

**ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABI
for
MASTER OF TECHNOLOGY
in
POWER ELECTRONICS AND DRIVES
(For the batches admitted from 2019-2020)
CHOICE BASED CREDIT SYSTEM**



**SREE VIDYANIKETHAN ENGINEERING COLLEGE
(AUTONOMOUS)**

**(Affiliated to JNTU Anantapur, Approved by AICTE Programs
Accredited by NBA; NAAC with 'A' grade)
Sree Sainath Nagar, A.Rangampet, Near Tirupati - 517 102. 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 ELECTRICAL AND ELECTRONICS ENGINEERING

Vision

To become the Nation's premiere centre of excellence in electrical engineering through teaching, training, research and innovation to create competent engineering professionals with values and ethics.

Mission

Department of Electrical Engineering strives to create human resources in Electrical Engineering to contribute to the nation development and improve the quality of life.

Imparting Knowledge through implementing modern curriculum, academic flexibility and learner centric teaching methods in Electrical Engineering

Inspiring students for aptitude to research and innovation by exposing them to industry and societal needs to creating solutions for contemporary problems

Honing technical and soft skills for enhanced learning outcomes and employability of students with diverse background through comprehensive training methodologies

Inculcate values and ethics among students for a holistic engineering professional practice.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

After few years of graduation, the graduates of M.Tech. (PED) Program will

- PEO1. Enroll in doctoral studies or engage in research activities of societal importance.
- PEO2. Assume key positions in research divisions, industry and academia.
- PEO3. Advance professionally through continuing education, ethics and values.

PROGRAM OUTCOMES

On successful completion of the Program, the graduates of M.Tech. (PED) will be able to

- PO1. Demonstrate in-depth knowledge of power electronics and drives with an ability to practice, distinguish, evaluate and integrate the existing and advanced knowledge.
- PO2. Investigate complex problem in power electronics and drives critically to design, evaluate and synthesize optimal solutions keeping in view of societal and environmental factors.
- PO3. Select, learn and apply appropriate tools, techniques and resources to solve power electronics and drives problems.
- PO4. Work independently or in groups to solve problems in power electronics and drives.
- PO5. Communicate effectively on complex engineering activities with the engineering community and society at large through effective reports, documents and presentations adhering to appropriate standards.
- PO6. Advance professionally through continuing education practicing professional ethics and values.

The Challenge of Change

“Mastery of change is in fact the challenge of moving human attention from an old state to a new state. Leaders can shift attention at the right time and to the right place. The real crisis of our times is the crisis of attention. Those who lead are the ones who can hold your attention and move it in a purposeful way. Transformation is nothing but a shift in attention from one form to another. The form of a beautiful butterfly breaks free from a crawling caterpillar. If you pay enough attention, you would be able to see how the butterfly hides within the caterpillar. The leader points out a butterfly when the follower sees only a caterpillar”.

- Debashis Chatterjee

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

ACADEMIC REGULATIONS
(SVEC-19)

CHOICE BASED CREDIT SYSTEM

M. Tech. Regular Two Year Degree Program
(For the batches admitted from the academic year 2019-2020)

For pursuing Two year degree program of study in Master of Technology (M.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 Academic Council in the forth coming meeting. As per the requirements of statutory bodies, Principal, SVEC shall be the Chairman, Academic Council.

3. Admission :

3.1. Admission into the Two Year M. Tech. Degree Program:

3.1.1. Eligibility:

A candidate seeking admission into the two year M. Tech Degree Program should have

- (i) Passed B.Tech/B.E or equivalent Program recognized by JNTUA, Ananthapuramu, for admission as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE).
- (ii) A minimum percentage of marks in the qualifying degree as prescribed by the AICTE / UGC or Government at the time of admission.
- (iii) Rank/score secured in the PGECET/GATE examination conducted by APSCHE/ MHRD for allotment of a seat by the convener PGECET, for admission.

3.1.2. Admission Procedure:

Admissions are made into the two year M.Tech. Degree Program as per the stipulations of APSCHE, Government of Andhra Pradesh:

- (a) By the Convener, PGECET (for Category-A Seats)
- (b) By the Management (for Category-B Seats).

4. Programs of study offered leading to the award of M.Tech. Degree and Eligibility:

Following are the two year M.Tech degree Programs of study with specializations, offered by the departments in SVEC leading to the award of M.Tech. degree and the qualifying degree eligible for admission:

Name of the M.Tech specialization	Offered by the Department	Qualifying Degree / Branch eligible for Admission
Electrical Power Systems	EEE	BE/ B.Tech / AMIE in Electrical & Electronics Engineering / Electrical Engineering or equivalent
Power Electronics and Drives		
Digital Electronics and Communication Systems	ECE	BE / B.Tech in ECE / AMIE in ECE, AMIE (Electronics & Telecommunication Engineering) / AMIETE (Electronics & Telematics Engineering)/ Electronics & Computer Engineering/ Electronics/ Electronics & Telematics or equivalent
Communication Systems		
VLSI		
Computer Science	CSE	BE / B.Tech / AMIE in CSE / CSIT / IT / CSSE , M.Sc. (Computer Science), M.Sc. (Information Systems), M. Sc. (Information Technology), MCA or equivalent.
Computer Networks and Information Security		
Software Engineering	IT	

5. Duration of the Program:

5.1 Minimum Duration:

The program will extend over a period of two years leading to award of the Degree of Master of Technology (M.Tech) by JNTUA University, Ananthapuramu. The two academic years are divided into four semesters with two semesters per year. Each semester shall consist of 21 weeks (≥ 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.

5.2 Maximum Duration:

The student shall complete all the passing requirements of the M.Tech degree program within a maximum duration of 04 years excluding the Gap year. This duration is reckoned from the commencement of the semester into which the student is first admitted to the program.

6. Course Structure:

Each M.Tech Program of study shall comprise of:

- Professional Core courses:
The list of professional core courses shall be chosen as per the suggestions of the experts, to impart knowledge and skills needed in the concerned specialization of study.
- Professional Elective courses:
Professional elective courses shall be offered to the students to diversify their spectrum of knowledge and skills. The elective courses can be chosen based on the interest of the student to broaden his individual knowledge and skills.
- Audit Courses: Audit courses shall be offered to the students to diversify their knowledge.
- Projects (Internship, Project work)

7. **Credit System:** All Courses are to be registered by a student in a Semester to earn Credits. Credits are assigned based on the following norms given in Table 1.

Table 1

Course	Periods/Week	Credits
Theory	01	01
Practical	01	0.5
Internship	--	02
Project Work Phase-I	--	10
Project Work Phase-II	--	16

All Courses are to be registered by a student in a Semester to earn Credits. Credits shall be assigned to each Course in an 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
- **Audit Courses:** No **CREDIT** is awarded.
- **Open Elective (MOOC):** 03 Credits

For courses like 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. Other student activities like NCC, NSS, Sports, Study Tour, and Guest Lecture etc. shall not carry Credits.

The two year curriculum of any M. Tech Degree Program of study shall have total of **68** credits.

8. Choice Based Credit System (CBCS):

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

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

A Student has a choice of registering for courses comprising program core, Program electives, Open elective through MOOC course.

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 The enrollment of courses in I-Semester will commence on the day of admission. If the student wishes, the student may drop or add courses (vide clause 8) within **three** days before commencement of I-Semester class work and complete the registration process. The student shall enroll for the courses with the help of Faculty Advisor (Mentor). The enrollment of courses in II-Semester will commence 10 days prior to the last instructional day of the I-Semester and complete the registration process for all the remaining theory courses as per program course structure, 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 course 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 No elective course shall be offered by a Department unless a minimum of 08 students register for the 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 M.Tech II-Semester, and pursued through Massive Open Online Course (MOOC) platforms.

10.2 The student shall confirm registration by enrolling the course within 10 days prior to the last instructional day of the M.Tech I-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 HOD shall appoint one faculty member as **mentor** during the M.Tech I-Semester for each Open Elective Course registered through MOOC.

10.5 There shall be ONLY semester-end examination for open elective (MOOC) course. It shall be evaluated by the department through ONLINE with 50 multiple choice questions for 100 marks. The department shall prepare the Question Bank for Conducting the ONLINE Open Elective (MOOC) Examination.

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 one year.

11.2 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, professional Volunteering and chronic illness. 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.

11.3 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.

11.4 The one year period of break of study shall not be counted for the maximum period for the award of the degree (i.e 05 years shall be the maximum period for the award of degree for the students availing Gap Year).

11.5 If a student has not reported to the college after completion of approved period of break of study without prior intimation, he is deemed to be detained in that semester. Such students are eligible for readmission into the semester when offered next.

12. Examination System: All components in any Program of study shall be evaluated through internal evaluation and/or an external evaluation conducted as semester-end examination.

12.1. Distribution of Marks:

Sl. No.	Course	Marks	Examination and Evaluation	Scheme of examination
1.	Theory	60	Semester-end examination of 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 will have internal choice and 5 questions shall be answered, one from each unit.
		40	Mid-term Examination of 2 hours duration (Internal evaluation).	Two mid-term examinations each for 40 marks are to be conducted. For a total of 40 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).

Sl. No.	Course	Marks	Examination and Evaluation		Scheme of examination
					<p>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 10 marks, out of which 3 are to be answered and evaluated for 30 marks. There shall be also 5 short answer questions each of 2 marks, all are to be answered and evaluated for 10 marks.</p>
2	Laboratory	50	Semester-end Lab Examination for 3 hours duration (External evaluation)		The examination will 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 include 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.
			20	Practical test (Internal evaluation).	Laboratory examination-II: Shall be conducted just before SECOND mid-term examinations.
3	Audit Courses	--	--		As detailed in 12.2.1
4	Internship	100	Semester-end Examination		100 marks are allotted for Internship During semester-end evaluation by the Department Evaluation Committee (DEC) as given in 12.2.2.
5	Open Elective (MOOC)	100	Semester-end Examination		The evaluation shall be done by the department through ONLINE with 50 multiple choice questions.
6	Project Work Phase-I	100	50	Internal evaluation	Continuous evaluation shall be done by the Project Evaluation Committee (PEC) as given in 12.2.3.1
			50	Semester-end evaluation	Project Work Viva-Voce Examination shall be conducted by a Committee at the end of the semester as given in 12.2.3.1
7	Project Work Phase-II	300	150	Internal evaluation	Continuous evaluation shall be done by the Project Evaluation Committee (PEC) as given in 12.2.3.2
			150	Semester-end evaluation	Project Work Viva-Voce Examination shall be conducted by a Committee at the end of the semester as given in 12.2.3.2

12.2 Audit Course/ Internship and Project Work Evaluation:

12.2.1. Audit Course:

Audit courses carry "ZERO" credits. There shall be **NO Internal Examination** 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 will be indicated in the GRADE Sheet.

12.2.2. 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 II-Semester and taken up during the summer vacation after completion of the 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 III-Semester.

12.2.3. Project Work:

12.2.3.1. The Project Evaluation Committee (PEC) consisting of concerned supervisor and two senior faculty members shall monitor the progress of the project work of the student. The PEC is constituted by the Principal on the recommendations of the Head of the Department. Project Work Phase-I is to be completed in the III-Semester. A Student has to identify the topic of the Project Work, collect relevant Literature, preliminary data, implementation tools/ methodologies etc., and perform a critical study and analysis of the problem identified and submit a Report.

(i) **Internal Evaluation:** The Internal Evaluation of Project work Phase-I shall be made by the PEC on the basis of TWO project reviews on the topic of the project. Each review shall be conducted for a maximum of "50" marks. For a total of 50 marks, 80% of better one of the two and 20% of the other one are added and finalized.

(ii) **Semester-end Evaluation:** The semester-end Project Work Phase-I 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.

12.2.3.2 A student shall continue to undertake the Project Work Phase-II during the IV Semester by undertaking practical investigations, implementation, analysis of results, validation and report writing. The student shall submit a Project report at the end of the semester after approval of the PEC.

(i) **Internal Evaluation:** The Internal Evaluation of Project work Phase-II shall be made by the PEC by conducting TWO project reviews on the progress, presentations and quality of work. Each review shall be conducted for a maximum of "150" marks. For a total of 150 marks, 80% of better one of the two and 20% of the other one are added and finalized.

(ii) **Semester-end Evaluation:** A candidate shall be allowed to submit the dissertation on the recommendations of the PEC. 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 and one copy to be sent to the examiner. The examiner shall be nominated by the Chief Controller of the Examinations from the panel of THREE examiners submitted by the Department for a maximum of 05 students at a time for adjudication.

If the report of the examiner is favorable, Semester-end Project Work Phase-II Viva-Voce Examination shall be conducted by a Committee consisting of External examiner (nominated by the Chief Controller of Examinations), HOD and concerned Supervisor at the end of the IV Semester.

If the report of the examiner is not favorable, the dissertation should be revised and resubmitted after a minimum period of three months.

12.2.3.3 The students who fail in Project work Phase-I (or) Phase-II Viva-Voce examination shall have to re-appear for the Viva-Voce examination after three months. Extension of time for completing the project is to be obtained from the Chairman, Academic Council, SVEC (Autonomous).

12.2.3.4 Change of the project work topic shall be permitted only in Project Work Phase-I, within FOUR weeks after commencement of the III-Semester with the approval of the PEC.

12.3. Eligibility to appear for the semester-end examination:

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 shall not be eligible to take their semester-end examination 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 semester, as applicable. The student may seek readmission for the semester when offered next. He will not be allowed to register for the courses of the semester while he is in detention.

12.3.6 A stipulated fee shall be payable to the college towards condonation of shortage of attendance.

12.4. Evaluation:

Following procedure governs the evaluation.

12.4.1. Marks for components evaluated internally by the faculty should 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 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.

12.5. Personal verification / Revaluation / Recounting:

Students shall be permitted for personal verification/request for recounting/ revaluation of the semester-end examination answer scripts within a stipulated period after payment of prescribed fee. After recounting or revaluation, records shall be 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. Re-Registration for Improvement of Internal Marks:

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

13.1 The student should have completed all the course work and obtained examinations results for I, II and III semesters.

13.2 If the student has **failed** in the examination due to internal evaluation marks secured being less than 50%, he shall be given one chance for a maximum of 3 theory courses for improvement of internal evaluation marks.

13.3 The candidate has to register for the chosen courses and fulfill the academic requirements.

13.4 For each course, the candidate has to pay a fee equivalent to one third of the semester tuition fee and the amount is to be remitted in the form of D.D/ Challan in favour of the Principal, Sree Vidyanikethan Engineering College payable at Tirupati along with the requisition through the concerned Head of the Department.

13.5 If a student avails the benefit for 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 stands cancelled.

14. Academic Requirements for Completion of M.Tech degree Program:

The following academic requirements have to be satisfied in addition to the attendance requirements for completion of M.Tech degree Program.

14.1 A student shall be deemed to have satisfied the minimum academic requirements for each theory, laboratory and project work, if he secures not less than 40% of marks in the semester-end examination and a minimum of 50% of marks in the sum total of the internal evaluation and semester-end examination taken together. For the **internship** and **open elective (MOOC) courses**, he should secure not less than 50% of marks in the semester-end examination.

14.2 A student shall register for all the 68credits and earn all the 68 credits. Marks obtained in the 68credits shall be considered for the calculation of the DIVISION based on CGPA.

14.3 A student who fails to earn 68credits as indicated in the curriculum within **four** academic years from the year of his admission shall forfeit his seat in M.Tech. Program and his admission stands cancelled.

15. 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 will 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 **four years** for the award of M.Tech Degree.

16. Grades, Grade Point Average and Cumulative Grade Point Average:

16.1. 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 to letter grades on a "**10 point scale**" as described below.

Grades conversion and Grade points allotted

% 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
≥ 50 to < 55	D	Pass	5
< 50	F	Fail	0
Not Appeared	N	Absent	0

Pass Marks:

A student shall be declared to have passed theory course, laboratory course and project work if he secures minimum of 40% marks in Semester-end examination, and a minimum of 50% marks in the sum total of internal evaluation and Semester-end examination taken together. For the seminar, he shall be declared to have passed if he secures minimum of 50% of marks in the semester-end examinations. 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.

16.2 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:

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

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.

16.3. 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 will 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:

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

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.

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

18. 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 will also be issued, if required, after payment of requisite fee.

19. 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).

19.1. Eligibility: A student shall be eligible for the award of M.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 Program of study within the stipulated time.
- Obtained CGPA greater than or equal to 5.0 (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.

19.2. 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

20. Additional Academic Regulations:

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

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

20.3 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 will be done accordingly.

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

21. 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 will not be allowed/promoted to the next higher semester

22. 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.

23. 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.*

ANNEXURE-I

GUIDELINES FOR DISCIPLINARY ACTION FOR MALPRACTICES / IMPROPER CONDUCT IN EXAMINATIONS

Rule No.	Nature of Malpractices/ Improper conduct	Punishment
	<i>If the candidate:</i>	
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.
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.
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.

SREE VIDYANIKETHAN ENGINEERING COLLEGE

(Autonomous)

Sree Sainath Nagar, Tirupati – 517 102

M. Tech. (PED) Course Structure

I-Semester

S. No.	Course Code	Course Title	Contact Hours per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
1	19MT18301	Dynamics of Electrical Machines	3	-	-	3	3	40	60	100
2	19MT18302	Power Electronic Converters	3	-	-	3	3	40	60	100
3	19MT18303	Power Semiconductor Devices and Modeling	3	-	-	3	3	40	60	100
4	Program Elective – 1									
	19MT10704	High Voltage DC Transmission	3	-	-	3	3	40	60	100
	19MT18304	Control System Design								
	19MT18305	Intelligent Controllers								
	19MT18306	Microcontroller and Applications								
5	Program Elective – 2									
	19MT10705	Digital Signal Processing	3	-	-	3	3	40	60	100
	19MT10706	Power Quality								
	19MT10707	Smart Grids								
	19MT18307	Electromagnetic Field Computation and Modeling								
6	19MT10708	Research Methodology and IPR	2	-	-	2	2	40	60	100
7	19MT18331	Power Electronics Design Lab	-	-	4	4	2	50	50	100
8	19MT18332	Power Electronics Simulation Lab	-	-	4	4	2	50	50	100
		Total	17	-	8	25	21	340	460	800
8	19MT1AC01	Technical Report Writing	2	-	-	2	-	-	-	-

II-Semester

S. No.	Course Code	Course Title	Contact Hours per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
1	19MT28301	Digital Control of Power Electronics and Drive Systems	3	-	-	3	3	40	60	100
2	19MT28302	Electrical Drives	3	-	-	3	3	40	60	100
3	Program Elective - 3		3	-	-	3	3	40	60	100
	19MT28303	Advanced Power Electronic Circuits								
	19MT28304	Multilevel Inverters								
	19MT28305	Solar Energy Conversion Systems								
	19MT28306	Special Electrical Machines								
4	Program Elective - 4		3	-	-	3	3	40	60	100
	19MT20706	Flexible AC Transmission System								
	19MT28307	Hybrid Electric Vehicles								
	19MT28308	Switched Mode Power Supplies and UPS								
	19MT28309	Wind Energy Conversion Systems								
5	19MT2MOOC	Open Elective (MOOC)	-	-	-	-	3	-	100	100
6	19MT28331	Electrical Drives Lab	-	-	4	4	2	50	50	100
7	19MT28332	Electrical Drives Simulation Lab	-	-	4	4	2	50	50	100
		Total	12	-	8	20	19	260	440	700
8	19MT2AC01	Statistics with R	2	-	-	2	-	-	-	-

III-Semester

S. No.	Course Code	Course Title	Contact Hours per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
1	19MT38331	Internship	-	-	-	-	2	-	100	100
2	19MT38332	Project Work Phase-I	-	-	20	20	10	50	50	100
		Total	-	-	20	20	12	50	150	200

IV-Semester

S. No.	Course Code	Course Title	Contact Hours per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
1	19MT48331	Project Work Phase-II	-	-	32	32	16	150	150	300
		Total	-	-	32	32	16	150	150	300
Total Credits:							68	Total Marks:		2000

M. Tech. – I Semester
(19MT18301) DYNAMICS OF ELECTRICAL MACHINES

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

PRE-REQUISITES: Courses on DC Machines, Transformers, Induction Machines & Synchronous Machines at UG level.

COURSE DESCRIPTION: Modelling and analysis of DC, induction and synchronous machines in stationary and rotating reference frames.

COURSEOUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate the potential knowledge of magnetically coupled circuits, model and analyze the performance of AC machines.
- CO2. Apply the knowledge of two pole DC machines and use appropriate technique to model different types DC Machines mathematically.
- CO3. Apply appropriate transformation technique to obtain reference frame variables, analyze and design induction machine and synchronous machine.

DETAILED SYLLABUS:

Unit - I: Basic Principles of Electrical Machine Analysis (10 hours)

Magnetically coupled circuits: Review of basic concepts, magnetizing inductance, modeling linear and non-linear magnetic circuits. Numerical Problems.

Electromechanical energy conversion: Principles of energy flow, concept of field energy and co-energy. Derivation of torque expression for various machines using the principles of energy flow and the principle of co-energy. Inductance matrices of induction and synchronous machines.

Unit - II: Theory of DC Machines (08 hours)

Basic Two-pole DC machine - Primitive 2-axis machine – Voltage and Current relationship – Torque equation. Mathematical model of separately excited DC motor, DC Series motor and DC shunt motor in state variable form – Transfer function of DC motors.

Unit - III: Reference Frame Theory (09 hours)

Concept of space vector, types of transformation, condition for power invariance, zero-sequence component, expression for power with various types of transformation. Transformations between reference frames: Clarke and Park's Transformations, variables observed from various frames.

Unit - IV: Theory of Symmetrical Induction Machines (09 hours)

Voltage and torque equation in machine variables, derivation of dq0 model for a symmetrical induction machine, voltage and torque equation in arbitrary reference frame variables, analysis of steady state operation. State-space

model of induction machine in 'd-q' variables. Numerical problems.

Unit - V: Theory of Synchronous Machines

(09 hours)

Equations in arbitrary reference frame. Park's transformation, derivation of dq0 model for a salient pole synchronous machine with damper windings, torque expression of a salient pole synchronous machine with damper windings and identification of various components. Numerical problems.

Total hours: 45

TEXT BOOKS:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, *Analysis of Electric Machinery & Drive systems*, IEEE Press, 2002.
2. R. Krishnan, *Electric motor drives, Modeling, Analysis and Control*, Prentice Hall, 2001.

REFERENCE BOOKS:

1. P.S. Bimbhra, *Generalized Theory of Electrical Machines*, Khanna Publishers, 2008.
2. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, *Electric Machinery*, 5th edition, Tata McGraw – Hill Publishing Company, 2003.

M. Tech. – I Semester
(19MT18302) POWER ELECTRONIC CONVERTERS

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

PRE-REQUISITES: Courses on Engineering Mathematics, Electrical circuits, Power Electronics at UG Level.

COURSE DESCRIPTION: Single phase and three phase converters - Types, operation of controlled and uncontrolled converters; Inverters – Types, operation of Single and Three Phase Voltage Source Inverters; Current Source Inverters; DC-DC Converters and AC Voltage Controllers.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate the knowledge of AC-DC Converters of various configurations to model and apply appropriate control technique to analyze their performance subjected to various loads.
- CO2. Apply the knowledge of various types of inverter topology and analyze the performance parameters subjected to various control techniques to provide feasible solutions.
- CO3. Apply the knowledge of DC-DC converters & AC voltage Controllers and analyze their performance subjected to different load conditions.

DETAILED SYLLABUS:

Unit - I: Single Phase Rectifiers (09 hours)

Classification of converters, analysis of semi controlled and fully controlled converters with R, R-L, freewheeling diodes, continuous & discontinuous modes of operation and evaluation of various performance parameters. Total Harmonic Distortion (THD), power factor, effect of source impedance, extinction angle control, symmetrical angle control and SPWM control.

Unit - II: Multi Pulse Converters (09 hours)

Analysis of semi converter and fully controlled converters with R, R-L loads, freewheeling diodes, continuous and discontinuous modes of operation. Total Harmonic Distortion (THD), power factor improvements and effect of source impedance.

Unit - III: Single and Three Phase Voltage Source Inverters (11 hours)

Single Phase Voltage Source Inverter: Classification of inverters, single phase half bridge and full bridge voltage source inverters and performance parameters of inverter. Voltage control of single phase inverters – single PWM, multiple PWM, sinusoidal PWM, modified sinusoidal PWM and phase displacement control. Three Phase Voltage Source Inverter: 180° and 120° conduction modes with R load.

Unit - IV: Current Source Inverters**(08 hours)**

Operation of six-step thyristor inverter, commutated Inverters, Auto Sequential Current source Inverter (ASCI), current pulsations, comparison of current source inverter and voltage source inverters, PWM techniques for current source inverters.

Unit - V: DC-DC Converters and AC Voltage Controllers (08 hours)

DC-DC Converters: Principles of step down and step up converters. Choppers: Types – Class A, B, C, D & E operation and characteristics. Concept of duty ratio and current limit control.

Principle of phase control: Single phase and three phase controllers - Analysis with R and R-L loads.

Total hours: 45**TEXT BOOKS:**

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education, 2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, 3rd Edition, Wiley, 2007.

REFERENCE BOOKS:

1. M. D. Singh & K. B. Kanchandhani, *Power Electronics*, 3rd Edition, Tata McGraw – Hill Publishing Company, 2008.
2. Dr. P. S. Bimbhra, *Power Electronics*, 4th Edition, Khanna Publishers, New Delhi, 2012.
3. P C Sen, *Modern Power Electronics*, 1st Edition, Wheeler publishing Co, New Delhi, 1998.

M. Tech. – I Semester
(19MT18303) POWER SEMICONDUCTOR DEVICES AND MODELING

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

PRE-REQUISITES: Courses on Electronic Devices and Power Electronics at UG Level.

COURSE DESCRIPTION: Construction, types, switching, operating characteristics and applications of power semiconductor devices; Design of firing, protective circuits and heat sinks for various power semiconductor devices.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Apply the knowledge of various power switching devices to model and analyze their performance parameters & characteristics when used for various power converters.
- CO2. Demonstrate the operation, analyze the performance characteristics and there by suggest suitable special power devices for power converters.
- CO3. Apply the knowledge of firing and protection circuits to model and design power converters.

DETAILED SYLLABUS:

Unit - I: Introduction To Power Switching Devices (08 hours)

Power semiconductor devices: Introduction, classifications of various power switching devices – circuit symbols and ratings. Characteristics of an ideal switch, characteristics of practical devices, switch specifications, device selection strategy and Electro Magnetic Interference (EMI).

Power diodes: Construction, steady state characteristics, switching characteristics, electrical rating, Types – schottky diodes, fast recovery diodes, silicon carbide diodes, series and parallel connected diodes.

Unit - II: Thyristor (09 hours)

Construction, steady state characteristics and switching characteristics. Thyristor protection – di/dt protection, dv/dt protection, design of snubber circuits, over voltage protection, over current protection and gate protection. Heat sink – Thermal resistance and specifications. Improvements of thyristor ratings and thyristor mounting techniques. SPICE Thyristor Model.

Unit - III: Power Transistors (10 hours)

Power Bipolar Junction Transistor: Construction, steady state characteristics, switching characteristics and Safe Operating Area (SOA). Power MOSFETs: Types - Depletion & Enhancement, construction, steady state characteristics and switching characteristics.

IGBTs: Construction, steady state characteristics, switching characteristics, series & parallel operation, comparison of BJT, MOSFET & IGBT and design of snubber circuit. BJT, MOSFET and IGBT SPICE Model.

Unit - IV: Special Power Devices (09 hours)

Thyristors: GTOs – Construction, operation, steady state characteristics and switching characteristics. Construction and operation: BCTs, TRIAC, FET – CTHs, ETOs, IGCTs, MCTs, SITHs, ASCR, RCT, SCS and light activated thyristor. Comparison of various thyristors.

Transistors: Construction and operation – COOLMOS and SITs. GTO, MCT and SITH SPICE Model.

Unit - V: Gate Drive Circuits (09 hours)

MOSFET and BJT gate drive circuits. Isolation of gate and base drives – Pulse transformer and opto-couplers. Thyristor firing circuits – R, RC firing circuits, photo – SCR isolator, pulse transformer isolation, 1:6 isolation transformer for inverter gate bias circuits, thyristor converter gating circuits and UJT firing circuits. Gate drive ICs – MOSFETs and IGBTs. Drive ICs for converters – MOS Gated Driver.

Total hours: 45

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education, 2014.
2. Dr. P. S. Bimbhra, *Power Electronics*, 4th Edition, Khanna Publishers, New Delhi, 2012.

REFERENCE BOOKS:

1. M. D. Singh & K. B. Kanchandhani, *Power Electronics*, 3rd Edition, Tata McGraw – Hill Publishing Company, 2008.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, 3rd Edition, Wiley, 2007.

M. Tech. – I Semester
(19MT10704) HIGH VOLTAGE DC TRANSMISSION

(Program Elective - 1)
(Common to EPS and PED)

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

PRE-REQUISITES: Power Electronics and Power Systems at UG level

COURSE DESCRIPTION: HVDC Transmission: Capabilities, Applications and planning; Analysis and control of power converter; Harmonics and Filters; Types of Multi-Terminal DC Systems and control; Faults and Protection.

COURSE OUTCOMES: On successful completion of the course, student will be able to

- CO1. Demonstrate the knowledge on HVDC transmission systems, MTDC systems and to analyze and control static power converters.
- CO2. Analyze harmonics, filters, faults and protection schemes in HVDC Transmission system.
- CO3. Design and develop various types of filters to suppress harmonics in HVDC systems.

DETAILED SYLLABUS:

Unit - I: Introduction To HVDC Transmission (10 hours)

HVDC Transmission – Comparison of HVAC and HVDC transmission, types of DC Links, power handling capabilities of HVDC lines, applications of HVDC Transmission, planning for HVDC transmission, modern trends in DC Transmission, basic conversion principles.

Unit - II: Static Power Converter Analysis and Control (10 hours)

Static Power Converters: Static converter configuration- 6 pulse & 12 pulse converters, converter station and terminal equipment, rectifier and inverter operation, converter bridge characteristics, equivalent circuit for converter.

Control of HVDC converter: Principle of DC link control – constant current, constant extinction angle and constant ignition angle control. Individual phase control and equidistant firing angle control.

Unit - III: Harmonics and Filters (09 hours)

Generation of harmonics in HVDC systems, methods of harmonics elimination, harmonic instability problems, Causes for instability, remedies for instability problems. Design of AC filters, single frequency tuned filter, Double frequency tuned filter, high pass filter, cost consideration of AC harmonic filter, DC filters.

Unit - IV: Multi-Terminal DC Links and Systems (08 hours)

Introduction – Potential applications of MTDC systems – Types of MTDC systems – series, parallel and series-parallel systems, their principle of operation and control - Protection of MTDC systems.

Unit - V: Faults and Protection (08 hours)

Over voltages due to disturbance on DC side, over voltages due to DC and AC side line faults – Converter faults, over current protection– Valve group and DC line protection. Over voltage protection of converters – Surge arresters.

Total hours: 45

TEXT BOOKS:

1. K.R.Padiyar, *High Voltage Direct current Transmission*, New Age International (P) Ltd, Publishers, 2004.
2. S. Rao, *EHV-AC, HVDC Transmission & Distribution Engineering*, Khanna Publishers, 2006.

REFERENCE BOOKS:

1. E. Uhlman, *Power Transmission by Direct Current*, Springer Verlag, Berlin, 2000.
2. E. W. Kimbark, *Direct current Transmission*, John Wiley & sons, New York, 1971.
3. J. Arillaga, *HVDC Transmission*, Peter Peregrinus Ltd., London UK, 1983.

M.Tech. - I Semester
(19MT18304) CONTROL SYSTEM DESIGN
 (Program Elective - 1)
 (Common to EPS and PED)

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

PRE-REQUISITES: Course on Control systems in UG Level.

COURSE DESCRIPTION: Design of compensators and controllers; Controllability and observability of a system; Control systems design using state space; Nonlinear systems.

COURSEOUTCOMES: On successful completion of the course, students will be able to

- CO1. Apply the knowledge of Lag, Lead and Lead-Lag compensators to analyze and design the systems in frequency and time domains for the given specifications.
- CO2. Demonstrate the knowledge of PD, PI & PID Controllers to develop a suitable controller based on the required time and frequency domain specifications and analyze their performance.
- CO3. Apply appropriate methods to solve linear and non-linear systems using state space approach.
- CO4. Identify the attributes for analyzing the given non-linear systems.

DETAILED SYLLABUS:

Unit - I: Introduction to Design (09 hours)

The Design Problem, Preliminary considerations of classical design, Realization of Basic Compensators, Design of Lead, Lag and Lag-Lead compensators using root locus technique. Lead, Lag and Lag-Lead compensators design using Bode plot.

Unit - II: Controllers Design (09 hours)

Introduction to controllers, Types of controllers, Effect of P, PI and PID controllers. Design of PI, PD and PID controllers using bode plot and root locus technique.

Unit - III: Controllability and Observability (09 hours)

Review of state variable techniques – Concept of controllability and observability for Continuous Time Systems. Principles of Duality. Controllability and Observability of state models in Jordan canonical form and other canonical forms – effect of state feedback on controllability and observability.

Unit - IV: Design of Control Systems in State Space (09 hours)

Necessity of pole placement, design by pole placement, necessary and sufficient conditions for arbitrary pole placement. Determination of feedback gain matrix using direct substitution method and Ackermann's formula. Full order observer and reduced order observer.

Unit - V: Introduction To Non Linear System (09 hours)

Introduction to non-linear systems, behavior of non linear systems, common physical nonlinearities, describing function method, concept derivation of describing function method, phase plane method, singular points, stability of non linear system, construction of phase trajectories by isocline method.

Total hours: 45

TEXT BOOKS:

1. M. Gopal, *Modern Control System Theory*, 2nd edition, New Age International (P) Ltd., New Delhi, 2005.
2. K. Ogata, *Modern Control Engineering*, 4th edition, Prentice Hall of India, 2006.
3. Hasan A. Khalil, *Nonlinear Systems*, 3rd edition, Prentice Hall of India, 2002.

REFERENCE BOOKS:

1. Nagoorkani, *Advanced control theory*, 2nd edition, RBA publications, Chennai, 2009.
2. I.J. Nagrath and M.Gopal, *Control Systems Engineering*, New Age International (P) Ltd., New Delhi, 2007.

M. Tech. – I Semester
(19MT18305) INTELLIGENT CONTROLLERS
 (Program Elective – 1)
 (Common to EPS and PED)

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

PRE-REQUISITES: Engineering Mathematics, Electrical Machines, Power Systems at UG level.

COURSE DESCRIPTION: Neural Networks; Fuzzy Logic Systems; Genetic Algorithms; Differential Evaluation; Hybrid Intelligent Systems; Swarm intelligence; Applications.

COURSE OUTCOMES: On successful completion of the course, student will be able to

CO1. Apply the conceptual knowledge of neural networks and fuzzy logic controllers, evolutionary algorithms in hybrid intelligent controllers to analyze and develop the suitable controller for solving engineering problems.

CO2. Analyze the conceptual knowledge of neural networks and fuzzy logic controllers and various evolutionary algorithms to provide optimal solutions.

DETAILED SYLLABUS:

Unit - I: Neural Networks (10 hours)

Neural network architectures, perceptron model, learning strategies: supervised learning, radial basis function network, back propagation network. Unsupervised learning: Kohonen's SOM, reinforced learning, load forecasting using neural networks.

Unit - II: Fuzzy Logic Systems (9 hours)

Fuzzy sets: relations & operations, membership functions, Fuzzification, rule base, Inference mechanism, defuzzification and design of fuzzy control system, speed control of separately excited DC motor using fuzzy logic.

Unit - III: Genetic Algorithms and Differential Evaluation (10 hours)

Genetic algorithms: Introduction to evolutionary computation, Genetic algorithms (GA): biological background, traditional optimization and search techniques, basic terminologies, simple GA, Flow chart, operators in GA, encoding, selection, crossover, mutation, constraints in GA, fitness function, advantages and limitations of GA, optimal allocation of DG using GA. Differential Evaluation: Overview, initialization, base vector selection, Differential mutation, recombination, selection and Termination criteria.

Unit - IV: Swarm Intelligence**(9 hours)**

Introduction to swarm intelligence, Swarm intelligence algorithms-Ant colony optimization: Biological and artificial ant colony systems, applications of ant colony intelligence: Static & dynamic combinatorial optimization problems, Algorithm of Ant colony system, Particle swarm optimization: The basic PSO method, characteristic features of PSO, PSO algorithm, Optimum parameter setting for the best performance of PSO, Comparison with other Evolutionary computing techniques, MPPT of PV system by using PSO and Ant-colony.

Unit - V: Hybrid Intelligent Systems**(7 hours)**

Introduction to hybrid intelligent systems: Adaptive neuro-fuzzy Inference Systems, Architecture and learning. Fuzzy GA systems: rules generation. ANN Learning Using GA: Optimization of weights, Load forecasting problem using Neuro-fuzzy approach.

Total hours: 45**TEXT BOOKS:**

1. S. N. Sivanandam, S.N. Deepa, *Principles of Soft Computing, Wiley-India Edition, 2008.*
2. N.P. Padhy, *Artificial Intelligence and Intelligent Systems, Oxford University press, 10th reprint, 2011.*

REFERENCE BOOKS:

1. Saroj Kaushik, *Artificial Intelligence, Cengage Learning India Private Limited, Fifth Indian reprint, 2013.*
2. J.S.R. Jang, C.T. Sun, E. Mizutani, *Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Pearson Education Taiwan Limited, 2004.*
3. Fakhreddine O. karray, Clarence De Silva, *Soft computing and Intelligent systems Design, Theory, tools and applications, Pearson Education Limited, 2009.*
4. Kenneth V. Price · Rainer M. StornJouni A. Lampinen, *Differential Evolution, A Practical Approach to Global Optimization, Springer, 2005.*

M.Tech. – I Semester
(19MT18306) MICROCONTROLLER AND APPLICATIONS
 (Program Elective - 1)
 (Common to EPS and PED)

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

PRE-REQUISITES: Digital logic design, Microprocessors and Microcontrollers at UG level.

COURSE DESCRIPTION: PIC Microcontroller: Architecture, Peripherals, Programming, Interfacing and Applications.

COURSEOUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate the knowledge of PIC Microcontroller and its internals and use appropriate tools to program it for the control of systems.
- CO2. Interface the peripherals and control them by programming the PIC microcontroller through MPLAB, PIC 'C' Compiler etc.,

DETAILED SYLLABUS:

Unit - I: PIC Microcontrollers (9 hours)

Microcontrollers and Embedded processors, Overview of PIC18 family, CISC vs RISC. Harvard vs Von Neumann architectures. PIC18 architecture and features. PIC18 Memory organization – program memory, data memory. PIC18 Register file – General purpose registers and SFRs.

Unit - II: PIC 18 Basic Programming and Tools (9 hours)

Introduction to PIC18 Assembly Programming, PIC18 Data Format and Directives. PIC18 programming tools. Instruction set – data transfer, arithmetic, logical, bit manipulation, branch Instructions. Addressing modes – Immediate, Direct, Register Indirect Addressing Modes. Macros and Modules. PIC18 programming using MPLAB and PIC 'C' Compiler.

Unit - III: Timers, Serial Port and I/O Ports programming (9 hours)

Timer –Programming Timers 0 and 1 in Assembly language, Programming Timers 2 and 3 in Assembly language, Serial Port – Basics of Serial Communication and PIC Serial Port programming in Assembly language. I/O Ports – Port A TRISA, Port B TRISB, Port C TRISC, Port D and Port E.

Unit - IV: Interrupts, CCP and ECCP Programming (9 hours)

PIC18 Interrupts, Programming Timer Interrupts, Programming the Serial Communication Interrupts, Port-B - Change Interrupt, Interrupt Priority in the PIC18. Standard and Enhanced CCP Modules, Compare Mode programming, Capture Mode programming, PWM Programming, ECCP Programming.

Unit - V: PIC Interfacing**(9 hours)**

ADC Characteristics, ADC Programming in the PIC18, DAC Interfacing, Sensor Interfacing and Signal Conditioning, Relays and Opto-isolators, Stepper Motor Interfacing, DC Motor Interfacing and PWM, PWM Motor Control with CCP, DC Motor Control with ECCP.

Total hours: 45**TEXT BOOKS:**

1. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, *PIC Microcontroller and Embedded Systems: Using assembly and C for PIC 18*, Pearson Education, India, 2008.
2. John B. Peatman, *Design with PIC Microcontrollers*, Pearson Education, India, 2007.

REFERENCE BOOKS:

1. PIC18C MCU Family Reference Manual, Microchip.
2. John B. Peatman, *Embedded design with the PIC18F452 Microcontroller*, Prentice Hall, 2003.

M. Tech. - I Semester
(19MT10705) DIGITAL SIGNAL PROCESSING
 (Program Elective – 2)
 (Common to EPS and PED)

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

PRE-REQUISITES: Laplace transforms, Z-transforms, Fourier Transforms, Signal and Systems.

COURSE DESCRIPTION: Discrete-time signals and systems; Discrete Fourier series, Discrete Fourier Transforms (DFT) and Fast Fourier Transform (FFT) algorithms for the analysis of discrete time sequences; design and realization of Digital IIR and FIR filters; implementation of Park's and Clark's transformation using LF240X processor; DSP based implementation of DC-DC buck-boost converters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate knowledge of digital signals and systems to analyze DFT and FFT techniques.
- CO2. Apply the knowledge of analog and digital filters to design and realize IIR and FIR filters using different techniques.
- CO3. Apply DSP controllers for buck-boost converter, control of motors and further extend to real time application.

DETAILED SYLLABUS:

Unit - I: Discrete Time Signals and Systems (8 hours)

Review of discrete time signals and systems; Review of Z-transforms, Solutions for difference equation of discrete time systems; frequency response of discrete time signals; A/D and D/A conversion; Introduction to DSP system with block diagram.

Unit - II: Frequency Transformations (9 hours)

Introduction to DFT – Properties of DFT, relation between DFT and Z-transforms, linear convolution, Circular Convolution. FFT Algorithms – Decimation in time Algorithms, Decimation in frequency Algorithms, inverse DFT.

Unit - III: IIR Filter Design (10 hours)

Digital Vs Analog filters, Analog low pass filter design: Butterworth and chebyshev low pass filters. Design of IIR filter from analog filters using Impulse Invariance and Bilinear transformation techniques. Frequency transformation in digital domain. Realization of Digital filters - Direct form-I and Direct form-II structures.

Unit - IV: FIR Filter Design**(8 hours)**

Linear phase FIR filters and its frequency response; location of zeros in linear phase FIR filters; Fourier series method of design of FIR filters. Design of FIR filters using windows - Rectangular, Triangular, Hamming, Hanning and Blackmann windows.

Unit - V: DSP Applications**(10 hours)**

Introduction to peripherals-types of physical memory-software used (Preliminary approach). DSP based implementation of DC-DC buck boost converters – introduction, converter structure, continuous and discontinuous conduction modes, connecting DSP to buck-boost converter, controlling the buck-boost converter. Field Oriented Control (FOC) transformations, implementing Clarke's and Park's Transformations on the LF240X

Total hours: 45**TEXT BOOKS:**

1. Anand kumar, *Digital signal processing*, PHI Learning Private limited, New Delhi, 2013.
2. Hamid A. Toliyat, Steven G. Campbell, *DSP based electromechanical motion control*, CRC Press Special Indian edition, 2012.

REFERENCE BOOKS:

1. Nagoorkani, *Digital signal processing*, 2nd Edition, TMH Education Pvt., Ltd., 2012.
2. Alan.V. Oppenheim, Ronald.W. Schaffer, John R Buck, *Discrete Time Signal Processing*, Prentice Hall, 2nd edition, 2006.

**M. Tech. – I Semester
(19MT10706) POWER QUALITY**

(Program Elective – 2)
(Common to EPS and PED)

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

PRE-REQUISITES: Power electronics, Electric Machines, Electronic Devices and Circuits at UG level and high power converters at PG level.

COURSE DESCRIPTION: Power Quality concepts; harmonics and power quality standards and monitoring; power quality enhancement using custom power devices; power quality issues in distributed generation.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Apply the conceptual knowledge of power quality and it's standards to analyze, monitor and mitigate various power quality issues.
- CO2. Apply the knowledge of filters to mitigate harmonic distortion due to industrial and commercial loads.
- CO3. Apply the conceptual knowledge of various custom power devices to enhance power quality for specific applications.
- CO4. Demonstrate the conceptual knowledge of distributed generation to analyze the power quality issues in power systems.

DETAILED SYLLABUS:

Unit - I: Fundamentals Of Power Quality (10 hours)

Definition of Power Quality, Classification of Power Quality Issues, Power Quality Standards, Categories and Characteristics of Electromagnetic Phenomena in Power Systems: Impulsive and Oscillatory Transients, Interruption, Sag, Swell, Sustained Interruption, Under Voltage, Over Voltage, Outage. Sources and causes of different Power Quality Disturbances.

Unit - II: Harmonics & Applied Harmonics (10 hours)

Harmonic Distortion, Voltage Vs Current Distortion, Harmonics Vs Transients, Power System Qualities under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads. Applied Harmonics: Effects of Harmonics, Harmonic Distortion Evaluations, Principles of controlling harmonics, devices for Controlling Harmonic Distortion.

Unit - III: Power Quality Monitoring (08 hours)

Power quality benchmarking, monitoring considerations, choosing monitoring locations, permanent power quality monitoring equipment, historical perspective of power quality measuring instruments, power quality

measurement equipment-types of instruments, assessment of power quality measurement data, power quality monitoring standards.

**Unit - IV: Power Quality Enhancement Using Custom Power Devices
(09 hours)**

Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL) -Solid State Breaker (SSB) -Solid State Transfer Switch (SSTS). Compensating Type: Dynamic Voltage Restorer, Distribution STATCOM and Unified Power Quality Conditioner –operation, realization and control of DVR, DSTATCOM and UPQC – load compensation.

Unit - V: Power Quality Issues in Distributed Generation (08 hours)

DG Technologies, Perspectives on DG benefits- Interface to the Utility System - power quality issues affected by DG - Operating Conflicts: Utility fault-clearing, Reclosing, Interference with relaying, Voltage regulation issues, Islanding - siting DG.

Total hours: 45

TEXT BOOKS:

1. Roger C. Dugan, Mark E. Mc. Granaghan, Surya Santosoh and H. Wayne Beaty, Electrical Power Systems Quality, 2nd edition, TATA McGraw Hill, 2010.
2. Arindam Ghosh, Gerard Ledwich, Power Quality Enhancement Using Custom Power Devices, Springer, 2002.

REFERENCE BOOKS:

1. Math H J Bollen, Understanding Power Quality Problems, IEEE Press, 1998.
2. C. Sankaran, Power quality, CRC Press, 2002.

**M. Tech. - I Semester
(19MT10707) SMART GRIDS**

(Program Elective - 2)
(Common to EPS and PED)

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

PRE-REQUISITES: Power Systems at UG level.

COURSE DESCRIPTION: Concept of smart grid; various information and communication technologies for smart Grid; Smart metering; Demand side integration; Energy management systems.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Apply the conceptual knowledge of smart grid and communication technologies to analyze fault levels and to estimate the state of the system.

CO2. Apply

- modern techniques to integrate renewable energy sources to power system.
- information security tools for secured operation of smart grid.

DETAILED SYLLABUS:

Unit - I: Smart Grid (05 hours)

smart grid introduction, ageing assets and lack of circuit capacity, thermal constraints, operational constraints, security of supply, national initiatives, early smart grid initiatives, active distribution networks, virtual power plant, other initiatives and demonstrations, overview of the technologies required for the smart grid.

Unit - II: Transmission and Distribution Management System

(09 hours)

Data Sources, Energy Management System, Wide Area Applications, Visualization Techniques, Data Sources and Associated External Systems, SCADA, Customer Information System, Modeling and Analysis Tools, Distribution System Modeling, Topology Analysis, Load Forecasting, Power Flow Analysis, Fault Calculations, State Estimation, Applications, System Monitoring, Operation, Management, Outage Management System, Overview of energy storage technologies.

Unit - III: Smart Metering and Demand Side Integration (11 hours)

Introduction, smart metering – evolution of electricity metering, key components of smart metering, smart meters: an overview of the hardware used – signal acquisition, signal conditioning, analogue to digital conversion, computation, input/output and communication. Communication infrastructure and protocols for smart metering - Home area network,

Neighborhood Area Network, Data Concentrator, meter data management system, Protocols for communication. Demand Side Integration- Services Provided by DSI, Implementation of DSI, Hardware Support, Flexibility Delivered by Prosumers from the Demand Side, System Support from DSI.

Unit - IV: Communication Technologies for the Smart Grid (11 hours)

Data Communications: Dedicated and Shared Communication Channels, Switching Techniques, Circuit Switching, Message Switching, Packet Switching, Communication Channels, Introduction to TCP/IP

Communication Technologies: IEEE 802 Series, Mobile Communications, Multi-Protocol Label Switching, Power line Communication.

Unit - V: Information Security for the Smart Grid (09 hours)

Introduction, Encryption and Decryption, Symmetric Key Encryption, Public Key Encryption, Authentication, Authentication Based on Shared Secret Key, Authentication Based on Key Distribution Center, Digital Signatures, Secret Key Signature, Public Key Signature, Message Digest.

Total hours: 45

TEXT BOOKS:

1. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins, *Smart Grid Technology and Applications*, Wiley Publications, 2012.
2. James Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Wiley, IEEE Press, 2012.
3. Bharat Modi, Anuprakash, Yogesh Kumar, *Fundamentals of Smart Grid Technology*, S.K Kataria& Sons, 2015.

REFERENCE BOOKS:

1. Eric D. Knapp, Raj Samani, *Applied Cyber Security and the Smart Grid- Implementing Security Controls into the Modern Power Infrastructure*, Syngress Publishers, 2013.
2. Nouredine Hadjsaid, Jean Claude Sabonnadiere, *Smart Grids*, Wiley Blackwell Publications.
3. Peter-Fox Penner, *Smart Power: Climate Changes, the Smart Grid, and the future of electric utilities*, Island Press, 1stedition, 2010.

M. Tech. –I Semester
(19MT18307) ELECTROMAGNETIC FIELD COMPUTATION AND MODELING

(Program Elective - 2)
(Common to EPS and PED)

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

PRE-REQUISITES: Electromagnetic fields, Electrical Machines at UG level.

COURSE DESCRIPTION: Review of basic field theory; Basic solution methods for field equations; Formulation of finite element method; Computation of basic quantities using FEM packages; Design applications.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Apply the knowledge of Electromagnetic fields to analyze various electrical field problems using analytical and numerical methods.
- CO2. Demonstrate the knowledge in Computation of electrical parameters using Finite Element Method.
- CO3. Provide solutions to design electrical equipment.

DETAILED SYLLABUS:

Unit - I: Introduction (9 hours)

Review of basic field theory – Maxwell’s equations – Constitutive relationships and Continuity equations – Laplace, Poisson and Helmholtz equation – principle of energy conversion –energy and co-energy- force/torque calculation.

Unit - II: Basic Solution Methods for Field Equations (9 hours)

Limitations of the conventional design procedure, need for the field analysis based design, problem definition, boundary conditions, solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods-Finite Difference Method.

Unit - III: Formulation of Finite Element Method (9 hours)

Variational Formulation – Energy minimization – Discretization – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problems.

Unit - IV: Computation of Basic Quantities Using FEM Packages (6 hours)

Basic quantities – Energy stored in Electric Field – Capacitance – Magnetic Field – Linked Flux – Inductance – Force – Torque – Skin effect – Resistance.

Unit - V: Design Applications**(12 hours)**

Electromagnetic field analysis of Magnetic actuators, transformers, switched reluctance motors, three phase induction motors.

TEXT BOOKS:

1. Matthew. N.O. Sadiku, *Elements of Electromagnetics*, Fourth Edition, Oxford University Press, First Indian Edition 2007.
2. Nicola Bianchi , *Electrical Machine analysis using Finite Elements*, Taylor and Francis Group, CRC Publishers, 2005.

REFERENCE BOOKS:

1. Nathan Ida, Joao P.A.Bastos, *Electromagnetics and calculation of fields*, SpringerVerlage, 1992.
2. S.J Salon, *Finite Element Analysis of Electrical Machines*, Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai, India.
3. User manuals of MAGNET, MAXWELL & ANSYS software.

M. Tech.-I Semester
(19MT10708) RESEARCH METHODOLOGY and IPR
(Common to all M. Tech. Programs)

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

PRE REQUISITES: Engineering Mathematics at UG level.

COURSE DESCRIPTION: Overview of research; research problem and design; various research designs; Data collection methods; Statistical methods for research; Interpretation & drafting reports and Intellectual property rights.

COURSE OUTCOMES: On successful completion of the course, student will be able to:

- CO1. Apply the conceptual knowledge of research methodology to formulate the hypothesis, data collection and processing, analyzing the data using statistical methods, interpret the observations and communicating the novel findings through a research report.
- CO2. Practice ethics and have responsibility towards society throughout the research process and indulge in continuous learning process.
- CO3. Apply the conceptual knowledge of intellectual property rights for filing patents and trade mark registration process.

DETAILED SYLLABUS:

Unit - I: Introduction to Research Methodology (07 hours)

Objectives and Motivation of Research, Types of Research, Defining and Formulating the Research Problem; Features of research design, Different Research Designs; Different Methods of Data Collection, Data preparation and Processing.

Unit - II: Data Analysis and Hypothesis Testing (09 hours)

ANOVA; Principles of least squares-Regression and correlation; Normal Distribution- Properties of Normal Distribution; Testing of Hypothesis – Hypothesis Testing Procedure, Types of errors, t-Distribution, Chi-Square Test as a Test of Goodness of Fit.

Unit - III: Interpretation and Report Writing (04 hours)

Interpretation – Need, Techniques and Precautions; Report Writing – Significance, Different Steps, Layout, Types of reports, Mechanics of Writing a Research Report, Precautions in Writing Reports; Research ethics.

Unit - IV: Introduction to Intellectual Property and Trade Marks (07 hours)

Importance of intellectual property rights; types of intellectual property, international organizations; Purpose and function of trademarks, acquisition

of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Unit - V: Law of Copyrights

(08 Hours)

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

New Developments in IPR: Administration of Patent System.

Total hours: 35

TEXT BOOKS:

1. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd revised edition, New Age International Publishers, New Delhi, 2004.
2. Deborah, E. Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, 5th edition, Cengage learning, 2017.

REFERENCE BOOKS:

1. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.
2. Prabuddha Ganguli, *Intellectual property right - Unleashing the knowledge economy*, Tata McGraw Hill Publishing Company Ltd, 2001.

M. Tech. – I Semester
(19MT18331) POWER ELECTRONICS DESIGN LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Courses on Electronic Devices, Power Electronics at UG Level

COURSE DESCRIPTION: Design and development of various power converters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Identify appropriate devices, domain specific tools and techniques to develop and control power electronic converters.
- CO2. Analyze and evaluate the performance of Power converters by practicing professional code of ethics.
- CO3. Prepare laboratory reports that clearly communicate experimental information.
- CO4. Function effectively as an individual to solve various problems.

PRACTICAL EXERCISES/LIST OF EXPERIMENTS: Conduct any **Two Experiments** from the following:

1. Design, develop and analyze DC to DC converter using IGBTs.
2. Design, develop and analyze DC to DC converter using Power MOSFETs.
3. Design, develop and analyze DC to AC converter using IGBTs.
4. Design, develop and analyze DC to AC converter using Power MOSFETs.
5. Design, develop and analyze AC to AC converters using SCRs.
6. Design, develop and analyze AC to AC converters using TRIACs.
7. Design, develop and analyze AC to AC converters using IGBTs.
8. Design, develop and analyze AC to DC converters using SCRs and Diodes.
9. Analysis of Three Level Neutral Point Clamped Multilevel Inverter.
10. Design, develop and analyze a five level cascaded multilevel inverter.

M. Tech. – I Semester
(19MT18332) POWER ELECTRONICS SIMULATION LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Courses on Electronic Devices, Power Electronics at UG Level.

COURSE DESCRIPTION: Design and simulation of various power converters.

COURSEOUTCOMES: On successful completion of the course, students will be able to

- CO1. Identify appropriate devices, domain specific tools and techniques to develop and control power electronic converters.
- CO2. Analyze and evaluate the performance of Power converters by practicing professional code of ethics.
- CO3. Prepare laboratory reports that clearly communicate experimental information.
- CO4. Function effectively as an individual to solve various problems.

LIST OF EXPERIMENTS: Conduct any **TEN** Experiments from the following using **MATLAB/PSPICE**

1. Simulation of single phase semi converter.
2. Simulation of single phase fully controlled converter.
3. Simulation of three phase semi converter.
4. Simulation of three phase fully controlled converter.
5. Simulation of single phase full bridge inverter.
6. Simulation of three phase full bridge inverter.
7. Simulation of sinusoidal PWM inverter.
8. Simulation of single phase and three phase AC voltage controllers.
9. Simulation of DC–DC Buck–Boost Converter.
10. Simulation of Three Level Neutral Point Clamped Multilevel Inverter.
11. Simulation of Five Level Flying Capacitor Multilevel Inverter.
12. Simulation of Five Level H–Bridge Cascaded Multilevel Inverter.

M. Tech. - I Semester
(19MT1AC01) TECHNICAL REPORT WRITING
(Audit Course)

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

PRE-REQUISITES: -

COURSE DESCRIPTION: Introduction; Process of writing; Style of writing; Referencing; Presentation.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate knowledge of Technical Report Writing by examining kinds of reports and structure with scientific attitude.
- CO2. Apply the techniques in preparing effective reports by examining Techniques of Description, Describing Machines and Mechanisms and Describing Processes.
- CO3. Communicate effectively through writing technical reports by demonstrating the knowledge of Industry Reports, Survey Reports, Interpretive Report and Letter Report.

DETAILED SYLLABUS:

Unit - I: Introduction (6 hours)

Introduction to Technical Report - Types of Reports - Planning Technical Report Writing - Components of a Technical Report - Report Writing in Science and Technology - Selecting and Preparing a 'Title' - Language Use in Report Writing.

Unit - II: Process of Writing (5 hours)

Writing the 'Introduction' - Writing the 'Materials and Methods' - Writing the Findings/Results' - Writing the 'Discussion' - Preparing and using 'Tables'.

Unit - III: Style of Writing (6 hours)

Preparing and using Effective 'Graphs' - Citing and Arranging References—I - Citing and Arranging References —II - Writing for Publication in a Scientific Journal.

Unit - IV: Referencing (9 hours)

Literature citations - Introductory remarks on literature citations - Reasons for literature citations - Bibliographical data according to ISO - Citations in the text - Copyright and copyright laws - The text of the Technical Report - Using word processing and desktop publishing (DTP) systems - Document or page layout and hints on editing - Typographic details - Cross-references.

Unit - V: Presentation**(4 hours)**

Giving the presentation - Appropriate pointing - Dealing with intermediate questions - Review and analysis of the presentation - Rhetoric tips from A to Z.

Total hours: 30**TEXT BOOKS:**

1. R C Sharma – Krishna Mohan, *Business Correspondence and Report Writing*, Tata McGraw-Hill Publishing Company Limited, New Delhi, Third Edition, 2005 (reprint).
2. Patrick Forsyth, *How to Write Reports and Proposals*, THE SUNDAY TIMES (Kogan Page), New Delhi, Revised Second Edition, 2010.

REFERENCE BOOKS:

1. John Seely, *The Oxford Writing & Speaking*, Oxford University Press, Indian Edition.
2. Anne Eisenberg, *A Beginner's Guide to Technical Communication*, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

M. Tech. – II Semester
(19MT28301) DIGITAL CONTROL OF POWER ELECTRONICS AND DRIVE SYSTEMS

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

PRE-REQUISITES: Courses on Power Electronics, Power Semiconductor Drives at UG Level.

COURSE DESCRIPTION: Peripherals; Memory addressing modes; DSP based control of dc-dc converters; DSP based control of matrix converters; DSP based control of PMBLDC and SRM drives.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Apply the knowledge of various addressing modes of LF2407 processor and its instruction set to develop simple and complex programs to control power electronic circuits.
- CO2. Apply the knowledge of Space vector modulation technique to control inverter fed AC drives and to implement them in real time using LF2407.
- CO3. Design and develop controller for PMBLDC and SRM drives using LF2407.

DETAILED SYLLABUS:

Unit - I: Motor Control Signal Processors (09 hours)

Introduction- Brief Introduction to Peripherals -Types of Physical Memory - The Components of the C2xx DSP Core -System configuration registers- Memory Addressing modes - Instruction set – Programming techniques – simple programs.

Unit - II: Peripherals of Signal Processors (09 hours)

General purpose Input/output (GPIO) Functionality- Interrupts - A/D converter-Event Managers (EVA, EVB)- PWM signal generation.

Unit - III: DSP-Based Control of DC-DC Converters (09 hours)

Introduction- Converter Structure-Continuous Conduction Mode, Discontinuous Conduction Mode- Connecting the DSP to the Buck-Boost Converter- Controlling the Buck-Boost Converter-Main Assembly Section Code Description Interrupt Service Routine. The regulation Code Sequences.

Unit - IV: DSP-Based Control of Matrix Converters (09 hours)

Space Vector Pulse Width Modulation- Principle of Constant V/Hz Control for Induction Motors- Space Vector PWM Technique- DSP Implementation- Introduction to matrix converter-Topology and Characteristics- Control Algorithms- Bidirectional Switch-Current Commutation - Overall Structure of

Three-Phase Matrix Converter-Implementation of the Venturini Algorithm using the LF2407.

Unit - V: DSP-Based Control of PMLDC and SRM Drives (09 hours)

Control of PMLDC motor drives: Introduction-Principles of the BLDC Motor-Torque Generation -BLDC Motor Control System Implementation of the BLDC Motor Control System Using LF2407.Control of SRM drives: Introduction-Fundamentals of Operation-Fundamentals of Control in SRM Drives- Open Loop Control Strategy for Torque- Closed Loop Torque Control of the SRM Drive.

Total hours: 45

TEXT BOOKS:

1. Hamid A.Toliat, Steven Campbell, *DSP based electromechanical motion control*, CRC Press, Special Indian Edition.

REFERENCE BOOKS:

1. R.Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010
2. T.Kenjo and S.Nagamori, *Permanent magnet and Brushless DC motors*, Clarendon press, London, 1988.

**M. Tech. – II Semester
(19MT28302) ELECTRICAL DRIVES**

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

PRE-REQUISITES: Courses on Power Electronic Converters, Modelling & Analysis of Electrical Machines.

COURSE DESCRIPTION: Performance characteristics and parameters of single phase, three phase converters fed DC motor; Chopper control of DC drives; Open loop and closed loop speed control of induction motor; Induction motor drive, torque control, field oriented control; Synchronous motor drive; synchronous motor control.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate knowledge on various electrical drives.
- CO2. Use the knowledge of converter/chopper fed DC drives of various configurations to analyze and select appropriate power circuit configuration for obtaining the better torque-speed characteristics.
- CO3. Apply the knowledge of various types of induction motor drives and analyze their performance characteristics with the effects of various control strategies
- CO4. Apply the knowledge of synchronous motor drive and analyze the performance parameters subjected to various control techniques.
- CO5. Design and develop electrical drives to solve engineering problems pertaining to drives in real time applications.

DETAILED SYLLABUS:

Unit - I: Rectifier Control of DC Drives (09 hours)

Principle of phase control–Fundamental relations; Analysis of separately excited DC motor with single-phase and three-phase converters–waveforms, performance parameters, performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter.

Unit - II: Chopper Control of DC Drives (09 hours)

Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor–performance analysis, multi quadrant control, chopper based implementation of braking schemes; Multi-phase chopper; Related problems.

Unit - III: Control of Induction Motor Drives-Stator Side and Rotor Side (09 hours)

AC voltage controller circuit, six step inverter voltage control, closed loop variable frequency PWM inverter with dynamic braking, CSI fed variable frequency drives- comparison. Static rotor resistance control, injection of voltage in the rotor circuit, static scherbius drives, power factor considerations, modified Kramer drives.

Unit - IV: Field Oriented Control of Induction Motor Drives (09 hours)

Field oriented control of induction machines–theory. DC drive analogy, Direct and Indirect methods, Flux vector estimation, Direct torque control of Induction Machines–torque expression with stator and rotor fluxes, DTC control strategy.

Unit - V: Synchronous Motor Drives (09 hours)

Wound field cylindrical rotor motor–Equivalent circuits, performance equations for operation from a voltage source, starting and braking, V curves. Self-control, margin angle control, torque control, power factor control. Brushless excitation systems

Total hours: 45

TEXT BOOKS:

1. P.C Sen, *Thyristor DC Drives*, John Wiley and sons, New York, 1981
2. Gopal K Dubey, *Power Semiconductor controlled Drives*, Prentice Hall Inc., New Jersey, 1989
3. Gopal K. Dubey, *Fundamentals of Electrical Drives*, 2nd Edition, Narosa Publishing House, New Delhi, 2009
4. Bimal K Bose, *Modern Power Electronics and AC Drives*, Pearson Education Asia, 2002.

REFERENCE BOOKS:

1. R. Krishnan, *Electric Motor Drives–Modeling, Analysis and Control*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.
2. Vedam Subramanyam, *Electric Drives–Concepts and Applications*, Tata McGraw-Hill publishing company Ltd., New Delhi, 2002
3. W. Leonhard, *Control of Electrical Drives*, Narosa Publishing House, 1992
4. Murphy J.M.D and Turnbull, *Thyristor Control of AC Motors*, Pergamon Press, Oxford, 1988.

M. Tech. – II Semester
(19MT28303) ADVANCED POWER ELECTRONIC CIRCUITS
(Program Elective – 3)

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

PRE-REQUISITES: Courses on Power Electronic Converters, Power Semiconductor Devices.

COURSE DESCRIPTION: Improved DC-DC Converters – Types and operation; Voltage-Lift DC-DC Converters; Super-Lift Converters; Ultra-Lift DC-DC Converter; Multilevel and Soft-Switching DC-AC Inverters – Types, operation and applications; Improved AC-AC Converters Inverters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Apply the knowledge of various types of improved AC-DC Converters and use appropriate control technique to model and analyze with different configurations subjected to various loads.
- CO2. Describe the operation of voltage-lift, super-lift & ultra-lift DC-DC converter and analyze their performance factors with the effects of various control techniques.
- CO3. Demonstrate the knowledge of various types of multilevel and soft-switching DC-AC inverter topology and analyze the performance parameters with various control techniques.
- CO4. Understand the knowledge of different types of improved AC-AC converters and use appropriate control techniques to model and analyze with different configurations.

DETAILED SYLLABUS:

Unit - I: Improved AC-DC Converters (09 hours)

DC/DC Converterized Rectifiers, PWM Boost-Type Rectifiers - DC-Side PWM Boost-Type Rectifier - Constant-Frequency Control, Constant-Tolerance-Band (Hysteresis) Control and Source-Side PWM Boost-Type Rectifiers. Tapped-Transformer Converters, Single-Stage PFC AC/DC Converters - Operating Principles, Mathematical Model Derivation - Averaged Model over One Switching Period T_s and Averaged Model over One Half Line Period T_L . VIENNA Rectifiers - Circuit Analysis and Principle of Operation, Proposed Control Arithmetic, Block Diagram of the Proposed Controller for the VIENNA Rectifier and Converter Design and Waveform Analysis.

Unit - II: Voltage-Lift DC-DC Converters (09 hours)

Self-Lift Cuk-Converter – Continuous and Discontinuous mode operation. P/O Luo-Converters - Relift Circuit, Triple-Lift Circuit and Quadruple-Lift Circuit. N/O Luo-Converters - Relift Circuit, N/O Triple-Lift Circuit and N/O Quadruple-Lift Circuit. Voltage Lift SEPICs - Self-Lift SEPIC, Relift SEPIC and Multiple-Lift SEPICs.

Unit - III: Super-Lift Converters and Ultra-Lift DC-DC Converter

(09 hours)

P/O SL Luo-Converters: Elementary Circuit, Relift Circuit, Triple-Lift Circuit and Higher Order Lift Circuit. N/O Cascaded Boost Converters: Main series - N/O Elementary Boost Circuit, N/O Two-Stage Boost Circuit, N/O Three-Stage Boost Circuit and N/O Higher Stage Boost Circuit. UL Luo-Converter – Operation of Continuous and Discontinuous Conduction Mode.

Unit - IV: Multilevel and Soft-Switching DC-AC Inverters (09 hours)

Multilevel Inverters: Types - Diode-Clamped Multilevel Inverters, Capacitor-Clamped Multilevel Inverters and Multilevel Inverters using H-Bridge Converters. Soft-Switching Multilevel Inverters: Notched DC-Link Inverters for Brushless DC Motor Drive - Resonant Circuit, Design Consideration, Control Scheme and waveform analysis. Resonant Pole Inverter: Operating Principle, Topology of the Resonant Pole Inverter, Design Considerations waveform analysis.

Unit - V: Improved AC-AC Converters (09 hours)

DC-Modulated Single-Phase Single-Stage AC/AC Converters: Bidirectional Exclusive Switches S_M-S_S , Mathematical Modeling of DC/DC Converters, DC-Modulated Single-Stage Buck-Type AC/AC Converter, DC-Modulated Single-Stage Boost-Type AC/AC Converter, DC-Modulated Single-Stage Buck-Boost-Type AC/AC Converter. DC-Modulated P/O Luo-Converter-Type AC/AC Converter and DC-Modulated Two-Stage Boost-Type AC/AC Converter. DC-Modulated Multiphase AC/AC Converters: Types - DC-Modulated Three-Phase Buck-Type AC/AC Converter, Boost-Type AC/AC Converter and Buck-Boost-Type AC/AC Converter. Matrix Converter – Principle of operation.

Total hours: 45

TEXT BOOKS:

1. Fang Lin Luo and Hong Ye, *Power Electronics Advanced Conversion Technologies*, 2nd Edition, CRC Press, 2018.
2. Sergio Alberto Gonzalez, Santiago Andres Verne & Maria Ines Valla, *Multilevel Converters for Industrial Applications*, 1st Edition, CRC Press, 2014.

REFERENCE BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education, 2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, 3rd Edition, Wiley, 2007.

M. Tech. – II Semester
(19MT28304) MULTILEVEL INVERTERS
(Program Elective – 3)

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

PRE-REQUISITES: Courses on Power Electronic Converters and Power Semiconductor Devices & Modeling.

COURSE DESCRIPTION: Symmetric and Asymmetric multilevel inverter; Diode Clamped Multilevel Converter – Types and operation; Flying Capacitor Multilevel Converter: Types and operation; Cascaded Asymmetric Multilevel Converter: Types and operation; Application of Multilevel Inverter fed Drive.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate the knowledge of multilevel and control techniques to design a three level inverter.
- CO2. Demonstrate the knowledge of various topologies of multilevel inverter and use appropriate control technique to model and evaluate their performance parameters.
- CO3. Select appropriate multilevel inverter and control techniques to provide feasible solutions.

DETAILED SYLLABUS:

Unit - I: Introduction (08 hours)

Generalized topology with a Common DC Bus - Basic cell, Generalized topology, Characteristics and Three-level generalized Topology. Filtering circuit - Inductor as a low pass filter and capacitor as a low pass filter. Sine Triangle Pulse Width Modulation (PWM) and power switches requirements. H-bridge multilevel inverters - operation, topology, waveforms and advantages.

Unit - II: Diode Clamped Multilevel Converter (10 hours)

Diode Clamped Topology - Neutral Point Clamped (NPC) Converter topology, Four level diode clamped topology, Five level diode clamped topology and n-Level Diode Clamped Multilevel Converter (DCMC) topologies. Converter structure and functional description - Voltage clamping and switching logic. Modulation of Multilevel Converters - Multilevel Space Vector Modulation - Hexagonal co-ordinate System, Nearest three vectors identification, Duty cycle calculation, Voltage balance control - Capacitor voltage calculation, Voltage balance optimization and Flow diagram.

Unit - III: Flying Capacitor Multilevel Converter (10 hours)

Voltage on the flying capacitor, Four level flying capacitor topology, Five level flying capacitor multilevel inverter and charge balance on the flying capacitors. Modulation scheme for the Flying Capacitor Multilevel Converter

(FCMC) - Phase Shifted Carrier Pulse Width Modulation (PSPWM) - Charge balance using PSPWM. Dynamic voltage balance of the FCMC - Dynamic model and Tuned balancing network - Root locus analysis.

Unit - IV: Cascaded Asymmetric Multilevel Converter (08 hours)

Symmetric topologies without a Common DC Link - Five level Cascaded Cell Multilevel Converter (CCMC), Asymmetric topologies: Hybrid Asymmetric topologies - Hybrid Asymmetric Topologies and CCMC with Different Values of Voltage Sources, Combining Different Topologies and Cascade Asymmetric Multilevel Converter. General Characteristics of the Cascaded Asymmetric Multilevel Converter (CAMC) - Modulation Strategy and Averaged Voltage. Comparison of the Five-Level Topologies - DCMC, FCMC, CCMC and CAMC.

Unit - V: Application of Multilevel Inverter (09 hours)

Medium-Voltage Motor Drive Built with Diode Clamped Multilevel Converter (DCMC): Back-to-Back DCMC Converter, Unified Predictive Controller of the Back-to-Back DCMC in an IM Drive Application - Control of the Back-to-Back DCMC Converter, Load converter - Predictive torque control, Line converter - Predictive power control, Current and Power calculations, Dynamic active power reference design and Switching transition constraint, Performance evaluation - Mechanical load variation, Voltage sag, Energy recovery and Effectiveness of the DC Bus balancing algorithm.

Total hours: 45

TEXT BOOKS:

1. Sergio Alberto Gonzalez, Santiago Andres Verne & Maria Ines Valla, *Multilevel Converters for Industrial Applications*, 1st Edition, CRC Press, 2014.
2. Krishna Kumar Gupta & Pallavee Bhatnagar, *Multilevel Inverters Conventional and Emerging Topologies and their Control*, 1st Edition, Academic Press, 2018.

REFERENCE BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education, 2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, 3rd Edition, Wiley, 2007.

M. Tech. – II Semester
(19MT28305) SOLAR ENERGY CONVERSION SYSTEMS
 (Program Elective - 3)
 (Common to EPS and PED)

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

PRE-REQUISITES: Courses on Power Electronic Converters.

COURSE DESCRIPTION: Solar energy conversion system; Types of photovoltaic systems – Stand-alone, hybrid and grid connected systems; Energy storage systems; Applications.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Demonstrate knowledge on solar cell and analyze the behavior of solar cells for different irradiations.

CO2. Apply the knowledge of solar modules, energy storage system and MPTT to design the stand-alone and grid connected PV systems for various real time applications.

DETAILED SYLLABUS:

Unit - I: Photovoltaic Basics (09 hours)

Structure and working of Solar Cells - Types, Electrical properties and Behaviour of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays – open circuit (Voc) and short circuit characteristics of a PV array- Basics of Load Estimation.

Unit - II: Stand Alone PV System (09 hours)

Solar modules – storage systems – power conditioning and regulation - MPPT- protection – stand alone PV systems design – sizing.

Unit - III: Grid Connected PV Systems (09 hours)

Schematics, Components, solar converters –state of charge characteristics (SOC) - Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings-Micro Grid structure.

Unit - IV: Design of PV Systems (09 hours)

Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies.

UNIT - V: Applications (09 hours)

Water pumping, Battery chargers, Solar car, Direct-drive applications, Space and Telecommunications.

Total hours: 45

TEXT BOOKS:

1. Solanki C.S., *Solar Photovoltaics: Fundamentals, Technologies and Applications*, PHI Learning Pvt. Ltd., 2015.
2. Stuart R. Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, *Applied Photovoltaics*, Earthscan, 2007.
3. Earthscan, UK. Eduardo Lorenzo G. Araujo, *Solar electricity engineering of photovoltaic systems*, Progensa, 1994.

REFERENCE BOOKS:

1. Frank S. Barnes & Jonah G. Levine, *Large Energy storage Systems Handbook*, CRC Press, 2011.
2. McNeils, Frenkel, Desai, *Solar & Wind Energy Technologies*, Wiley Eastern, 1990.
3. S.P. Sukhatme, *Solar Energy*, Tata McGraw Hill, 1987.
4. Nikos Hatziargyriou - *Microgrids- Architectures and control*, Wiley, IEEE press, 2013.

M. Tech. – II Semester
(19MT28306) SPECIAL ELECTRICAL MACHINES
(Program Elective - 3)

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

PRE-REQUISITES: Courses on Electrical Machines, Control Systems, power electronics at UG level.

COURSE DESCRIPTION: Constructional features, operating principles, characteristics and control of synchronous reluctance motor, stepping motor, switched reluctance motor, permanent magnet synchronous motor, permanent magnet brushless DC motor.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate potential knowledge on construction and characteristics of synchronous reluctance motors.
- CO2. Analyze and design appropriate power circuit configuration for stepper motor drive of various configurations to obtain better performance characteristics.
- CO3. Demonstrate potential knowledge on construction of switched reluctance motors and design controllers for SRM using Microprocessor.
- CO4. Apply the knowledge on construction of permanent magnet synchronous motors and analyze their performance characteristics with the effects of various control strategies.
- CO5. Apply the knowledge of various types of permanent magnet brushless DC motor drives to develop chip based controllers.

DETAILED SYLLABUS:

Unit - I: Synchronous Reluctance Motors (08 hours)

Constructional features: Axial and radial air gap motors. Operating principle, characteristics, reluctance torque and phasor diagram. Linear induction motor.

Unit - II: Stepper Motors (10 hours)

Constructional features, principle of operation of Variable Reluctance (VR) and hybrid motors. Single and multi-stack configurations, theory of torque predictions, linear and non-linear analysis, dynamic characteristics, drive systems and circuit for open loop control, closed loop control of stepper motor.

Unit - III: Switched Reluctance Motors (07 hours)

Constructional features, principle of operation, torque equation, power controllers and characteristics of SRM. Microprocessor based power controller for SRM.

Unit - IV: Permanent Magnet Synchronous Motors (10 hours)

Principle of operation, EMF, power input and torque expressions, phasor diagram, power controllers, torque-speed characteristics, self-control, vector control, current control schemes.

Unit - V: Permanent Magnet Brushless DC Motors (10 hours)

Commutation in DC motors, difference between mechanical and electronic commutator. Hall sensors, optical sensors. Multiphase brushless motor. Square wave permanent magnet brushless motor drives - Torque and EMF equation, torque-speed characteristics. Microprocessor based controller.

Total hours: 45

TEXT BOOKS:

1. Miller.T.J.E., *Brushless permanent magnet and reluctance motor drives*, Clarendon Press, Oxford, 1989.
2. Kenjo.T, *Stepping motors and their microprocessor control*, Clarendon Press, Oxford, 1989.

REFERENCE BOOKS:

1. Kenjo.T and Naganori.S, *Permanent Magnet and brushless DC motors*, Clarendon Press, Oxford, 1989.
2. Bimal.K.Bose, *Modern Power Electronics and AC Drives*, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2002.
3. R.Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.

M. Tech. – II Semester
(19MT20706) FLEXIBLE AC TRANSMISSION SYSTEM

(Program Elective – 4)
(Common to EPS and PED)

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

PRE-REQUISITES: Power Electronics and Power Systems at UG level.

COURSE DESCRIPTION: Need for flexible AC transmission systems; objectives of shunt and series compensations, phase angle regulators; FACTS controllers: shunt, series and combined; coordination of various FACTS controllers.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Apply the conceptual knowledge of compensation techniques and appropriate conventional and FACTS devices for active and reactive power flows in parallel and meshed systems.
- CO2. Analyze the active and reactive power flow, transient stability enhancement, power oscillation damping and optimal operation through various FACTS devices/controllers and their coordination.

DETAILED SYLLABUS:

Unit - I: Introduction to AC Transmission Systems (7 hours)

Overview of interconnected power system. Power flow in AC systems – Expression for real and reactive power flow between two nodes of a power system, controllable parameters. Power flow in parallel and meshed system. Overview of compensated transmission lines – shunt and series compensation. Conventional controllers for real and reactive power flows – merits and demerits. FACTS – benefits, types of FACTS controllers.

Unit - II: Static Shunt Compensation (10 hours)

Expression for real and reactive power flow with mid-point voltage regulation. Variable impedance type static VAR generators - V-I characteristics and control schemes of TCR, TSR, TSC. QD-QO characteristic and control scheme of TSC-TCR. Switching converter type VAR generators – V-I characteristics and control schemes of STATCOM. Hybrid VAR generators – V-I characteristics of SVC and STATCOM, regulation of V-I slope. Applications of static shunt compensators – Voltage regulation, improvement in transient stability, prevention of voltage instability, power oscillation damping. Comparison of static shunt compensators.

Unit - III: Static Series Compensation (10 hours)

Expression for real and reactive power flow with series line compensation. Variable impedance type series compensators: V-I characteristics and control

schemes of GCSC, TSSC, TCSC- modes of operation. Sub-synchronous resonance. Switching converter type series compensator – V-I characteristics, internal and external control schemes of SSSC. Applications of static series compensators – improvement in transient stability, power oscillation damping. Comparison of static series compensators.

Unit - IV: Static Phase Angle Regulators and Combined Compensators

(10 hours)

Power flow control by phase angle regulators - Concept of voltage and phase angle regulation. Operation and control of TCVR and TCPAR. Switching converter type phase angle regulators. Objectives of TCPAR - improvement of transient stability, power oscillation damping. UPFC – Principle, expression for real and reactive power between two nodes of UPFC, independent real and reactive power flow control using UPFC, control schemes of UPFC - operating principle and characteristics of IPFC.

Unit - V: Co-ordination of FACTS Controllers

(8 hours)

FACTS controller interactions – interaction between multiple SVC's – interaction between multiple TCSC's – SVC-TCSC interaction – Coordination of multiple controllers using linear control techniques. Comparative evaluation of different FACTS controllers: performance comparison and cost comparison.

Total hours: 45

TEXT BOOKS:

1. Narain G. Hingorani, Laszi Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, Wiley-IEEE Press, 1999.
2. R. Mohan Mathur and Rajiv k. Varma, *Thyristor based FACTS Controllers for Electrical Transmission Systems*, Wiley-IEEE Press, 2002.

REFERENCE BOOKS:

1. Xiao-Ping Zhang, ChristianRehtanz, BikashPal, *Flexible AC Transmission Systems: Modeling and Control*, Springer Power Systems Series, 2006.
2. T.J.E. Miller, *Reactive Power Control in Electric Systems*, Wiley, 1982.

M. Tech. – II Semester
(19MT28307) HYBRID ELECTRIC VEHICLES
(Program Elective – 4)

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

PRE-REQUISITES: Courses on Power Electronics, Special Electrical Machines, Power Semiconductor Drives at UG Level

COURSE DESCRIPTION: Transportation vehicles and their impact in society; Concept and configurations of Electric Vehicles (EV); Principle, Types and operation of Hybrid-Electric Vehicles (HEVs); Power Electronic converters in HEVs; Different motor drives & energy storage technologies in EVs and HEVs.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Demonstrate knowledge on fundamental concepts of Electric Vehicles (EVs) and Hybrid-Electric Vehicles (HEVs) and apply the appropriate power converter & energy storage techniques to analyze and design EVs and HEVs for various applications.

CO2. Apply the knowledge of various types of AC & DC motor drives and analyze their performance characteristics with the effects of various control strategies.

DETAILED SYLLABUS:

Unit - I: Electric and Hybrid Electric Vehicles (09 hours)

Environmental impact and history of modern transportation, history of transportation electrification, Electric Vehicles (EVs) - Introduction, configurations and traction motor characteristics; Hybrid-Electric Vehicles (HEVs) - Concept and architectures; Series HEV - Configuration, operation, advantages and disadvantages; HEVs - Interdisciplinary nature, challenges and key technologies.

Unit - II: Power Electronics in HEVs (10 hours)

Introduction, principle of power electronics, rectifiers used in HEVs, Buck converter used in HEVs. Non-isolated bidirectional DC-DC Converter - operating principle, torque and power capability, current ripple and regenerative braking. Isolated bidirectional DC - DC converter - principle, steady state operations, output voltage and output power. Battery chargers - forward, fly back and bridge converters.

Unit - III: Electric Propulsion Systems (10 hours)

Introduction, Typical functional block diagram and classification of electric motor drive, DC motor drives - Control methods, class A and B choppers, two and four quadrant chopper control. Induction Motor drives - Operating principle, steady - state performance, v/f control and power electronic

control. PMBLDC Motor drives - Construction, advantages and disadvantages, performance analysis and control. Switched Reluctance Motor drives - SRM basic magnetic structure, torque production, converter topologies.

Unit - IV: Energy Storage Technologies (10 hours)

Battery - basic theory and characterization, battery technologies, Types – lead acid batteries, nickel-based batteries and lithium-based batteries. Ultra-capacitors - Features, Basic Principles, Performance, Battery modeling based on electric equivalent circuit, Modeling of ultra -capacitors, Battery charging control and Flywheel Energy Storage System. Fuel Cells - modeling and block diagrams of hybrid fuel cell energy storage systems.

Unit -V: Applications of Hybrid Electric Vehicles (06 hours)

Introduction, Hydraulic Hybrid Vehicles (HHV) - Principle and operation of regenerative braking. Hybrid off road vehicular system, electric or hybrid ships and locomotives. Military applications - Electromagnetic launchers and hybrid-powered ships.

Total hours: 45

TEXT BOOKS:

1. MehrdadEhsani, Yimin Gao and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles*, 2nd edition, CRC Press, 2015.
2. Chris Mi, M. AbulMasrur, David WenzhongGao, *Hybrid Electric Vehicles Principles and Applications with Practical Perspectives*, Wiley, 2011.

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.

M. Tech. – II Semester
(19MT28308) SWITCHED MODE POWER SUPPLIES AND UPS
(Program Elective - 4)

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

PRE-REQUISITES: Courses on Power Electronic Converters, Power Semiconductor Devices & Modeling.

COURSE DESCRIPTION: DC-DC Converters and Switching Mode Power Converters; Resonant Converters – Types and operating waveforms; ZCS and ZVS Resonant converters; Power conditioners, UPS and Filters – ON and OFF line operation.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate the knowledge of various switch mode DC-DC Converters and use appropriate control technique to design and analyze with different modes of operation.
- CO2. Understand the knowledge of resonant converter and use appropriate control technique to model and evaluate their performance parameters.
- CO3. Demonstrate the knowledge of power conditioners, UPS and filters to design and analyze for different operating conditions.

DETAILED SYLLABUS:

Unit - I: DC-DC Converters (09 hours)

Performance analysis of buck, boost, buck-boost, cuk, sepic and quadratic converters – Modes of operation, Equivalent circuits and steady state waveforms.

Unit - II: Switching Mode Power Converters (09 hours)

Performance analysis of forward, fly-back, push-pull, Luo, half-bridge and full-bridge Converters – Modes of operation, Equivalent circuits and steady state waveforms.

Unit - III: Resonant Converters (09 hours)

Series Resonant Inverters: Series Resonant Inverter with unidirectional switches – Modes of operations, Waveforms, Types – Based on coupled inductors, Half-Bridge and Full-Bridge resonant inverters. Series Resonant Inverter with bidirectional switches – Types – Half-Bridge and Full-Bridge resonant inverters.
Parallel Resonant inverters, Voltage control of resonant inverters, Class E resonant inverter and rectifiers.

Unit - IV: ZCS and ZVS Resonant Converters (09 hours)

Zero-Current-Switching Resonant Converter: Types – L-Type and M-Type ZCS, Equivalent circuit, Modes of operation and Waveforms. Zero-Voltage-Switching Resonant Converters: Equivalent circuit, Modes of operation, Waveforms and Two quadrant ZVS resonant converters. Resonant DC-link inverters – Basic concept, Waveforms, Three phase DC-link inverter – Operation and Waveforms. Active clamp dc-link resonant inverter – Operation and Waveforms. Comparison of ZVS and ZCS.

Unit - V: Power Conditioners, UPS & Filters (09 hours)

Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

Total hours: 45

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th Edition, 2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd Edition, 2007.

REFERENCE BOOKS:

1. M. D. Singh & K. B. Kanchandhani, *Power Electronics*, Tata McGraw – Hill Publishing Company, New Delhi, 3rd Edition, 2008.
2. Dr. P. S. Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 4th Edition, 2012.

M. Tech. – II Semester
(19MT28309) WIND ENERGY CONVERSION SYSTEMS
 (Program Elective - 4)
 (Common to EPS and PED)

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

PREREQUISITE(S): Courses on Power Electronics, control systems in UG level.

COURSE DESCRIPTION: Fundamentals of wind energy and its measurement; wind turbine design and basic aerodynamics principles; need of usage of wind generators; wind turbine control, monitor and implementation in the wind farm and site selection; power quality issues and mitigation methods of wind power integration in the power system.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Demonstrate knowledge on various components, types, characteristics and measurements of wind turbines.
- CO2. Apply the knowledge of aerodynamics forces to analyze wind turbine blade rotation.
- CO3. Use the knowledge of various design procedures and converters for designing modern wind turbines and to integrate.
- CO4. Demonstrate knowledge on various types of control and monitoring techniques used in WECS.
- CO5. Demonstrate knowledge on power quality problems in WECS and apply suitable mitigation techniques/ custom power devices to improve the power quality.

DETAILED SYLLABUS:

Unit - I: Wind Energy Fundamentals and Measurements (08 hours)

wind power scenario in India; basics of wind characteristics: extractable limits of wind power; estimation of wind power potential; gust/extreme wind speeds; wind turbulence wind measurement and instrumentation; horizontal/vertical axis wind turbines; wind turbine components, braking, yaw system, tower.

Unit - II: Design and Aerodynamics of Wind Turbine (10 hours)

Analysis of semi Review on basic aerodynamics, Airfoils and General Concepts of Aerodynamics, types and characteristics of wind turbine, Blade Design for Modern Wind Turbines, blade element theory, Betz limit, Generalized Rotor Design Procedure, turbine design: Design procedure, topologies, Wind Turbine Standards, Technical Specifications, and Certification, Wind Turbine Design Loads, power curve prediction.

Unit - III: Wind Turbine Generators (09 hours)

Fixed speed and variable speed systems, Electrical machines for wind energy systems, synchronous and asynchronous generators and its performance, Integration of wind energy systems to electrical networks, converters, inverters, directly connected, wind energy storage solutions.

Unit - IV: Wind Turbine Control, Testing and Applications (12 hours)

Types of Control Systems in Wind Turbines, Overview of Wind Turbine Control Systems, Typical Grid-connected Turbine Operation, and Typical Constant-speed and variable speed Operating Schemes, Supervisory Control Overview Implementation, overview of testing methods. Applications: hybrid power systems, special purpose applications, overview of energy storage, site selection and environmental impacts.

Unit - V: Power Quality Issues in Integration of WECS (06 hours)

Stand alone and Grid connected wind systems, Power Quality issues, Impact of power quality problems on WECS, Harmonic reduction and Power factor improvement, Mitigation of power quality problems, and role of custom power devices in Distributed Generation.

Total hours: 45

TEXT BOOKS:

1. J. F. Manwell, J. G. McGowan and A. L. Rogers, *Wind Energy Explained – Theory, Design and Application*, Wiley, 2009.
2. G.D. Rai, *Non - Conventional Energy Resources*, Khanna Publishers, 2002.

REFERENCE BOOKS:

1. V. Daniel Hunt, *Wind power: a handbook on wind energy conversion systems*, 4th Edition, Van Nostrand Reinhold Co., 1981, Khanna Publishers, New Delhi, 2012.
2. Arindam Ghosh, Gerard Ledwich, *Power Quality Enhancement Using Custom power devices Power Devices*, Springer, 2002.
3. Roger C. Dugan, Mark F. Mc Granaghan, Surya Santoso and H. Wayne Beaty, *Electrical Power Systems Quality*, 2nd edition, TATA McGraw Hill, 2008.

**M. Tech. – II Semester
(19MT28331) ELECTRICAL DRIVES LAB**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Courses on Power converters.

COURSE DESCRIPTION: Design and development of various AC and DC drives.

COURSEOUTCOMES: On successful completion of the course, students will be able to

- CO1. Identify appropriate devices, domain specific tools and techniques to develop and control power electronic converters fed drive.
- CO2. Analyze and evaluate the performance of Power converters fed drive by practicing professional code of ethics.
- CO3. Prepare laboratory reports that clearly communicate experimental information.
- CO4. Function effectively as an individual to solve various problems.

PRACTICAL EXERCISES/LIST OF EXPERIMENTS: Conduct any **Two Experiments** from the following:

1. Single phase half controlled rectifier fed DC motor using IGBT.
2. Single phase half controlled rectifier fed DC motor using MOSFET.
3. Single phase fully controlled rectifier fed DC motor using IGBT.
4. Single phase fully controlled rectifier fed DC motor using MOSFET.
5. DC-DC converter fed DC Motor using IGBT.
6. DC-DC converter fed DC Motor using MOSFET.
7. Single phase inverter fed induction motor using IGBT.
8. Three phase three level inverter (MLI) fed induction motor drive.
9. Five level cascaded multilevel inverter fed induction motor drive.

M. Tech. – II Semester
(19MT28332) ELECTRICAL DRIVES SIMULATION LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Courses on Power converters.

COURSE DESCRIPTION: Design and simulation of various AC and DC drives.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Identify appropriate devices, domain specific tools and techniques to develop and control power electronic converters fed drive.
- CO2. Analyze and evaluate the performance of Power converters fed drive by practicing professional code of ethics.
- CO3. Prepare laboratory reports that clearly communicate experimental information.
- CO4. Function effectively as an individual to solve various problems.

LIST OF EXPERIMENTS: Conduct any **TEN Experiments** from the following using MATLAB

1. Single phase half-wave converter fed DC motor.
2. Single phase Semi converter fed DC drive.
3. Single phase full controlled fed DC drive.
4. Single phase inverter fed induction motor fed drive.
5. Speed control of stepper motor fed drive.
6. Speed control of universal motor using AC voltage controller.
7. Speed Control of Induction motor using cyclo converter.
8. Step up chopper fed DC drive.
9. Step down chopper fed DC drive.
10. Speed control of single phase induction motor using AC voltage controller.
11. Speed control of Permanent Magnet Synchronous motor fed drive.
12. Speed Control Brushless DC Motor fed drive.
13. Speed control of Switched Reluctance Motor fed drive.

M. Tech. – II Semester
(19MT2AC01) STATISTICS WITH R
 (Audit Course)
 (Common to All M. Tech. Programs)

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

PRE-REQUISITES: A course on Statistics.

COURSE DESCRIPTION: Concepts of R programming basics, Bivariate and multivariate data, Confidence intervals, Goodness of fit, Analysis of variance.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Import, manage, manipulate, and structure data files using R programming.
- CO2. Implement models for statistical analysis of a given dataset and visualize the results to identify trends, patterns and outliers in data.

DETAILED SYLLABUS:

Unit - I: Introduction (5 hours)

Data, R's command line, Variables, Functions, The workspace, External packages, Data sets, Data vectors, Functions, Numeric summaries, Categorical data.

Unit - II: Bivariate and Multivariate Data (7 hours)

Lists, Data frames, Paired data, Correlation, Trends, Transformations, Bivariate categorical data, Measures of association, Two-way tables, Marginal distributions, Conditional distributions, Graphical summaries, Multivariate data - Data frames, Applying a function over a collection, Using external data, Lattice graphics, Grouping, Statistical transformations.

Unit - III: Populations (6 hours)

Populations, Discrete random variables, Random values generation, Sampling, Families of distributions, Central limit theorem, Statistical Inference - Significance tests, Estimation, Confidence intervals, Bayesian analysis.

Unit - IV: Confidence Intervals (6 hours)

Confidence intervals for a population proportion, p - population mean, Other confidence intervals, Confidence intervals for differences, Confidence intervals for the median, Significance test - Significance test for a population proportion, Significance test for the mean (t-tests), Significance tests and confidence intervals, Significance tests for the median.

Unit - V: Goodness of FIT**(6 hours)**

The chi-squared goodness-of-fit test, The multinomial distribution, Pearson's χ^2 -statistic, chi-squared test of independence and homogeneity, Goodness-of-fit tests for continuous distributions, ANOVA - One-way ANOVA, Using *lm* for ANOVA.

Total hours: 30**TEXT BOOKS:**

1. John Verzani, *Using R for Introductory Statistics*, CRC Press, 2nd Edition, 2014.
2. Sudha G Purohit, Sharad D Gore, Shailaja R Deshmukh, *Statistics Using R*, Narosa Publishing house, 2nd Edition, 2015.

REFERENCE BOOKS:

1. Francisco Juretig, *R Statistics Cookbook*, Packt Publishing, 1st Edition, 2019.
2. Prabhanjan N. Tattar, Suresh Ramaiah, B. G. Manjunath, *A Course in Statistics with R*, Wiley, 2018.

**M. Tech. – III Semester
(19MT38331) INTERNSHIP**

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

PRE-REQUISITES: -

COURSE DESCRIPTION: Acquaint students with the industrial environment; Create competent professionals for the industry; Gain professional experience and understand engineer's responsibilities and ethics.

COURSE OUTCOMES: On successful completion of the course, students will be able to

- CO1. Develop problem solving skills, critical thinking skills through designing and developing solutions for complex problems.
- CO2. Utilize appropriate modern tools and techniques for implementing the proposed solutions.
- CO3. Discern various challenges in developing solutions for complex problems, design and conduct experiments to evaluate alternative solutions for the chosen engineering problems.
- CO4. Function effectively as an individual and participate well as a team member to build professional network for growth in career.
- CO5. Develop communication, enrich professional, interpersonal and technical skills pertaining to the internship experience.
- CO6. Understand the industry/organization customs and practices that will help to develop a solid work ethic and professional demeanor, as well as a commitment to ethical conduct and social responsibility.
- CO7. Utilize real work experiences to explore their interests, career alternatives that will help with future education or employment through and develop professional skills and competencies to engage in lifelong learning.

M. Tech. – III Semester
(19MT38332) PROJECT WORK PHASE-I

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	20	10

PREREQUISITES: -

COURSE DESCRIPTION: Identification of topic for the project work, Literature survey, Collection of preliminary data, Critical study and analysis of the topic identified, Time and cost analysis.

COURSE OUTCOMES:-On successful completion of the course, students will be able to

- CO1. Apply contextual knowledge to identify a domain of interest and a specific problem in core and allied areas of discipline.
- CO2. Conduct a systematic literature review, analyze, cognize and comprehend the extracted information to recognize the current status of research pertinent to the chosen problem.
- CO3. Discern various issues, challenges and identify alternative solutions for the chosen engineering problems.
- CO4. Function effectively as an individual to recognize the opportunities in the chosen domain of interest and engage in independent learning.
- CO5. Write and present a substantial technical report/document to present the findings on the chosen problem.
- CO6. Acquire intellectual integrity through understanding the need for ethics in research, profession and its impact on the society.

**M. Tech. – IV Semester
(19MT48331) PROJECT WORK PHASE-II**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
150	150	300	-	-	32	16

PREREQUISITES: Project Work Phase-I

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; Writing of thesis and presentation.

COURSE OUTCOMES:-On successful completion of the course, students will be able to

- CO1. Investigate, conceptualize and design optimal solutions for the chosen engineering problems.
- CO2. Utilize appropriate modern tools and techniques for implementing the proposed solution.
- CO3. Design and conduct experiments, visualize, analyze and interpret results to test and evaluate the proposed solution.
- CO4. Function effectively as an individual to recognize the opportunities in the chosen domain of interest and engage in independent learning.
- CO5. Write and present a substantial technical report/document to present the findings on the chosen problem.
- CO6. Acquire intellectual integrity through understanding the need for ethics in research, profession and its impact on the society.
- CO7. Engage in lifelong learning for development of technical competence in the advanced fields of Power electronics and drives to contribute to the development of scientific/technological knowledge.