ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABI

For

MASTER OF TECHNOLOGY

in

COMPUTER NETWORKS AND INFORMATION SECURITY

(For the batches admitted from 2019-2020)

CHOICE BASED CREDIT SYSTEM

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SREE VIDYANIKETHAN ENGINEERING COLLEGE

(AUTONOMOUS)

(Affiliated to JNTUA, Ananthapuramu, Approved by AICTE,
Programs Accredited by NBA, Accredited by NAAC with 'A' grade)
Sree Sainath Nagar, A. Rangampet, Near Tirupati - 517102 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 COMPUTER SCIENCE AND ENGINEERING

VISION

To become a Centre of Excellence in Computer Science and Engineering by imparting high quality education through teaching, training and research

MISSION

- The Department of Computer Science and Engineering is established to provide undergraduate and graduate education in the field of Computer Science and Engineering to students with diverse background in foundations of software and hardware through a broad curriculum and strongly focused on developing advanced knowledge to become future leaders.
- Create knowledge of advanced concepts, innovative technologies and develop research aptitude for contributing to the needs of industry and society.
- Develop professional and soft skills for improved knowledge and employability of students.
- Encourage students to engage in life-long learning to create awareness of the contemporary developments in computer science and engineering to become outstanding professionals.
- Develop attitude for ethical and social responsibilities in professional practice at regional, National and International levels.

PROGRAM EDUCATIONAL OBJECTIVES

*After few years of graduation, the graduates of **M. Tech. (CNIS)** program would have:*

PEO1. Pursuing advanced studies in the areas of Computer Networks, Network Security, Cloud Computing and related disciplines.

PEO2. Employed in reputed computer, IT, Government and Research organizations or be able to establish startup companies.

PEO3. Achieve professional advancement through continuing education, demonstrate effective communication, increased responsibility, leadership skills, team work and ethical code of conduct.

PROGRAM OUTCOMES

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

PO1. Demonstrate knowledge with ability to select, learn and apply appropriate techniques, skills and modern engineering tools to solve engineering problems appropriate to the relevant discipline.

PO2. Analyze engineering problems critically, conceptualize, design, implement and evaluate potential solutions to contribute to the development of scientific/technological solutions in the context of relevant discipline.

PO3. Independently carry out research /investigation and development work to solve practical problems.

PO4. Function effectively as an individual and in a team to possess knowledge and recognize opportunities for career progression and research.

PO5. Communicate effectively in professional practice through verbal and written formats.

PO6. Recognize the need for self-motivated pursuit of knowledge to show commitment and competence in the broadest context of technological change.

The Challenge of Change

*"**M**astery 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		BE / B.Tech / AMIE in ECE, / EEE / CSE / Electronics & Computer Engineering / ETE / IT / CSIT / Electronics and Control Engineering / Instrumentation Engineering / Instrumentation Technology / EIE / Electronics Engineering / Bio-Medical Engineering / AMIETE (Electronics & Telematics Engineering)/ Electronics or equivalent
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). **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.
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. **Laboratory examination-II:** Shall be conducted just before SECOND mid-term examinations.
			20	Practical test (Internal evaluation).	
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.

Sl. No.	Course	Marks	Examination and Evaluation		Scheme of examination
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:

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

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

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

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:

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

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

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
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the course of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the course of the examination)	Expulsion from the examination hall and cancellation of the performance in that course only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that course only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the course of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses of that Semester. The Hall Ticket of the candidate is to be cancelled.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred for four consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the courses of the examination (including labs and project work) already appeared and shall not be allowed to appear for examinations of the remaining courses of that semester. The candidate is also debarred for four consecutive semesters from class work and all Semester-end examinations, if his involvement is established. Otherwise, The candidate is debarred for two consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
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, A.Rangampet-517 102

Department of Computer Science and Engineering

SVEC19 - M. Tech. (Computer Networks and Information Security)

I Semester

Sl. No.	Course Code	Course Title	Contact Hours per week				Credits C	Scheme of Examinations Max. Marks		
			L	T	P	Total		Internal Marks	External Marks	Total Marks
1.	19MT10501	Advanced Algorithms	3	-	-	3	3	40	60	100
2.	19MT10502	Advanced Data Structures	3	-	-	3	3	40	60	100
3.	19MT10503	Mathematical Foundations of Computer Science	3	-	-	3	3	40	60	100
4.	**Program Elective -1**		3	-	-	3	3	40	60	100
	19MT10504	Artificial Intelligence								
	19MT10505	Data Warehousing and Data Mining								
	19MT16301	Advanced Computer Networks								
	19MT16302	Network Intrusion Detection Systems								
5.	**Program Elective -2**		3	-	-	3	3	40	60	100
	19MT10509	Machine Learning								
	19MT16303	Cloud Computing								
	19MT16304	Digital Forensics								
	19MT16305	Malware and Risk Analysis								
6.	19MT10708	Research Methodology and IPR	2	-	-	2	2	40	60	100
7.	19MT10531	Advanced Algorithms Lab	-	-	4	4	2	50	50	100
8.	19MT10532	Advanced Data Structures Lab	-	-	4	4	2	50	50	100
		Total	**17**	**-**	**8**	**25**	**21**	**340**	**460**	**800**
9.	19MT1AC01	Technical Report Writing	2	-	-	2	-	-	-	-

II Semester

Sl. No.	Course Code	Course Title	Contact Hours per week				Credits C	Scheme of Examinations Max. Marks		
			L	T	P	Total		Internal Marks	External Marks	Total Marks
1.	19MT26301	Cryptography and Network Security	3	-	-	3	3	40	60	100
2.	19MT26302	Wireless Sensor Networks	3	-	-	3	3	40	60	100
3.	**Program Elective - 3**		3	-	-	3	3	40	60	100
	19MT20503	Artificial Neural Networks and Deep Learning								
	19MT26303	Database Security								
	19MT26304	GPU Computing								
	19MT26305	Internet of Things								
4.	**Program Elective - 4**		3	-	-	3	3	40	60	100
	19MT20508	Soft Computing								
	19MT26306	Blockchain Technologies								
	19MT26307	Secure Software Design and Enterprise Computing								
	19MT26308	Software Defined Networks								
5.	19MT2MOOC	Open Elective (MOOC)	-	-	-	-	3	-	100	100
6.	19MT26331	Cryptography and Network Security Lab	-	-	4	4	2	50	50	100
7.	19MT26332	Wireless Sensor Networks Lab	-	-	4	4	2	50	50	100
		Total	**12**	**-**	**8**	**20**	**19**	**260**	**440**	**700**
8.	19MT2AC01	Statistics with R	2	-	-	2	-	-	-	-

III Semester

Sl. No.	Course Code	Course Title	Contact Hours per week				Credits C	Scheme of Examinations Max. Marks		
			L	T	P	Total		Internal Marks	External Marks	Total Marks
1.	19MT36331	Internship	-	-	-	-	2	-	100	100
2.	19MT36332	Project Work Phase-I	-	-	20	20	10	50	50	100
Total			**-**	**-**	**20**	**20**	**12**	**50**	**150**	**200**

IV Semester

Sl. No.	Course Code	Course Title	Contact Hours per week				Credits C	Scheme of Examinations Max. Marks		
			L	T	P	Total		Internal Marks	External Marks	Total Marks
1.	19MT46331	Project Work Phase-II	-	-	32	32	16	150	150	300
Total			**-**	**-**	**32**	**32**	**16**	**150**	**150**	**300**
Total Credits							**68**			
Grand Total Marks										**2000**

M. Tech. (CNIS) - I Semester
(19MT10501) ADVANCED ALGORITHMS
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Design and Analysis of Algorithms.

COURSE DESCRIPTION:
Introduction to algorithm design techniques; Divide and conquer, greedy methods and dynamic programming; Backtracking, branch and bound techniques and NP-completeness; Methods of advanced graph theory; approximation algorithms and number theoretic algorithms; max flow and string matching algorithms and randomizing algorithms.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Perceive and apply the concepts of different algorithmic techniques to find solutions for a specific problem.
CO2. Design solutions for societal problems by applying the concepts from dynamic programming, backtracking.

DETAILED SYLLABUS:

UNIT-I: The Role of Algorithms in Computing, Divide and Conquer, Greedy Methods (8 Hours)
The Role of Algorithms in Computing: Algorithms, Analyzing algorithms, Designing algorithms, Asymptotic notations.
Divide and Conquer: General method, Binary search, The maximum sub-array problem.
Greedy Method: General method, Job sequencing with deadlines, Knapsack problem, Huffman codes.

UNIT-II: Dynamic Programming, Back Tracking, Branch and Bound (10 Hours)
Dynamic Programming: Optimal binary search trees, 0/1 Knapsack problem, Traveling sales person problem.
Back Tracking: N–Queen's problem, Graph coloring, Sum of subsets problem, Hamiltonian cycles.
Branch and Bound: LC Search, LIFO and FIFO branch and bound solutions of 0/1 Knapsack problem.

UNIT-III: NP-Completeness and Approximation Algorithms (9 Hours)
NP-Completeness: Polynomial time, Polynomial time verification, NP-completeness and reducibility, NP-completeness proofs, NP-complete problems.
Approximation Algorithms: The vertex-cover problem, The traveling salesman problem, The set-covering problem, The subset-sum problem.

UNIT-IV: Max Flow and Number Theoretic Algorithms (9 Hours)
Max Flow: Flow networks, Ford-Fulkerson method, Maximum Bi-partite matching.
Number Theoretic Algorithms: Elementary number theoretic notions, Greatest common divisor, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem.

UNIT-V: String Matching Algorithms, Probabilistic and Randomized Algorithms (9 Hours)
String Matching: The Naive string-matching algorithm, The Rabin-Karp algorithm, String matching with finite automata, The Knuth-Morris-Pratt algorithm.
Randomizing Deterministic Algorithms: Monte Carlo and Las Vegas algorithms, Probabilistic numeric algorithms.

Total Hours: 45

TEXT BOOKS:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, PHI Learning, 3rd Edition, 2009.
2. Ellis Horowitz, Sartaj Sahni, and S Rajasekaran, *Fundamentals of Computer Algorithms*, Universities Press, 2nd Edition, 2008.

REFERENCE BOOKS:

1. Michael T. Goodrich, Roberto Tomassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Wiley, 2002.
2. Adrian J., Bondy, U.S.R.Murty, *Graph Theory*, Springer, 2008.

M. Tech. (CNIS) – I Semester
(19MT10502) ADVANCED DATA STRUCTURES
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Computer Programming and Data Structures.

COURSE DESCRIPTION:
Introduction to elementary data structures including stacks, queues, and lists, analysis of algorithms and recurrences, Trees and Graphs, Skip lists, Computational Geometry, Heap and Hash tables.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Develop appropriate data structures for efficient storage and retrieval of data.
CO2. Choose appropriate data structures, understand the ADT/libraries, and use it to solve a specific problem.

DETAILED SYLLABUS:

UNIT-I: Introduction to Data Structures (9 Hours)
Introduction to Data Structures: Types of data structures, time and space complexity, Asymptotic notations.
Recurrences: The substitution method, Recurrence tree method, Master's theorem for solving recursions.
Elementary data structures: Stacks and its applications, Queues - Circular Queue, Dequeue, applications; Linked lists implementations and its types.

UNIT-II: Trees (10 Hours)
Trees: Representation and applications of trees, Binary trees, Expression trees, Binary Search Trees, AVL Trees, Red Black Trees, B-Trees, Splay Trees, Sets and maps implementation.

UNIT-III: Graphs and Skip Lists (10 Hours)
Graphs: Basic terminologies of graphs, Representation and applications, Graph traversal techniques, Minimum spanning trees, Maximum Bipartite Matching, Minimum cost flow.
Skip Lists: Need for Randomizing data structures and algorithms, Search and update operations on skip lists, Probabilistic analysis of skip lists, Deterministic skip lists.

UNIT-IV: Heaps and Hash Tables (9 Hours)
Heaps: Definition, Heap Implementation, priority queues, Applications, Binomial heaps, operations on binomial heaps, Fibonacci heaps, Mergeable heap operations, decreasing a key and delete a node, Bounding a maximum degree.
Hashing: Definition, Hash functions and problems, Collision resolution techniques, Universal hashing, Applications**.**

UNIT-V: Computational Geometry (7 Hours)
One dimensional range searching, Two dimensional range searching, Constructing a priority search tree, Searching a priority search tree, Priority range trees, Quad trees, k-D Trees.

Total Hours: 45

TEXT BOOKS:

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, Pearson, 4th Edition, 2014.
2. Michael T. Goodrich, Roberto Tomassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Wiley, 2002.

REFERENCE BOOKS:

1. Sartaj Sahni, *Data Structures, Algorithms and Applications in C++*, Universities Press, 2nd Edition, 2005.
2. Richard F. Gilberg, Behrouz A. Forouzan, *Data Structures: A Pseudocode Approach with C*, Cengage, 2nd Edition, 2007.

M. Tech. (CNIS) - I Semester
(19MT10503) MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Multivariable Calculus and Differential Equations.

COURSE DESCRIPTION:
Mathematical Logic, Predicate calculus, Set theory, Relations, functions, Algebraic Structures, Combinations and Permutations, Recurrence Relations, Graph Theory and its Applications.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Understand and apply the fundamental concepts of mathematical logic to solve engineering problems.
CO2. Formulate problems and solve using recurrence relations and graph theory.

DETAILED SYLLABUS:

UNIT-I: Mathematical Logic and Predicate Calculus (9 Hours)
Mathematical Logic: Introduction, Statements and notations, Connectives, Truth tables, Tautology, Tautological implications, Well formed formulae, Other connectives, Normal forms, The theory of inference for the statement calculus, Automatic theorem proving.
Predicate Calculus: Predicates, Quantifiers, Predicate formulas, Free and bound variables, The universe of discourse, Theory of inference for the predicate calculus.

UNIT-II: Set Theory and Algebraic Structures (9 Hours)
Set Theory: Basic concepts of set theory, Relations, Properties of binary relation, Relation matrix and the graph of a relation, Equivalence relations, Compatibility relations, Partial ordering, Partially ordered set, Functions - Definition and introduction, Composition of function, Inverse function.
Algebraic Structures: Algebraic systems, Semigroups and monoids, Groups, Homomorphism and isomorphism, Cosets and Lagrange's theorem.

UNIT-III: Elementary Combinatorics (9 Hours)
Basics of counting, Combinations and permutations, Enumeration of combinations and permutations, Enumerating combinations and permutations with and without repetitions, The binomial and multinomial Theorems, The principle of inclusion exclusion, Pigeon hole principle.

UNIT-IV: Recurrence Relations (9 Hours)
Generating functions of sequences, Calculating coefficients of generating functions, Recurrence relations, Solving recurrence relations by substitution and generating functions, The method of characteristic roots, Solutions of inhomogeneous recurrence relations.

UNIT-V: Graph Theory and Its Applications (9 Hours)
Introduction, Isomorphism and sub graphs, Trees and their properties, Spanning trees, Planar graphs, Euler's formula, Multigraphs and Euler circuits, Hamiltonian graphs and circuits, Chromatic number, The four-color problem.

Total Hours: 45

TEXT BOOKS:

1. J. P. Tremblay, R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*, Mc Graw Hill, 2008.
2. Joe L. Mott, Abraham Kandel, Theodore P. Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*, Pearson, 2nd Edition, 2008.

REFERENCE BOOKS:

1. John Vince, *Foundation Mathematics for Computer Science: A Visual Approach*, Springer, 2015.
2. K.H. Rosen, *Discrete Mathematics and its Applications*, McGraw Hill, 7th Edition, 2012.

M. Tech. (CNIS) - I Semester
(19MT10504) ARTIFICIAL INTELLIGENCE
(Program Elective -1)
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Mathematical Foundations of Computer Science and Data Structures.

COURSE DESCRIPTION:
Artificial intelligence concepts, Intelligent agents, Problem solving agents, Logical agents, Knowledge representation and processing, Probabilistic learning, Natural language processing.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Apply knowledge of artificial intelligence techniques to develop an intelligent system for a given problem.
CO2. Design and develop solutions for natural language processing applications.

DETAILED SYLLABUS:

UNIT-I: Introduction (9 Hours)
AI Definition, Foundations of artificial intelligence, State of the art.
Intelligent Agents - Agents and environments, The concept of rationality, Nature of environments, Structure of agents.

UNIT-II: Problem Solving (9 Hours)
Problem solving agents, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions, Local search algorithms and optimization problems.

UNIT-III: Logical Agents (9 Hours)
Knowledge based agents, The Wumpus World, Logic, Propositional logic, Propositional theorem proving.
First Order Logic - Syntax and semantics of first-order logic, Using first order logic, Knowledge engineering.

UNIT-IV: Knowledge Representation and Probabilistic Learning (9 Hours)
Ontological engineering, Categories and objects, Events, Mental events and mental objects, Reasoning systems for categories, Reasoning with default information, The Internet shopping world, Knowledge representation in uncertain domain, Bayesian networks, Independence, Bayes' rule.

UNIT-V: Probabilistic Reasoning over Time (9 Hours)
Time and uncertainty, Inference in temporal models, Hidden Markov models, Kalman filters, Dynamic Bayesian networks, Multi object tracking.
Natural Language Processing - Language models, Text classification, Information retrieval, Machine translation, Speech recognition.

Total Hours: 45

TEXT BOOK:
1. Stuart J. Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson, 3rd Edition, 2010.

REFERENCE BOOKS:
1. Elaine Rich, Kevin Knight, B. Shivashankar B. Nair, *Artificial Intelligence*, McGraw Hill, 3rd Edition, 2017.
2. Saroj Kaushik, *Artificial Intelligence*, Cengage Learning, 1st Edition, 2011.

M. Tech. (CNIS) – I Semester
(19MT10505) DATA WAREHOUSING AND DATA MINING
(Program Elective – 1)
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Database Management Systems.

COURSE DESCRIPTION:
Introduction to Data warehousing and OLAP with its operations, Need for data pre-processing and pre-processing techniques, Functionalities of Data mining, Classification, Association pattern mining, Cluster analysis, Trends in Data mining.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Identify the key concepts of data warehousing and design data warehouses to support OLAP applications.
CO2. Analyze and preprocess various datasets to improve the quality of data in the process of knowledge discovery.
CO3. Choose and apply appropriate data mining techniques for the given datasets to generate patterns, visualize and analyze patterns to discover actionable knowledge.

DETAILED SYLLABUS:

UNIT-I: Data Warehousing and Online Analytical Processing (9 Hours)
Data warehouse, Operational database systems versus data warehouses, A Multi-tiered architecture, A Multidimensional data model, Star, Snowflake and Fact Constellation schemas, Role of concept hierarchies, Measures, OLAP operations, From online analytical processing to multidimensional data mining, Indexing OLAP data.

UNIT-II: Data Mining and Data Preprocessing (8 Hours)
Introduction to data mining, Kinds of data, Kinds of patterns, Major issues in data mining, Data pre-processing, Data cleaning, Data integration, Data reduction, Data transformation and discretization.

UNIT-III: Associations And Classification (10 Hours)
Basic concepts, Frequent itemset mining methods, Pattern evaluation methods, From association mining to correlation analysis, Classification, Decision tree induction, Bayesian classification methods, Rule based classification, Prediction - linear regression.

UNIT-IV: Cluster Analysis (9 Hours)
Types of data in cluster analysis, A categorization of major clustering methods, Partitioning Methods - K-Means, K-Medoids; Hierarchical methods - Agglomerative method, Divisive method; Density based method - DBSCAN; Grid based method - STING; Outlier analysis.

UNIT-V: Data Mining Trends (9 Hours)
Mining sequence data, Mining graphs and networks, Spatial data mining, Text mining , Mining multimedia and web data, Statistical data mining, Privacy security and social impacts of data mining, Social network analysis.

Total Hours: 45

TEXT BOOK:
1. Jiawei Han, Micheline Kamber and Jian Pei, *Data Mining: Concepts and Techniques*, Elsevier, 3rd Edition, 2013.

REFERENCE BOOKS:
1. Mohammed J. Zaki, Wagner Meira Jr., *Data Mining and Analysis: Fundamental Concepts and Algorithms*, Cambridge University Press, 2014.
2. Pang-Ning Tan, Vipin Kumar, Michael Steinbach, *Introduction to Data Mining*, Pearson, 2nd Edition, 2019.

M. Tech. (CNIS) - I Semester
(19MT16301) ADVANCED COMPUTER NETWORKS
(Program Elective -1)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Computer Networks.

COURSE DESCRIPTION:
Computer Networks and Protocols, Data Link Layer, LAN and Network Routing, Transport Layer and Internet Protocols, Wireless and Optical Networks, MANETs and Wireless Sensor Networks.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Apply contextual knowledge of principles of computer networks, network topologies, routing mechanisms to analyze the problems related to network protocols and algorithms in computer networks.
CO2. Evaluate solutions pertaining to advanced networking technologies to solve engineering problems.

DETAILED SYLLABUS:

UNIT-I: Review of Computer Networks and Foundation of Networking Protocols (9 Hours)
The network edge, The network core, Access networks and physical media, ISPs and Internet backbones, Delay and loss in packet, Packet-switched networks, 5-layer TCP/IP model, 7-Layer OSI model, Internet protocols and addressing, Equal-sized packets model – ATM.

UNIT-II: Data Links, Transmission And Routing (10 Hours)
The Link Layer and Local Area Networks: Link layer introduction and services, Error detection and error correction techniques, Multiple access protocols, Link layer addressing.
Routing and Internetworking: Network layer routing, Least-cost-path algorithms, Non-least-cost-path algorithms, Intra-domain routing protocols, Inter-domain routing protocols.

UNIT-III: Transport Layer Protocols and Network Applications (8 Hours)
Transport and End-to-End Protocols: Transport layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), TCP congestion control.
Application Layer: Principles of network applications, The Web and HTTP, File Transfer Protocol (FTP), Electronic mail in the Internet, Domain Name System (DNS).

UNIT-IV: Wireless Networks and Optical Networks (10 Hours)
Wireless Networks and Mobile IP: Infrastructure of wireless networks, Wireless LAN technologies, IEEE 802.11 wireless standards, Cellular networks, Mobile IP, Wireless Mesh Networks (WMNs).
Optical Networks and WDM Systems: Overview of optical networks, Basic optical networking devices, Large-scale optical switches, Optical routers.

UNIT-V: MANETS and Wireless Sensor Networks (8 Hours)
Mobile Ad-hoc Networks: Overview of wireless ad-hoc networks, Routing in ad-hoc networks, Routing protocols for ad-hoc networks - DSDV, DSR, CGSR and AODV.
Wireless Sensor Networks: Sensor networks and protocol structures, Communication energy model, Clustering protocols, Routing protocols.

Total Hours: 45

TEXT BOOKS:

1. Nader F. Mir, *Computer and Communication Networks*, Pearson Education, 2007.
2. F. Kurose, Keith W. Ross, *Computer Networking: A Top-Down Approach Featuring the Internet*, Pearson Education, 3rd Edition, 2007.

REFERENCE BOOKS:

1. Behrouz A. Forouzan, *Data Communications and Networking*, Tata McGraw Hill, 4th Edition, 2007.
2. Andrew S. Tanenbaum, *Computer Networks*, Pearson Education, 4th Edition, 1997.

M. Tech. (CNIS) – I Semester
(19MT16302) NETWORK INTRUSION DETECTION SYSTEMS
(Program Elective - 1)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Computer Networks and Network Security.

COURSE DESCRIPTION: Introduction to network anomalies, An overview of machine learning methods, Detecting anomalies in network data, Feature selection, Approaches to network anomaly detection, Evaluation methods, Tools and systems.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Understand the machine learning methods and feature selection to analyze and detect network anomalies.
CO2. Use various tools and systems for attack detection in computer networks.

DETAILED SYLLABUS:

UNIT-I: Networks and Anomalies (9 Hours)
Networking Basics: Communication media, Network software, Reference models, protocols, Types of networks, Network topologies, Hardware components, Network performance.
Anomalies in a Network: Network vulnerabilities, Security-related network anomalies, Who attacks networks, Precursors to an attack, Network attacks taxonomy.

UNIT-II: Machine Learning Methods and Detecting Anomalies in Network Data (9 Hours)
Overview of Machine Learning Methods: Supervised learning, Unsupervised learning, Probabilistic learning, Soft computing, Reinforcement learning, Hybrid learning methods.
Detecting Anomalies in Network Data: Detection of network anomalies, Aspects of network anomaly detection, Datasets.

UNIT-III: Feature Selection and Approaches to Network Anomaly Detection (11 Hours)
Feature Selection: Feature selection vs. feature extraction, Relevance, Advantages, Applications, Prior surveys on feature selection, Problem formulation, Steps in feature selection, Existing methods of feature selection, Subset evaluation measures, Systems and tools for feature selection.
Approaches to Network Anomaly Detection: Network anomaly detection methods, Types of network anomaly detection methods, Anomaly detection using supervised learning, Anomaly detection using unsupervised learning, Anomaly detection using probabilistic learning, Anomaly detection using soft computing, Knowledge in anomaly detection, Anomaly detection using combination learners.

Unit-IV: Evaluation Methods (8 Hours)
Accuracy, Performance, Completeness, Timeliness, Stability, Interoperability, Data quality, Validity and reliability, Alert information, Unknown attacks detection, Updating references.

UNIT-V: Tools and Systems (8 Hours)
Attacker's motivation, Steps in attack launching, Launching and detecting attacks, Attack related tools, Attack launching tools, Network monitoring tools, Attack detection systems.

Total Hours: 45

TEXT BOOK:
1. Dhruba Kumar Bhattacharyya, Jugal Kumar Kalita, *Network Anomaly Detection: A Machine Learning Perspective*, CRC Press, 2014.

REFERENCE BOOKS:
1. Stephen Northcutt, Judy Novak, *Network Intrusion Detection*, New Riders Publishing, 3rd Edition, 2002.
2. Carl Endorf, Eugene Schultz and Jim Mellander, *Intrusion Detection and Prevention*, McGraw Hill, 2004.
3. Earl Carter, Jonathan Hogue, *Intrusion Prevention Fundamentals*, Pearson Education, 1st Edition, 2002.

M. Tech. (CNIS) – I Semester
(19MT10509) MACHINE LEARNING
(Program Elective – 2)
(Common to CS, CNIS and SE)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on statistics.

COURSE DESCRIPTION:
Concepts of supervised, unsupervised and reinforcement learning, Bayesian decision theory, Learning rules from data, Performance evaluation of classification algorithms, Ensemble learners, Elements of Reinforcement Learning.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Understand, select and apply appropriate machine learning strategies of supervised, unsupervised and reinforcement learning for solving a given problem.
CO2. Evaluate the performance of machine learning algorithms and select optimal models to suit needs of a given problem.
CO3. Redesign existing machine learning algorithms to improve efficiency of classification models.

DETAILED SYLLABUS:

UNIT-I: Introduction (9 Hours)
Machine Learning, Applications, Supervised Learning - Learning a class from examples, Vapnik Chervonenkis (VC) dimension, Probably Approximately Correct (PAC) learning, Noise, Learning multiple classes, Regression, Model selection and generalization.

UNIT-II: Bayesian Decision Theory and Linear Discrimination (9 Hours)
Bayesian Decision Theory: Classification, Losses and risks, Discriminant functions, Utility theory, Value of information, Bayesian networks, Influence diagrams, Association rules.
Linear Discrimination: Generalizing linear model, Geometry of the linear discriminant, Pairwise separation, Parametric discrimination, Gradient descent, Support vector machines.

UNIT-III: Decision Trees and Clustering (9 Hours)
Decision trees: Univariate trees, Pruning, Rule extraction from trees, Learning rules from data, Multivariate trees.
Clustering: Mixture densities, K-Means clustering, EM algorithm, Supervised learning after clustering, Hierarchical clustering, Choosing the number of clusters.

UNIT-IV: Performance Evaluation of Classification Algorithms (9 Hours)
Cross validation and resampling methods, Measuring error, Interval estimation, Hypothesis testing, Assessing a classification algorithm's performance, Comparing two classification algorithms.
Combining Multiple Learners: Rationale, Voting, Bagging, Boosting, The mixture of experts revisited, Stacked generalization, Cascading.

UNIT-V: Reinforcement Learning (9 Hours)
Single state case - *K*-Armed Bandit; Elements of reinforcement learning, Model based learning, Temporal difference learning, Generalization, Partially observable states.

Total Hours: 45

TEXT BOOK:
1. Ethem Alpaydin, *Introduction to Machine Learning,* MIT Press (Adaptive Computation and Machine Learning Series), 3rd Edition, 2014.

REFERENCE BOOKS:
1. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2nd Edition, 2014.
2. Richard O. Duda, Peter E. Hart, David G. Stork, *Pattern Classification*, Wiley, 2nd Edition, 2012.

M. Tech. (CNIS) – I Semester
(19MT16303) CLOUD COMPUTING
(Program Elective – 2)
(Common to CNIS, CS and SE)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Computer Networks and Operating Systems.

COURSE DESCRIPTION:
Characteristics and taxonomy of virtualization techniques, Cloud services, Cloud architecture - NIST and other models, communication protocols, and applications, Cloud programming concepts - concurrent programming, task programming, data intensive computing,; Trends and industrial platforms.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Create virtual environments to deploy cloud services by using the concepts of virtualization and cloud computing.
CO2. Analyze and deploy cloud architectures for providing cloud services to cater needs of diverse applications.

DETAILED SYLLABUS:

UNIT-I: Introduction to Virtualization (9 Hours)
Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples - XEN, VMware, Microsoft Hyper-V.

UNIT-II: Fundamental Cloud Computing (9 Hours)
Understanding Cloud Computing - Origins and influences, Basic concepts and terminology, Goals and benefits, Risks and challenges; Fundamental concepts and models - Roles and boundaries, Cloud characteristics, Cloud delivery models, Cloud deployment models; Cloud enabling technology - Broadband networks and Internet architecture, Data center technology; Fundamental cloud security - Basic terms and concepts, Threat agents, Cloud security threats, Additional considerations.

UNIT-III: Defining Cloud Services (9 Hours)
Defining Infrastructure as a Service (IaaS) - IaaS workloads, Pods, Aggregation, and silos; Defining Platform as a Service (PaaS), Defining Software as a Service (SaaS) - SaaS characteristics, Open SaaS and SOA, Salesforce.com and CRM SaaS; Defining Identity as a Service (IDaaS) - Introduction to identity, Networked identity service classes, Identity system codes of conduct, IDaaS interoperability; Defining Compliance as a Service (CaaS).

UNIT-IV: Cloud Programming Concepts (9 Hours)
Concurrent programming - Introduction to parallelism for single machine computation, Programming applications with threads; High throughput computing - Task programming, Task based application models; Data intensive computing - Introduction to data intensive computing and technologies for data intensive computing.

UNIT-V: Industrial Platforms And Trending Developments (9 Hours)
Case Studies on Cloud Platforms: Software as a Service (SaaS) - Salesforce.com; Platform as a Service (PaaS) - Google App Engine, MS-Azure and IBM Bluemix; Infrastructure as a Service (IaaS) - Amazon EC2, Amazon S3 and Netflix; Enhancements in cloud - Energy efficiency in clouds, Market based management of clouds, Federated clouds / InterCloud, Third party cloud services.

Total Hours: 45

TEXT BOOKS:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, *Mastering Cloud Computing: Foundations and Applications Programming*, Morgan Kaufmann, 1st Edition, 2013.
2. Thomas Erl, Zaigham Mahmood, Ricardo Puttini, *Cloud Computing: Concepts, Technology & Architecture*, PHI, 1st Edition, 2013.

REFERENCE BOOKS:

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, McGraw Hill, 1st Edition, 2010.
2. George Reese, *Cloud Application Architectures: Building Applications and Infrastructure in the Cloud*, O'Reilly, 1st Edition, 2009.

M. Tech. (CNIS) – I Semester
(19MT16304) DIGITAL FORENSICS
(Program Elective – 2)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Information Security.

COURSE DESCRIPTION: Concepts of computer forensic technologies and cybercrime; Evidence collection and data seizure; Initial response and forensic duplication; Forensic data analysis and validation; Processing crimes and incident scenes; Mobile device forensics, Network forensics and E-mail investigations.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Understand Computer forensics technology, forensic evidence, data recovery, initial response and forensic duplication, tools and Analyze forensic data related to provide solutions for a wide range of forensic problems.
CO2. Apply appropriate forensic techniques and tools to capture the evidence and investigate cyber crimes in order to evaluate the effectiveness to optimize the efficiency and quality of digital forensics investigations.
CO3. Interpret and appropriately apply the laws and procedures associated with identifying, acquiring, examining and presenting digital evidence.

DETAILED SYLLABUS:

UNIT-I: Overview of Computer Forensics Technology and Cybercrime (12 Hours)
Introduction to computer forensics, Use of computer forensics in law enforcement, Computer forensics assistance to human resources/employment proceedings, Computer forensics services, Benefits of professional forensics methodology, Steps taken by computer forensics specialists, Types of Computer Forensics Technologies - Types of military computer forensic technology, Types of law enforcement, Computer forensic technology, Types of business computer forensic technology; Introduction to Cybercrime - Introduction to Cybercrime, Cybercrime and information security, Cybercriminals, Classification of cybercrimes, Cyber detectives, Tools - Digx/nslookup, Whois, Ping; IT Act 2000.

UNIT-II: Computer Forensics Evidence and Data Recovery (8 Hours)
Evidence Collection and Data Seizure: Importance of collecting evidence, Collection options, Obstacles, Types of evidence, The rules of evidence, Volatile evidence, General procedure – collection and archiving; Methods of collection, Artifacts, Collection steps, The chain of custody for controlling contamination.
Data Recovery: Data back-up and recovery, Role of back-up in recovery, Data-recovery solution.

UNIT-III: Initial Response and Forensic Duplication (7 Hours)
Initial response & volatile data collection from Windows system, Initial response & volatile data collection from Unix system, Forensic duplication - Forensic duplicates as admissible evidence, Forensic duplication tool requirements, Creating a forensic duplicate/qualified forensic duplicate of a hard drive, Live data collection for systems (Windows & Unix).

UNIT-IV: Processing Crime Incident Scenes and Mobile Forensics (9 Hours)
Processing Crime and Incident Scenes: Identifying digital evidence, Collecting evidence in private sector incident scenes, Mobile forensic unit, Processing law enforcement crime, Preparing for a search, Seizing digital evidence at the scene, Storing digital evidence.
Cell Phone & Mobile Device Forensics: Understanding mobile device forensics, Acquisition procedures for cell phones and mobile devices, Tool kits for handheld device forensics like EnCase, Device Seizure and PDA Seizure.

UNIT-V: Forensics Applications and Tools (9 Hours)
Network Forensics - Overview, Performing live acquisitions, Developing standard procedure for network forensics, Investigating routers, Network tools; E-mail Investigation - Exploring the role of E-mail in investigations, Investigating E-mail crimes and violations; Current Computer Forensics Tools - Types of computer forensics tools, Tasks performed by computer forensics tools, Computer forensics software tools, Computer forensics hardware tools.

Total Hours: 45

TEXT BOOKS:

1. John R. Vacca, *Computer Forensics, Computer Crime Investigation,* Firewall Media, 1st Edition, 2009.
2. Nelson, Amelia Phillips, Christopher Steuart, *Computer Forensics and Investigations,* Cengage Learning, 4th Edition, 2009.

REFERENCE BOOKS:

1. SuKevin Mandia, Chris Prosise, *Incident Response and Computer Forensics*, McGraw Hill Osborne Media, 2nd Edition, 2003.
2. Peter Stephenson, Keith Gilbert, *Investigating Computer Related Crime*, CRC Press, 2nd Edition, 2004.

M. Tech. (CNIS) – I Semester
(19MT16305) MALWARE AND RISK ANALYSIS
(Program Elective - 2)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Computer Networks.

COURSE DESCRIPTION:
Study of methods for identifying malwares in a system or network, Advanced static and dynamic malware analysis, Risk management and identification, Methods to maintain information by applying risk management policies, Threat vulnerability and assessment, Risk evaluation.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Analyze and apply the techniques of static and dynamic methods to identify and classify malwares.
CO2. Evaluate the threats and vulnerability of risk using risk evaluation procedures in order to protect information.

DETAILED SYLLABUS:
UNIT-I: Basic Analysis (9 Hours)
Basic Static Techniques: Antivirus scanning, A fingerprint for malware, Finding strings, Packed and obfuscated malware, Portable executable file Format, Linked libraries and functions.
Malware Analysis in Virtual Machines: The structure of a virtual machine, Creating and using malware analysis machine, The risks of using VMware for malware analysis, Record/Replay - Running computer in reverse.
Basic Dynamic Analysis: Sandboxes, The Quick-and-Dirty Approach, Running malware, Monitoring with process monitor, Viewing processes with process explorer, Comparing registry snapshots with Regshot, Faking a network, Packet sniffing with Wireshark, Using INetSim.

UNIT-II: Advanced Static Analysis (9 Hours)
X86 Disassembly: Levels of abstraction, Reverse engineering, x86 architecture.
Interactive Disassembler Professional (IDA): IDA Pro interface, Using cross references, Analyzing functions, Using graphing options, Enhancing disassembly.
Recognizing Code Constructs in Assembly: Global vs. Local variables, Disassembling arithmetic operations, Recognizing if statements, Recognizing loops, Understanding function call conventions, Analyzing switch statements, Disassembling arrays, Identifying structs, Analyzing linked list traversal.

UNIT-III: Advanced Dynamic Analysis (9 Hours)
Debugging: Source level vs. assembly level debuggers, Kernel mode vs. user mode debugging, Using a debugger, Exceptions, Modifying execution with a debugger, Modifying program execution.
OllyDbg: The OllyDbg interface, Memory map, Viewing threads and stacks, Tracing, Patching, Analyzing shellcode.
Anti-Reverse Engineering: Anti-disassembly, Anti-debugging, Packers and unpacking.

UNIT-IV: Risk Management and Identification (9 Hours)
Information Risk Management Programme: Goals, Scope and objectives, Roles and responsibilities, Governance of the risk management programme, Information risk management criteria.
Risk Identification: The approach to risk identification, Impact assessment, Types of impact, Qualitative and quantitative assessments

UNIT-V: Risk Assessment, Analysis and Evaluation (9 Hours)
Threat and Vulnerability Assessment: Conducting threat assessments, Conducting vulnerability assessments, Identification of existing controls
Risk Analysis and Risk Evaluation: Assessment of likelihood, Risk analysis, Risk evaluation.

Total Hours: 45

TEXT BOOKS:

1. Michael Sikorski and Andrew Honig, *Practical Malware Analysis*, No Starch Inc. 2012.
2. Sutton, David, *Information Risk Management: A Practitioner's Guide*, BCS Learning & Development Limited, 2014.

REFERENCE BOOKS:

1. Michael Ligh, Steven Stair, *Malware Analyst's Cookbook and DVD: Tools and Techniques for Fighting Malicious Code*, Wiley Publishing Inc., 2011.
2. Monnappa K. A., *Learning Malware Analysis*, Packt Publisher, 2018.

M. Tech. (CNIS) – I Semester
(19MT10708) RESEARCH METHODOLOGY AND IPR
(Common to all M. Tech. Programs)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	2	-	-	2

PRE-REQUISITES: NIL

COURSE DESCRIPTION:
Overview of research, Research problem and design, Various research designs, Data collection methods, Statistical methods for research, Interpretation and drafting reports, Intellectual property rights.

COURSE OUTCOMES:
On successful completion of the course, students 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 (7 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 (9 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 (4 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 (7 Hours)
Importance of intellectual property rights, Types of intellectual property, International organizations, Purpose and function of trademarks, acquisition of trademark rights, Protectable matter, Selecting and evaluating trademark, Trademark registration processes.

UNIT-V: Law of Copyrights (8 Hours)
Fundamental of copyright law, Originality of material, Rights of reproduction, Rights to perform the work publicly, Copyright ownership issues, Copyright registration, Notice of copyright, 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*, New Age International Publishers, New Delhi, 2nd Revised Edition, 2004.
2. Deborah E. Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, Cengage Learning, 5th Edition, 2017.

REFERENCE BOOKS:
1. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.
2. Prabuddha Ganguli, *Intellectual Property Rights - Unleashing the Knowledge Economy*, Tata McGraw Hill Publishing Company Ltd., 2001.

M. Tech. (CNIS) – I Semester
(19MT10531) ADVANCED ALGORITHMS LAB
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: A Course on Computer Programming.

COURSE DESCRIPTION:
Hands on practice on algorithmic design techniques - Divide and conquer, Greedy methods Dynamic programming, Backtracking, Sum of subset problem, Vertex cover problem, Flow networks, String matching algorithms and Randomized algorithms.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Implement various algorithmic techniques greedy method, dynamic programming, backtracking, advanced graph theory and analyze the comparison of different techniques.
CO2. Design algorithms to solve real world computing problems and evaluate their efficiency.
CO3. Write, present technical report/document effectively.
CO4. Function effectively as an individual and as a member in team to implement mini-project.

LIST OF EXERCISES:

1. Write a program to implement Job sequencing with deadlines using greedy method.
2. Implement the 0/1 Knapsack problem using

   a) Dynamic Programming method b) Greedy method
3. Implement N-queen's problem using Backtracking. The N Queen is the problem of placing N chess queens on an N×N chessboard so that no two queens attack each other. The expected output is a binary matrix which has 1s for the blocks where queens are placed. For example following is the output matrix for above 4 queen problem's solution.

   {0, 1, 0, 0},{0, 0, 0, 1},{1, 0, 0, 0},{0, 0, 1, 0}
4. Find a subset of a given set S = {s1, s2,.....,Sn} of n positive integers whose sum is equal to a given positive integer d. For example, if S= {1, 2, 5, 6, 8} and d = 9 there are two solutions {1, 2, 6} and {1, 8}.A suitable message is to be displayed if the given problem instance doesn't have a solution.
5. Write a program to implement

   a) Vertex cover problem b) Maximum bipartite matching problem in the graph
6. Write a program to implement Ford-Fulkerson method for maximum flow networks.
7. Write a program to implement Chinese remainder theorem.
8. Write a program to solve string matching problem using Naïve approach and Knuth-Morris-Pratt algorithm.
9. Write a program to solve string matching problem and determine its performance.

   a) Finite Automata b) Rabin Karp algorithm
10. Write a program to implement a Monte Carlo algorithm to test the primarily of a given integer and determine its performance.
11. Mini Project

REFERENCE BOOKS:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, PHI Learning, 3rd Edition, 2009.
2. Ellis Horowitz, Sartaj Sahni, and S Rajasekaran, *Fundamentals of Computer Algorithms*, Universities Press, 2nd Edition, 2008.

M. Tech. (CNIS) – I Semester
(19MT10532) ADVANCED DATA STRUCTURES LAB
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: A Course on Computer Programming.

COURSE DESCRIPTION:
Hands on practice on Linked Lists, Stacks and Queues, Binary search tree, AVL tree, Red black tree, Splay tree, KD tree, Priority search tree and Hashing.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Implement linear and non linear data structures like stacks, queues, linked lists, trees, graphs and hash functions to simulate by organizing the data in memory.
CO2. Design and develop appropriate algorithms to store and retrieve the data.
CO3. Write, present technical report/document effectively.
CO4. Function effectively as an individual and as a member in team to implement mini-project.

LIST OF EXERCISES:

1. Write program to implement the following Data structures:
    a) Single linked list
    b) Double linked list
    c) Circular linked list
2. Write a program to implement Stack and Queue
    a) Dequeue
    b) Circular queue
    c) Stack using two queues
    d) Queue using two stacks
3. Write a program to perform the following operations on binary search tree:
    a) Insertion b) Deletion c) Searching
4. Write a program to perform the following operations on AVL-tree:
    a) Insertion b) Deletion
5. Write a program to perform operations on Red Black tree.
6. Write a program to perform the following operations on splay-tree:
    a) Insertion b) Deletion
7. Write a program to implement Graph traversal techniques.
8. Implement the following functions of a dictionary using open addressing hashing techniques.
    a) Insertion b) Searching c) Deletion
9. Write a program to implement searching in Priority Search Tree.
10. Implement the following functions of K-D tree operations.
    a) Insert b) Update c) Delete
11. Mini Project

REFERENCE BOOKS:

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, Pearson, 4th Edition, 2014.
2. Michael T. Goodrich, Roberto Tomassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Wiley, 2002.

M. Tech. (CNIS) – I Semester
(19MT1AC01) TECHNICAL REPORT WRITING
(Audit Course)
(Common to all M. Tech. Programs)

Internal Marks	External Marks	Total Marks	L	T	P	C
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PRE-REQUISITES: NIL

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 (6 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 (8 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, 3rd edition, 2005 (reprint).
2. Patrick Forsyth*, How to Write Reports and Proposals,* The Sunday Times (Kogan Page), New Delhi, Revised 2nd 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. (CNIS) – II Semester
(19MT26301) CRYPTOGRAPHY AND NETWORK SECURITY

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Course on Computer Networks.

COURSE DESCRIPTION:
Concepts of Security models, Cryptographic algorithms, Public key and private key encryption and decryption, Hash algorithms, Intrusion Detection and prevention, IP security, Web security, Analysis of security principles in Internet and system security.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Cognize the concepts of cryptography and network security to identify potential threats in computer networks.
CO2. Develop solutions to solve security related issues in computer network applications.
CO3. Apply the appropriate cryptographic techniques and security algorithms in the area of information security to maintain security services.

DETAILED SYLLABUS:

UNIT-I: Network Security Concepts (9 Hours)
Security attacks, Security services, Security mechanisms, Fundamental security design principles, A model for network security, Mono-alphabetic ciphers and poly-alphabetic ciphers.

UNIT II -Introduction to Number Theory and Symmetric Ciphers (9 Hours)
Number Theory - Divisibility and the division algorithm, Euclidean algorithm, Modular arithmetic, Prime numbers, Fermat's and Euler theorem, Testing for primality.
Classical Encryption Techniques - Symmetric cipher model, Substitution techniques, Transposition techniques, Data Encryption Standard (DES), Advanced Encryption Standard (AES).

UNIT-III: Asymmetric Ciphers and Cryptographic Data Integrity Algorithms (9 Hours)
Public Key Cryptography: Principles of public key cryptosystems, RSA algorithm, Diffie-Hellman key exchange, ElGamal cryptosystem.
Cryptographic Hash Functions and MAC: Simple hash functions, Requirements, Secure hash functions – SHA-1, SHA-512; Message authentication requirements, HMAC and MD5.

UNIT-IV: Mutual Trust (9 Hours)
Key Distribution and User Authentication: Symmetric Key Distribution Using symmetric and asymmetric encryption, X.509 certificates, Kerberos, Personal identity verification.
Electronic Mail Security: S/MIME, Pretty Good Privacy (PGP), DNSSEC, Domain keys identified mail.
Web Security- Web security landscape, Controlling access to your web content, Code signing and Microsoft's Authenticode.

UNIT-V: System Security and Intrusion Detection (9 Hours)
Malicious Software - Types, Viruses, Virus counter measures, DDOS attacks; Intruders - Intrusion detection, Password management; Firewalls - Firewall characteristics, Firewall basing, Types of firewalls, Firewall location and configurations.

Total Hours: 45

TEXT BOOKS:

1. William Stallings, *Cryptography and Network Security: Principles and Practice*, Pearson Education, 7th Edition, 2017.
2. Douglas R. Stinson, *Cryptography: Theory and Practice*, CRC Press, 3rd Edition, 2005.

REFERENCE BOOKS:

1. Simson Garfinkel, *Web Security: Privacy & Commerce*, 2nd Edition, O'Reilly Media, 2002.

M. Tech. (CNIS) – II Semester
(19MT26302) WIRELESS SENSOR NETWORKS

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Computer Networks.

COURSE DESCRIPTION:
Introduction to wireless sensor networks; Medium access control protocol design; Various routing protocols for wireless sensor networks; Security issues and requirements in wireless sensor Networks; Advanced concepts in wireless sensor networks.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Analyze and apply the concepts of wireless sensor networks to evaluate network architectures for improving the performance of the networks.
CO2. Evaluate varying routing protocols for wireless sensor networks to overcome the problems of transmission.

DETAILED SYLLABUS:

UNIT-I: Introduction of Wireless Sensor Networks (9 Hours)
Basic concepts of wireless sensor networks, Motivations, Applications, Performance metrics, History and design factors, Architecture of a sensor node, Different sensing scenarios using WSN, Challenges in implementing WSNs.

UNIT-II: Medium Access Control Protocol Design (9 Hours)
Characteristics of WSN, MAC related properties, MAC performance issues, MAC protocols for WSNs - Schedule based protocols, Random access based protocols; WSN protocols - synchronized, duty cycled; Contention based and contention free MAC protocols.

UNIT-III: Routing Protocols for Wireless Sensor Networks (9 Hours)
Issues with the adoption of ad-hoc routing protocols, Data-centric routing, Position based Geographic routing, Clustering based routing algorithm, QoS based routing protocols, Analysis of opportunistic routing.

UNIT-IV: Security in Wireless Sensor Networks (9 Hours)
Security requirements in WSNs, Different types of attacks in WSNs, Security protocols for WSNs, Time synchronization, Requirements and challenges, Basic ideas, Various protocols, Coverage problem in WSNs, OGDC coverage algorithm, Placement problem.

UNIT-V: Advanced Concepts in Wireless Sensor Networks (9 Hours)
Overview, Types and challenges, Design of wireless sensor networks for emerging scenarios, Design analysis of transition from WSN to IoT, Real life deployment, Underwater sensor nodes vs Terrestrial sensor networks.

Total Hours: 45

TEXT BOOKS:

1. W. Dargie and C. Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, Wiley, 2010.
2. K. Sohraby, D. Minoli and Taieb Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, Wiley, 2007.

REFERENCE BOOKS:

1. Fei Hu and Xiaojun Cao, *Wireless Sensor Networks: Principles and Practice*, CRC Press, 2010.
2. Feng Zhao, Leonidas Guibas, *Wireless Sensor Networks: An Information Processing Approach*, Elsevier, 1st Edition, 2005.

M. Tech. (CNIS) – II Semester
(19MT20503) ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING
(Program Elective – 3)
(Common to CS, CNIS and SE)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Machine Learning.

COURSE DESCRIPTION:
Representation of neural network, Learning rule, Training algorithm, Activation functions, Convolution neural network and its variants, Long term dependencies in sequence-to-sequence classification, Regularization for deep learning, hyper parameter selection, Applications of deep learning.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Apply conceptual knowledge to analyze various approaches for learning with deep neural networks.
CO2. Select appropriate libraries for using deep learning algorithms to implement various types of learning tasks in diverse domains.
CO3. Select optimal model parameters for different deep learning techniques using optimization techniques.

DETAILED SYLLABUS:

UNIT-I: Neural Networks (9 Hours)
Neural network representation, Topologies, Training, Activation functions, Perceptron learning, Rule and convergence Theorem, Adaline, Delta Rule, Exclusive OR problem, Multilayer perceptron.

UNIT-II: Training Feed-Forward Neural Networks (9 Hours)
Multilayer Feed Forward Backpropagation Algorithm, Delta rule and Learning rates, Other activation functions, Deficiencies of Backpropagation, Advanced algorithms, The effect of number of learning samples and number of hidden units, Stochastic and Minibatch gradient descent, Test sets, Validation sets, Overfitting - Preventing Overfitting.

UNIT-III: Convolutional Neural Networks (9 Hours)
The convolution operation, Parameter Sharing, Pooling, Variants of the basic convolution function, Data types, Efficient convolution algorithms, Random or Unsupervised features, Convolutional networks and the history of deep learning.

UNIT-IV: Recurrent Neural Networks (9 Hours)
Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence architectures, Deep recurrent networks, Recursive neural networks, The challenge of long-term dependencies, Echo state networks, Leaky units and other strategies for multiple time scales, The long short-term memory and other gated RNNs, Optimization for long-term dependencies, Explicit memory.

UNIT-V: Regularization for Deep Learning (9 Hours)
Parameter norm penalties, Dataset augmentation, Early stopping, Parameter tying and sharing, Dropout, Sparse representations, Bagging and other ensemble methods, Adversarial training, Performance metrics, Default baseline models, Selecting hyper parameters, Debugging strategies, Applications - Computer Vision, Speech Recognition, Natural Language Processing.

Total Hours: 45

TEXT BOOKS:

1. Ian Goodfellow I, Yoshua Bengio, Aaron Courville , *Deep Learning*, MIT Press, 2016.
2. Ben Krose, Patrick van der Smagt, *An Introduction to Neural Networks*, MIT Press, 8th Edition, 1996.

REFERENCE BOOK:

1. Yegnanarayana B., *Artificial Neural Networks*, PHI, 2012.

M. Tech. (CNIS) – II Semester
(19MT26303) DATABASE SECURITY
(Program Elective – 3)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Database Management Systems.

COURSE DESCRIPTION:
Study of principles and practices of database security in modern businesses and industries, Password policies, Privileges, Database auditing, Views and virtual private databases, Security implementation and database reliability.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Demonstrate knowledge of database security issues to analyze risks and vulnerabilities in an operating system from a database perspective.
CO2. Design good password policies and secure database system architecture and implement audit/access controls and virtual private databases using views, roles, and application context.
CO3. Use SQL server for creating database user administration roles and conduct database auditing for security and reliability.

DETAILED SYLLABUS:

UNIT-I: Security Architecture and Operating System Security Fundamentals (9 Hours)
Security Architecture: Introduction, Security, Information systems, Database management systems, Information security, Information security architecture, Database security, Asset type and their values, Security methods.
Operating System Security Fundamentals: Operating system security environment, Components, Authentication methods, User administration, Password policies, Vulnerabilities.

UNIT-II: Administration of Users and Profiles, Password Policies, Privileges (9 Hours)
Administration of Users: Introduction, Documentation of user administration, Operating system authentication, Creating users, Creating SQL server user, Removing users, Modifying users, Default users, Remote users, Database links, Linked servers, Remote servers, Practices for administrators and managers.
Profiles, Password Polices, Privileges: Defining and using profiles, Designing and implementing password polices, Granting and revoking user privileges.

UNIT-III: Security Models and Virtual Private Databases (9 Hours)
Database Application Security Models: Introduction, Types of users, Security models, Application types, Application security models.
Virtual Private Databases: Introduction, Overview of VPD, Implementing VPDs, Implementing Oracle VPD, Viewing VPD Policies and application context using the data dictionary and policy manager, Implementing row and column level security with SQL server.

UNIT-IV: Database Security Design (9 Hours)
Secure DBMS Design: Introduction, Security mechanisms in DBMSs, Secure DBMS architectures.
Design of Secure Databases: Preliminary analysis, Requirement analysis and security policy selection, Conceptual design, Logical design, Physical design, Implementation of security mechanisms, Verification and testing.

UNIT-V: Data Auditing and Auditing Database Activities (9 Hours)
Application Data Auditing: Introduction, DML action auditing architecture, Oracle triggers, SQL server triggers, Fine grained auditing with Oracle, DML statement audit trail, Auditing application errors with Oracle.
Auditing Database Activities: Using Oracle database activities, Creating DLL triggers with Oracle, Auditing database activities with Oracle, Auditing server activity with Microsoft SQL server 2000, Implementing AQL profiler, Security auditing with SQL server, SQL injection.

Total Hours: 45

TEXT BOOKS:

1. Hassan A. Afyouni, *Database Security and Auditing: Protecting Data Integrity and Accessibility*, Cengage Learning, 2006.
2. S. Castano, M. Fugini, G. Martella, P. Samarati, *Database Security*, Addison Wesley, 1994.

REFERENCE BOOKS:

1. Ron Ben Natan, *Implementing Database Security and Auditing*, Elsevier Digital Press, 2005.
2. Michael Gertz, Sushil Jajodia, *Handbook of Database Security: Applications and Trends*, Springer, 2008.

M. Tech. (CNIS) – II Semester
(19MT26304) GPU COMPUTING
(Program Elective – 3)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Computer Architecture.

COURSE DESCRIPTION:
Parallelism and supercomputing, Multi-CPU and Multi-GPU solutions, Memory handling – Caches, Constant memory; Optimizing an application – Memory considerations, Transfers, Designing GPU-based systems, Parallel programming issues and challenges.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Acquire the concepts and principles of parallelism with GPUs, memory handling in a Multi-CPU/Multi-GPU environment and analyze the methods for optimizing computing applications.
CO2. Analyze problems to identify the bottlenecks in parallel programming and to design robust and efficient systems equipped with modern GPUs.
CO3. Apply memory techniques to solve memory issues in Multi-GPU environment for optimizing computing applications.

DETAILED SYLLABUS:

UNIT-I: Parallelism and Supercomputing (7 Hours)
Traditional serial code, Serial/Parallel problems, Concurrency, Types of parallelism, Flynn's taxonomy, Parallel patterns, History of Supercomputing – Multi-node computing, The early days of GPU coding, Single-core solution, NVIDIA and CUDA, GPU hardware.

UNIT-II: Multi-CPU and Multi-GPU Solutions (8 Hours)
Threads, Blocks, Grids, Warps, Block scheduling, Multi-CPU and Multi-GPU Solutions - Introduction, Locality, Multi-CPU systems, Multi-GPU systems, Algorithms on multiple GPUs, Selecting GPUs, Single-node systems, Streams, Multiple-node systems.

UNIT-III: Memory Handling (11 Hours)
Caches - Types of data storage, Register Usage; Shared Memory - Sorting using shared memory, Radix sort, A hybrid approach, Shared memory on different GPUs; Constant Memory - Constant memory caching, Constant memory broadcast, Constant memory updates at runtime; Global Memory - Score boarding, Global memory sorting, Sample sort, Texture Memory.

UNIT-IV: Optimizing an Application (10 Hours)
Parallel/Serial GPU/CPU problem breakdown, Analyzing the problem, Time, Problem decomposition, Dependencies, Dataset size, Resolution, Identifying the bottlenecks, Grouping the tasks for CPU and GPU.
Memory Considerations: Memory bandwidth, Source of limit, Memory organization, Memory accesses to computation ratio, Loop and kernel fusion, Use of shared memory and cache.
Transfers: Pinned memory, Zero-copy memory, Bandwidth limitations, GPU timing, Overlapping GPU transfers.

UNIT-V: Designing GPU-Based Systems (9 Hours)
CPU processor, GPU device, PCI-E bus, GeForce cards, CPU memory, Air cooling, Liquid cooling, Desktop cases and motherboards, Mass storage, Power considerations, Operating systems.
Problems, Causes, and Solutions: Introduction, Parallel programming issues; Algorithmic issues; Finding and avoiding errors; Developing for future GPUs.

Total Hours: 45

TEXT BOOK:
1. Shane Cook, *CUDA Programming: A Developer's Guide to Parallel Computing with GPUs,* Morgan Kaufman, 1st Edition, 2013.

REFERENCE BOOK:
1. Gerassimos Barlas, *Multicore and GPU Programming: An Integrated Approach,* Morgan Kaufman, 1st Edition, 2015.

M. Tech. (CNIS) – II Semester
(19MT26305) INTERNET OF THINGS
(Program Elective - 3)
(Common to CNIS, CS, SE, DECS and CMS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Computer Networks, Python Programming.

COURSE DESCRIPTION:
Concepts of Domain Specific IoTs, M2M and system management with Netconf-Yang, IoT privacy and security, IoT physical devices, Amazon Web Services for IoT and case studies illustrating IoT design.

COURSE OUTCOMES:
CO1. Understand the concepts of IoT, IoT protocols, privacy and security issues in IoT applications to analyze domain specific IoT's.
CO2. Design solutions through implementing IoT applications on raspberry pi, AWS and develop security solutions to strengthen IoT environment.

DETAILED SYLLABUS:

UNIT-I: Concepts of IoT (7 Hours)
Definition and characteristics of IoT, Physical design of IoT – IoT protocols, Logical design of IoT, IoT enabling technologies, IoT levels and deployment templates.

UNIT-II: Domain Specific IoTs, IoT and M2M (9 Hours)
Domain Specific IoTs: Home automation, Cities, Environment, Energy, Logistics, Agriculture, Industry.
IoT and M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT.

UNIT-III: IoT System Management with NETCONF-YANG and Developing IoTs (9 Hours)
Need for IoT systems management, Simple Network Management Protocol (SNMP), Network operator requirements, NETCONF-YANG, IoT systems management with NETCONF-YANG.
Developing Internet of Things: Introduction, IoT design methodology.

UNIT-IV: IoT Privacy, Security And Vulnerabilities Solutions and IoT Physical Devices (11 Hours)
Introduction, Vulnerabilities, Security requirements and treat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity management and establishment, Access control and secure message communication, Security models, Profiles and protocols for IoT.
IoT Physical Devices and Endpoints: What is an IoT device, Exemplary device, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python and other IoT devices.

UNIT-V: Amazon Web Services for IoT and Case Studies Illustrating IoT Design (9 Hours)
Amazon Web Services for IoT: Amazon EC2, Amazon AutoScaling, Amazon S3, Amazon RDS, Amazon DynamoDB.
Case Studies Illustrating IoT Design: Home automation, Cities, Environment and Agriculture.

Total hours: 45

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press, 2015.
2. Raj Kamal, *Internet of Things: Architecture and Design Principles*", McGraw Hill, 1st Edition, 2017.

REFERENCE BOOKS:

1. Adrian McEwen, Hakim Cassimally, *Designing the Internet of Things*, Wiley, 2013.
2. Jeeva Jose, *Internet of Things*, Khanna Publishing, 1st Edition, 2018.

M. Tech. (CNIS) – II Semester
(19MT20508) SOFT COMPUTING
(Program Elective - 4)
(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Mathematical Foundations of Computer Science, Machine Learning.

COURSE DESCRIPTION:
Introduction to neural networks, Applications and scope of neural networks, Basic models of artificial neural networks, Supervised and unsupervised learning networks, Associative memory networks, Fuzzy logic and fuzzy sets, Genetic algorithms, Hybrid soft computing techniques and its applications.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Review the feasibility of applying a soft computing methodology for a particular problem.
CO2. Analyze architectures of neural networks, genetic algorithms, hop field networks, and hybrid soft computing techniques to solve combinatorial optimization problems using genetic algorithms.
CO3. Develop hybrid algorithms using soft computing techniques by integrating ANN and genetic algorithms.

DETAILED SYLLABUS:

UNIT-I: Introduction (9 Hours)
Neural networks, Application and scope of neural network, Fuzzy logic, Genetic algorithm, Hybrid systems, Basic models of artificial neural network, Linear separability.

UNIT-II: Supervised and Unsupervised Learning Networks (9 Hours)
Supervised Learning Networks: Perceptron networks, Adaptive linear neuron, Multiple adaptive linear neuron, Radial basis function network, Backpropagation network.
Unsupervised Learning Networks: Kohonen self-organizing feature maps, Learning vector quantization.

UNIT-III: Associative Memory Networks (9 Hours)
Training algorithms for pattern association, Autoassociative memory network, Heteroassociative memory network, Bidirectional associative memory, Hop field networks.

UNIT-IV: Fuzzy Logic and Genetic Algorithms (9 Hours)
Fuzzy Logic: Classical sets, Fuzzy sets, Fuzzy relations, Cartesian product of relation, Tolerance and equivalence relation, Fuzzy decision making.
Genetic Algorithms: Biological background, Traditional optimization and search techniques, Genetic algorithm and search space, Terminologies, General genetic algorithm, Operators, Stopping condition, Constraints, Schema theorem.

UNIT-V: Hybrid Soft Computing Techniques (9 Hours)
Genetic neuro-hybrid system, Properties, Genetic algorithm based back-propagation network (BPN).
Applications: Flood area analysis, Optimization of travelling salesman problem, Internet search engines.

Total Hours: 45

TEXT BOOKS:
1. S.N. Sivanandam and S.N. Deepa, *Principles of Soft Computing,* Wiley, 2nd Edition, 2011.

REFERENCE BOOKS:
1. J. –S. R. Jang, C. –T. Sun, E. Mizutani, *Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence*, Pearson, 2015.
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications*, PHI, 2011.

M. Tech. (CNIS) – II Semester
(19MT26306) BLOCKCHAIN TECHNOLOGIES
(Program Elective – 4)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses Data Structures & Algorithms, Network Security and Cryptography.

COURSE DESCRIPTION: Introduction to Blockchain Technologies and its decentralization concepts, Smart Contracts, Ethereum, Hyperledger, Alternative Blockchains, Emerging Trends, Challenges and Scope of Research.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Cognize the concepts of distributed systems, decentralization and Blockchains and analyze the ecosystem of Blockchains.
CO2. Evaluate different distributed Blockchain platforms and devise suitable platforms for scalable and secured applications.

DETAILED SYLLABUS:

UNIT-I: Introduction to Blockchain Decentralization (11 Hours)
Distributed Systems: CAP theorem, Byzantine general's problem, Consensus, History of Blockchain, Introduction to Blockchain - Definitions, Generic elements, Features, Applications, Tiers, Types of Blockchain, CAP theorem & Blockchain, Benefits and limitations of Blockchain technology.
Decentralization: Decentralization using Blockchain, Methods of decentralization, Routes to decentralization, Blockchain & full ecosystem decentralization, Smart contract, Decentralized organizations, Decentralized autonomous organizations, Decentralized autonomous corporations, Decentralized autonomous societies, Decentralized applications, Platforms for decentralization.

UNIT-II: Smart Contracts (7 Hours)
History & Definition, Ricardian contracts, Smart contract templates, Oracles, Smart Oracles, Deployment of smart contracts on Blockchains.

UNIT-III: Ethereum (9 Hours)
Introduction, Ethereum Blockchain, Elements of Ethereum Blockchain, Precompiled contracts, Accounts, Block, Ether, Messages, Mining, Clients & wallets, Ethereum network, Applications developed on Ethereum, Scalability & security issues.

UNIT-IV: Hyperledgers and Alternative Blockchains (9 Hours)
Hyperledgers: Projects, Hyperledger as protocol, Fabric, Hyperledger Fabric, Sawtooth Lake, Corda.
Alternative Blockchains: Blockchains - Kadena, Stellar, Rootstock, Quorum, Tezos, Storj, Maidsafe, BigChainDB, Multichain, Tendermint; Platforms - BlockApps, Eris.

UNIT-V: Challenges, Emerging Trends and Research (9 Hours)
Current Challenges: Scalability - Block size increase, Block internal reduction, Invertible Blooms lookup tables, Sharding, State channels, Private Blockchain, Proof of stake; Privacy - Indistinguishability obfuscation, Homomorphic encryption, Zero knowledge proofs, State channels, Secure multiparty computation, Usage of hardware to provide confidentiality, Coinjoin, Confidential transactions, MimbleWimble; Security - Smart contract security.
Emerging Trends: Emerging Trends, Improvement proposals, Blockchain research - Smart contracts, Centralization issues, Limitations in cryptographic functions, Consensus algorithms, Scalability, Code obfuscation.

Total Hours: 45

TEXT BOOK:
1. Imran Bashir, *Mastering Blockchain*, Packt Publishing Ltd., 1st Edition, 2017.

REFERENCE BOOKS:
1. Arshdeep Bahga, Vijay Madisetti, *Blockchain Applications: A Hands-On Approach*, VPT Books, 2017.
2. Josh Thompson, *Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming*, Create Space Independent Publishing Platform, 2017.

M. Tech. (CNIS) – II Semester
(19MT26307) SECURE SOFTWARE DESIGN AND ENTERPRISE COMPUTING
(Program Elective – 4)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Cryptography and Network Security, Software Engineering.

COURSE DESCRIPTION:
Importance of design secure software's for enterprises, Approaches to design, develop, test and deploy the secure software systems to satisfy the goals of enterprise computing, Operating and maintaining secure software.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Create a security process by identifying the roles of security team for an enterprise.
CO2. Analyze and design the enterprise software to enhance the security features based on code reuse, coding resources, reviews and security tiers.
CO3. Design and develop operation and maintenance procedures of secure software according to enterprise security policies.

DETAILED SYLLABUS:

UNIT-I: Introduction (8 Hours)
Introduction, Enterprise security, Project Inception - Without a formal security process, Case for project security team, Tasks for the project security team, Roles to cover on the security team.

UNIT-II: Design Activities (9 Hours)
Security tiers, On confluence, Requirements, Specifications, Design and architecture, Deployment and operation planning.

UNIT-III: Implementation Activities (9 Hours)
Confluence, Security mechanism and controls, Code reuse, Coding resources, Implementing security tiers, Code reviews, Servlet.

UNIT-IV: Testing and Deployment Activities (9 Hours)
Testing: Security testing, Tools of the trade, Security bug life cycle.
Deployment and Integration: Advances in deployment, Integrating with security operations infrastructure, Log analysis tools, Third party components.

UNIT-V: Operating and Maintaining Software (10 Hours)
Operating Software Securely: Adjusting security thresholds, IDS in operations, Identifying critical applications, CSIRT utilization.
Maintaining Software Securely: Common pitfalls, Maintaining software securely relate to confluence, Evolving threats, Security patch, Maintaining software securely fit into security SDLCs.

Total Hours: 45

TEXT BOOK:
1. Kenneth R. van Wyk, Mark G. Graff, *Enterprise Software Security: A Confluence of Disciplines*, Addison-Wesley Professional, 1st Edition, 2014.

REFERENCE BOOKS:
1. Gary McGraw, *Software Security: Building Security In*, Addison Wesley, 2006.
2. Mark Dowd, John McDonald and Justin Schuh, *The Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities*, Addison Wesley, 1st Edition, 2006.
3. John Viega and Gary McGraw, Bu*ilding Secure Software: How to Avoid Security Problems the Right Way,* Addison-Wesley, 2001.

M. Tech. (CNIS) – II Semester
(19MT26308) SOFTWARE DEFINED NETWORKS
(Program Elective – 4)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Computer Networks.

COURSE DESCRIPTION:
Evolution of switches and control planes, SDN operations, Devices and controllers, Open flow basics, Network functions virtualizations, P2P overlay networks, SDN applications.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Design sustainable software defined network by comparing different architecture and open flow specifications.
CO2. Apply network function virtualization using hypervisor and cloud computing technology for network automation and orchestration.
CO3. Create proactive and reactive software defined network applications using tools like floodlight controller, daylight controller, Cisco XNC controller and Hewlett-Packard controller.

DETAILED SYLLABUS:

UNIT-I: Software Defined Networking (9 Hours)
Introduction, Evolution of switches and control planes, Cost, Data center innovation, Data center needs, The genesis of SDN, The evolution of networking technology, Sustaining SDN interoperability, Open source contributions, Legacy mechanisms evolve toward SDN, and network virtualization.

UNIT-II: Working of SDN (9 Hours)
Fundamental Characteristics of SDN, SDN operation, SDN devices, SDN controller, SDN applications, Alternate SDN methods, The open flow specification, Open flow overview, Open flow 1.0 and open flow basics, Open flow 1.1 additions, Open flow 1.2 additions, Open flow 1.3 additions, Open flow limitations.

UNIT-III: Alternative Definitions of SDN (9 Hours)
Potential drawbacks of open SDN, SDN via APIs, SDN via Hypervisor-based overlays, SDN via opening up the device, Network functions virtualization, Alternatives overlap and ranking.

UNIT-IV: SDN in the Data Center (9 Hours)
Data center definition, Data center demands, Tunneling technologies for the data center, Path technologies in the data center, Ethernet fabrics in the data center, SDN use cases in the data center, Open SDN versus overlays in the data center, Real-world data center implementations.

UNIT-V: SDN APPLICATINS (9 Hours)
Reactive versus proactive applications, Analyzing simple SDN applications, A simple reactive Java application, Background on controllers, Using the floodlight controller, Using the open daylight controller, Using the Cisco XNC controller, Using the Hewlett-Packard controller, Switch considerations, Creating network virtualization tunnels, Offloading flows in the data center, Access control for the campus, Traffic engineering for service providers.

Total Hours: 45

TEXT BOOKS:

1. Paul Goransson, Chuck Black, *Software Defined Networks: A Comprehensive Approach*, Elsevier, 2014.
2. Thomas D. Nadeau, Ken Gray, *SDN: Software Defined Networks*, O'Reilly Media, 2013.

REFERENCE BOOKS:

1. Siamak Azodolmolky, *Software Defined Networking with Open Flow*, Packt Publishing, 2013.
2. Patricia A. Morreale and James M. Anderson, *Software Defined Networking: Design and Deployment*, CRC Press, 2014.

M. Tech. (CNIS) – II Semester
(19MT26331) CRYPTOGRAPHY AND NETWORK SECURITY LAB

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: A Course on Computer Programming.

COURSE DESCRIPTION:
Practical implementation on Mono-alphabetic Ciphers, Poly-alphabetic Ciphers, DES, RSA, Diffie-Hellman Key Exchange mechanism, SHA-1 algorithm, MD5 algorithm, Digital Signature Standards and Intrusion Detection Systems.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Implement mono-alphabetic, poly-alphabetic ciphers, symmetric and public key encryption algorithms, secure hash functions, digital signature standards and intrusion detection systems.
CO2. Analyze the symmetric key encryption and public key encryption algorithms and evaluate their efficiency for different applications.
CO3. Write, present technical report/document effectively.
CO4. Function effectively as an individual and as a member in team to implement mini-project.

LIST OF EXERCISES:

1. Implement the following Mono-alphabetic Ciphers.
   a. Shift Cipher b. Hill Cipher
2. Implement the following Poly-alphabetic Ciphers.
   a. Playfair b. Vigenere
3. Write a program to implement the Data Encryption Standard(DES).
4. Write a program to implement RSA algorithm.
5. Write a program to implement Diffie-Hellman Key Exchange mechanism.
6. Write a program to determine the message digest of a given message using the SHA-1 algorithm.
7. Write a program to implement MD5 algorithm.
8. Write a program to implement the Signature Scheme - Digital Signature Standard.
9. Demonstrate how to provide secure data storage, secure data transmission and for creating digital signatures (GnuPG).
10. Demonstrate Intrusion Detection System (IDS) using any tool (snort or any other s/w).
11. Mini Project.

REFERENCE BOOKS:

1. William Stallings, *Cryptography and Network Security: Principles and Practice*, Pearson Education, 7th Edition, 2017.
2. Douglas R. Stinson, *Cryptography: Theory and Practice*, CRC Press, 3rd Edition, 2005.

M. Tech. (CNIS) – II Semester
(19MT26332) WIRELESS SENSOR NETWORKS LAB

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES:

COURSE DESCRIPTION:
Hands on Practice on Schedule-based, Random-based, Content-based and Cluster-based MAC Protocols, Split horizon of Routing Information Protocol, Position-based Geographic Routing Protocol, AODV Protocol in ADHOC.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Design and compute protocols for network requirements.
CO2. Apply latest tools and technologies for designing applications in various networking protocols.
CO3. Write, present technical report/document effectively.
CO4. Function effectively as an individual and as a member in team to implement mini-project.

LIST OF EXERCISES:

1. Simulate and evaluate a schedule-based multi-channel MAC Protocol for wireless sensor networks.
2. Simulate and evaluate a random access based MCMAC Protocol for wireless sensor networks.
3. Simulate and evaluate energy model of CSMA and ALOHA in content based MAC protocols.
4. Simulate and evaluate virtual cluster based on common sleep schedules in a contention free MAC Protocols (FDMA, TDMA,CDMA).
5. Reproduce and assess the split horizon of RIP in data-centric routing protocols.
6. Simulate and appraise the position of vehicular ad-hoc in position-based geographic routing protocols.
7. Reproduce and evaluate clustering scheme and hierarchies of AODC, a clustering based routing algorithm.
8. Simulate and performance evaluation of AODV protocol with QoS.
9. Mini Project

REFERENCE BOOKS:

1. W. Dargie and C. Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, Wiley, 2010.
2. K. Sohraby, D. Minoli and Taieb Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, Wiley, 2007.

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

Internal Marks	External Marks	Total Marks	L	T	P	C
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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. (CNIS) - III Semester
(19MT36331) INTERNSHIP

Internal Marks	External Marks	Total Marks	L	T	P	C
--	100	100	-	-	-	2

PRE-REQUISITES: --

COURSE DESCRIPTION:

Expose students to the industrial environment, Create competent professionals for the industry, Gain professional experience, Develop communication skills and understand engineer's responsibilities and ethics.

COURSE OUTCOMES:

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

CO1. Discern various challenges in developing solutions for complex problems, utilize appropriate modern tools and techniques to provide solutions for the chosen engineering problems.

CO2. Develop problem solving skills, critical thinking skills through designing and developing solutions for complex problems.

CO3. Discern various challenges in developing solutions for complex problems, design and conduct experiments to evaluate alternative solutions for the chosen engineering problems.

CO4. Develop communication, enrich professional and interpersonal skills pertaining to the internship experience.

CO5. Function effectively as an individual and participate well as a team member to build professional network for growth in career.

CO6. 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. (CNIS) - III Semester
(19MT36332) PROJECT WORK PHASE – I

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	20	10

PRE-REQUISITES: --

COURSE DESCRIPTION:

Identify of a domain of interest and a specific problem, Conduct literature review, Collect preliminary data, Conduct a critical study and analysis of the chosen problem, Identify appropriate modern tools/techniques, Write thesis and present.

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 and discern various issues, challenges to identify alternative methodologies, tools for implementing a solution for the chosen problem.

CO2. Conduct a systematic literature review, analyze, cognize and comprehend the extracted information for recognizing the current status of research pertinent to the chosen problem.

CO3. Write and present technical report/document to report the findings on the chosen problem.

CO4. Function effectively as an individual to recognize the opportunities in the chosen domain of interest and engage in independent learning.

CO5. Recognize the need to engage in lifelong learning for development of technical competence in the advanced fields of computer networks and information security to contribute to the development of scientific/ technological knowledge.

M. Tech. (CNIS) - IV Semester
(19MT46331) PROJECT WORK PHASE – II

Internal Marks	External Marks	Total Marks	L	T	P	C
150	150	300	-	-	32	16

PRE-REQUISITES: --

COURSE DESCRIPTION:

Design and develop solutions for the proposed system, Use appropriate modern tools/techniques, Implement the proposed system, Execute practical investigations, Conduct critical analysis and interpretation of results, Test and evaluate the proposed system, Write thesis and present.

COURSE OUTCOMES:

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

CO1. Investigate, conceptualize and design optimal solution for the chosen problem.

CO2. Utilize appropriate modern tools/techniques to implement the proposed system.

CO3. Design and conduct investigations and experiments to test and evaluate the proposed system.

CO4. Write and present technical report/document to report the findings on the chosen problem.

CO5. Function effectively as an individual to recognize the opportunities in the chosen domain of interest and engage in independent learning.

CO6. Recognize the need to engage in lifelong learning for development of technical competence in the advanced fields of computer networks and information security to contribute to the development of scientific/ technological knowledge.