 | Sustainable Energy Resources | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50231 | Electrical Workshop Practice | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| III B.Tech. II-Sem (2 Theory + 1 Lab) | 19BM60201 | Principles of Energy Auditing and Conservation | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60202 | Special Machines and their Controllers | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60203 | Utilization of Electrical Energy | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60231 | Auditing and Conservation Practice lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| IV B.Tech. I-Sem (1 Theory + 1 Lab) | 19BM70201 | Power Electronic Converters | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70202 | Fundamentals of Electric Vehicles | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70203 | Protection of Electrical systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70231 | Simulation of Electrical Systems lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |

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**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

(19BM50201) **ELECTRICAL ENGINEERING MATERIALS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Basic Electrical and Electronics Engineering.

**COURSE DESCRIPTION:**

Dielectric properties of organic and inorganic materials and their required properties; Dielectric properties of insulators in static fields and alternating fields; Breakdown of dielectric materials in presence of high voltages; polymer insulation materials and their behaviour in presence of High voltages; Applications of various dielectric materials in high voltage equipment.

**COURSE OUTCOMES:**

After successful completion of the course, students will be able to

CO1. understand the dielectric properties of various organic and inorganic materials and their suitability for high voltage applications.

CO2. realize the behavior of dielectric materials in the presence of static and in alternating fields.

CO3. understand the breakdown mechanism of various dielectric materials in the presence of high voltages.

CO4. realize the various polymer type insulation system for high voltage applications and the breakdown mechanism in composite insulation system.

CO5. understand the suitability of various dielectric materials for various high voltage equipment.

**DETAILED SYLLABUS:**

**UNIT I: CONDUCTING AND SEMICONDUCTOR MATERIALS        (07 Periods)**

Ohms law and relaxation time of electrons, Electron scattering and resistivity of metals, thermal conductivity of metals, superconductivity; classification of semiconductors, Energy gap, conductivity in intrinsic semiconductors, Hall Effect and carrier density.

**UNIT II: DIELECTRIC PROPERTIES OF INSULATORS IN STATIC FIELDS AND ALTERNATING FIELDS                                             (08 Periods)**

Dielectric Properties of Insulating Materials, Various Types of Polarization in Dielectrics; Static dielectric constant, Polarization and dielectric constant, Internal fields in solids and liquids, static dielectric constant of solids, spontaneous polarization; Frequency dependency of polarization, Ionic polarization, complex dielectric constant, dipolar relaxation, dielectric losses.

**UNIT III: BREAKDOWN PHENOMENA OF DIELECTRIC MATERIALS     (12 Periods)**

**Breakdown in Gases** — Townsend's theory, Streamer's theory, breakdown in electro negative gases, Paschen's law, time lags of breakdown; insulation co-ordination.

**Breakdown in Solid Dielectrics** — Thermal breakdown and electro mechanical breakdown, treeing and tracking, Internal discharges.

**Breakdown in Liquid Dielectrics** — Suspended particle theory and stressed oil volume theory.

## UNITIV: POLYMER AND COMPOSITE INSULATING MATERIALS (09 Periods)

Polymeric Organic Materials, Thermoplastic Polymers, Thermoset Polymers, Polymer Compounds, Polyvinylchloride (PVC), Polyethylene (PE), Epoxy resins; Composite Insulating System—Impregnated Paper as a Composite Insulation System, Insulating Board Materials, Fiber Reinforced Plastics, Breakdown in composite insulators.

## UNIT V: APPLICATIONS OF INSULATION MATERIALS (09 Periods)

Applications in Power Transformers, Applications in Rotating Machines, Applications in Circuit Breakers, Applications in Cables, Applications in Power Capacitors, Applications in Electronic Equipment.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Dekker, Adrianus J. *Electrical engineering materials*. Prentice-Hall, 1959.
2. Naidu MS. *High voltage engineering*. Tata McGraw-Hill Education; 2013 Jun 16.

**REFERENCE BOOKS:**

1. Arora, Ravindra, and Wolfgang Mosch. *High voltage and electrical insulation engineering*. Vol. 69. John Wiley & Sons, 2011.

(19BM50202) **ELECTRICITY SAFETY AND SAFE PRACTICES**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Basic Electrical and Electronics Engineering.

**COURSE DESCRIPTION:**

The course deals with the various aspects of potential risk due to electrical shock; safety precautions to be followed while working in hazardous zones; safe practices while handling various electrical equipment and during maintenance; and relevant electrical safety standards and Indian rules and acts.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand the Indian electricity rules, regulations and various standards to be maintained for safety of life and equipment.

CO2. Understand the potential effects of electrical shock and safety measures to protect against such risk.

CO3. Understand the safety aspects and safe practices to be followed while installing residential, commercial and agricultural appliances.

CO4. Identify various hazardous working zones and take necessary precautionary measures while working in such areas.

CO5. Follow safety measures during installation, testing, commissioning and maintenance of electrical equipment/plant.

**DETAILED SYLLABUS:**

**UNIT I: INDIAN ELECTRICITY RULES AND ACTS** (09 Periods)

OSHA standards o electrical safety, Basic electrical safety rules as per OSHA; Objectives and scope of IE acts and IE rules; Significance of Equipment earthing, Earthing of equipment bodies, structures and non-current carrying metallic parts, earthing of system neutral; Rules regarding first aid and firefighting facility, Electrical safety general requirements as per IE rules.

**UNIT II: ELECTRICAL SAFETY AND SAFETY MANAGEMENT** (10 Periods)

**Electric Safety:** Terms and definitions, objectives of safety and security measures, Hazards associated with electric current and voltage, Protection against electrical hazards and types, Effect of current on human body, Principles of electrical safety and approach to prevent accidents.

**Electric Shocks and its Prevention:** Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns.

**UNIT III: ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS** (08 Periods)

Introduction—Wiring and fitting; Domestic appliances—water tap giving shock, shock from wet wall, fan firing shock; Multi-storied building, Temporary installations, Agricultural pump

installation; Do's and Don'ts for safety in the use of domestic electrical appliances; Principles of safety management in electrical plants.

## UNIT IV: ELECTRICAL SAFETY IN HAZARDOUS AREAS                     (08 Periods)

Hazardous zones—class 0, 1 and 2; Sparks, flashovers and corona discharge in electrical plants; equipment for hazardous locations; Equipment/Enclosures for hazardous gases and vapours; Classification of Enclosures for hazardous locations; Explosives and provisions of Explosives Act.

## UNIT V: SAFETY DURING INSTALLATION, TESTING AND MAINTENANC

**(10 Periods)**

**Safety during installations:** Preliminary preparations, preconditions for start of installation work and safe sequence, safety aspects during installations.

**Safety during testing:** Purpose of commissioning checks and tests, equipment tests, high voltage energization tests, performance and acceptance tests, safety aspects during commissioning.

**Safety during maintenance:** Operators safety, Types of safety maintenance, Safety procedures, safety precautions during maintenance, planning of maintenance.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan**

**TEXTBOOKS:**

1. S.Rao, Prof. H.L.Saluja, "*Electrical Safety, Fire Safety Engineering and Safety Management*", 2nd edition, Khanna Publishers. New Delhi, 2018 Reprint.

**REFERENCE BOOKS:**

1. Cadick, John, Mary Capelli-Schellpfeffer, and Dennis K. Neitzel. *Electrical safety handbook.* McGraw-Hill Education, 2012.

**ADDITIONAL LEARNING RESOURCES:**

**Indian Electricity acts:**

1. https://cercind.gov.in/Act-with-amendment.pdf
2. https://www.indiacode.nic.in/handle/123456789/2058?view_type=browse&sam_han dle=123456789/1362

# III B. Tech. – I Semester

## (19BM50203) SUSTAINABLE ENERGY RESOURCES

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** Course on Basic Electrical and Electronics Engineering

**COURSE DESCRIPTION:** Concepts of non-conventional and hybrid energy systems; Operational modes of Co-generation and their economic benefits.

**COURSEOUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand the impacts of conventional energy resources on environment and realize various measures to minimize the greenhouse gas effects.
CO2. Understand the generating principles and operational aspects of energy from solar.
CO3. Understand the generating principles and operational aspects of wind energy conversion technologies.
CO4. Understand the generating principles and operational aspects of  Ocean energy, Biomass and geothermal energy conversion technologies.
CO5. Asses the energy harnessing methods and develop a hybrid energy and energy storage systems.

**DETAILED SYLLABUS:**

**UNIT I: ENVIRONMENTAL ASPECTS OF POWER GENERATION FROM CONVENTIONAL SOURCES** **(07 Periods)**

Impact of conventional sources on Environment; Limitation of fossil fuels – effects of hydro-electric projects - Atmospheric pollution – Green House Gases (GHG) emission from various energy sources and its effects – disposal of nuclear waste— need for renewable energy sources.

**UNIT II: ENERGY FROM SOLAR** **(11 Periods)**

Introduction, solar radiation, measurement of solar radiation—pyranometer; solar energy collectors; flat plate collectors— liquid and air (non-porous) types; Focusing type— parabolic & point types; solar photovoltaic system— PV cell and its types, configuration of solar panel, PV system; Applications: solar pump, solar water heater.

**UNIT III: ENERGY FROM WIND** **(08 Periods)**

Introduction, power extraction from the wind, Wind turbines— horizontal axis wind turbine— propeller type and vertical axis wind turbine— darrieus rotor type; basic components of wind energy conversion systems, Applications: energy storage, water pumping; environmental impacts.

**UNIT IV:  ENERGY FROM OCEAN, BIOMASS AND GEOTHERMAL RESOURCES**

**(11 Periods)**

**Energy from ocean:** Introduction, ocean thermal energy conversion (OTEC): open and closed cycle power plants; tidal energy: schematic diagram of tidal power plant; advantages and disadvantages.

**Energy from Biomass:** Introduction, biomass conversion technologies-direct, thermochemical and biochemical conversions; biogas generation—anaerobic digestion process.

**Geothermal energy**: Introduction, Geothermal resources, geothermal power plants—vapor dominated and liquid dominated; environmental issues.

**UNIT V: COGENERATION AND HYBRID ENERGY SYSTEMS          (08 Periods)**

**Cogeneration-** Electricity generating systems, Economic and Environmental benefits. Operational modes of co-generation.

**Hybrid energy systems:** Need for hybrid systems, configuration and coordination, Block diagram approach of Stand-alone PV-wind system, PV-Diesel and Wind-diesel; energy storage systems — ultra capacitors, SMES.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Rai, G.D., *Non-conventional Energy Sources*, Khanna Publishers, New Delhi, 2017.
2. *S.Rao, Dr.B.B.Parulekar, Energy Technology,* 3rd edition, Khanna publications, 2013.

**REFERENCE BOOKS:**

1. J K Kaldellis, *Stand-alone and Hybrid Wind Energy Systems*, Wood head, publishing, 1st Edition 2010.
2. David Flin, Cogeneration: *A User's Guide. Renewable energy series*, Vol. 11. IET, 2010.
3. D P Kothari, K C Singal and Rakesh Ranjan, '*Renewable Energy Sources and Emerging Technologies'* 2nd Edition, 2012.
4. S N Bhadra, D Kastha and S Banerjee, '*Wind Electric Systems'*, Oxford Publications, 2nd Edition, 2007
5. C S Solanki, '*Solar Photo-voltaics – Fundamentals, Technologies and Applications'*, PHI Pvt.,Ltd., 2nd Edition, 2011.
6. R. K. Rajput, *A textbook of power system engineering*, Laxmi publications (P) Ltd, 2016.

(19BM50231) **ELECTRICAL WORKSHOP PRACTICE**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:**

Course on Basic Electrical and Electronic Engineering

**COURSE DESCRIPTION:**

Exercises on assessing of electrical parameters and functionality of electrical apparatus; Design and estimation of electrical systems, and protection system for electrical devices and systems; Troubleshooting of electrical appliances and calibration of measuring instruments.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the usage of power tools for installation applications and cable laying with relevant accessories.

CO2. Install panel boards for domestic/industrial applications, design and estimate wiring requirements following the code of conduct.

CO3. Practice the measurement of electrical quantities using modern day tools and also calibrate the precession of the measuring instruments.

CO4. Realize the protection equipment used in domestic/industry and practice protection schemes for a particular application.

CO5. Demonstrate the practice of using various ancillary equipment for electrical appliances and also troubleshoot in the case of malfunctioning of electrical appliances.

CO6. Work independently or in teams to solve problems with effective communication.

**List of Exercises/List of Experiments:**

*(Minimum **Ten** experiments are to be conducted)*

1. Identification and usage of hand and power tools, PPE for electrical installation applications.
2. Practice of cable laying and termination using conduits, casings, cable joints and its necessary items.
3. Installation and testing of single/three phase distribution boards for domestic/industrial applications.
4. Design and estimation of wiring for a typical house.
5. Measurement of electrical quantities using analog and digital meters.
6. Practice energy meter for measurement of energy and tariff estimation.
7. Calibration of measuring instruments.

8.  Operation and testing of Fuse, MCB and Relays.

9.  Measurement of equipment to earth resistance and determine the internal leakage currents.

10. Practicing and testing of DOL starter for Induction Motors.

11. Design of Timers for operation of electrical appliances.

12. Troubleshooting of electrical appliances — Fan, Mixer/grinder, Water heater/Iron box.

**REFERENCE BOOKS/LABORATORY MANUALS:**

1.  http://www.srisaiuniversity.org/downloads/files/n59b79d6117211.pdf
2.  https://www.gtu.ac.in/syllabus/NEW_Diploma/sem-1/Pdf%20Content%20detailing/3312401Electrical%20&%20Electronic%20Workshop.pdf

**ADDITIONAL LEARNING RESOURCES:**

1.  https://www.youtube.com/watch?v=ax-KUL17YJ4
2.  https://www.youtube.com/watch?v=TJpQ3fZIt20
3.  https://www.youtube.com/watch?v=6RJnsa83xTA
4.  https://www.youtube.com/watch?v=w2M4tS2OMsU
5.  https://www.youtube.com/watch?v=DzVJiSQNbew

(19BM60201) **PRINCIPLES OF ENERGY AUDITING AND CONSERVATION**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

A course on Basic Electrical and Electronics Engineering.

**COURSE DESCRIPTION:**

Principles of energy audit, management and conservation; Energy efficient motors, lighting schemes; Energy measuring instruments and significance of energy economics.

**COURSE OUTCOMES:**

After successful completion of this course, student will be able to:

CO1. apply the relevant rules, regulations and procedure of energy audit in industries and realize the energy management principles and protocols for effective conservation of energy.

CO2. analyze performance of energy efficient motors and illumination system by applying the relevant protocols of energy auditing.

CO3. apply appropriate energy auditing instruments for energy auditing in industries and assess their economic benefits.

CO4. apply the demand side management techniques and relevant standards for organization of energy conservation awareness programs.

**DETAILED SYLLABUS:**

**UNIT I: ENERGY AUDIT AND MANAGEMENT PRINCIPLES** (10 periods)

Energy audit — definitions, concept, types of audit, energy index-cost index, pie charts, Sankey diagrams, load profiles,energy saving potential, energy audit of process industry, building energy audit. IE rules and regulations for energy audit.

Energy management — Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting.

**UNIT II: ENERGY CONSERVATION PRINCIPLES** (08 Periods)

Energy scenario in India and world; Rules for efficient energy conservation; Technologies for energy conservation; Principles of energy conservation, roles and responsibilities of energy managers and auditors in industries.

**UNIT III: ENERGY EFFICIENT MOTORS AND LIGHTING** (09 Periods)

**Energy efficient motors** - factors affecting efficiency, loss distribution, constructional details, characteristics, variable speed, variable duty cycle systems.

**Lighting -**Good lighting system, lighting control, lighting energy audit.

**UNIT IV: ENERGY INSTRUMENTS AND ECONOMIC ANALYSIS** (10 periods)

Principles of energy instruments— Infrared thermometer, data loggers, thermo-couples, pyrometers, Lux meters, tongue testers, power quality analyzer, and PLC and pic applications.

Principles of Energy Economic Analysis— The time value of money concept. Cash flow models, payback analysis, depreciation—numerical problems.

## UNIT V: PRINCIPLES OF DEMAND SIDE MANAGEMENT                    (08 periods)

Introduction to DSM, Principles of DSM, benefits of DSM, different techniques of DSM – time of day pricing;Management and organization of energy conservation awareness programs.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan**

**REFERENCE BOOKS:**

1. W.R. Murphy & G. Mckay Butter worth, *Energy management*, Butter worth-Heinemann    publications, 2nd  edition, 2016.
2. Albert Thumann, William J. Younger, *Handbook of energy audits*, Taylor & Francis Ltd,7th edition,   2008.
3. UmeshRathore, *Energy management*, S.K. Kataria& Sons, 2nd  edition, 2014.
4. W.C.Turner,Stevedoty, *Energy management hand boo*k, CRC press, 6th edition, 2006.
5. D.P. Sen, K.R. Padiyar, IndraneSen, M.A. Pai, *Recent Advances in Control and Management of Energy Systems*, Interline Publisher, Bangalore, 1993.
6. Ashok V. Desai, Wiley Eastern, *Energy Demand - Analysis, Management and Conservation Hand book  on energy auditing - TERI (Tata Energy Research Institute)*, 2005.
7. Craig B. Smith, Kelly E. Parmenter, *Energy management principles Applications*, benefits, Savings, Elsevier Inc(Pergamon Press), 1st  edition, 2016.

**ADDITIONAL LEARNING RESOURCES:**

1. https://beeindia.gov.in/sites/default/files/1Ch3.pdf
2. https://www.youtube.com/watch?v=M1zijCmeXJg
3. https://www.youtube.com/watch?v=FTpMWXMBSyM
4. https://www.youtube.com/watch?v=_T1Au_P5bnQ
5. https://www.youtube.com/watch?v=ENLzwTVjxms
6. https://www.youtube.com/watch?v=7hDyLuFJ0c8
7. https://www.youtube.com/watch?v=lkNIuFkzxBk

**USEFUL WEBSITES:**

1. https://beeindia.gov.in/news-events/energy-conservation-building-code-rules-2018
2. https://beeindia.gov.in/content/energy-auditors
3. https://nayaenergy.com/difference-between-energy-audit-and-energy-management/
4. https://www.sgsgroup.in/en-gb/sustainability/environment/energy-  services/energy-audits-and-management/energy-audit
5. https://www.consultivo.in/environment-energy/energy-audit-and-management/
6. https://www.teriin.org/energy
7. http://jnujprdistance.com/assets/lms/LMS%20JNU/Dual%20Degree%20Courses/PGD+MBA%20%20Energy%20Management/Sem%20III/General%20Aspects%20of%20Energy%20Management%20and%20Energy%20Audit.pdf

(19BM60202) **SPECIAL MACHINES AND THEIR CONTROLLERS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Construction, Working, Types, control operation, characteristics and applications of Stepper Motors, Switched Reluctance Motors, Synchronous Reluctance Motors, Permanent Magnet Brushless DC Motors and Linear Induction Motors.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. analyze the open and closed loop operational characteristics of stepper motor and assess its performance under various scenarios.

CO2. analyse the operational aspects of switched reluctance motor to assess the performance and design the constructional features for sustainability.

CO3. analyse the operational aspects of synchronous reluctance motor to assess its performance, sustainability and applications.

CO4. analyse the sensorless and sensor based operation and control aspects of permanent magnet brushless DC motor and assess the performance under diverse scenarios.

CO5. analyze the operational and control aspects of linear induction motor and assess their performance for special applications.

**DETAILED SYLLABUS:**

**UNIT I: STEPPER MOTORS** **(9 Periods)**

Constructional features, types, working principle, torque equation, characteristics, open loop and closed loop control of stepper motor, applications.

**UNIT II: SWITCHED RELUCTANCE MOTORS** **(9 Periods)**

Construction details, principle of operation, design of stator and rotor pole arcs, torque equation, characteristics, power converters, torque equations, control of switched reluctance motor and applications.

**UNIT III: SYNCHRONOUS RELUCTANCE MOTORS** **(9 Periods)**

Constructional features, Types – Axial and Radial flux motors. Principle of operation, characteristics, phasor diagram, control of SyRM, advantages and applications.

**UNIT IV: PERMANENT MAGNET BRUSHLESS DC MOTOR** **(9 Periods)**

Constructional details, principle of operation, types of BLDC motor, sensorless and sensor based control of BLDC motors, torque/speed characteristics and applications.

**UNIT V: LINEAR INDUCTION MOTOR** **(9 Periods)**

Construction, principle of operation– single sided and double-sided LIM, thrust equations, performance equations based on current sheet concept, equivalent circuit, goodness factor, characteristics and applications.

**Total Periods: 45**

**TEXTBOOKS:**

1. K. VenkataRatnam, *Special Electrical Machines*, University press, New Delhi, 2009.
2. E.G. Janardhanan, *Special Electrical Machines*, PHI learning private limited, 2014.

**REFERENCE BOOKS:**

1. Takashi Kenjo, *Stepping Motors and their Microprocessor controls*, clarenden press, Oxford, 1984.
2. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drives*, clarenden press, Oxford 1989.
3. R. Krishnan, *Switched Reluctance Motor Drives – Modeling, Simulation, analysis, Design and Applications*, CRC press, Special Indian Edition, 2015.

## (19BM60203) **UTILIZATION OF ELECTRICAL ENERGY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Basic Electrical and Electronics Engineering.

**COURSE DESCRIPTION:**

Types and characteristics of electric drives; types of electric heating and welding; Fundamentals and various methods of Illumination; electric traction; electrolysis, Extraction and refining of metals.

**COURSE OUTCOMES:**

After successful completion of this course, student will be able to:

CO1.  Understand the operational aspects of various drives and apply an appropriate electric drives for various industrial applications.

CO2.  understand the different types of heating and welding techniques.

CO3.  design illumination system for proper lighting system under given circumstances.

CO4.  understand the basic principle of traction systems and different braking techniques used in electric traction.

CO5.  understand the basic principle and applications of electrolytic process.

**DETAILED SYLLABUS:**

**UNIT I: ELECTRIC DRIVES                                    (8 periods)**

Type of electric drives – rating and choice of motor - starting and running characteristics - particular applications of electric drives - types of industrial loads - Continuous - intermittent and variable loads.

**UNIT II: ELECTRIC HEATING & WELDING                       (10 periods)**

**Introduction** - Advantages and methods of electric heating - resistance heating - induction heating and dielectric heating.

**Electric welding:** Classification- resistance and arc welding - electric welding equipment - comparison between AC and DC Welding.

**UNIT III: ILLUMINATION                                    (10 periods)**

Introduction - terms used in illumination - laws of illumination - sources of light. Discharge lamps – mercury vapor and sodium vapor lamps – comparison between tungsten filament lamps and fluorescent tubes – compact fluorescent lamp – LED -Basic principles of light control - Types and design of good lighting system and practice - flood lighting.

**UNIT IV: ELECTRIC TRACTION                                (10 periods)**

Traction systems: System of electric traction and track electrification - Review of existing electric traction systems in India - Special features of traction motor - Speed-time curves for different services - methods of electric braking - plugging - rheostatic braking, regenerative braking.

**UNIT V: ELECTROLYTIC PROCESS** **(7 periods)**

Introduction - Basic principles - Faradays laws of electrolysis - Energy efficiency - Electrodeposition-Factors governing deposition Processes - Deposition of Alloys - Extraction and refining of metals.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan:**

**TEXTBOOKS:**

1. C.L Wadhwa, *Generation Distribution and Utilization of Electrical Energy*, New age International Publishers,
2. J. B. Gupta, *Utilization of Electrical Power and Electric Traction*, S. K. Kataria and ons, 2002.

**REFERENCE BOOKS:**

1. N. V. Suryanarayana, *Utilization of Electrical Power including Electric drives and Electric traction*, New Age International (P) Limited, Publishers, 1996.
2. Alan.V. Oppenheim, Ronald.W. Schafer, John R Buck, Discrete Time Signal Processing, Prentice Hall, 2ndedition, 2006. E.Openshaw Taylor, Utilization of Electric Energy, Orient Longman,1971.

**ADDITIONAL LEARNING RESOURCES:**

1. https://www.NPTEL video lectures.
2. https://www.opto-e.com/basics/led-pulsing-and-strobing

## (19BM60231) **AUDITING AND CONSERVATION PRACTICE LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:--**

**COURSE DESCRIPTION:**

Experimental investigations on behavior of insulators, performance of synchronous and asynchronous machines, relay testing and fault analysis.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate skill in identifying an appropriate auditing tool for measuring appropriate electrical and non-electrical preliminary quantities for auditing.

CO2. Demonstrate skills to apply the auditing principles for illumination, house hold utilities and suggest a suitable conservation methods for economic benefits.

CO3. Demonstrate skills to audit various industrial drives and suggest suitable methods for energy conservation adhering the protocols of auditing.

CO4. Perform auditing by following the auditing protocols in various commercial, agricultural and domestic class of customers and suggest an appropriate energy conservation practices for economical benefits.

CO5. Work independently or in teams to solve problems with effective communication.

**Practical Exercises/List of Experiments:**

*(Minimum Ten experiments are to be conducted.)*

1. Demonstration of auditing instruments for measuring electrical and non-electrical quantities for auditing purpose.
2. Measurement of active, reactive power and energy for auditing purpose.
3. Assess power quality problems using power quality analyzer and suggest a suitable conservative measures to mitigate.
4. Testing of Electric motor drive for energy conservation.
5. Analyze star labeled electrical apparatus and compare the data sheet of various star ratings.
6. Determine energy consumption by fluorescent/incandescent lamp and evaluate net energy savings and payback period by replacing with energy efficient lamp.
7. Evaluate energy conservation in a ceiling fan with and without an electronic regulator.
8. Conserve the energy consumption in a three phase induction motor by applying an appropriate energy conservation method.
9. Determine the energy conservation in an induction motor operating in star and delta mode of operation.
10. Estimate energy and economic savings by improving power factor for a given class of consumer.
11. Estimate the economic benefits of improving load factor for a domestic consumer.
12. Audit the energy of a commercial consumer and suggest an appropriate energy conservation practice to reduce energy bill.

**ADDITIONAL LEARNING RESOURCES:**

1. https://sites.google.com/a/venusict.org/energy-conservation-and-management/ntpl-video-links
2. https://nptel.ac.in/courses/108/105/108105058/
3. https://www.youtube.com/watch?v=Nd_EL_B3JBQ
4. https://www.youtube.com/watch?v=lkNIuFkzxBk
5. https://www.youtube.com/watch?v=730netBSZKY
6. https://www.youtube.com/watch?v=R_FdTPbgzTs

(19BM70201) **POWER ELECTRONIC CONVERTERS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | -- | -- | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Switched mode power supplies; Silicon Controlled Rectifier — with and without isolation, single and multiple outputs; Single phase and three phase topologies; DC-DC converter; AC-AC converter and AC-DC converter; DC-AC converter.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  demonstrate the knowledge on energy conversion of Switched mode power supplies, Matrix converter and soft switch converters.
CO2.  analyze closed loop control and regulation of Switched mode dc power supplies based converter.
CO3.  analyze AC-DC, AC-AC and DC-AC circuit operation and evaluate their output parameters by using different firing pulses.
CO4.  analyze the Soft switching techniques of AC-DC, DC-DC and DC-AC converter circuits by using ZVS, ZCS and quasi resonance operation.

**DETAILED SYLLABUS:**

**UNIT I: SWITCHED MODE POWER SUPPLIES                    (11 Periods)**

DC Power supplies and Classification; Switched mode dc power supplies - with and without isolation, single and multiple outputs; Closed loop control and regulation; Design examples on converter and closed loop performance.

**UNIT II: AC-DC CONVERTERS                              (11 Periods)**

Switched mode AC-DC converters. Synchronous rectification - single and three phase topologies - switching techniques - high input power factor . Reduced input current harmonic distortion. improved efficiency with and without input-output isolation; Performance indices design examples.

**UNIT III: DC-AC CONVERTERS                             (07 Periods)**

Multi-level Inversion - concept, classification of multilevel inverters, Principle of operation, main features and analysis of Diode clamped, Flying capacitor and cascaded multilevel inverters; Modulation schemes.

**UNIT IV: AC-AC CONVERTERS WITH AND WITHOUT DC LINK      (07 Periods)**

Matrix converters. Basic topology of matrix converter; Commutation – current path; Modulation techniques - scalar modulation, indirect modulation; Matrix converter as only AC-DC converter; AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter; Performance comparison with matrix converter with DC link converters.

## UNIT V: SOFT-SWITCHING POWER CONVERTERS                    (09 Periods)

Elementary principles of Soft switching techniques: ZVS and ZCS; Performance comparison hard switched and soft switched converters— AC-DC converter, DC-DC converter, DC-AC converter; Resonant DC power supplies.

**Total Periods: 45**

***Topics for self-study are provided in the lesson plan***

**TEXTBOOKS:**

1. M.H.Rashid, *Power Electronics Handbook*, Academic press, New york, 2000.
2. Fang Lin Luo and Fang Lin Luo, *Advanced DC/DC Converters, CRC Press*, NewYork, 2004.
3. Marian P.Kazmierkowski, R.Krishnan and Frede Blaabjerg, *Control in Power Electronics- Selected Problem*, Academic Press (Elsevier Science), 2002.

**REFERENCE BOOKS:**

1. Issa Batarseh, *Power Electronic Circuits*, John Wiley and Sons, Inc.2004
2. Frede Blaabjerg and Zhe Chen,*Power Electronics for Modern Wind Turbines*, Morgan & Claypool Publishers series, United States of America, 2006.
3. Krein Philip T, *Elements of Power Electronics*, Oxford University press, 2008
4. Agarwal ,*Power Electronics: Converters, Applications, and Design*, 3rd edition, Jai P, Prentice Hall,2000
5. L. Umanand, *Power Electronics: Essentials & Applications*, John Wiley and Sons,2009

**ADDITIONAL LEARNING RESOURCES:**

1. https://nptel.ac.in/courses/108/102/108102145/
2. https://nptel.ac.in/courses/108/101/108101126/
3. https://nptel.ac.in/courses/108/101/108101038/
4. https://nptel.ac.in/courses/108/107/108107128/

(19BM70202) **FUNDAMENTALS OF ELECTRIC VEHICLES**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | -- | -- | 3 |

**PRE-REQUISITES:**

Course on Basic Electrical and Electronics Engineering.

**COURSE DESCRIPTION:**

Transportation vehicles and their impact in society; Concept, configurations, principle, types and operation of Electric Vehicles (EV); Power Electronic converters in EVs; Different motor drives & energy storage and management technologies in EVs.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Understand the principle of operation of electric, hybrid-electric vehicles and various emerging technological challenges while confronting the issues during transportation.

CO2. Analyze the performance characteristics of various power converters operating in different modes to assess a suitable convertor and its control strategies for sustainability of electric vehicle.

CO3. Analyze various propulsion motor drives operating in different modes for sustainability and to determine their performance/operational parameters of electric vehicle.

CO4. Analyze various battery energy storage & management systems and assess their adaptability for sustainable performance of electric vehicle.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO EVS AND HEVS                    (10 Periods)**

Environmental impact and history of modern transportation, , Electric Vehicles (EVs) — configurations, traction motor characteristics; Hybrid Electric Vehicles (HEVs) — concept and architectures; series and parallel HEVs — configuration, operation, advantages and disadvantages; HEVs — interdisciplinary nature, challenges and key technologies; Plug-in EV — concept and architectures.

**UNIT II: POWER ELECTRONICS IN EVs AND HEVs             (08 Periods)**

Power electronics  — semiconductor devices and circuits used for control and distribution of electric power, AC-DC, DC-DC, DC-AC conversion, four quadrant operation of converters, Thermal Management of HEV power electronics.

**UNIT III: ELECTRIC PROPULSION SYSTEM                  (09 Periods)**

Introduction, configuration and  control — DC  motor  drives, Induction  Motor drives, Permanent Magnet Motor drives and Switched Reluctance Motor drives and drive efficiency.

## UNIT IV: ENERGY STORAGE SYSTEMS                                    **(09 Periods)**

Electrochemical Batteries — terminology, specific energy, specific power, energy efficiency in lead-acid batteries, nickel based batteries, lithium based batteries; Ultra-capacitors — features, principle of operation and performance; High speed fly-wheels — operating principle, power capacity, fly-wheel technologies and hybrid energy storage systems; Fuel cell — principle of operation and performance.

## UNIT V: ENERGY MANAGEMENT SYSTEM                                    **(09 Periods)**

Energy Management Strategies, Concept of State of Charge (SoC) and State of Health (SoH), EV charging standards, concept of V2G, V2V, V2H — principle of operation (Block diagram approach only). Wireless Power Transfer — principle of operation (Block diagram approach only).

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

### TEXTBOOKS:

1. K. T. Chau, *Electric Vehicle Machines and Drives, Design, Analysis and Application*, Wiley, 2015.
2. John G. Hayes, *Electric Powertrain*, Wiley, 2018.

### REFERENCE BOOKS:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals*, 2nd edition, CRC Press, 2011.
2. Jack Erjavec, Hybrid, Electric & Fuel-Cell Vehicles, 2nd edition, Delmar Cengage learning, 2013.
3. Mehrdad Ehsani, Yimin Gao and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 2nd edition, CRC Press, 2015.
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles Principles and Applications *with Practical Perspectives*, Wiley, 2011.

### ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://swayam.gov.in/nd1_noc20_ee18/preview
3. https://www.coursera.org/learn/electric-vehicles-mobility?#syllabus

(19BM70203) **PROTECTION OF ELECTRICAL SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Basic Electrical and Electronics Engineering

**COURSE DESCRIPTION:**

Overview of protective schemes; fuses; circuit breakers; electromagnetic relays; protective schemes applied for various components under various operating conditions; different grounding schemes.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the conceptual knowledge of various fuses for secured operation of domestic and industrial appliances.

CO2. Apply the conceptual knowledge of various circuit breakers for secured operation of power system network.

CO3. Apply the conceptual knowledge of various relays for secured operation of power system network.

CO4. Analyze various protection schemes for the protection of alternators, transformers and motors.

CO5. Apply various neutral grounding methods and determine the system parameters for protection in power system.

**DETAILED SYLLABUS:**

**UNIT I: FUSES** **(6 periods)**

Necessity of power system protection; Types of fuses — low voltage fuse and high voltage fuse; Advantages and disadvantages; Important terms — Current rating of fuse element, fusing current, fusing factor, cut-off current, pre-arcing time, arcing time, breaking capacity; Application of fuse in residential and commercial loads.

**UNIT II: ELECTRICAL SWITCHGEAR** **(9 periods)**

Essential features of switchgear, switchgear components; Phenomenon of arc, arc voltage, recovery voltage, restriking voltage; Types of circuit breakers; Construction and principle of operation — minimum oil circuit breaker, air blast circuit breaker, vacuum circuit breaker and $SF_6$ circuit breaker, and their comparisons, advantages and disadvantages; Applications of circuit breakers, importance of rating of circuit breakers.

**UNIT III: PROTECTIVE RELAYS** **(8 periods)**

Fundamental requirements of protective relaying, classification of relays — electromagnetic attraction and induction type relays; Construction and working principle of induction type over current relays, differential relays and biased differential relays; Universal torque equation; Characteristics of overcurrent, differential relays; Importance of primary and backup protection, elementary principles of static relays and microprocessor based relays.

## UNIT IV: PROTECTION OF ALTERNATORS, TRANSFORMERS AND MOTORS

**(11 periods)**

**Protection of alternators:** Various faults in alternators — failure of prime-mover, failure of field, overcurrent, overvoltage, unbalanced loading, stator winding faults, rotor winding faults; Rotor protection; Stator protection — restricted earth fault protection and internal fault protection.

**Transformer protection:** Internal and external faults; Percentage differential protection, Protection against internal faults – Buchholtz relay.

**Motor protection:** Various faults & abnormal operating conditions, protection in motors, thermal relays and protection of small and large induction motors.

## UNIT V: SUBSTATION PROTECTION                              (11 periods)

**Protection of feeders:** Protection of radial and ring main feeders using over current relays.

**Protection against over-voltages:** Causes of over voltages in power systems, protection against lightning over voltages — surge diverters and absorbers; Working and applications of sphere gap, horn gap and valve type of lighting arrestors.

**Neutral grounding:** Necessity of neutral grounding, effects of ungrounded neutral on system performance; Methods of neutral grounding — solid, resistance and reactance grounding—merits and demerits.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan**

### TEXTBOOKS:

1. Sunil S. Rao, *Switchgear Protection and Power Systems (Theory, practice and Solved Problems)*, 13th edition, Khanna Publishers, New Delhi, 2013.
2. Rohit Mehta and V.K. Mehta *Principles of Power System, 24thedition,* S. Chand Publishiing, 2010.

### REFERENCE BOOKS:

1. Badri Ram, D. N. Viswakarma, *Power system Protection and Switchgear*, 2nd edition, McGraw Hill education (India) Private Limited, New Delhi, 2011.
2. C. L. Wadhwa, *Electrical Power systems*, 7th edition, New Age International (P) Limited, Publishers, New Delhi, 2017.

### ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/101/108101039/
2. https://lsin.panasonic.com/blog/understand-importance-switchgear-protection-devices/
3. https://www.eit.edu.au/courses/professional-certificate-of-competency-electrical-power-system-fundamentals/
4. https://electrical-engineering-portal.com/download-center/books-and-guides/relays/protection-fundamentals
5. https://www.youtube.com/watch?v=LAiBuu_nICI

(19BM70231) **SIMULATION OF ELECTRICAL SYSTEMS LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:**

Course on Basic Electric and Electronics Engineering.

**COURSE DESCRIPTION:**

Investigation of behavior/operational aspects of various electrical systems using simulation tools.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate generation of signals and perform basic operations on the signals

CO2. Analyze various electric circuits operating under different scenarios.

CO3. Investigate the time domain specifications of a electrical system and develop a controller to control the dynamics.

CO4. Determine the operational aspects of various electrical machines

CO5. Analyze the operation of power electronic circuits for different operating conditions

CO6. Estimate the tariff for domestic load and also forecast the load from the time series data.

CO7. Work independently or in teams to solve problems with effective communication.

**Practical Exercises/List of Experiments:**

*(Minimum Ten experiments are to be conducted.)*

1. Generation of continuous and discrete time signals.

2. Basic operations on continuous and discrete time signals — Time scaling and amplitude scaling.

3. Simulate Locus diagram for RL and RC circuits.

4. Determine maximum power transfer using Maximum power transfer theorem.

5. Determine time domain specifications of a transfer function.

6. PID controller for controlling time domain response.

7. Load characteristics of asynchronous machine.

8. Determination of transformer efficiency.

9. Simulation of Single-phase half and full controlled bridge converter with R and RL loads.

10. Simulation of step-down and step-up choppers.

11. Load forecasting using statistical methods.

12. Estimating load consumption and tariff for the domestic load profile.

# MINOR DEGREE IN

## INSTRUMENTATION AND CONTROL ENGINEERING

**Offering Department:**  ELECTRONICS AND INSTUMENTATION ENGINEERING

**Students of Eligible Branches:** CSE, CSSE, IT, ECE, EEE, ME and CE

## COURSE STRUCTURE

| Year & Semester | Course code | Course title | Contact Periods per week | | | | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | C | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem (2 Theory + 1 Lab) | 19BM51001 | Electrical and Electronic Measurements | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM51002 | Industrial Instrumentation | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM51003 | Computer Control of Process | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM51031 | Industrial Instrumentation lab | - | - | 2 | 1 | 50 | 50 | 100 |
| III B.Tech. II-Sem (2 Theory + 1 Lab) | 19BM61001 | Aircraft Instrumentation | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM61002 | Process Control Instrumentation | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM61003 | Smart Sensors | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM61031 | Process Control Lab | - | - | 2 | 1 | 50 | 50 | 100 |
| IV B.Tech. I-Sem (1 Theory + 1 Lab) | 19BM71001 | Biomedical Instrumentation | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM71002 | Programmable Logic Controllers | 3 | - | - | 3 | 40 | 60 | 100 |
| | 19BM71031 | Biomedical Instrumentation Lab | - | - | 2 | 1 | 50 | 50 | 100 |

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

# III B. Tech. – I Semester

## (19BM51001) ELECTRICAL AND ELECTRONIC MEASUREMENTS

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Science of measurement; construction and principle of operation of ammeters, voltmeters, ohmmeters; potentiometers; power meter; power factor meter; energy meter; design of AC and DC bridges; frequency and time measurements.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Select suitable measuring instrument for measurement of voltage, current, resistance, power and energy by applying the fundamental concepts of measuring instruments.

CO2.  Calibrate the DC and AC potentiometers and apply the concepts for calibration of ammeter& voltmeter and measurement of resistance & inductance.

CO3.  Design AC and DC bridges for measurement of resistance, capacitance and Inductance.

CO4.  Demonstrate the digital measuring instrument used for measurement of frequency and time period.

**DETAILED SYLLABUS:**

**UNIT I: AMMETERS AND VOLTMETERS                          (11 Periods)**

Classification of analog instruments, Principle of operation of analog instruments, operating forces of electromechanical indicating instruments: deflecting, control and damping; Permanent Magnet Moving Coil (PMMC): Construction, working principle, Expression of torque equation, Errors in PMMC Instruments, Advantage and Disadvantages of PMMC Instruments; Moving Iron Instruments: Classification of Moving Iron Instruments, Construction, working principle and Expression of torque equation; Ammeter: Ammeter shunt, Effect of Temperature Change in Ammeter, Multi-range Ammeters; Voltmeter: Voltmeter Multipliers, Effect of Temperature Change in Voltmeters, Multi-range Voltmeter Analog voltmeter, AC voltmeter using rectifiers, true RMS Voltmeter

**UNIT II: OHMMETERS AND POTENTIOMETERS                   (9 Periods)**

Ohmmeters: Series type ohmmeter, shunt type ohmmeter, Multimeter.

DC Potentiometers: Basic potentiometer circuit, standardization, Compton's Potentiometers, Multiple-range potentiometer, applications: Calibration of Voltmeter, Calibration of Ammeter, Measurement of Resistance.

AC Potentiometers: Standardization, Types of A.C Potentiometers: Polar types, Coordinate types, applications: Voltmeter Calibration, Ammeter Calibration, Measurement of Self reactance of a coil.

## UNIT III: POWER & ENERGY METERS                    (8 Periods)

Power in D.C Circuits, Power in A.C Circuits, Electrodynamometer wattmeter: Construction, working principle, Torque equation, Errors in Electrodynamometer wattmeter, Three Phase Wattmeter. Electrodynamometer Power Factor Meter: Single Phase, Three Phase. Energy Meter: Single Phase Induction Type Energy Meter: Construction, Working Principle, Errors in Single Phase energy meter; Polyphase energy meters: Two element energy meter

## UNIT IV: BRIDGES                                    (8 Periods)

Measurement of Resistance: Medium Resistance Measurement: Wheatstone bridge, Kelvin Bridge; Low Resistance Measurement: Kelvin double bridge; High Resistance Measurement: Direct deflection methods.

Measurement of Inductance: Maxwell Bridge, Hay's Bridge and Anderson Bridge.

Measurement of capacitance: De Sauty's Bridge and Schering bridge, Q-meter.

## UNIT V: FREQUENCY AND TIME MEASUREMENTS              (9 Periods)

Digital Frequency Meter - Basic Circuit, Time Base Selector, Start and Stop gate; Circuit for Measurement of Frequency; Simplified Composite Circuit for a Digital Frequency Meter; High Frequency Measurement, Frequency synthesizer; Period Measurement; Ratio and Multiple Ratio Measurements; Time Interval Measurements; Universal Counter Timer.


**Total Periods: 45**


**Topics for self-study are provided in the lesson plan**


**TEXTBOOK:**

1. A.K.Sawhney, *A Course in Electrical and Electronics Measurements and Instrumentation*, Dhanpat Rai and Sons, New Delhi, 19th Revised edition, 2013.

2. H S Kalsi, *Electronic Instrumentation and Measurements*, McGraw-Hill, 4th edition, 2019.


**REFERENCE BOOKS:**

1. E.W. Golding & F.C. Widdis, *Electrical Measurements and Measuring Instruments*, 5th edition, Wheeler Publishing.

2. Doeblin, E.O., Measurement Systems: Applications and Design, McGraw-Hill, 4th edition 2003.


**ADDITIONAL LEARNING RESOURCES:**

1. https://nptel.ac.in/courses/108/105/108105153/

2. https://swayam.gov.in/nd1_noc19_ee44/preview

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|--|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:-**

**COURSE DESCRIPTION:**

Measurement of humidity, Viscosity, Density, Pressure, Level and Flow parameters; Signal Conditioning & Safety Instruments.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Analyze and identify the appropriate transducer to measure density, viscosity, humidity and pressure based on applications.

CO2.  Analyze and identify the appropriate transducer to measure level and flow based on applications.

CO3.  Design signal conditioning circuit for amplifiers, range extension and conversion of V to I & I to V.

CO4.  Demonstrate the safety instruments, requirements for safety and standards.

**DETAILED SYLLABUS:**

**UNIT I: DENSITY, VISCOSITY & HUMIDITY MEASUREMENT          (11 Periods)**

Density: Introduction, Pressure head type, Displace type, Float type, Buoyancy effect densitometer method, Hot-wire gas bridge type, Vibration type, Radioactive method. Viscosity: Introduction, Friction tube viscometer, Saybolt's viscometer, Rotameter viscometer, Searle's rotating cylinder, Cone and Plate viscometer. Consistency meter – Rotating vane type and oscillating type. Humidity: Psychrometer, hygrometer & Types, Dew point device. Analysis and selection of Density, Viscosity and Humidity sensors.

**UNIT II: PRESSURE MEASUREMENT                              (8 Periods)**

Dead weight gauges, Manometer and its Types, Elastic transducers – Bourdon tube, Diaphragm, Bellows, Electrical Types, Resistive, Inductive and Capacitive, Force balance & Vibrating Cylinder, High pressure measurement – Very high pressure transducer (Bulk modulus Gage), Low Pressure (Vacuum) measurement – McLeod Gage, Knudsen Gage, Momentum transfer gage, Thermal conductivity gage, Ionization gage, Sound level meter, Microphone. Analysis and selection of pressure sensors.

**UNIT III: LEVEL MEASUREMENT                               (7 Periods)**

Introduction, Gauge Glass technique, Float Types – Float–and– tape method, Float–and– shaft method, Magnetic float types. Displacer types, Hydrostatic types – Air-Purge type, Bubbler type. Thermal effect types, Electrical types – Resistance switch type, Inductive and Capacitance type. Ultrasonic Methods, bellow element type level transmitters, Fibre - optic type, Analysis and selection of level sensors.

## UNIT IV: FLOW MEASUREMENT                          (10 Periods)

Introduction, Head types – Orifice, Venturi, Flow Nozzle, Dahl Tube, Pitot tube, Area Flow meter - Rotameter & types, Mass flow meters – Turbine Mass flow meter, Coriolis flow meter, Gyroscopic flow meter, Liquid bridge mass flow meter, Calorimetric flow meter. Positive Displacement type flow meters - Nutating Disc, Rotary Vane, Lobed Impeller, Reciprocating Piston type, Fluted Rotor.Electrical type flow meter – Turbo magnetic flow meter, Electromagnetic flow meter, Ultrasonic flow meter, Hotwire anemometer type, Vertex Shedding type.Analysis and selection of Flow sensors.

## UNIT V: SIGNAL CONDITIONING & SAFETY INSTRUMENTS        (9 Periods)

Wheatstone bridge: Compensation & Sensitivity. Design of I to V, V to I converters, Range conversion of current, voltage, Design application of Instrumentation amplifier, Signal conditioning for Self-generating sensors: Chopper and low drift amplifiers Composite amplifier, charge amplifier and electrometer amplifier.

Proximity Sensors, Limit switches, Electrical & Intrinsic Safety: NEMA types, Fuses & Circuit breakers. Explosion hazards & intrinsic safety – Protection methods, Purging, pressurization, ventilation.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan**

**TEXTBOOKS:**

1.      D. Patranabis, *Principles of Industrial Instrumentation*, TMH, 3rd Edition, 2010.

2.      A. K. Sawhney, *A Course in Electrical and Electronics Measurements and Instrumentation*, Dhanpat Rai and Sons, 19th edition, 2011.

**REFERENCE BOOKS:**

1.      Bela G Liptak, *Instrument Engineers' Handbook: Process Measurement and Analysis*, CRC Press - Butterworth Heinemann, 4th Edition, 2003.

2.      Ramon PallásAreny, John G. Webster, *Sensors and Signal Conditioning*, John Wiley and Sons, 2nd Edition, 2000.

3.      Ernest Doebelin, Dhanesh Manik, *Measurement Systems*, McGraw-Hill International, 6th Edition, 2011.

**ADDITIONAL LEARNING RESOURCES:**

1.      https://nptel.ac.in/courses/108105064/
2.      https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/108105064/lec 1.pdf
3.      https://www.ibiblio.org/kuphaldt/socratic/sinst/book/liii.pdf

## III B. Tech. – I Semester

## (19BM51003) **COMPUTER CONTROL OF PROCESS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:-**

**COURSE DESCRIPTION:**

Analysis of discrete state variable system identification techniques, direct discrete design techniques, advanced control strategies used in industries, Adaptive Control.

**COURSE OUTCOMES**:

After successful completion of the course the student will be able to

CO1. Demonstrate knowledge on discrete data systems, Z –Transform and modified Z - Transform of Sampled Data system.

CO2. Design of controllers based on discrete time models are used in Industries.

CO3. Analyze various control strategies and identify mathematical model for various systems.

CO4. Asses the information to provide effective solution for real time problems using adaptive control methods.

**DETAILED SYLLABUS:**

**UNIT I: DISCRETE STATE-VARIABLE TECHNIQUE**     **(11 Periods)**

State equation of discrete data system with sample and hold, State transition equation, Methods Of computing the state transition matrix, Decomposition of discrete data transfer functions, State Diagrams of discrete data systems, System with zero-order hold, Controllability and observability of linear time invariant discrete data system, Stability tests of discrete-data system.

**UNIT II: SYSTEM IDENTIFICATION**     **(8 Periods)**

System Theory, Mathematical models, Model properties, Structural model representation, System identification procedure. Modified Z – Transform, First order system with time delay.

**UNIT III: DESIGN OF CONTROLLERS**     **(9 Periods)**

Computer control loop, Converting continuous time controller to discrete time domain, Design of controllers based on discrete time model beat and Dahlin's algorithms. Design of Feed Forward Controller: Block Diagram.

**UNIT IV: ADVANCED PROCESS CONTROL STRATEGIES**     **(9 Periods)**

Cascade Control- Dynamic response, Types, Implementation, Predictive Control–Model based and Multivariable System, Statistical Process Control. Algorithms for Processes with Dead Time–Smith Predictor, Analytical Predictor.

**UNIT V: ADAPTIVE CONTROL**                                              **(8 Periods)**

Self-Tuning Regulators, Adaptive Control Adjustment, Indirect Adaptive Control, Direct Adaptive Control, Model Reference Adaptive Control, Relationship between MRAC and STR, Inertial Control with examples.

**Total Periods: 45**

**TEXTBOOKS:**

1. S.K.Singh, *Computer Aided Process Control*, PHI,2009.
2. Gopal, M., Digital Control and State Variable Methods, Tata McGraw Hill, 2003.

**REFERENCE BOOKS:**

1. M. Chidambaram, *Computer Control of Processes*, Narosa Publications, 2nd Edition,2003.

2. Karel J. Keesman, *System Identification: An Introduction*, Springer,2011.

3. Pradeep B.Deshpande and Raymond H Ash, *Elements of Computer Process Control with Advanced Applications*, 2nd Edition, Instrument Society ofAmerica,1981.

4. Krishna Kant, *Computer-based Industrial Control*, 2nd Edition, PHI, Delhi, 2010.

**ADDITIONAL LEARNING RESOURCES:**

1. http://nptel.ac.in/courses/112103174/4
2. http://nptel.ac.in/courses/112103174/3
3. www.freevideolectures.com /Course/3126/Process-Control-and-Instrumentation
4. www.nptel.ac.in/courses/103105064/

(19BM51031) **INDUSTRIAL INSTRUMENTATION LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** Course on Industrial Instrumentation

**COURSE DESCRIPTION:**

LabVIEW basics; Circuit design and simulation in Multisim; Measurement of Torque, Temperature, Viscosity, Humidity, Pressure, Level and Flow.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply the LabVIEW functions in programming.

CO2. Simulate electrical circuits using Multisim.

CO3. Analyze the characteristics of measuring instruments by applying the fundamental concepts.

CO4. Develop PC based data logger systems by interfacing hardware devices like myRIO, ELVIS and required sensors for measurement.

CO5. Design and solve problems in the measurement of parameters for required specifications.

CO6. Work independently and in teams to solve problems with effective communication.

**LIST OF EXPERIMENTS:**

*(Minimum ELEVEN experiments are to be conducted)*

1. LabVIEW Basics : Practice of Virtual Instrumentation Course content Numeric, Boolean, Strings, For, While, Case Structures, Arrays, Clusters, Sequence: Flat, Stacked, Formula Node, SubVI's, Local/Global Variables.

2. Data Acquisition and analysis using Graphs, Charts, myRio/ELVIS and LabVIEW.

3. Data Logging and analysis of simulated or acquired signals using File I/O.

4. Design and verification of converters using op-amps in Multisim.

    a) I to V

    b) V to I

5. Design and verification of resistance measurement, conversion in Multsim using

    a) Op-Amp

    b) Wheatstone bridge for improving sensitivity, compensation and linearity.

6. Measurement of Pressure.

7. Measurement of Humidity.

8. Measurement of Flow.

9. Measurement of Torque.

10. Measurement of Viscosity.

11. Design and verification of level measurement.

12. Design and verification of Speed measurement.

13. Design and verification of temperature measurement using LabVIEW & ELVIS.

**REFERENCE BOOKS/LABORATORY MANUALS**:

1. Travis Jeffrey, Jim Kring, *LabVIEW for Everyone*, Pearson Education, 2009.

2. Johnson Jennings, *LabVIEW Graphical Programming*, McGraw Hill, 4th Edition, 2014.

3. D. Roy Chowdhury, *Linear Integrated Circuits*, New Age International Pvt. Ltd., 4th Edition, 2010.

4. D. Patranabis, *Principles of Industrial Instrumentation*, TMH, 3rd Edition, 2010.

5. Ramon PallásAreny, John G. Webster, *Sensors and Signal Conditioning*, John Wiley and Sons, 2nd Edition, 2000.

6. A. K. Sawhney, *A Course in Electrical and Electronics Measurements and Instrumentation*, Dhanpat Rai and Sons, 19th edition, 2011.

**SOFTWARE/Tools used:**

1. NI Labview 2018
2. NI Circuit Design Suite – Multisim 2019
3. NI myRIO
4. NI ELVIS

**ADDITIONAL LEARNING RESOURCES:**

1. https://www.ni.com/pdf/manuals/320999e.pdf
2. https://ieeexplore.ieee.org/document/8960023/
   A Different way of Level measurement for PBL in Education of Students using NI-LabVIEW, Multisim and MyRIO
3. http://www.ni.com/pdf/manuals/376047c.pdf
4. https://www.clemson.edu/cecas/departments/ece/document_resource/undergrad/lab_manuals/NI_ELIVS_II_Orientation_Manual.pdf
5. http://www.ni.com/pdf/manuals/374629c.pdf
6. http://www.ni.com/pdf/manuals/373363f.pdf

# IIIB. Tech. – II Semester

## (19BM61001) **AIRCRAFT INSTRUMENTATION**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Aircraft Instruments; Air Data Instruments; Gyroscopic Instruments; Engine Instruments and Flight Control and Navigational Aids, EFIS, Electronic warfare and Aircraft safety.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on aircraft system.

CO2. Select suitable instrument for specific parameter measurement in an aircraft.

CO3. Design control schemes for Auto pilot and Auto-throttle system in an aircraft.

CO4. Select navigation aids for appropriate communication in an aircraft.

CO5. Demonstrate knowledge on aircraft safety systems and electronic warfare.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO AIRCRAFT**                           **(10 Periods)**

Control Surfaces, Forces, Moments and Angle of Attack, Modern Aircraft System, Aircraft Instruments and their Layout, Aircraft Display Types: Quantitative Displays, Display Color and Markings, Glass Cockpits of Modern Aircraft: Attitude Director Indicator, Electronic Attitude Director Indicator, Horizontal Situation Indicator, EFIS, Command bars, HSI, ADP.

**UNIT II: COCKPIT INSTRUMENTS**                                 **(10 Periods)**

Introduction to Air Data Instruments, Air Data Computer, Combined Pitot and Static Probe, Position Error, ASI, ALTI, VSI, Introduction to Gyro, Vibrating Gyros, Ring Laser Gyroscope, Fibre Optic Gyros, Directional Gyro, Gyro Horizon.

**UNIT III: ENGINE INSTRUMENTS**                                 **(10 Periods)**

Introduction, Engine Speed Measurement: Electrical TachoGenerator/Indicator, Non-Contact type TachoProbe, Torque Measurement, Electronic Torque Meter, Pressure Measurement, Engine vibration Measurement and Monitoring, Fuel Flow Rate Indicator, Engine Fuel Quantity Indicator

**UNIT IV: FLIGHT CONTROL AND NAVIGATIONAL AIDS**          **(8 Periods)**

Introduction to AFCS, Auto pilot, Auto-throttle, IFCS, Fundamentals of Radio Navigation Aids, VOR, DME, Instrument Landing system, GPS.

**UNIT V: ELECTRONIC WARFARE AND AIRCRAFT SAFETY**           **(7 Periods)**

Introduction to Electronic warfare, Electronic support, EP, EA, Jamming and Spoofing, DEW, Air data warning systems, Stall warning systems, GPWS, TCAS

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan**

**TEXTBOOK:**

1. S.Nagabhushana, L.K.Sudha, *Aircraft Instrumentation andSystems*, I K International Publishing House Pvt. Ltd,2010

**REFERENCE BOOK:**

1. Pallett, E.H.J, *AircraftInstruments and Integrated Systems*,Pearson higher Education, 1992.

**ADDITIONAL LEARNING RESOURCES:**

1. https://nptel.ac.in/courses/101/104/101104069/
2. https://nptel.ac.in/courses/112/103/112103281/
3. http://www.nptelvideos.in/2012/11/space-flight-mechanics.html

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Mathematical modeling of processes, Different types of controllers, characteristics of controllers, design of controllers, Tuning of controllers, characteristics of control valves, multi loop controllers.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Develop mathematical model of various process by applying fundamental laws.

CO2.  Design controller by applying fundamental concepts of control schemes and tuning methods.

CO3.  Demonstrate knowledge on various final control elements used in process

Industries

CO4.  Apply the Multi loop control concepts of real time industrial and domestic applications.

**DETAILED SYLLABUS:**

**UNIT I: PROCESS CHARACTERISTICS**            **(10 Periods)**

Elements of process control, Process variables, Degree of freedom, Characteristics of electric system, liquid system, gas system and thermal system, Elements of process dynamics, Mathematical model of liquid process, gas process and thermal processes, Servo operation, Regulatory operation, Self-regulation.

**UNIT II: CONTROL SCHEMES AND CONTROLLERS**       **(10 Periods)**

Discontinuous controller modes: Two position, Multi-position, Floating control modes; Continuous controller modes: Proportional, Integral, Derivative; Composite controller modes: PI, PD, PID; Electronic controllers: Design of discontinuous, continuous and composite controller modes. Pneumatic controllers (displacement type).

**UNIT III: CONTROLLER TUNING**            **(8 Periods)**

One-Quarter decay ratio criteria, Time integral performance criteria, Process loop tuning: open-loop transient response method, Ziegler-Nichol's method, Cohen- Coon method, Direct synthesis method, Frequency responsemethod.

**UNIT IV: FINAL CONTROL ELEMENTS**            **(9 Periods)**

Pneumatic actuators: Spring actuator, Hydraulic actuators: Piston actuator, Electrical actuators: Solenoid, Electro-pneumatic actuators, Control valves: Types of control valves and its characteristics, Sliding-stem control valves, Rotating-shaft control valves, Selection of control valves, Control-valve sizing, Pneumatic valve positioner.

**UNIT V: MULTI LOOP CONTROL SCHEMES**                    **(8 Periods)**

Cascade control, Ratio control, Feed forward control, Over-ride, Split range, Case study on distillation column: Principle control scheme- constant top product, constant bottom product and reflex rate, constant reflex rate and steam rate.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan**

**TEXTBOOKS:**

1. Donald P. Eckman, Automatic Process Control, Wiley Eastern Ltd., 1993.
2. Curtis D. Johnson, *Process Control Instrumentation Technology*, Pearson Education, New Delhi,  7th Edition, 2002.
3. G. Stephanopoulis, *Chemical Process Control,* Prentice Hall, 1990.

**REFERENCE BOOKS:**

1. Patranabis, *Principles of Process Control*, TMH.,1981.
2. Peter Harriot, *Process Control*,TMH.
3. K. Krishnaswamy, *Process Control*, New Age International, 2nd Edition, 2009.

**ADDITIONAL LEARNING RESOURCES:**

1. https://nptel.ac.in

2. https://www.amtekcompany.com › Amatrol

3. https://wiki.metakgp.org › H31011:Instrumentation and Process Control

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

**COURSE DESCRIPTION:**

Smart sensors for physical variables, Different smart materials and technologies, getting sensor information to MCU, Communication protocols and different standards for smart sensors.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Apply suitable smart sensor for measurement of physical parameters.

CO2. Demonstrate knowledge on smart materials and its fabrication techniques.

CO3. Design signal conditioning circuits for various smart sensors.

CO4. Select appropriate protocol for real time applications.

CO5. Demonstrate knowledge on IEEE standards for smart sensors.

**DETAILED SYLLABUS:**

**UNIT I: SMART SENSORS FOR ELECTRICAL AND NON-ELECTRICAL, PHYSICAL AND CHEMICAL VARIABLES: TENDENCIES AND PERSPECTIVES        (8 Periods)**

Introduction, Temperature IC and Smart Sensors, Pressure IC and Smart Sensors and Accelerometers, Rotation Speed Sensors, Intelligent Opto Sensors, Humidity Frequency Output Sensors, Chemical and Gas Smart Sensors.

**UNIT II: MATERIALS AND TECHNOLOGIES                (9 Periods)**

Materials: Silicon as a Sensing Material, Plastics, Metals, Ceramics, Structural Glasses, Optical Glasses, Nano-materials, Surface Processing: Spin-Casting, Vacuum Deposition, Sputtering, Chemical Vapor Deposition, Electroplating, MEMS Technologies: Photolithography, Silicon Micromachining, Micromachining of Bridges and Cantilevers, Wafer Bonding.

**UNIT III: GETTING SENSOR INFORMATION INTO THE MCU        (10 Periods)**

Introduction, Amplification and Signal Conditioning: Instrumentation Amplifiers, SLEEP MODE Operational Amplifier, Rail-to-Rail Operational Simplifiers, Switched-Capacitor Amplifier, 4- to 20-mA Signal Transmitter, Inherent Power-Supply Rejection, Separate Versus Integrated Signal Conditioning: Integrated Passive Elements, Integrated Active Elements, Digital Conversion: A/D Converters, Performance of A/D Converters, Implications of A/D Accuracy and Errors.

**UNIT IV: COMMUNICATIONS FOR SMART SENSORS                (9 Periods)**

Introduction, Sources (Organizations) and Standards, Automotive Protocols: CAN Protocol, LIN Protocol, Media Oriented Systems Transport, FlexRay, Industrial Networks, Protocols in Silicon: MCU with Integrated CAN, LIN Implementation, Ethernet Controller, Transitioning Between Protocols, Application Example.

**UNIT V: STANDARDS FOR SMART SENSING** **(9 Periods)**

Introduction, Setting the Standards for Smart Sensors and Systems, IEEE 1451.1, IEEE 1451.2, IEEE 1451.3, IEEE 1451.4, IEEE 1451.5, IEEE 1451.6, IEEE 1451.7, Application Example.

**Total Periods: 45**

**Topics for self-study are provided in the lesson plan.**

**TEXTBOOKS:**

1. Nikolay Kirianaki, Sergey Yurish, Nestor Shpak, Vadim Deynega , "*Data Acquisition and Signal Processing for Smart Sensors*", John Wiley & Sons Ltd, 1st edition, 2002.

2. Jacob Fraden , "*Handbook of Modern Sensors: Physics, Designs, And Applications*", Springer, 5th edition, 2016.

3. Randy Frank, "*Understanding Smart Sensors*", Artech House, 3rd Edition, 2013.

**REFERENCE BOOKS:**

4. Sergio Franco*, "Design with Operational Amplifiers and Analog Integrated Circuits",* McGraw-Hill Education, 4th edition, 2015.

5. G.K. Ananthasuresh K.J. Vinoy S. Gopala krishnan K.N. Bhat V.K. Aatre, *"Micro and Smart Systems: Technology and Modeling*", John Wiley & Sons, Inc., 1st edition, 2012.

**ADDITIONAL LEARNING RESOURCES:**

1. **Smart sensors:**
   https://www.electrochem.org/dl/interface/wtr/wtr10/wtr10_p029-034.pdf

   https://www.ee.iitb.ac.in/~esgroup/es_mtech02_sem/es02_sem_rep_dubey.pdf

2. **MEMS Technologies: Photolithography**
   https://nanoscale.unl.edu/pdf/Photolithography_Participant_Guide.pdf

3. **Standards for smart sensors- ieee-1451:**
   https://www.electronicdesign.com/technologies/components/article/21787128/smart-sensors-ieee-1451.

# III B. Tech. – II Semester

## (19BM61031) **PROCESS CONTROL LAB**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|------------|------------|-------------|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:** Course on Process Control and Instrumentation

**COURSE DESCRIPTION**:

Tuning methods, Characteristics of control valve, Response of controllers for different processes like flow, level, pressure etc., Design of controllers.

**COURSE OUTCOMES:**

After completion of the course the student will be able to

CO1. Demonstrate knowledge on process equipments.

CO2. Develop the transfer function of the process and analyze the performance of the process in terms of time domain specifications.

CO3. Design electronic PID controller and tune its controller parameters using various tuning methods.

CO4. Analyze the response of flow, level and pressure process.

CO5. Work independently and in teams to solve problems with effective communication.

**LIST OF EXPERIMENTS:**

*(Minimum 10 experiments to be conducted)*

1. Analyze the behavior of Flow process with and without controller.
2. Obtain the performance for liquid level process with and without controller.
3. Response of Pressure Process using controller.
4. Obtain the transfer function model for Interacting Systems.
5. Obtain the transfer function model for Non-Interacting Systems.
6. Analyze the servo and regulatory response for pressure control process.
7. Obtain the characteristics of electro-pneumatic converter.
8. Obtain the controller parameters using Process reaction curve method.
9. Obtain the controller parameters using continuous oscillation method.
10. Study the response of ratio controller.
11. Study the closed loop performance of cascade controller.
12. Obtain the valve flow-lift characteristics of Linear, On-OFF and equal percentage control valve.
13. Realization of control actions- Electronic PID controller.

**REFERENCE BOOKS/LABORATORY MANUALS**:

1. Donald P. Eckman, *Automatic Process Control*, Wiley Eastern Ltd., 1993.
2. Curtis D. Johnson, *Process Control Instrumentation Technology*, Pearson Education, New Delhi, 7<sup>th</sup> Edition, 2002.

**ADDITIONAL LEARNING RESOURCES:**

1. http://www.vlab.co.in/lab_ready_for_use.php
2. https://www.pidlab.com/en/
3. http://www.eiecouncil.com/process-control-lab.html

## IV B. Tech. – I Semester

### (19BM71001) BIOMEDICAL INSTRUMENTATION

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: --**

**COURSE DESCRIPTION:**

Human Anatomy & Physiology; Bio-signals; Cardiovascular and Neuro-muscular Instrumentation; Therapeutic Equipment; Advanced Imaging techniques.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge on Bioelectric Potentials and various electrodes for measuring Potentials.

CO2. Analyze ECG signals and measure various cardiovascular parameters.

CO3. Analyze EEG and EMG signals and measure various parameters in neuro muscular and respiratory systems.

CO4. Demonstrate the working of various theraptic instruments.

CO5. Demonstrate the working of imaging instruments used for diagnosis by following ethical values.

**UNIT I: BIO ELECTRIC POTENTIALS AND ELECTRODES                (9 Periods)**

Block diagram of biomedical instrumentation, Problems encountered in measuring a living system, system, Structure of cell, Resting and Action Potentials, Propagation of Action Potentials, sources of Bioelectric Potentials, Electrode theory, Bio potential electrodes, Bio chemical transducers.

**UNIT II: CARDIOVASCULAR INSTRUMENTATION                    (9 Periods)**

Physiology of cardiovascular system, electrical conduction system of the heart, interpretation of ECG waveform, standard 12-lead configurations, Einthoven triangle, specifications of ECG Machine; Blood pressure, blood flow and heart sound measurements; Relation between electrical and mechanical activities of the heart.

**UNIT III: NEURO-MUSCULAR AND RESPIRATORY INSTRUMENTATION   (9 Periods)**

Physiology of nervous system, electrode placement for EEG and EMG recording, Specification of EEG and EMG machines, Interpretation of EEG and EMG.

Respiratory Instrumentation: Mechanism of respiration, Spirometry, Pnemuotachograph Ventilators.

**UNIT IV: THERAPEUTIC EQUIPMENT                          (9 Periods)**

Pacemakers: Need for Cardiac pacemakers, pacing modes, Ventricular asynchronous Pacemaker (Fixed rate Pacemaker), Ventricular inhibited Pacemaker (demand Pacemaker), Atrial Synchronous pacemaker, Comparision between internal & external Pacemakers; Defibrillators: AC Defibrillator, DC Defibrillator, Synchronised DC Defibrillator; Diathermy: Shortwave and microwave, Dialysis: Hemo Dialysis, Peritonal Dialysis.

**UNIT V:   MEDICAL IMAGING SYSTEM** **(9 Periods)**

Ultrasonic Imaging: Doppler principle, Modes of Display: A-Mode, B-Mode and Echocardiography. Computed Tomography: Block diagram of CT scanner, Applications of Computed Tomography. MRI Imaging System, Cine angiogram, Endoscope.

**Total Periods: 45**

**TEXTBOOKS:**

1. Leslie Cromwell, Fred. J. Weibell and Erich. A. Pfeiffer, "*Biomedical Instrumentation and Measurements"*, 2nd Edition, PHI, 2003.

2. R.S. Khandpur, "*Hand Book of Biomedical Instrumentation*", Tata McGraw Hill, 2nd Edition, 2002.

**REFERENCE BOOKS:**

1. John G.Webster, "*Medical Instrumentation Application and Design*", 3rd Edition, Wiley India Pvt. Ltd.,2004

2. M. Arumugam, "*Biomedical Instrumentation*", Anuradha Publications, 1992.

**ADDITIONAL LEARNING RESOURCES:**

- https://www.nibib.nih.gov›science-education›students-resource

- https://www.who.int›medical_devices›support

- https://nptel.ac.in

## TEXT BOOKS:

1. John W Webb & Ronald A Reis, "Programmable Logic Controllers-Principles and Applications", Prentice Hall Inc., New Jersey, 5th Edition, 2003.
2. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson Learning, 2nd Edition, 2002.

## REFERENCE BOOKS:

1. Frank D Petruzella, "Programmable Logic Controllers", McGraw Hill, 3rd Edition, 2011.
2. John R Hackworth & Frederick D Hackworth Jr., "Programmable Logic Controllers-Programming Methods and Applications", Pearson, 1st Edition, 2004.

**UNIT V: ADVANCED PLC FUNCTIONS** (10 Periods)

Analog modules & systems, Analog signal processing, Multi-bit Data Processing, Analog output application examples, PID principle, position indicator with PID control, PID Modules, PID tuning, PID functions, Networking of PLCs, Alternative Programming languages.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOK:**

1. John W. Webb & Ronald A. Reiss, *Programmable Logic Controllers Principles and Applications*, 5th edition, PHI 2009.

**REFERENCE BOOKS:**

1. Frank D. Petruzella, *Programmable Logic Controller*, 3rd edition, Tata Mc-Graw Hill, 2010.
2. M.Chidambaram, *Computer Control of Process*, Narosa 2003.

**ADDITIONAL LEARNING RESOURCES**

1. https//openautomationsoftware.com/use cases /allenbradleywpfscada/

2. https//new.siemens.com/global/en/products/automation/industrysoftware/automationsoftware/scada.html

3. https//ab.rockwellautomation.com/Programmable Controllers

## IV B. Tech. – I Semester

## (19BM71031)BIOMEDICAL INSTRUMENTATION LAB

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 50 | 50 | 100 | | - | - | 2 | 1 |

**PRE-REQUISITES:**

Course on Biomedical Instrumentation

**COURSE DESCRIPTION:**

Measurements of parameters: pH, Dissolved Oxygen, Conductivity blood pressure, respiration rate and heart sounds; Analysis of Bio-Signals; Compression of Bio-Signals.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Select suitable biomedical instrument for specific measurement of physiological parameters.

CO2. Design signal conditioning circuit for various biosensors.

CO3. Analyze the response of various biosignals to detect abnormalities.

CO4. Work independently and in teams to solve problems with effective communication.

**LIST OF EXPERIMENTS:**

**Minimum of TEN experiments to be conducted**

1. Calibration and measurement of pH value, Dissolved Oxygen and Thermal Conductivity of a given sample.

2. Blood pressure measurement.

3. Analysis of ECG for different lead configurations.

4. Analysis of EEG Signals.

5. Analysis of EMG Signals.

6. Design of Instrumentation Amplifier for bioelectrical Signals.

7. Measurement of Heart Sounds.

8. Real time EPR System.

9. Electrical Safety analyzer for biomedical equipments.

10. Analysis of Bio-Signals using Lab View.

11. Compression of Bio-Signals using Lab View.

12. Flame photometer for biomedical applications.

13. Study and analyze the performance of UV-VIS Spectrophotometer.

**REFERENCE BOOKS/LABORATORY MANUALS**:

1. Leslie Cromwell, Fred. J. Weibell and Erich. A. Pfeiffer, "*Biomedical Instrumentation and Measurements*", 2nd Edition, PHI, 2003.

2. R.S. Khandpur, "*Hand Book of Biomedical Instrumentation*", Tata McGraw Hill, 2nd Edition, 2002.

3. John G.Webster, "*Medical Instrumentation Application and Design*", 3$^{rd}$ Edition, Wiley India Pvt. Ltd.,2004

**ADDITIONAL LEARNING RESOURCES:**

1. Lab view 2013 biomedical toolkit.

2. http://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering

3. https://physionet.org/

**Offering Department:** MECHANICAL ENGINEERING

**Students of Eligible Branches:** CSE, CSSE, IT, ECE, EEE, EIE and CE

## COURSE STRUCTURE

| Semester | Course Code | Course Title | Contact Periods per week | | | | Credits | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem (2 Theory) | 19BM50301 | Computer Integrated Manufacturing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50302 | CNC Programming | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50303 | Introduction to Mechanical systems * | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| III B.Tech. II-Sem (2 Theory) | 19BM60301 | Principles of Industrial Automation | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60302 | Principles of Robotics* | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60303 | Robot Kinematics and Dynamics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| IV B.Tech. I-Sem (2 Theory) | 19BM70301 | Applied and Industrial Robotics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70302 | Robotic Programming | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70303 | Sensors and Machine Vision Systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |

\* Compulsory Course, if not studied in Major Degree.

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete the prerequisite before taking the respective course.

## III B. Tech. – I Semester

## (19BM50301) COMPUTER INTEGRATED MANUFACTURING

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Introduction to CIM, CAD/CAM, product life cycle, Fundamentals of NC and CNC, Group Technology AND FMS, Computer Aided Planning Systems, Adaptive control systems.

**COURSE OUTCOMES:** After successful completion of this course, the students will be able to:

CO1. Apply the principles of Computer integrated manufacturing to control and foster the production process.

CO2. Analyze the architecture of numerical control and apply the Numerical control programming techniques for the machining process.

CO3. Analyze different part families through grouping and construe different machine cell designs and flexible manufacturing systems.

CO4. Demonstrate different approaches and techniques for computer-aided process planning in automation.

CO5. Demonstrate knowledge of Adaptive control systems for different applications.

**DETAILED SYLLABUS:**

### UNIT I: FUNDAMENTALS OF CIM                                         (9 Periods)

Introduction to Manufacturing; CIM - Types, Manufacturing Systems, CIM Definition, CIM wheel, CIM components, Evolution of CIM - Development of computers, needs of CIM, Benefits of CIM, CIM Hardware & Software, Fundamentals of CAD / CAM, Product cycle.

### UNIT II: FUNDAMENTALS OF NC AND CNC                                (9 Periods)

**Numerical control machines**: Introduction, basic components of an NC system, the NC procedure, NC coordinate system, NC motion control system, application of numerical control and Economics of Numerical control.

**Computer controls in NC:** Principle of CNC, types of CNC machine tools, programming and applications of CNC machine tools, Direct Numerical control (DNC), Database and DBMS-requirement, features and architecture of DBMS.

### UNIT III: GROUP TECHNOLOGY AND FMS                                 (9 Periods)

**Group Technology**: Group Technology - Part families, Parts classification and coding, Production flow analysis, Composite part concept, Machine cell design and Benefits of GT.

**Flexible Manufacturing Systems**: FMS - Components of FMS, FMS Work stations, Material Handling Systems, Computer Control system, FMS layout configurations and Benefits of FMS.

**UNIT IV: COMPUTER AIDED PLANNING SYSTEMS**                    **(9 Periods)**

Computer aided planning systems - Approaches to Computer aided Process Planning

(CAPP), Generative and Retrieval CAPP systems, Benefits of CAPP, Material Requirement

Planning (MRP), Mechanism of MRP, Benefits of Capacity Planning.

**UNIT V: ADAPTIVE CONTROL SYSTEMS:**                    **(9 Periods)**

Adaptive control machining system - Adaptive control optimization system, Adaptive control constraint system, Applications to machining processes, Computer process monitoring, Hierarchical structure of computers in manufacturing, and computer process control.


                                                    **Total Periods: 45**

***Topics for self-study are provided in the lesson plan***


**TEXTBOOKS:**

1. Mikel.P.Groover, *Automation, Production systems and Computer Integrated Manufacturing Systems*, Pearson Education; 4th Edition,2016.

2. P.N.Rao, *CAD/CAM: Principles and Applications,* McGraw Hill Education*, 3rd edition, 2017.*


**REFERENCE BOOKS:**

1. Radhakrishnan and Subramanian, *CAD/CAM/CIM*, New Age International Pvt Ltd, 4th Edition, 2018.

2. M. Groover, *CAD/CAM*, Pearson Education; 1st Edition, 2003.

(19BM50302) **CNC PROGRAMMING**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Fundamentals of NC And CNC Machines, CNC Machine Elements, CNC Machine Structure and Machining Centers, Machining Centers, Adaptive Control Systems and Drives, DNC Systems and Adaptive Control, Feedback Devices, Fundamentals of CNC Programming, CNC Part Programming, CNC Turning and Milling Programming, CNC Turning, CNC Milling.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of numerical controls & computerized numerical control of a manufacturing system.

CO2. Demonstrate the knowledge of constructional and functional features of machines and its support systems.

CO3. Analyze CNC machines with the knowledge of Adaptive control systems and drive systems considering societal needs.

CO4. Apply CNC coding used in CNC programming for a given operation.

CO5. Apply CNC programming for basic Turning and Milling Operations.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTALS OF NC and CNC MACHINES                    (9 Periods)**

**NC machines:** Fundamentals of numerical control, advantage of NC systems, classification of NC systems, point to point, NC and CNC, incremental and absolute, open and closed-loop systems, features of NC Machine tools, interpolations.

**CNC Machines**: CNC machine elements, principle of operation of CNC, features of CNC, classification of CNC systems, Advantages of CNC system, Application of CNC systems.

**UNIT II: CNC MACHINE STRUCTURE AND MACHINING CENTERS          (9 Periods)**

**CNC Machine Structure:** Guideways, feed drives, spindles, spindle bearings, slide ways - Friction, Antifriction and types of guideways; Recirculating ball screw; Torque transmission elements - gears, timing belts, flexible couplings and bearings.

**Machining centers**: Features, Auto Tool Changer (ATC) & Automatic Pallet Changer (APC).

**UNIT III: ADAPTIVE CONTROL SYSTEMS AND DRIVES                 (9 Periods)**

**DNC Systems and Adaptive Control**: Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, adaptive control with constraints. **Feedback devices** – Open loop and closed loop control systems, positional feedback, velocity feedback devices.

**Drives:** spindle drives-DC shunt motor, 3 phase induction motor, Feed drives-stepper motors, servo principle, DC and AC servo motors.

## UNIT IV: CNC PROGRAMMING                                    (9 Periods)

**CNC PART PROGRAMMING**: Coordinate systems- structure of part program, Types of interpolation, Methods of CNC part programming, Part Program Terminology-G and M Codes, Machine and workpiece datum, absolute and incremental programming, tool offset and tool nose radius compensation, fixed cycles, subroutines in part programming, computer-aided part programming, CNC controllers (FANUC and SINUMERIC),

## UNIT V:  CNC TURNING AND MILLING PROGRAMMING              (9 Periods)

**CNC Turning**: Basic programs on Turning, Facing, Drilling, Threading, Taper Turning, Boring, reaming, and tapping

**CNC Milling**: Basic programs on Face Milling, End Milling, Drilling, Chamfering, Boring, Reaming, Tapping, Sinking.

Features of typical CAM packages: Master CAM, Edge CAM, Siemens NX CAM.


                                                         **Total Periods: 45**

*Topics for self-study are provided in the lesson plan*



**TEXTBOOKS:**

1. Mike Mattson, *CNC Programming: Principles & Applications: Principles and Applications*, Delmar; 1st edition, 2013.
2. Yorem Koren, *Computer Control of Manufacturing Systems*, Mc Graw Hill Book Co, 2017.
3. P. Radhakrishnan, *Computer Numerical Control (CNC) Machines*, New Central Book Agency; 1st edition,2013

**REFERENCE BOOKS:**

1. M. Adithan and B.S. Pable, *CNC Machines*, New Age, Third edition, 2018.
2. Mikell P. Groover, *Automation, Production Systems and Computer-Integrated Manufacturing*, Pearson Education; Fourth edition, 2016.
3. J.S. Narang, *CNC Machines And Automation*, Dhanpat Rai & Co. (P) Limited, 2016.

(19BM50303) **INTRODUCTION TO MECHANICAL SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Statics of rigid bodies; Laws of mechanics; Force couple system; Equilibrium of rigid bodies; Supports and reactions forces; Moment and couple and their representation; Dynamics of rigid bodies; Motion of a rigid bodies; Energy equations; Frictional forces; Robotics and automation; Configuration and anatomy of robots; End effectors; Robotic drive and control systems; Actuators.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Analyze the mechanical behavior of a rigid body and components of forces involved
in it.

CO2.  Analyze conditions of equilibrium applied over a rigid body in different dimensions and compute its moments and couples.

CO3.  Analyze the dynamic behavior of a rigid body and its condition of motion.

CO4.  Demonstrate knowledge of robots and their components.

CO5.  Analyze the functional characteristics of robot drives, actuators and controls for configurations.


**DETAILED SYLLABUS:**

**UNIT I: STATICS                                                      (9 Periods)**

Introduction, Units and Dimensions, Laws of Mechanics, Force Characteristics, System of forces, Lami's theorem, Parallelogram and triangular Law of forces, Statics of rigid bodies in two dimensions, force couple system.

**UNIT II: EQUILIBRIUM OF RIGID BODIES                        (9 Periods)**

Free body diagram, Types of supports, Action and reaction forces, Moments and Couples, Moment of a force about a point and about an axis, Vectorial representation of moments and couples, Varignon's theorem, Equilibrium of Rigid bodies in two dimensions.

**UNIT III:  RIGID BODY DYNAMICS                              (9 Periods)**

Displacements, Velocity and acceleration, their relationship, Relative motion, Curvilinear motion, Newton's laws of motion, Work Energy Equation; Friction force – Laws of sliding friction, Equilibrium analysis of simple systems with sliding friction.

**UNIT IV: ROBOTICS                                          (9 Periods)**

Robotics and programmable automation, Law of robotics, Anatomy, Configuration of robots, Robot end effectors-classification, force analysis, active and passive grippers.

## UNIT V: ROBOTIC DRIVES, ACTUATORS & CONTROLS                    (9 Periods)

Functions of Drive Systems, General Types of Fluids, Classification of fluid power systems, Components of hydraulic fluid power systems, components of pneumatic systems, Pump Classification, Introduction to Pneumatic Systems, Electrical Drives, D.C. Motors and Transfer Functions, A.C. Motors, Piezoelectric Actuators, Stepper Motor, Drive Mechanisms.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Beer F.P, Johnston Jr.E.R, *Vector Mechanics for Engineers Statics and Dynamics,* McGraw Hill Education, 11th Edition, 2017.

2. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta *"Industrial Robotics (SIE): Technology, Programming and Applications*, McGraw Hill Education India, 2012

3. S.R. Deb and S.Deb *"Robotic Technology and Flexible Automation"* McGraw Hill Education India. Second Edition, 2012.

4. Khushdeep goyal, Deepak Bhandari*, Industrial automation and robotics*, Katson books, 2013.

**REFERENCES:**

1. Hibbeller R.C, Ashok Gupta "*Engineering Mechanics Statics and Dynamics*", Pearson Education, 11th Edition, 2009.

2. Bhavikatti S.S "*Engineering Mechanics*", 7th Edition, New Age International (P) Limited Publishers, 2019.

3. Young D H, Timashenko S "*Engineering Mechanics*", Tata McGraw-Hill., 2006

4. S K Saha *"Introduction to Robotics",* 2nd Edition, McGraw Hill Education India, 2014.

## (19BM60301) **PRINCIPLES OF INDUSTRIAL AUTOMATION**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Introduction to automation, Types of automation systems, Fluid power and fluid power systems, Assembly automation equipment, Material handling, transfer and assembly equipment, Types of automated assembly machines, Programmable Logic Controllers, PLC hardware components, Microprocessors and Microcontrollers, Feedback devices.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of automation and its different applications.

CO2. Analyze functional characteristics of power systems for industrial applications.

CO3. Demonstrate knowledge of assembly automation equipment and its related components.

CO4. Demonstrate the knowledge of programming logic controller units for industrial applications.

CO5. Demonstrate the knowledge of microprocessors and microcontrollers in integrating mechanical systems with computer and electronic systems.

**DETAILED SYLLABUS:**

**UNIT I: INTRODUCTION TO AUTOMATION                                    (9 Periods)**

History, Elements of Automation, Types of Automation systems, Applications of Automation, Goals of Automation, low cost automation, Hierarchical levels in industrial automation systems.

**UNIT II: FLUID POWER AND FLUID POWER SYSTEMS            (9 Periods)**

Introduction to fluid power- Classification of fluid power systems, comparison of electrical, hydraulic and Pneumatic systems; Basic circuit diagram of Hydraulic fluid power and pneumatic power systems, Components of Hydraulic fluid power systems, Components of Pneumatic power system, Logic Gates, Truth tables and Boolean algebra.

**UNIT III: ASSEMBLY AUTOMATION EQUIPMENT                      (9 Periods)**

**Material Handling**: Principles of Material Handling, Material handling equipment- Wheel conveyor, Gravity Roller conveyor, Chain conveyor, Flat belt conveyor, Magnetic belt conveyor, bucket conveyor, Vibrating conveyor, screw conveyor, vertical lift conveyor, trolley conveyor, sortation conveyor, cranes and Hoists, storage equipment, AS/RS, AGV.

**Transfer and assembly equipment:** Introduction to feeder units, Cycled transfer equipment and non-cycled transfer equipment.

**Automated assembly machines:** Dial indexing machine, In-line machine, and floating work platform machines.

## UNIT IV: PROGRAMMABLE LOGIC CONTROLLERS                    (9 Periods)

**Programmable Logic Controllers (PLC):** Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Applications.

**PLC hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, Typical Discrete I/O Module Specifications, Typical Analog I/O Module Specifications, The Central Processing Unit (CPU),Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).

## UNIT V: MICROPROCESSORS AND MICROCONTROLLERS           (9 Periods)

Evolution of microprocessors and microcontrollers; Architectures of microprocessors and microcontrollers; Integration of mechanical systems with computer and electronic systems (Mechatronic systems).

**Feedback devices:** LVDT, Linear/Rotary encoders, absolute encoders, resolvers and potentiometers, Fundamentals of SCADA and Data Acquisition Systems.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Khushdeep Goyal, *Industrial Automation and Robotics*,  S.K.Kataria & Sons, 4th Edition, 2013.

2. Frank. D.Petruzella*, Programmable Logic Controllers,* Tata McGraw-Hill Education, 4th Edition, 2011.

**REFERENCE BOOKS:**

1. M.P. Groover, Automation, *Production systems and Computer Integrated Manufacturing*, Fourth edition, PHI Learning, 2016.

2. Geoffrey Boothroyd, Assembly Automation and Product design, Taylor and Francis Publishers, Second edition 2005.

(19BM60302) **PRINCIPLES OF ROBOTICS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES: -**

**COURSE DESCRIPTION:**

Brief history - Robot – Definition, Various robot manipulators – Linear and angular velocities, tactile, proximity and range sensors, End Effectors and robot economics

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate knowledge of robotics, its specifications, functions and different applications.

CO2. Demonstrate knowledge of various robot manipulators

CO3. Demonstrate knowledge of sensors, work cells and programming languages.

CO4. Analyze functional characteristics of robot end effectors through design considerations.

CO5 Analyze the economic aspects of robots by considering different safety parameters.

**DETAILED SYLLABUS:**

**UNIT I: BASIC CONCEPTS** **(9 Periods)**

Brief history, Robot - Definition, Anatomy; Co-ordinate Systems, Work Envelope types and Classification, Robotic Specifications, Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load, Robot Parts and their Function; Need for Robots, Applications.

**UNIT II: ROBOT MANIPULATORS** **(9 Periods)**

Various robot manipulators, Linear and angular velocities, Manipulator Jacobian, Prismatic and rotary joints, Robotic Inverse, Wrist and arm singularity.

**UNIT III: ROBOT SENSORS** **(9 periods)**

Desirable features of Sensors; Tactile, proximity and range sensors; Uses of sensors in robotics; work cell; Introduction to Programming languages.

**UNIT IV: ROBOT END EFFECTORS** **(9 periods)**

End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

**UNIT V: IMPLEMENTATION AND ROBOT ECONOMICS** **(9 p***eriods***)**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

**Total Periods: 45**

***Topics for self-study are provided in the lesson plan.***

**TEXTBOOKS:**

3. R.K.Mittal and I.J.Nagrath, *Robotics and Control*, Tata McGraw Hill, New Delhi,4th Reprint, 2005.

4. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, *Industrial Robotics*, McGraw-Hill Singapore, 1996.

**REFERENCE BOOKS**:

3. JohnJ.Craig ,*Introduction to Robotics Mechanics and Control*, Pearson Education, Third edition, 2009.

4. Ashitava Ghoshal, *Robotics-Fundamental Concepts and Analysis*, Oxford University Press, Sixth impression, 2010.

# III B. Tech. – II Semester

## (19BM60303) **ROBOT KINEMATICS AND DYNAMICS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Robot Manipulation, Robot Classification, Robot Specifications, Direct Kinematics, Inverse Kinematics, Manipulator Differential Motion and Statics, Manipulator Jacobian, Dynamic Modeling,

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge on robot manipulation and control for industrial applications

CO2. Analyze forward and Inverse kinematics for different robot schemes.

CO3. Analyze manipulator differential motion and statics for different robot schemes

CO4. Develop dynamic models for robots using Langrangian mechanics, Lagrange–Euler formulation, Newton–Euler formulation and other techniques.

**DETAILED SYLLABUS:**

### UNIT I: ROBOT MANIPULATION                                (9 Periods)

Automation and robots; Robot anatomy; Robot Classification; Manipulation and control; Applications; Robot Specifications-Number of axes, Capacity and speed, Reach and stroke, Tool orientation, Repeatability, precision and accuracy, Operating environment.

### UNIT II: DIRECT KINEMATICS                                (9 Periods)

Dot and cross products; coordinate frames; Rotations; Homogeneous coordinates; link coordinates; D-H Representation; The ARM equation; Schematic diagram of four, five and six axis articulated robot.

### UNIT III: INVERSE KINEMATICS                                (9 Periods)

Manipulator workspace; Solvability of inverse kinematic model; Existence of solutions; Multiple solutions, Solution techniques; Closed form solution; The inverse kinematics problem; General properties of solutions; Tool configuration; Inverse kinematics of four axis SCARA robot and six axis articulated robot.

### UNIT IV: MANIPULATOR DIFFERENTIAL MOTION AND STATICS        (9 Periods)

Linear and angular velocity of a rigid body; Relationships between transformation; Mapping, Velocity vector; Velocity propagation along links; Manipulator Jacobian; Jacobian inverse; Jacobian singularities; Static analysis.

**UNIT V: DYNAMIC MODELING:**                                    **(9 Periods)**

Langrangian mechanics; Two degrees of freedom manipulator–Dynamic model, Lagrange – Euler formulation, Newton–Euler formulation; Comparison of Lagrange–Euler formulation and Newton–Euler formulation; Inverse dynamics.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Robert J. Schilling, *Fundamentals of Robotics Analysis and Control,* PHI Learning, 2011.

2. R.K.Mittal and Nagrath*, Robotics and Control, TMH, 2017.*

**REFERENCE BOOKS:**

1. Niku S B*, Introduction to Robotics, Analysis, Systems, Applications,* Prentice Hall, Second edition 2006.

2. Geoffrey Boothroyd, *Assembly Automation and Product design*, Taylor and Francis Publishers, Second edition 2005.

(19BM70301) **APPLIED AND INDUSTRIAL ROBOTICS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

General considerations in Robot material handling, material transfer application, machine loading and unloading, CNC machine tool loading; repeatability, maximum working envelop, kinematic and state values. Robot safety Considerations, Factors affecting robot safety measures; Cooperative manipulation; field robots and robots in health care

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.  Demonstrate knowledge of robotic material handling and assembly systems.

CO2.  Demonstrate the knowledge of expert systems in robotic performance testing and safety

CO3.  Demonstrate knowledge of various cooperative and SWARM robots and its applications.

CO4.  Analyze robotic configurations and specifications for field and service applications.

CO5.  Demonstrate the core concepts of robots in medical applications.

**DETAILED SYLLABUS:**

**UNIT I**:  **ROBOT MATERIAL HANDLING**                      **(10 periods)**

General considerations in Robot material handling, material transfer application, machine loading and unloading, CNC machine tool loading, Robot centered cell Assembly and parts presentation methods, Assembly operation, Compliance and the Remote center compliance (RCC) Device, Assembly system configurations, Adaptable programmable assembly system, Designing for robotic assembly, Inspection automation - vision inspection system, robot - manipulated inspection.

**UNIT II: EXPERT SYSTEMS**                               **(9 periods)**

Factors influencing the choice of a robot, Robot performance testing - Path/point accuracy and repeatability, Maximum working envelop, Kinematic and State values. Robot safety Considerations, Factors affecting robot safety measures, Safety features built into industrial robot, Safety barriers and other devices.

**UNIT III: COOPERATIVE AND SWARM ROBOTS**               **(7 periods)**

Cooperative manipulation, Challenges in cooperative manipulation- Case studies for Cooperative manipulation for Industrial and Service applications; Introduction to swarm Robots, Comparison with other multi-agent systems, challenges and benefits of swarm systems- Algorithms for swarm Robots, application, case study of swarm Robots.

## UNIT IV: FIELD ROBOTS                                              (10 periods)

Forestry, Robot locomotion, Forestry automation, Broadacre Applications- Automatic guidance, sowing, weeding, spraying and broad-acre harvesting; Horticulture, Picking of fruits, Robot milking, Sheep shearing, Slaughtering, livestock inspection, Robots in construction, Future directions; Robots for hazardous applications, Enabling technologies- Search and Rescue robotics: Disaster characteristics-Impact on Robots, Robots actually used at disaster, Promising robots, open issues – Case studies; Cleaning Robots, lawn moving Robots- Smart appliances and smart homes.

## UNIT V: ROBOTS IN HEALTH CARE                                      (9 periods)

Medical robotics, Core concepts, Technology- Medical robotic systems, Research areas and applications; Rehabilitation and Health care robotics- Overview, physical therapy

and training Robots; Robotic aid for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

### TEXTBOOKS

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, *Industrial Robotics Technology, Programming and Applications*, Mc Graw Hill Book company, 4th edition, 2016.

2. Bernard Hodges, *Industrial Robotics*, Second Edition, Jaico Publishing House, 1993.

### REFERENCE BOOKS

1. Yangsheng Xu Huihuan Qian Xinyu Wu, *Household and Service Robots*, ElsevierLtd, 2015.

2. Aleksandar Lazinica, *-Mobile Robots Towards New Applications*, Advanced Robotic Systems International, 2006.

3. L Marques,A de Almeida,Mo Tokhi,GSVirk, *-Advances in Mobile Robotics*, World Scientific Publishing Co. Pte. Ltd. 2008.

4. Bruno Siciliano, OussamaKhatib, *-Springer Handbook of Robotics*, Springer-Verlag Berlin Heidelberg, 2008.

## IV B.Tech. – I Semester

### (19BM70302) **ROBOTIC PROGRAMMING**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:-**

**COURSE DESCRIPTION:**

Robotic programming; Robotic software functions; Program planning; Modes of programming; Commands for motion control; Lead through robotic programming; Textual robotic programming; End effectors and sensors commands; Program control and subroutines; VAL II Programming; AML Programming;

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of basic planning schemes involved in the development of robotic programming.

CO2. Develop Programmes for robots based on the techniques of pendent and command control.

CO3. Demonstrate the knowledge of robotic languages for operations and control.

CO4. Develop Programs for robots on VAL II platform with complete command-based control.

CO5: Develop Programs for robots on AML platform with complete command-based control.

**DETAILED SYLLABUS:**

### UNIT I: FUNDAMENTALS OF ROBOT PROGRAMMING (9 Periods)

Robot software functions - coordinate systems, Position control, Oher control functions, sub-routines, Planning of robotic programming using flowcharting - examples.

### UNIT II: METHODS OF ROBOT PROGRAMMING (9 Periods)

Online programming, off-line programming advantages of off-line programming; lead through methods - powered lead through, manual lead through, Teach pendant; Robot program as a path in space, defining position in space, motion interpolation, WAIT, SIGNAL and DELAY commands, Branching capabilities and Limitations of lead through methods.

### UNIT III: ROBOT LANGUAGES (9 Periods)

Textual robot Languages, first generation and Second-generation languages, Structure of a robot language - Operating Systems, Elements and Functions, Constants, Variables and Other data objects, Motion commands, Points in workspace, End effectors and sensor commands, Computations and operations, Program control and subroutines, Communications and Data processing.

### UNIT IV: VARIABLE ASSEMBLY LANGUAGE (9 Periods)

Variable Assembly Language II - Introduction, Monitor commands, motion command, Hand Control, Configuration control, interlock commands, INPUT/OUTPUT Controls, Program Control, Examples

**UNIT V: A MANUFACTURING LANGUAGE** **(9 Periods)**

A Manufacturing Language (AML) - Introduction, AML statements, Constant and variables, Program control statements, motion commands, Sensor commands; Grip sensing capabilities, Data processing, Examples.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, *Industrial Robotics Technology, Programming and Applications*, McGraw Hill Book company, 1986

2. Bernard Hodges, *Industrial Robotic*, Jaico Publishing House, 2nd Edition, 1993.
3. S.R. Deb and S.Deb *Robotic Technology and Flexible Automation,* Second Edition McGraw Hill Education India., 2012

**REFERENCES:**

1. JJ Craig, *Introduction to Robotic Mechanics and Control*, Pearson, 3rd edition, 2004.
2. Fu, Lee and Gonzalez, *Robotics, control vision and intelligence*, McGraw Hill International, 2nd edition, 1987.

(19BM70303) **SENSORS AND MACHINE VISION SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:**

Vison systems; Components of vision systems; Elements of visual perception; Low level vison; Filters; Higher level visions; Boundary and regional description; Sensors in robots; Different sensing variables; Robotic control; Robotic operating System; Open CV.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Demonstrate the knowledge of vision system components and image interfaces.

CO2. Demonstrate the knowledge of image representations and filters for low level vision system.

CO3. Demonstrate the knowledge of higher level vision for industrial applications.

CO4. Analyze functional characteristics of sensors incorporated in a robot system.

CO5. Demonstrate knowledge of robotic operating system and vision system for robotic simulation.

**DETAILED SYLLABUS:**

**UNIT I: VISION SYSTEM                                             (9 Periods)**

Basic Components, Elements of visual perception: structure of the human eye, Image formation in the eye – pinhole cameras - colour cameras – Image formation model – Imaging components and illumination techniques-Picture coding–Basic relationship between pixels -Camera-Computer interfaces.

**UNIT II: LOW-LEVEL VISION                                         (9 Periods)**

Image representation–Gray level transformations, Histogram, Image subtraction, Image averaging – Filters: Smoothing spatial filters, sharpening spatial filters, smoothing frequency domain filters, sharpening frequency domain filters-Edge detection.

**UNIT III:  HIGHER LEVELVISION:                                   (9 Periods)**

Segmentation-Edge linking and Boundary Detection, Thresholding, Region-oriented segmentation, the use of motion Description: Boundary Descriptors, Regional Descriptors, Recognition: Decision-Theoretic methods, structural methods.

**UNIT IV: SENSORS IN ROBOTICS                                     (9 Periods)**

Position sensors - optical, non-optical, Velocity sensors, Accelerometers, Proximity Sensors - Contact, non-contact, Range Sensing, touch and Slip Sensors, Force and Torque Sensors. Different sensing variables - smell, Heat or Temperature, Humidity, Light, Speech or Voice recognition Systems, Telepresence and related technologies, robot control through vision

**UNIT V: ROBOT VISION** **(9 Periods)**

Robotic operating System (ROS) -Introduction, Real and Simulated Robots; Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV – The CV_bridge Package.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan*

**TEXTBOOKS:**

1. K.S.Fu, R.C.Gonzalez, CSG.Lee, -*Robotics control, sensing, vision and Intelligence‖,* McGraw Hill EducationPvt.Ltd.,2017.

2. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin,*Robotics Engineering: An Integrated Approach*, PHI Learning, New Delhi, 2009.

**REFERENCEBOOKS:**

1. Damian M.Lyons, *Cluster Computing for Robotics and Computer Vision*, World Scientific, Singapore, 2011.

2. Rafael C.Gonzalez, Richard E.Woods, StevenL. Eddins, *Digital Image Processing using MATLAB* ,2nd edition, Tata McGrawHill, 2010.

3. Carsten Steger, MarkusUlrich, Christian Wiedemann, *Machine Vision algorithms and Applications*, WILEY-VCH, Weinheim, 2008.

4. Kenneth Dawson-Howe, *A Practical Introduction to Computer Vision with OpenCV*, Wiley, Singapore, 2nd edition, 2013.

## SUSTAINABLE ENGINEERING

**Offering Department:** CIVIL ENGINEERING

**Students of Eligible Branches:** CSE, CSSE, IT, ECE, EEE, EIE and ME

## COURSE STRUCTURE

| Year & Semester | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem | 19BM50101 | Sustainable Engineering* | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50102 | Ecology and Environmental Impact | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| (2 Theory) | 19BM50103 | Waste to Energy | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| III B.Tech. II-Sem | 19BM60101 | Environmental Sustainability | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60102 | Sustainable Energy Systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| (2 Theory) | 19BM60103 | Sustainability in The Built Environment | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| IV B.Tech. I-Sem | 19BM70101 | Environmental Economics | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70102 | Sustainable Cities | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| (2 Theory) | 19BM70103 | Sustainable Design of Technology Systems | 3 | - | - | 3 | 3 | 40 | 60 | 100 |

\* Compulsory Course, if not studied in Major Degree.

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:** -

**COURSE DESCRIPTION:**

Principles of sustainability; Sustainability metrics and assessment tools; Sustainable engineering practices; Sustainable engineering applications; Sustainable urbanization and industrialization.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the principles of sustainability to solve complex environmental problems following relevant standards/protocols considering society, health, safety and environment.

CO2. Analyze sustainability metrics and assessment tools to solve complex environmental problems following relevant standards and emerging trends considering society, health, safety, environment and economics besides communicating effectively in graphical form.

CO3. Analyze sustainable engineering practices to solve complex environmental problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

CO4. Design sustainable engineering applications to solve complex environmental problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

CO5. Analyze sustainable urbanization and industrialization principles to solve complex environmental problems using appropriate tools and techniques following relevant standards considering society, health, safety, environment, economics and management besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: PRINCIPLES OF SUSTAINABILITY**                    **(09 Periods)**

Emerging challenges, Sustainability and sustainable engineering; Environmental concerns; Social, economic and legal issues; Availability and depletion of natural resources, Disaster resiliency; Multilateral environmental agreements – Basel convention, Clean development mechanism (CDM), Montreal and Kyoto protocols.

**UNIT II: SUSTAINABILITY METRICS AND ASSESSMENT TOOLS     (09 Periods)**

Sustainability indicators, metrics and assessment tools, Material flow analysis and material budget, Carbon footprint analysis, Life cycle assessment, Streamlined life-cycle assessment (SLCA), Economic input output-life cycle analysis, Environmental health risk assessment, Other emerging assessment tools.

## UNIT III: SUSTAINABLE ENGINEERING PRACTICES                    (09 Periods)

Sustainable energy engineering, Sustainable waste management, Green and sustainable buildings and infrastructure, Sustainable civil infrastructure, Sustainable remediation of contaminated sites, Climate geoengineering.

## UNIT IV: SUSTAINABLE ENGINEERING APPLICATIONS                 (09 Periods)

Environmental and chemical engineering projects, Materials engineering projects, Infrastructure engineering projects – Background, Methodology, Goal and Scope, Study area, Technical design, Environmental sustainability, Life cycle assessment, Economic sustainability, Social sustainability, Rating systems – ENVISION, LEED, GRIHA, IGBC; Conclusions.

## UNIT V: SUSTAINABLE URBANIZATION AND INDUSTRIALIZATION     (09 Periods)

Sustainable urbanization and industrialization, United Nations sustainable development goals – Right to education, Poverty eradication, Social and technological changes; Industrial Processes - Material selection, Energy efficiency, Pollution prevention and control techniques, Industrial Ecology, Industrial symbiosis.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*


**TEXTBOOKS:**

1. Reddy, K. R., Cameselle, C., and Adams, J. A., *Sustainable Engineering: Drivers, Metrics, Tools, and Applications*, John Wiley & Sons, Inc., Hoboken, New Jersey, 2019,

2. Allen, D. T. and Shonnard, D. R., *Sustainability Engineering: Concepts, Design and Case Studies*, Pearson Education, 1st Edition, 2012.


**REFERENCE BOOKS:**

1. Bradley. A. S; Adebayo, A. O., Maria, P., *Engineering Applications in Sustainable Design and Development*, Cengage Learning, 1st Edition, 2016.

2. Purohit, S. S., *Green Technology: An Approach for Sustainable Environment*, Agrobios Publication, 1st Edition, 2016.

3. *Energy Conservation Building Code (ECBC) 2007*, Bureau of Energy Efficiency, Govt. of India, New Delhi.

4. Twidell, J. W. and Weir, A. D., *Renewable Energy Resources*, Routledge, Taylor & Francis Group, 3rd Edition, 2015.

**ADDITIONAL LEARNING RESOURCES:**

1. Daniel A. Vallero and Chris Brasier, *Sustainable Design: The Science of Sustainability and Green Engineering*, Wiley-Blackwell, 1st Edition, 2008.

2. Jorge A. Vanegas, *Sustainable Engineering Practice: An Introduction*, Committee on Sustainability, American Society of Civil Engineers, https://doi.org/10.1061/9780784407509, 2004.

3. Mackenthun, K. M., *Basic Concepts in Environmental Management*, CRC Press, Taylor & Francis Group, 1st Edition, 1999.

4. *Environment Impact Assessment Guidelines*, Notification of Government of India, 2006.

## UNIT II: ECOSYSTEM

(10 Periods)

Concept and components of ecosystem, Trophic structure, Primary and secondary productivity, Energy flow in ecosystem, Food chain and food web, Ecological pyramids, Homeostasis; Biogeochemical cycles; Gaseous and sedimentary cycle; Carbon, Nitrogen, Phosphorous and Sulphur cycles.

## UNIT III: ECOLOGICAL IMPACT ASSESSMENT

(9 Periods)

Introduction, Basic concept of Environmental Impact Assessment (EIA), Ecological impact assessment; Environmental effects of development projects: water resources development, thermal power plants, mining; Prediction and assessment of impact on biological environment.

## UNIT IV: ECOTOXICOLOGY AND BIO-MONITORING

(9 Periods)

Ecotoxicology; Toxicity; Types of toxicity, Bioaccumulation, Bioconcentration, Biomagnification, Biotransformation; Dose-response relationships, Toxicity tests; Biomonitoring; Bioindicators; Bioassays.

## UNIT V: RESTORATION ECOLOGY

(7 Periods)

Ecology of disturbed ecosystems; Restoration, Concepts of ecological restoration, Restoration of specific ecosystems; Forest, grasslands, surface mined lands, aquatic ecosystems; Approaches for restoration, Rehabilitation and reclamation.

Total Periods: 45

## TEXT BOOKS:

1. P. D. Sharma, "Ecology and Environment", Rastogi Publications, 12th Edition, 2017.
2. Y. Anjaneyulu, "Introduction to Environmental Science", B. S. Publications, 2004.

## REFERENCE BOOKS:

1. Eugene P. Odum, "Fundamentals of Ecology", Cengage Learning India Pvt. Ltd, 5th Edition, 2009.
2. Charles H. Southwick, "Ecology and the Quality of our Environment", D Van Nostrand Company, 2nd Edition, 1976.
3. P. Meganathan, "Environmental Impact Assessment", Dominant Publishers and Distributors, 2002.

## UNIT II: ECOSYSTEM                                         (8 Periods)

Structure and function of ecosystems, Productivity, Decomposition, Energy flow, Ecological efficiencies, Ecological pyramids, Global pattern of productivity, Nutrient cycling (Carbon, Nitrogen and Phosphorus), Ecosystem stability – Inertia, Resilience; Fragile ecosystem, Hot spots, Ecosystem services, Net Present Value (NPV) of ecosystems, Major biomes of India and the world.

## UNIT III: ECOLOGICAL IMPACT ASSESSMENT                     (09 Periods)

Principles and practices of ecological assessment, Carrying capacity of environment and earth, Environmental quality, Ecological and social impact of man, Resource depletion, Loss of biological diversity, Land degradation and deforestation, Impact assessment methods through case studies at organism, Community and ecosystem levels, Detailed criteria, Survey methods and evaluation, Cost benefit analysis, Prediction of impacts on physical environment and biotic communities through modelling, Developing impact statement.

## UNIT IV: ECOTOXICOLOGY AND BIO-MONITORING                  (08 Periods)

**Ecotoxicology:** Ecotoxicology - Background, importance and measurement; LC50, EC50, NOEC, LOEC, Toxic units, Ecosystem response to de-oxygenation; Eutrophication - Kinetics, Lake phosphorous model, Pesticides.

**Bio-monitoring:** Bio-monitoring, Active and passive monitoring, Concept of bioaccumulation, Bio-indicator parameters, Bio-air conditioning and bio-purifiers, Pollution tolerance index of plants, Green belt development, Plant protection and protective substances to pollution stress, Data-gathering techniques, Organization of the survey and data analysis.

## UNIT V: RESTORATION ECOLOGY                                (10 Periods)

Ecological theories and principles that guide restoration practices in a variety of ecosystems, Causes of ecosystem degradation, Motivations for restoration, Factors that influence success in restoration; Ecology of disturbed ecosystems - Disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems; Aims and strategies of restoration - Concepts of restoration, Single vs. multiple end-points, Ecosystem reconstructions, Physical, chemical, biological and biotechnological tools of restoration; Restoration of biological diversity - Acceleration of ecological succession, Reintroduction of biota; Degradation and restoration of natural ecosystems – Rivers, Wetlands, Forests, Grassland, Savanna, Aquatic; Restoration of degraded soils - Restoration of contaminated soils and soil fertility, Mine spoil restoration.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Saha, T. K., *Ecology and Environmental Biology*, Books and Allied (P) Ltd., Kolkata, 1st Edition, 2010.
2. Walker, C. H., Hopkin, S. P., Sibly R. M. and Peakall, D. B., *Principles of Ecotoxicology*, Taylor and Francis Group, London, 2nd Edition, 2004.
3. Palmer, M. A., Zedler, J. B. and Falk, D. A., *Foundations of Restoration Ecology*, Island Press, USA, 2016.

**REFERENCE BOOKS:**

1. Dash, M. C. and Dash, S. P., *Fundamentals of Ecology*, Tata - McGraw Hill, New Delhi, 3rd Edition, 2001.
2. Smith, T. M. and Smith, R. L., *Elements of Ecology*, Pearson Education Ltd., England, 9th Edition, 2015.
3. Hughes, W., *Essentials of Environmental Toxicology*, Taylor & Francis Press, USA, 2005.
4. Wathern, P., and Hynman, U., *Impact Assessment and Sustainable Resource Management-Theory and Practice*, Routledge Press, 2014.
5. Westman, W. E., Ecology, *Impact Assessment and Environmental Planning*, John Wiley, New York, 1985.

**ADDITIONAL LEARNING RESOURCES:**

1. Rajgopalan, R., *Environment and Ecology - A Complete Guide*, OakBridge Publishing, 2nd Edition, 2019.
2. Charles J. Krebs, *Ecology: The Experimental Analysis of Distribution and Abundance*, Pearson Education India, 6th Edition, 2008.
3. Mani, M., Ganesh, L.S. and Varghese, K., *Sustainability and Human Settlements*, Sage Publications, New Delhi, 1st Edition, 2005.

(19BM50103) **WASTE TO ENERGY**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Course on Environmental Science.

**COURSE DESCRIPTION:**

Waste to energy concept; Municipal solid waste; Thermochemical waste to energy technologies; Biological waste to energy technologies; Waste to energy plants and the environment.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1    Analyze waste to energy process to solve waste management challenges using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO2    Analyze municipal solid waste characteristics and sampling techniques to solve solid waste management challenges using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO3    Analyze thermochemical waste to energy technologies to solve solid waste management challenges using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO4    Analyze traditional and advanced biological technologies for converting waste to energy using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO5    Analyze energy plants and the environment to solve waste to energy challenges using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: WASTE TO ENERGY CONCEPT              (09 Periods)**

Waste to energy- A historical prospective, Waste as a renewable resource, Global production of power from waste; The politics of waste - Waste management hierarchy, Circular economy/zero Waste, Energy from waste with the circular economy concept.

**UNIT II: MUNICIPAL SOLID WASTE              (08 Periods)**

Sources and types of solid waste, Quantity, Factors affecting generation of solid waste, Characteristics, Waste classification, Methods of sampling and characterization, Energy content of the waste.

## UNIT III: THERMOCHEMICAL WASTE TO ENERGY TECHNOLOGIES     (10 Periods)

Traditional waste combustion technologies - Waste processing and treatment facility, Rotary combustors, Fluidized bed combustors; Energy production from waste through advanced thermochemical techniques - Incineration, Gasification and Pyrolysis.

## UNIT IV: BIOLOGICAL WASTE TO ENERGY TECHNOLOGIES     (10 Periods)
Energy production from waste through biological techniques - Anaerobic digestion, Fermentation, Transesterification, Advanced microbial fuel cells; Cultivation of algal biomass from wastewater and energy production from algae.

## UNIT V: WASTE TO ENERGY PLANTS AND THE ENVIRONMENT     (08 periods)

Emission limits for waste combustion, Environmental politics and science, Waste to energy plant cost, Latest developments in waste to energy, Case Studies.

**Total Periods: 45**

***Topics for self-study are provided in the lesson plan.***

**TEXTBOOKS:**

1. Breeze, Paul, *Energy from Waste*, Academic Press, 1st Edition, 2017.

2. Singh, R. P., Prasad, V. and Vaish, B., *Advances in Waste-to-Energy Technologies*, CRC Press, 1st Edition, 2019.

**REFERENCE BOOKS:**

1. Maczulak, A. E., *Environmental Engineering: Designing a Sustainable Future,* Infobase Publishing, 4th Edition, 2010.

2. Kalogirou, E. N., *Waste-to-Energy Technologies and Global Applications*, CRC Press, 1st Edition, 2017.

3. Klinghoffer, N. B., & Castaldi, M. J., *Waste to Energy Conversion Technology*, Elsevier, 3rd Edition, 2013.

**ADDITIONAL LEARNING RESOURCES:**

1. Rogoff, M. J., & Screve, F., *Waste-to-energy: Technologies and Project Implementation*, Academic Press, 1st Edition, 2019.

2. Trabold, T., and Babbitt, C. W., *Sustainable Food Waste-to-Energy Systems*, Academic Press, 1st Edition, 2018.

(19BM60101) **ENVIRONMENTAL SUSTAINABILITY**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | – | 3 |

**PREREQUISITES:**

Course on Environmental Science, Sustainable Engineering

**COURSE DESCRIPTION:**

Environmental measurements from different disciplines and sustainability concepts; Environmental chemistry and physical process in environment; Environmental risk assessments with concepts of EIA and LCA; Sustainability assessment of water and wastewater treatment; Sustainability assessment of solid waste management and air pollution issues.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze environmental measurements and sustainability concepts to solve environmental sustainability challenges using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO2. Analyze environmental chemistry and physical processes to solve environmental sustainability challenges using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO3. Analyze environmental risk assessment with concepts of EIA and LCA to solve environmental sustainability problems using appropriate tools and techniques following relevant codes and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO4. Analyze water and wastewater treatment to solve environmental sustainability problems using appropriate tools and techniques, following relevant codes, regulations and latest developments considering health, society, environment, sustainability and economics besides communicating effectively in graphical form.

CO5. Analyze sustainable assessment of solid waste management and air pollution issue to solve complex problems using appropriate tools and techniques, following relevant codes, regulations and latest developments considering health, society, environment, sustainability and economics besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: ENVIRONMENTAL MEASUREMENTS FROM DIFFERENT DISCIPLINES AND SUSTAINABILITY CONCEPTS                                                    (09 Periods)**

Environmental measurements - Mass concentration units, Partial pressure units, Other types of units, Qualitative and quantitative measurements; Sustainability concepts and evolution, Engineering for sustainability.

## UNIT II: ENVIRONMENTAL CHEMISTRY AND PHYSICAL PROCESS IN ENVIRONMENT                                                    (09 Periods)

Environmental chemistry, Mass balance and reactor systems; Mass balance in continuous reactor, continuous stirred tank reactor (CSTR) and Plug flow reactor; Plug flow reactor and energy flow, Energy balance and earth overshot day, Mass transport processes.

## UNIT III: ENVIRONMENTAL RISK ASSESSMENT WITH CONCEPTS OF EIA AND LCA                                                    (09 Periods)

Life Cycle Assessment (LCA); Environmental Impact Assessment (EIA) - Fundamentals, Evolution of EIA (Global and Indian Scenario), Elements of EIA– Screening, Scoping, Public consultation, Environmental clearance process in India - Key elements in 2006 EIA (Govt. of India) notification; Environmental risk, Environmental impact calculation by using LCA technique, Risk assessments with concepts of EIA and LCA, Case studies.

## UNIT IV: SUSTAINABILITY ASSESSMENT OF WATER AND WASTEWATER TREATMENT                                                      (08 Periods)

Sustainability assessment in Water purification – Processes, Engineered systems – Aeration, Solids separation, Settling operations, Coagulation, Softening, Filtration, Disinfection; Sustainability assessment in wastewater treatment process and disposal – Primary, Secondary and Tertiary.

## UNIT V: SUSTAINABILITY ASSESSMENT OF SOLID WASTE MANAGEMENT AND AIR POLLUTION ISSUES                                              (10 Periods)

Sustainability assessment of solid waste management –Need and scope; Municipal solid waste – Types, Composition and characteristics; Methods of collection and transportation; Methods of disposal – Open dumping, Sanitary landfill, Composting and Incineration; Utilization - 6R Concept; Sustainability assessment of air pollution issues –Need and scope, Classification, Sources – Line, Area, Stationary, Mobile; Effects of air pollutants on man, Material and vegetation; Global effects of air pollution.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Davis, M. L. and Cornwell, D. A., *Introduction to Environmental Engineering,* McGraw-Hill, 5th Edition, 2008.
2. Keong, Choy Yee, *Global Environmental Sustainability: Case Studies and Analysis of the United Nations' Journey toward Sustainable Development*, Elsevier, 2020.

**REFERENCE BOOKS:**

1. Singh, Ritu, and Sanjeev Kumar, *Green Technologies and Environmental Sustainability*, Springer, 2nd Edition, 2017.
2. Joumard, Robert, and Henrik Gudmundsson, *Indicators of Environmental Sustainability in Transport: An Interdisciplinary Approach to Methods,* European Commission, 2nd Edition, *2010.*
3. Smith, Fraser, *Environmental Sustainability: Practical Global Applications*, CRC Press, 1st Edition, 2020.

**ADDITIONAL LEARNING RESOURCES:**

1. Burke, G., Singh,B. R. and Theodore, L., *Handbook of Environmental Management and Technology*, John Wiley & Sons, 2nd Edition, 2000.
2. Peavy, Howard S., Donald R. Rowe, and George Tchobanoglous, *Environmental Engineering*, McGraw-Hill, Indian Edition, 1st Edition, 2017.

# III B.Tech. - II Semester

## (19BM60102) SUSTAINABLE ENERGY SYSTEMS

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PREREQUISITES:**

Courses on Environmental Science, Sustainable Engineering

**COURSE DESCRIPTION:**

The energy landscape and sustainability; Solar and wind energy; Biomass, geothermal, tidal and wave energies; Electricity storage technologies; Grid integration of renewable energy.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze the energy landscape and sustainability to provide solutions to energy problems using appropriate tools and techniques following relevant standards considering society, health and environment besides communicating effectively in graphical form.

CO2. Analyze solar and wind energy systems to solve the complex energy problems using appropriate tools and techniques following relevant standards considering society, health, environment, sustainability and economics besides communicating effectively in graphical form.

CO3. Analyze biomass, geothermal, tidal and wave energy systems to solve the complex energy problems using appropriate tools and techniques following relevant standards considering society, health, environment, sustainability and economics besides communicating effectively in graphical form.

CO4. Analyze electric storage technology systems to solve the complex energy problems using appropriate tools and techniques following relevant standards and latest developments considering society, health, environment, sustainability and economics besides communicating effectively in graphical form.

CO5. Analyze grid integration of renewable energy to solve the complex energy problems using appropriate tools and techniques following relevant standards considering society, health, environment, sustainability and economics besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: THE ENERGY LANDSCAPE AND SUSTAINABILITY           (09 Periods)**

Current global energy use, National and international energy consumption and related greenhouse gas emissions, Lifetime of fossil fuels, Sustainability and energy use, Energy conversion technologies, Energy forms and conversion, First and second laws of thermodynamics and efficiencies; Devices - Heat engines, Refrigerators, Heat pumps; Instantaneous and average power.

**UNIT II: SOLAR AND WIND ENERGY                          (09 Periods)**

Principles of solar radiation, Resource foundations, Technology challenges, Sustainability, Solar energy industry and economics, Net Metering; Origin of the wind, Power in the wind, Wind resource basics, Wind energy technologies, Challenges, Sustainability, Wind energy Industry.

## UNIT III: BIOMASS, GEOTHERMAL, TIDAL AND WAVE ENERGIES     (09 Periods)

Sources of feedstocks; Biofuels - Bioethanol, Biodiesel, Algal, Jatropha and Biogas; Conversion technology, Diesel and ethanol, Biogas, Electricity production, Transportation, Challenges, Sustainability, Economics; Geothermal energy - Principles, Geothermal potential and technology, Electricity production, Conversion technology, Challenges, Economics; Tidal and wave energies, Conversion technologies, Sustainability.

## UNIT IV: ELECTRICITY STORAGE TECHNOLOGIES     (09 Periods)

Introduction, Battery energy storage technologies - Lithium-ion batteries, Full cells, Nickel-based batteries, Lead-acid batteries, Sodium-sulfur batteries; Hydro energy storage - Applications of pump hydro energy storage plant, Site selection for pump hydro energy storage plant; Thermal energy storage, Capacitors and applications, Latest developments.

## UNIT V:  GRID INTEGRATION OF RENEWABLE ENERGY     (09 Periods)

Variability, Intermittency and dispatchability, Electric grid infrastructure, Integrating renewable energy into the grid, Growing a more efficient grid, The smart grid,  Secure communication in the smart grid; Cogeneration plant and power distribution in industry, Micro grids.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Boyle, Godfrey, *Renewable Energy: Power for a Sustainable Future*, Oxford University Press, 3rd Edition, 2012.
2. Jefferson  W.  Tester, Elisabeth  M.  Drake, Michael  J.  Driscoll, Michael  W. Golay, William A. Peters, *Sustainable Energy (Choosing Among Options)*, MIT Press, 2nd  Edition, 2012.

**REFERENCE BOOKS:**

1. Gilbert M. Masters, *Renewable and Efficient Electric Power Systems*, John Wiley & Sons, Inc., Hoboken, New Jersey, 2nd Edition, 2013.
2. Vanek, F.M., Albright, L.D., *Energy Systems Engineering - Evaluation and Implementation*, McGraw-Hill, 2nd Edition, 2008.
3. David MacKay, *Sustainable Energy: Without the Hot Air*, UIT Cambridge Ltd., Cambridge, England, 2009.
4. Frank Kreith, *Principles of Sustainable Energy Systems*, , CRC Press, Taylor and Francis group, 2nd Edition, 2014.

**ADDITIONAL LEARNING RESOURCES:**

1. Richter Burton, *Beyond Smoke and Mirrors: Climate Change and Energy in the 21st Century*, Cambridge University Press, New York, 2010.

## (19BM60103) **SUSTAINABILITY IN THE BUILT ENVIRONMENT**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|------------|------------|-------------|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Environmental Science, Sustainable Engineering.

**COURSE DESCRIPTION:**

Sustainable urban development; Sustainable site planning and analysis; Sustainable buildings; Building envelope and services; Management of sustainable built environment.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze sustainable urban development to solve problems associated with the built environment using appropriate tools and techniques following relevant standards considering society, health and environment besides communicating effectively in graphical form.

CO2. Analyze sustainable site planning to solve complex problems associated with the built environment using appropriate tools and techniques following relevant standards considering society, health and environment besides communicating effectively in graphical form.

CO3. Analyze sustainable buildings to solve complex problems associated with the built environment using appropriate tools and techniques following relevant standards considering society, health and environment besides communicating effectively in graphical form.

CO4. Analyze building envelope and services to solve complex problems associated with the built environment using appropriate tools and techniques following relevant standards considering society, health and environment besides communicating effectively in graphical form.

CO5. Analyze management of sustainable built environment to solve complex problems using appropriate tools and techniques following relevant standards considering society, health and environment besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: SUSTAINABLE URBAN DEVELOPMENT                (09 Periods)**

Urban development - Human activities and their effects; Carbon cycle; Role of construction material such as concrete and steel; $CO_2$ contribution from cement and other construction materials; GHG emissions - Global climate change; Efforts in sustainable development and construction - Universal efforts, International organizations involved.

**UNIT II: SUSTAINABLE SITE PLANNING AND ANALYSIS          (09 Periods)**

Sustainable site planning, Principles of site analysis, Improving sustainability of a site – Stormwater, Reducing site disturbance, Vegetation; Site analysis - Examples of site analysis; Introduction to alternative energy - Solar, Wind, Hydro, Biofuel etc.

## UNIT III: SUSTAINABLE BUILDINGS                                    (09 Periods)

Introduction to sustainable buildings and standards, Green buildings, Energy efficiency and sustainability; Passive House; Net Zero Energy Buildings (NZEB), Examples of different types of NZEB.

## UNIT IV: BUILDING ENVELOPE AND SERVICES                          (09 Periods)

Building envelope effect and energy efficiency measures, Renewable energy integration, Sustainable building services, Sustainable construction and materials, Integrated design, Energy use and CO2, Built environment - Aging and susceptibility to natural disasters.

## UNIT V: MANAGEMENT OF SUSTAINABLE BUILT ENVIRONMENT        (09 Periods)

Life cycle planning, Measuring sustainability; Facilities management - Waste management, Improved amenities, Improved transport infrastructure, Social mix, Accessibility issues, Cultural and historical issues.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Alison Cotgrave and Mike Riley, *Total Sustainability in the Built Environment*, Macmillan Education, 1st Edition, 2012.
2. Kevin Lynch and Gary Hack, *Site Planning*, MIT Press, 3rd Edition, 1984.

**REFERENCE BOOKS:**

1. William McLean and Pete Silver, *Environmental Design Source Book: Innovative Ideas for a Sustainable Built Environment*, RIBA Publishing, 1st Edition, 2021.

2. Tim Dixon, John Connaughton, Stuart Green, *Sustainable Futures in the Built Environment to 2050: A Foresight Approach to Construction and Development*, John Wiley & Sons Ltd., 2018.

3. Rob Fleming, Saglinda H Roberts, *Sustainable Design for the Built Environment*, Routledge Press, London, 1st Edition, 2019.

4. Charles J. Kibert, *Sustainable Construction: Green Building Design and Delivery,* Wiley, 4th Edition, 2021.

**ADDITIONAL LEARNING RESOURCES:**

1. Mani, M., Ganesh, L.S. and Varghese, K., *Sustainability and Human Settlements,* Sage Publications, 1st Edition, 2005.

2. Barton, H., Grant, M., Guise, R., *Shaping Neighbourhoods: For Local Health and Global Sustainability*, Routledge Press, 2nd Edition, 2020.
3. https://nptel.ac.in/courses/105/102/105102195/
4. https://nptel.ac.in/courses/124/107/124107011/

(19BM70101) **ENVIRONMENTAL ECONOMICS**

| Int. Marks | Ext. Marks | Total | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | – | 3 |

**PREREQUISITES:**

Courses on Environmental Science, Sustainable Engineering.

**COURSE DESCRIPTION:**

Fundamentals of environmental economics; Economy and the natural environment interaction; Economic development and environment; Valuation of environmental goods and services; Sustainable economic development.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1 Analyze fundamentals of environmental economics to solve environmental economics challenges associated with sustainable design of technology systems considering latest developments, society, environment, economic, and sustainability besides communicating effectively in graphical form.

CO2 Analyze economy and the natural environment interaction to solve ecological limits and scarcity of eco-services approaches using different tools and techniques considering latest developments, relevant guidelines, environment and sustainability besides communicating effectively in graphical form.

CO3 Analyze economic development and environment to solve environmental cost-benefit challenges using different tools and techniques considering latest developments, relevant guidelines, environment and sustainability besides communicating effectively in graphical form.

CO4 Analyze valuation of environmental goods and services to solve methodical challenges using different tools and techniques considering latest developments, relevant guidelines, environment and sustainability besides communicating effectively in graphical form.

CO5 Analyze sustainable economic development to solve environmental economics challenges using different tools and techniques considering latest developments, relevant guidelines, environment and sustainability besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: FUNDAMENTALS OF ENVIRONMENTAL ECONOMICS          (10 Periods)**

Fundamentals of environmental economics, Review of microeconomics and welfare economics, Ecology-economy interaction, Perspective of economic modeling- the concept and conditions of sustainability of the human economy, Classification and characterization of resources and pollution as a public good or bad, Role of Externalities as the fundamental determinants, Property Rights, Market, Spatial-temporal dimensions of externality-command and control, Market approaches, Green tax, Taxes in controlling externalities

**UNIT II: ECONOMY AND THE NATURAL ENVIRONMENT INTERACTION**

**(08 Periods)**

An overview of the economy and the natural environment; Interaction using an input-output based general equilibrium approach to show how ecological limits and scarcity of eco-

services would affect the resource allocation and prices; Regimes of natural resources, Types of goods, Provision of public goods.

## UNIT III: ECONOMIC DEVELOPMENT AND ENVIRONMENT          (09 Periods)

The relation between development environmental Quality - Environmental Kuznets curve; Development vs conservation of environmental resources - Ecosystem flips and irreversibility - Krutilla-Fisher equation; Environmental cost-benefit analysis under strong and weak conditions of sustainability;  Choice of time discount rate for evaluation - Sustainability premium.

## UNIT IV: VALUATION OF ENVIRONMENTAL GOODS AND SERVICES

## (10 Periods)

Theory of environmental valuation and conceptual basis of its methods - Compensating variations and surplus, Equivalent variations and surplus, Willingness to pay or accept for improvement or loss of environmental goods and services; Empirical approaches in environmental valuation; Indirect methods of environmental valuation, Non-demand function methods of valuation, Revealed preference methods - (a) Hedonic Pricing, (b) Household production function approach, Defensive cost, Health cost and travel cost methods; The direct method of environmental valuation - Stated preference - Contingent valuation method.

## UNIT V:  SUSTAINABLE ECONOMIC DEVELOPMENT          (08 Periods)

Capital theoretic basis of the notion of sustainable development - Sustainable Development as non-declining intertemporal utility or that of the value of the wealth. Concepts of Genuine investment or savings, Green National Income, Natural capital stock and sustainable resource accounting, Strong and weak sustainability, Environmental adjustment of national income.

## Total Periods: 45

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. Siebert, H. and Siebert, H., *Economics of the Environment*. Massachusetts: Lexington Books, 9th Edition, 1981.

2. Pearce, David W., and Kerry Turner R., *Economics of Natural Resources and The Environment,* JHU Press, Revised and Enlarged Edition, 1990.

### REFERENCE BOOKS:

1. Nick Hanley, Jason F Shorgen and Ben White, *Environmental Economics Theory and Practice*, MacMillan, 2nd Edition, 2006.
2. Tietenberg, Tom and Lynne Lewis, *Environmental and Natural Resource Economics*, Routledge, 11th Edition, 2018.
3. Kumar, P., *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*, Routledge, 2012.

### ADDITIONAL LEARNING RESOURCES:

1. Field, C., *Environmental Economics: An Introduction*, McGraw-Hill Book Company (UK) Ltd, 8th Edition, 2021.
2. Sengupta, R., *Ecological Limits and Economic Development,* OUP Catalogue, 2013.

## (19BM70102) **SUSTAINABLE CITIES**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Environmental Science, Sustainable Engineering.

**COURSE DESCRIPTION:**

Sustainability and urban development; Functions of cities; Inclusive, Safe and productive cities; Sustainable urban services and infrastructure; Governing sustainable cities.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1. Analyze sustainability and urban development to solve problems associated with cities using appropriate tools and techniques following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO2. Analyze city functioning for sustainability to solve problems associated with cities using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO3. Analyze inclusiveness, safety and productivity in cities to solve problems associated with cities using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO4. Analyze sustainable urban services and infrastructure to solve problems associated with cities using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment, sustainability and economics besides communicating effectively in graphical form.

CO5. Analyze governance for sustainable cities to solve problems associated with cities using different tools and techniques considering latest developments, relevant guidelines, environment and sustainability besides communicating effectively in graphical form.

**DETAILED SYLLABUS:**

**UNIT I: SUSTAINABILITY AND URBAN DEVELOPMENT (08 Periods)**

The urban opportunity; Cities - Cultural and social transformation; Challenge of urban politics, Planning and governance, Urban research methods, Urban theory and history, Urban development and the environment, Urban growth and the environment - Why cities grow?, Externalities and the environment, Urban economic restructuring, City size and settlement planning.

**UNIT II: FUNCTIONS OF CITIES (09 Periods)**

Understanding urban systems, Municipal, Regional and national governance, Urban utilities, Urban public finance and taxation; Law, order and conflict; Land management and planning, Lessons from London and Mumbai.

## UNIT III: INCLUSIVE, SAFE AND PRODUCTIVE CITIES                    (10 Periods)

What is urban poverty?, Measuring urban poverty, Poverty reduction in cities, Affordable and adequate housing, Who can deliver the housing we need?, Safety and violence, Urban vulnerabilities;  Making cities productive and reduce inequality- City production and consumption, Women in the informal economy, Migration, mobility and the urban-rural continuum Wealth and inequality, Case: SEWA, India, Migration and the refugee crisis; Improving human development in cities – Addressing the challenges of urban public health, Solutions for improving urban health, Education and skills, Higher education in cities, Gender in the city, Human rights and justice, Law and equality, Apartheid in South African cities.

## UNIT IV: SUSTAINABLE URBAN SERVICES AND INFRASTRUCTURE      (08 Periods)
Sustainable environmental services and infrastructure, Sustainable transport planning, ICT, Sustainable urban energy systems, Sustainable transport: Bangkok; How can cities be resilient - Air, water, food and natural resources; City risk exposure; Climate impacts, adaptation and mitigation; Building urban resilience, Environmental planning and the politics of change.

## UNIT V: GOVERNING SUSTAINABLE CITIES                               (10 periods)

Sustainable environmental practices, Urban disaster risk management, Post-disaster recovery, SDGs and other global processes, New institutions and governance, Public participation and democracy, Financing sustainable development, Measuring and monitoring the SDGs, Opportunities of secondary cities.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

**TEXTBOOKS:**

1. Al-Zu'bi, Maha, and Vesela Radovic, *SDG11-Sustainable Cities and Communities: Towards Inclusive, Safe, and Resilient Settlements*, Emerald Group Publishing, 1st Edition, 2019.

2. Rydin, Yvonne, *Governing for Sustainable Urban Development*, Earthscan, 2012.

3. Evans, Bob, Marko Joas, Susan Sundback, and Kate Theobald, *Governing Sustainable Cities*, Routledge, 2013.

**REFERENCE BOOKS:**

1. Register, R., EcoCities: *Rebuilding Cities in Balance with Nature*, New Society Publishers, Revised Edition, 2006.
2. Yigitcanlar, T, *Sustainable Urban and Regional Infrastructure Development: Technologies, Applications and Management: Technologies, Applications and Management*, IGI Global, 2007.

**ADDITIONAL LEARNING RESOURCES:**

1. Flint J. and Raco M., *The Future of Sustainable Cities: Critical Reflections,* Policy Press, 2nd Edition, 2012.
2. Corburn, J., *Toward the Healthy City: People, Places and the Politics of Urban Planning,* MIT Press, 3rd Edition, 2009.

## (19BM70103) **SUSTAINABLE DESIGN OF TECHNOLOGY SYSTEMS**

| Int. Marks | Ext. Marks | Total Marks | | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 40 | 60 | 100 | | 3 | - | - | 3 |

**PRE-REQUISITES:**

Courses on Environmental Science, Sustainable Engineering.

**COURSE DESCRIPTION:**

Sustainability and sustainable development; Product life cycle design – Methods and strategies; Product life cycle design – Software tools; Designing for sustainable product-service system – Methods and tools; Design for sustainability – Engineering design criteria and guidelines.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to:

CO1.   Analyze sustainability and sustainable development to solve complex problems associated with sustainable design of technology systems using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment and economics besides communicating effectively in graphical form.

CO2.   Analyze product life cycle design methods and strategies to solve complex problems associated with sustainable design of technology systems using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment and economics besides communicating effectively in graphical form.

CO3.   Analyze product life cycle design software tools to solve complex problems associated with sustainable design of technology systems using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment and economics besides communicating effectively in graphical form.

CO4.   Design sustainable product-service systems to solve complex problems associated with sustainable design of technology systems using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment and economics besides communicating effectively in graphical form.

CO5.   Design engineering criteria and guidelines to solve complex problems associated with sustainable design of technology systems using appropriate tools and techniques, following relevant codes, regulations and latest developments considering society, environment and economics besides communicating effectively in graphical form.

## DETAILED SYLLABUS:

### UNIT I: SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT          (09 Periods)

Sustainability and sustainable development - Understanding un-sustainability and need for Sustainability, Definitions, Pathway, Systems approach to design; Evolution of sustainability within design - Diverse approaches to design for sustainability, Relationship between approaches to design for sustainability and the application context.

### UNIT II: PRODUCT LIFE CYCLE DESIGN – METHODS AND STRATEGIES (08 Periods)

Life Cycle Assessment (LCA) - Product Life Cycle Assessment, LCA introduction, LCA methodology, LCA goal, LCA scope, Inventory analysis, Impact assessment, Interpretation; Environmental risk,  Environmental impacts calculation by using LCA technique, Risk assessment with concepts of LCA.

### UNIT III: PRODUCT LIFE CYCLE DESIGN – SOFTWARE TOOLS          (08 Periods)

History of product design by LCA with examples; ISO 14000, Life cycle analysis, SIMA PRO, LCA software and other software for LCA, LCA methodical challenges - Allocation and uncertainty, Sensitivity analysis.

### UNIT IV: DESIGNING FOR SUSTAINABLE PRODUCT-SERVICE SYSTEM – METHODS AND TOOLS          (10 Periods)
Sustainable product service system design – Definition, Types and examples; Sustainable product service system – Transition path and challenges, Sufficiency economy philosophy applied to sustainable product-service system (PSS) thinking, Khadi movement as a precursor to PSS thinking.

### UNIT V: DESIGN FOR SUSTAINABILITY – ENGINEERING DESIGN CRITERIA AND GUIDELINES          (09 periods)

Sustainable product-service system design applied to distributed economy, Other design for sustainability tools and approaches – Agriculture, Cities and communities, Carbon footprint, Green buildings, Green materials, Green energy, Sustainable development, Zero waste, Circular economy.

**Total Periods: 45**

*Topics for self-study are provided in the lesson plan.*

### TEXTBOOKS:

1. Horne, Ralph, Tim Grant, and Karli Verghese, *Life Cycle Assessment: Principles, Practice and Prospects*, Csiro Publishing, 2009.

2. Bhamra, Tracy, and Vicky Lofthouse, *Design For Sustainability: A Practical Approach*. Routledge, 1st Edition, 2016.

### REFERENCE BOOKS:

1. Vezzoli, C., Kohtala, C., Srinivasan, A., Diehl, J. C, Fusakul, S. M., Xin, L. and Sateesh, D., *Product-service System Design for Sustainability*, Routledge, 1st Edition, 2017.

2. Curran, Mary Ann, *Life Cycle Assessment Student Handbook*, John Wiley & Sons,     1st Edition, 2015.

3. Hauschild, Michael Z., Ralph K. Rosenbaum and Stig Irvin Olsen, *Life Cycle Assessment*, Springer International Publishing, 2018.

4. Hendrickson, Chris T., Lester B. Lave, and H. Scott Matthews, *Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach*. Routledge, 2010.

**ADDITIONAL LEARNING RESOURCES:**

1. Sharmistha Banerjee, System Design for Sustainability, IIT Guwahati, https://nptel.ac.in/ courses/107/103/107103081/.

2. Curran, Mary Ann, *Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products*, John Wiley & Sons, 3rd Edition, 2012.