Regulations and Curriculum for

Master of Technology (M. Tech.)

Computer Science and Engineering

REGULATIONS GOVERNING
THE DEGREE OF MASTER OF TECHNOLOGY (M.Tech.)

UNDER OUTCOME BASED EDUCATION (OBE)

AND

CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME

OF

NMAM INSTITUTE OF TECHNOLOGY, NITTE

(Effective from academic year 2022 -23)

NITTE
(Deemed to be University)

(Deemed to be University under Section 3 of UGC Act, 1956)
(Placed under Category 'A' by MHRD, Govt. of India, Accredited with 'A+' Grade by NAAC)
University Enclave, Medical Sciences Complex, Deralakatte,
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Tel: +91-824-2204300/01/02/03, Fax: 91-824-2204305
Website: www.nitte.edu.in E-mail: info@nitte.edu.in

VISION

To build a humane society through excellence in the education and healthcare

MISSION

To develop
Nitte (Deemed to be University)
As a centre of excellence imparting quality education,
Generating competent, skilled manpower to face the scientific and social
challenges with a high degree of credibility, integrity,
ethical standards and social concern

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Off-campus Centre, Nitte (Deemed to be University)

NITTE-574110, Karkala Taluk, Udupi District, Karnataka, India

Vision Statement

Pursuing Excellence, Empowering people, Partnering in Community Development

Mission Statement

To develop N.M.A.M. Institute of Technology, Nitte, as Centre of Excellence by imparting Quality Education to generate Competent, Skilled and Humane Manpower to face emerging Scientific, Technological, Managerial and Social Challenges with Credibility, Integrity, Ethics and Social Concern.

M. Tech. Regulations and Curriculum

Batch

2022 – 2024

With Scheme of Teaching & Examination

REGULATIONS: 2022
for
M. Tech. Programs
(Academic year 2022-23)

COMMON TO ALL
M.Tech. DEGREE PROGRAMS
CHOICE BASED CREDIT SYSTEM (CBCS)

Key Information

Program Title	Master of Technology, abbreviated as M.Tech.
Short description	Two-year, four semester Choice Based Credit System (CBCS) type of Postgraduate Engineering Degree Program taught in English
Program Code	M.Tech. (Computer Science and Engineering)
Revision version	2022.01 These regulations may be modified from time to time as mandated by the policies of the University. Revisions are to be recommended by the Board of Studies for Computer Science and Engineering and approved by the Academic Council.
Effective from	12-09-2022
Approvals	Approved by the Board of Management and Academic Council of NITTE (Deemed to be University), vide notification.
Program offered at	NMAM Institute of Technology, Nitte Off Campus centre, Nitte (Deemed to be University)
Grievance and dispute resolution	All disputes arising from this set of regulations shall be addressed to the Board of Management. The decision of the Board of Management is final and binding on all parties concerned. Further, any legal disputes arising out of this set of regulations shall be limited to jurisdiction of Courts of Mangalore only

Contents

1. INTRODUCTION:

1.1 The general regulations are common to all Degree of Master of Technology Program under Outcome Based Education (OBE) and Choice Based Credit System (CBCS) conducted by Nitte (Deemed to be University), at the NMAM Institute of Technology, Nitte off Campus Centre and shall be called "Nitte(DU) Regulations for M.Tech.- 2022".

1.2 The provisions contained in this set of regulations govern the policies and procedures on the Registration of students, imparting Instructions of course, conducting of the examination and evaluation and certification of students' performance and all amendments there to leading to the said degree program(s)

1.3 This set of Regulations, on approval by the Academic Council and Governing Council, shall supersede all the corresponding earlier sets of regulations of the M.Tech. Degree program (of Nitte (DU)) along with all the amendments thereto, and shall be binding on all students undergoing M.Tech. Degree Program (s) (Choice Based Credit System) conducted at the NMAMIT, Nitte with effect from its date of approval and is applicable for students admitted to 1st year after September 2022. This set of regulations may evolve and get modified or changed through appropriate approvals from the Academic Council / Governing Council from time to time, and shall be binding on all stake holders, (the Students, Faculty, Staff of Departments of NMAMIT, Nitte). The decision of the Academic Council/ Governing Council shall be final and binding.

1.4 In order to guarantee fairness and justice to the parties concerned in view of the periodic evolutionary refinements, any specific issues or matters of concern shall be addressed separately, by the appropriate authorities, as and when found necessary.

1.5 The Academic Council may consider any issues or matters of Concern relating to any or all the academic activities of the NMAMIT courses for appropriate action, irrespective of whether a reference is made here in this set of Regulations or otherwise.

1.6 The course shall be called **Master of Technology** program abbreviated as M.Tech. (subject of specialization) – Choice Based Credit System.

2. DEFINITIONS OF KEYWORDS:

The following are the definitions/descriptions that have been followed for the different terms used in the Regulations of M.Tech. Programs:

2.1 **Program:** Is an educational program in a particular stream/branch of Engineering/branch of specialization leading to award of Degree. It involves events/activities, comprising of lectures/ tutorials/ laboratory work/ field work, outreach activities/ project work/ vocational training/ viva/ seminars/ Internship/ assignments/ presentations/ self-study etc., or a combination of some of these.

2.2 **Branch:** Means Specialization or discipline of M. Tech Degree Program, like Electrical Vehicle Technology, Structural Engineering, Machine Design, etc.

2.3 **Semester:** Refers to one of the two sessions of an academic year (vide: serial number 4), each session being of sixteen weeks duration (with working days greater than or equal to 90). The odd semester may be scheduled from August/September and even semester from February/March of the year.

2.4 **Academic Year:** Refers to the sessions of two consecutive semesters (odd followed by an even) including periods of vacation.

2.5 **Course:** Refers to usually referred to as 'subjects' and is a component of a program. All Courses need not carry the same credit weightage. The Courses should define learning objectives and learning outcomes. A Course may be designed to comprise lectures/ tutorials/ laboratory work/ field work/ outreach activities/ project work/ vocational training/ viva/ seminars/ term papers/ assignments/ presentations/ self-study etc.. or a combination of some of these.

2.6 **Credit:** Refers to a unit by which the Course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of lecture or two hours of laboratory/ practical Courses/ tutorials/ fieldwork per week etc.

2.7 **Audit Courses:** Means Knowledge/ Skill enhancing Courses without the benefit of credit for a Course.

2.8 **Choice Based Credit System (CBCS):** Refers to customizing the Course work, through Core, Elective and soft skill Courses, to provide necessary support for the students to achieve their goals.

2.9 **Course Registration:** Refers to formal registration for the Courses of a semester (Credits) by every student under the supervision of a Faculty Advisor (also called Mentor, Counsellor etc.,) in each Semester for the Institution to maintain proper record.

2.10 Course Evaluation: Means Continuous Internal Evaluation (CIE) and Semester End Examinations (SEE) to constitute the major evaluations prescribed for each Course. CIE and SEE to carry 50 % and 50 % respectively, to enable each Course to be evaluated for 100 marks, irrespective of its Credits.

2.11 Continuous Internal Evaluation (CIE): Refers to evaluation of students' achievement in the learning process. CIE shall be by the Course Instructor and includes tests, homework, problem solving, group discussion, quiz, mini-project and seminar throughout the Semester, with weightage for the different components being fixed at the University level.

2.12 Semester End Examinations (SEE): Refers to examination conducted at the University level covering the entire Course Syllabus. For this purpose, Syllabi to be modularized and SEE questions to be set from each module, with a choice confined to the concerned module only. SEE is also termed as university examination.

2.13 Make Up Examination: Refers to examination conducted for the candidates who has a CIE>=35 marks and may have missed to attend the SEE covering the entire course syllabus. The standard of Make Up Examination is same as that of the SEE.

2.14 Supplementary Examination: Refers to the examination conducted to assist slow learners and/or failed students through make up courses for a duration of 8 weeks. This comprises of both the CIE & SEE and will be conducted after the completion of First year M.Tech. even semester.

2.15 Credit Based System (CBS): Refers to quantification of Course work, after a student completes teaching – learning process, followed by passing in both CIE and SEE. Under CBS, the requirement for awarding Degree is prescribed in terms of total number of credits to be earned by the students.

2.16 Credit Representation: Refers to Credit Values for different academic activities considered, as per the Table.1. Credits for seminar, project phases, project viva–voce and internship shall be as specified in the Scheme of Teaching and Examination.

Table 1: Credit Values				
Theory/Lectures (L) (hours/week/Semester)	**Tutorials (T) (hours/week/ Semester)**	**Laboratory /Practical (P) (hours/week/ Semester)**	**Credits (L: T:P)**	**Total Credits**
4	0	0	4:0:0	4
3	0	0	3:0:0	3
2	2	0	2:1:0	3
2	0	2	2:0:1	3
2	2	2	2:1:1	4
0	0	2	0:0:1	1
NOTE: Activities like, practical training, study tour and participation in Guest lectures not to carry any credits.				

2.17 Letter Grade: It is an index of the performance of students in a said Course. Grades are denoted by letters O, A+, A, B+, B, C and F.

2.18 Grading: Grade refers to qualitative measure of achievement of a student in each Course, based on the percentage of marks secured in (CIE+SEE). Grading is done by Absolute Grading. The rubric attached to letter grades are as follows:

Letter Grade	O	A+	A	B+	B	C	F
Academic Level	Outstanding	Excellent	Very Good	Good	Above Average	Average	Fail

2.19 Grade Point (GP): Refers to a numerical weightage allotted to each letter grade on a 10-point scale as under.

Letter Grade and corresponding Grade Points on a typical 10 – Point scale							
Letter Grade	O	A+	A	B+	B	C	F
Grade Point	10	09	08	07	06	05	00

2.20 Passing Standards: Refers to passing a Course only when getting GP greater than or equal to 05 (as per serial number 2.20).

2.21 Credit Point: Is the product of grade point (GP) and number of credits for a Course i.e., Credit points CrP = GP × Credits for the Course.

2.22 Semester Grade Point Average (SGPA): Refers to a measure of academic performance of student/s in a semester. It is the ratio of total credit points secured by a student in various Courses of a semester and the total Course credits taken during that semester.

2.23 Cumulative Grade Point Average (CGPA): Is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points earned by a student in various Courses in all semesters and the sum of the total credits of all Courses in all the semesters. It is expressed up to two decimal places.

2.24 Grade Card: Refers to a certificate showing the grades earned by a student. A grade card shall be issued to all the registered students after every semester. The grade card will display the program details (Course code, title, number of credits, grades secured) along with SGPA of that semester and CGPA earned till that semester.

2.25 University: Nitte (Deemed to be University), Mangalore. NMAM Institute of Technology is an off-campus centre of Nitte (DU) and located at Nitte.

3. CLAUSE	
CLAUSE	**PARTICULARS**
22NMT1.0	**DURATION AND CREDITS OF THE PROGRAM OF STUDY** There shall be one category of program: Full-time Program (FT) **Full-time Program:** The Program shall extend over a period of four semesters (2 years). First Semester: i) 16 weeks – Class Work according to the scheme. ii) 4 weeks – Revision holidays and examinations iii) 2 weeks – Vacation **Second Semester:** i) 16 weeks – Class Work according to the scheme ii) 4 weeks – Revision holidays and examinations. **Summer Semester/Vacation** i) 4 weeks — Class work, Examination & Display of Grades **Third Semester: 20 weeks** i) 8 weeks — Industrial Training/Mini Project ii) 12 weeks — Project Part-I

<table>
<tr><td></td><td>— Industrial Training/Mini Project evaluation, Seminar on Special Topic Evaluation & Project Part-I Evaluation
Fourth Semester: 24 weeks
i) 22 weeks — Project Part-II
ii) 2 weeks – Submission, viva -voce
Prescribed Number of Credits for the Program: 80
The number of credits to be completed for the award of Degree shall be 80.</td></tr>
<tr><td>22NMT1.1</td><td>M.Tech Degree Programs are offered in the following specialization and the respective program hosting departments are listed below:
<table>
<tr><th><u>Program</u></th><th><u>Department</u></th></tr>
<tr><td>i) Computer Science & Engineering</td><td>Computer Science & Engineering</td></tr>
<tr><td>ii) Constructional Technology</td><td>Civil Engineering</td></tr>
<tr><td>iii) Structural Engineering</td><td>Civil Engineering</td></tr>
<tr><td>iv) VLSI Design & Embedded Systems</td><td>Electronics and Communication Engineering</td></tr>
<tr><td>v) Machine Design</td><td>Mechanical Engineering</td></tr>
<tr><td>vi) Energy Systems Engineering</td><td>Mechanical Engineering</td></tr>
<tr><td>vii) Cyber security</td><td>Computer Science Engineering</td></tr>
<tr><td>viii) Electric Vehicle Technology</td><td>Electrical and Electronics Engineering</td></tr>
</table>
The provisions of these Regulations shall be applicable to any new specialization that may be introduced from time to time and appended to the above list.</td></tr>
<tr><td>22NMT1.2</td><td>Maximum Duration for Program Completion:
A full-time candidate shall be allowed a maximum duration of 4 years from the I semester of admission to become eligible for the award of master’s degree, failing which he/she may discontinue of register once again as a fresh candidate to I semester of the program.</td></tr>
<tr><td>22NMT2.0</td><td>ELIGIBILITY FOR ADMISSION
(As per the Government orders issued from time to time):
Admission to I year/ I semester Master of Technology Program shall be open to all the candidates who have passed B.E./ B. Tech. Examinations (in relevant field) or any other recognized University/ Institution. AMIE in respective</td></tr>
</table>

	branches shall be equivalent to B.E./ B. Tech. Programs for admission to M.Tech. The decision of the equivalence committee shall be the final in establishing the eligibility of candidates for a particular Program. For the foreign Degrees, Equivalence certificate from the Association of Indian Universities shall be a must.
22NMT2.1	Admission to M.Tech. Program shall be open to the candidates who have passed the prescribed qualifying examination with not less than 50% of the marks in the aggregate of all the years of the Degree examination. Rounding off percentage secured in qualifying examination is not permissible.
22NMT2.2	**For admissions under GATE/ NUCAT qualification** The candidates should be GATE qualified or should have appeared for the NUCAT Entrance Examination conducted by Nitte (Deemed to be University) [Nitte (DU)]
22NMT2.3	**For admissions under Sponsored Quota:** The candidates should be GATE qualified or should have appeared for the NUCAT Entrance Examination conducted by Nitte (DU)
22NMT2.4	The candidates, who are qualified in the GATE Examination for the appropriate branch of engineering, shall be given priority. They are exempted from taking NUCAT Entrance Examination. In case a GATE qualified Candidate appears for entrance examination and become qualified to claim a seat under entrance examination quota, he/she will be considered in the order of merit along with other candidates appeared for the entrance examination.
22NMT2.5	If sufficient number of GATE qualified candidates are not available, the remaining vacant seats shall be filled from amongst the candidates appeared for NUCAT Entrance Examination in the order of merit.
22NMT2.6	Engineering graduates other than the Karnataka candidates shall get their Eligibility verified from Nitte (DU) to seek admission to M.Tech. Program at NMAMIT, Nitte
22NMT2.7	**Admission to vacant seats:** Seats remaining vacant (unfilled), after the completion of admission process through GATE/NUCAT Entrance Exam, the remaining seats shall be filled by Candidates based on merit in the entrance test conducted at the Institution level. An admission Committee, consisting of

<table>
<tr><td></td><td>the Principal, Head of the concerned Department and the subject experts, shall oversee admissions.</td></tr>
<tr><td>22NMT3.0</td><td>REGISTRATION:
Every student after consulting his Faculty-Advisor in parent department is required to register for the approved courses with the Departmental Post Graduate Committee (DPGC) of Parent Department at the commencement of each Semester on the days fixed for such registration and notified in the academic calendar.</td></tr>
<tr><td>22NMT3.1</td><td>Lower and Upper Limits for Course Credits Registered in a Semester.
Course Credit Assignment:
All courses comprise of specific Lecture/ Tutorial/ Practical (L-T-P) schedule. The course credits are fixed based on the following norms.
Lecture/Tutorials/ Practical:
(i) a 1-hour Lecture per week is assigned 1.0 Credit.
(ii) a 2-hour Tutorial session per week is assigned 1.0 Credit.
(iii) a 2-hour Lab. session per week is assigned 1.0 credits
For example, a theory course with L-T-P schedule of 3-2-0 hours will be assigned 4.0 credits.
A laboratory practical course with L-T-P schedule of 0-0-2 hours will be assigned 1.0 credit.
Calculation of Contact Hours / Week – A Typical Example
<table>
<tr><th colspan="5">Typical Academic Load (I & II Semester)</th></tr>
<tr><th>No. of Courses</th><th>LTP</th><th>Credits Per course</th><th>Total Credits</th><th>Contact Hours per Week</th></tr>
<tr><td>2 Lecture Courses</td><td>4-0-0</td><td>04</td><td>08</td><td>08</td></tr>
<tr><td>2 Lab Courses</td><td>0-0-2</td><td>01</td><td>02</td><td>04</td></tr>
<tr><td>1 Research based Course</td><td>0-0-4</td><td>02</td><td>02</td><td>04</td></tr>
<tr><td>3 Elective Courses</td><td>3-0-0</td><td>03</td><td>09</td><td>09</td></tr>
<tr><td>1 Audit Course</td><td>2-0-0</td><td>0</td><td>0</td><td>02</td></tr>
<tr><td>Total: 9 Courses</td><td></td><td></td><td>21</td><td>27</td></tr>
</table>
A student must register, as advised by Faculty Advisor, between a minimum of 16 credits and up to a Maximum of 28 credits. However, the minimum/</td></tr>
</table>

	maximum Credit limit can be relaxed by the Dean (Academic) on the recommendations of the DPGC, only under extremely exceptional circumstances.
22NMT3.2	**Mandatory Pre-Registration for higher semester:** In order to facilitate proper planning of the academic activities of the Semester, it is necessary for the students to declare their intention to register for courses of higher semesters (2nd and above) at least two weeks before the end of the current semester choosing the courses offered by each department in the next higher semester which is displayed on the Departmental Notice Board at least 4 weeks prior to the last working day of the semester. Students who fail to register on or before the specified date will have to pay a late fee. Registration in absentia is allowed only in exceptional cases with the permission of the Dean (Academic). Registration to a higher semester is allowed only if the student fulfills the following conditions- i) Satisfied all the academic requirements to continue with the program of studies without termination ii) Cleared all institute, hostel and library dues and fines, if any, of the previous semester. iii) Paid all required advance payments of the Institute and the hostel for the current semester. Has not been debarred from registering on any specific grounds by the Institute.
22NMT3.3	**Course Pre-Requisites:** In order for a student to register for some course(s), it may be required either to have completed satisfactorily or to have prior earned credits in some specified course(s). In such instances, the DPGC shall specify clearly, any such course pre-requisites, as part of the curriculum.
22NMT3.4	Students who do not register before the dead line day of registration may be permitted LATE Registration up to the notified day in academic calendar on payment of late fee.
22NMT3.5	REGISTRATION in ABSENTIA will be allowed only in exceptional cases on the recommendation of DPGC through the authorized representative of the student.

22NMT3.6	Medium of Instruction/Evaluation/etc. shall be English.
22NMT4.0	**COURSES:** The curriculum of the Program shall be any combination of following type of courses: i) **Professional Core Courses (PCC)** - relevant to the chosen specialization/ branch [May be split into Hard (no choice) and Soft (with choice), if required]. The core course is to be compulsorily studied by a student and is mandatory to complete the requirements of a program in a said discipline of study. ii) **Professional Electives Courses (PEC)** - relevant to the chosen specialization/ branch: these are the courses, which can be chosen from the pool of papers. It shall be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student skills. iii) **Research Experience** Through Practice-I and Research Experience Through Practice-II iv) **Project Work** v) **Seminar** vi) **Audit Courses (AC):** a) The Audit course can be any credit course offered by the program to which the candidate is admitted (other than the courses considered for completing the prescribed program credits) or other programs offered in the institution, where the student is studying. b) The students are required to register for one audit course during I and II semesters. Students who have registered to audit the courses, considered on par with students registered to the same course for credit, must satisfy attendance and CIE requirements. However, they need not have to appear for SEE. c) Registration for any audit course shall be completed at the beginning of I and II semesters. The Department should intimate the Controller of Examination about the registration at the beginning of the semester and obtain a formal approval for inclusion of the audit course/s in the Grade card issued to the students

<table>
<tr><td></td><td>vii) Internship/ Mini Project: Preferably at an industry/ R&D organization/IT company/ Government organization of significant repute or at the Research Centre of parent Institution for a specified period mentioned in Scheme of Teaching and Examination.</td></tr>
<tr><td>22NMT4.1</td><td>Program Structure:
The number of credits to be registered in a semester is between 16 and 28
Minimum Credit Requirement for the M.Tech. Degree is 80.
The total course package for an M.Tech. Degree Program will typically consist of the following components.
<table>
<tr><th>Course type</th><th>Range %</th><th>Suggested Credits</th></tr>
<tr><td>i) Program Core Courses</td><td>20 - 25</td><td>20</td></tr>
<tr><td>ii) Program Elective Courses</td><td>18 - 20</td><td>15</td></tr>
<tr><td>iii) Elective Courses (MOOCS)</td><td>4</td><td>03</td></tr>
<tr><td>iv) Industrial Internship/Research Internship/Mini Project</td><td>10</td><td>08</td></tr>
<tr><td>v) Project</td><td>35</td><td>28</td></tr>
<tr><td>vi) Seminar</td><td>2.5</td><td>02</td></tr>
<tr><td>vii) Research Experience Through Practice</td><td>5</td><td>04</td></tr>
<tr><td>viii)Audit courses (two courses)</td><td>-</td><td>-</td></tr>
<tr><td>Total credits</td><td></td><td>80</td></tr>
</table>
The Department Post Graduate Committee (DPGC) will discuss and recommend the exact credits offered for the program for the above components, the semester-wise distribution among them, as well as the syllabi of all postgraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS).
The BOS will consider the proposals from the departments and make recommendations to the Academic Council for consideration and approval.
Mandatory Learning Courses:
These are courses that must be completed by the student at appropriate time as suggested by the Faculty Adviser or the DPGC. Courses that come under the category are as following:</td></tr>
</table>

Industrial Training:

This is a 08-credit course. A full-time student will complete the Industrial Training (or a Mini Project) at appropriate time stipulated by DPGC and register for it in the following Semester and shall also submit a bound copy of training report certified by the authority of Training Organization. The duration and the details, including the assessment scheme, shall be decided by the faculty advisor, with approval from DPGC.

Seminar:

This also carries 2-credits to be completed at appropriate time stipulated by DPGC. The student will make presentations on topics of academic interest, as suggested by DPGC.

Research Experience through Practice-I and Research Experience through Practice-II:

- Research Experience through Practice-I and II are 2-credit courses in the first and second semesters respectively.
- The student will work under a faculty supervisor approved by the DPGC and submits a research proposal at the end of the first semester which is evaluated jointly by the faculty supervisor and a co-examiner.
- Students shall be offered inputs like how to conduct a literature survey, how to identify a research problem, how to write a research paper, research report, research proposal, and systematic way of conducting research etc.
- Department specific/PG Program specific skill sets required for carrying out a research work may be offered to the students like software tools for system/device simulation and analysis, software/ hardware tools for signal acquisition, data processing, control simulation, Testing/measuring equipment used in research and Testing/measuring procedure.
- At the end of Research Experience through Practice-I in the first semester, M. Tech. students should be able to identify a research problem, with clear objectives and methodologies backed by extensive literature review.
- Two internal examiners will evaluate the Research Experience through Practice-I out of which one will be the guide and the other examiner will a faculty member who is having expertise in the research area of the student

	being evaluated. The research proposal report and the research proposal presentation are evaluated for 100 marks in the first semester. • The student will work on the proposed research in the second semester and submit a research paper at the end of the second semester which is evaluated jointly by the faculty supervisor and a co-examiner. • In the second semester, the students are expected to carry out Mathematical modelling / Design calculations / computer simulations / Preliminary experimentation / testing of the research problems identified during Research Experience through Practice-I carried out in the first semester. At the end of the second semester, students are expected to write a full research paper based on the Mathematical modelling/ Design calculations/computer simulations/Preliminary experimentation/testing carried out during second semester. The research paper submitted by the student and the presentation of the research work carried out is evaluated for 100 marks in the second semester.
22NMT5.0	**INTERNSHIP/MINI PROJECT:** The student shall undergo Internship/Mini Project as per the Scheme of Teaching and Examination. 1. The internship can be carried out in any industry/R&D Organization/Research Institute/Institute of national repute/R&D Centre of Parent Institute. 2. The Department/college shall nominate a faculty to facilitate, guide and supervise students under internship. 3. The students shall report the progress of the internship/Mini Project to the internal guide in regular intervals and seek his/her advice. 4. The Internship shall be completed during the period specified in Scheme of Teaching and Examination. 5. After completion of Internship/mini project, students shall submit a report to the Head of the Department with the approval of both internal and external guides and with the approval of internal guide if the Internship/Mini-Project is carried out in the Institute.

	6. The Internship/Mini Project will be evaluated jointly by two internal examiners appointed by the Head of the Department/Controller of Examination. 7. The Internship/Mini Project report and the presentation by the student will be evaluated for 50 marks each immediately after completion of the Internship/Mini Project. The students are permitted to carry out the internship anywhere in India or Abroad. The Institution will not provide any kind of Financial Assistance to any student for Internship/Mini Project and for the conduct of Viva-Voce on internship.
22NMT5.1	**Failing to undergo Internship/Mini Project:** Securing a pass grade in Internship/Mini Project is mandatory as a partial requirement for the award of Degree. Internship/Mini Project Securing a pass grade in Internship/Mini Project is mandatory. If any student fails to undergo/complete the Internship/Mini Project, he/she shall be considered as fail in that Course.
22NMT6.0	**SEMINAR:** Securing a pass grade in Seminar is mandatory as a partial requirement for the award of Degree. i) Each candidate shall deliver seminar as per the Scheme of Teaching and Examination on the topics chosen from the relevant fields for about 30 minutes. The Head of the Department shall make arrangements for conducting seminars through concerned faculty members of the department. The Panel of Examiners constituted for the purpose by the Head of the Department shall award the CIE marks for the seminar.
22NMT7.0	**PROJECT WORK:** Securing a pass grade in Project Work is mandatory as a partial requirement for the award of Degree. Project work shall be on individual basis.

	Project Part-I and Part-II: **Project Part-I: (In third Semester)** The duration of the Project Part-I is of 12 weeks as notified in the academic calendar. The evaluation of the Project Part-I will be done during the end of third semester. Each department will prepare the Panel of Examiners in advance and also prepare the Project Part-I evaluation schedule indicating the names of the students, their USN, Title of the Project, Name of the Examiners, and time and Venue of the evaluation which will be submitted to the Controller of Examination Office in advance. Project Part-I evaluation will be done by two internal Examiners, one of them will be the Guide and other is preferably one of the experts in the area of PG Project being evaluated. The mark distribution of Project Phase-I evaluation is: 100 marks for report and 100 marks for presentation jointly awarded by the both the examiners. **Project Part-II: (In the fourth Semester)** The total duration of Project Part-II is of 22 weeks as notified in the academic calendar. There will be two Continuous Internal Evaluation of Project Part-II in fourth semester followed by Semester End Evaluation of the Project Phase-II, namely, Project Progress Evaluation-I (PPE-I), Project Progress Evaluation -II(PPE-II) and SEE. The same Panel of Examiners which was formed during Project Part-I evaluation is to be continued for the Project Progress Evaluation in the fourth semester. PPE-I and PPE-II will be scheduled as per the academic calendar and will be evaluated for 100 marks each (50 marks for report and 50 marks for presentation jointly conducted by the two internal examiners). Each department will prepare the Panel of Examiners in advance and also prepare the Project Part-II Project Progress Evaluation Schedule indicating the names of the students, their USN, Title of the Project, Name of the Examiners, and time and Venue of the evaluation as per the format which will be submitted to the Controller of Examination Office in advance.

	For the Off-Campus projects, the Internal Guide should visit the organization in which the M.Tech Student is carrying out his Project at least once during the project term. The candidate shall submit a soft copy of the dissertation work to the Institute. The soft copy of the dissertation should contain the entire Dissertation in monolithic form as a PDF file (not separate chapters). The Guide, after checking the report for completeness shall check the report for Plagiarism content. The allowable plagiarism index is less than or equal to 25%. If the check indicates a plagiarism index greater than 25%, the guide should advice the student to resubmit the dissertation after modifying the report. The report has to be once again checked for the plagiarism content and the signed hard copy of the Plagiarism Report along with the two hard copies of the dissertation is to be submitted to the Head of the Institution through the Head of the Department. The dissertation will be evaluated by two examiners, one of the examiners shall be the Guide of the candidate and the other examiner shall be an external expert in the area of the dissertation being evaluated. The guide shall submit panel of two approved external examiners to the office of the Controller of Examination through the head of the Department. The Controller of Examination will randomly select one of the external examiners and invites him/her formally for the evaluation of the dissertation and Viva-Voce examination giving sufficient time for the external examiner for reading the dissertation.
22NMT7.1	The dissertation will be evaluated by two examiners, one of the examiners shall be the guide of the candidate and the other examiner shall be preferably an external expert in the area of the dissertation being evaluated. The evaluation of the dissertation shall be made independently by each examiner.
22NMT7.2	Examiners shall evaluate the dissertation normally within a period of not more than two weeks from the date of receipt of dissertation through email.
22NMT7.3	The examiners shall independently submit the marks for the dissertation during the viva-voce examination date
22NMT7.4	Sum of the marks awarded by the two examiners shall be the final evaluation marks for the Dissertation.

22NMT7.5	(a) Viva-voce examination of the candidate shall be conducted, if the dissertation work and the reports are accepted by the external examiner. (b) If the external examiner finds that the dissertation work is not up to the expected standard and the minimum passing marks cannot be awarded, the dissertation shall not be accepted for SEE. (c) If the dissertation is rejected during the Project Part II, then the Second Examiner (external) will be appointed by the COE against whom the candidate has to re-present the same dissertation. The decision of the Second Examiner (external) will be final. If the second examiner (external) accepts the dissertation, then the viva-voce examination of the candidate shall be conducted as per the norms. If the second examiner (external) rejects the dissertation, then the student has to take an extension for a minimum period of 3 months and re-work on the project. After the completion of the extension period, viva-voce examination of the candidate shall be conducted as per the norms, if the dissertation work is accepted by the external examiner.
22NMT7.6	The candidate, whose dissertation is rejected, can rework on the same topic or choose another topic of dissertation under the same Guide or new Guide if necessary. In such an event, the report shall be submitted within four years from the date of admission to the Program.
22NMT7.7	Viva-voce examination of the candidate shall be conducted jointly by the external examiner and internal examiner/ guide at a mutually convenient date.
22NMT7.8	The relative weightages for the evaluation of dissertation and the performance at the viva-voce shall be as per the scheme of teaching and examination.
22NMT7.9	The marks awarded by both the Examiners at the viva-voce Examination shall be sent jointly to the office of Controller of Examination immediately after the examination.
22NMT7.10	Examination fee as fixed from time to time by the Institute for evaluation of dissertation report and conduct of viva-voce shall be remitted to the Institute as per the instructions of Dean-Academics, from time to time.
22NMT7.11	The candidates who fail to submit the dissertation work within the stipulated time have to apply for the extension of the Project duration through the Guide

	and the head of the department to the Office of the Controller of Examination. Such candidate is not eligible to be considered for the award of rank.
22NMT8.0	**ATTENDANCE REQUIREMENT:** 1. Each semester is considered as a unit and the candidate has to put in a minimum attendance of 85% in each subject with a provision of condoning 10% of the attendance by Principal for reasons such as medical grounds, participation in University level sports, cultural activities, seminars, workshops and paper presentation etc. 2. The basis for the calculation of the attendance shall be the period of term prescribed by the institution in its calendar of events. For the first semester students, the same is reckoned from the date of admission to the course 3. The students shall be informed about their attendance position in the first week of every month by the College so that the students shall be cautioned to make up the shortage. 4. The head of the department shall notify regularly, the list of such candidates who fall short of attendance. The list of the candidates falling short of attendance shall be sent to the Principal with a copy to Controller of Examinations. 5. A candidate having shortage of attendance (<75%) in any course(s) registered shall not be allowed to appear for SEE of such course(s). Such students will be awarded 'N' grade in these courses. 6. He/she shall have to repeat those course(s) with 'N' grade and shall re-register for the same course(s) core or elective, as the case may be when the particular course is offered next either in a main (odd/even) or summer semester. 7. If a candidate, for any reason, discontinues the course in the middle he/she may be permitted to register to continue the course along with subsequent batch, subject to the condition that he/she shall complete the class work, lab work and seminar including the submission of dissertation within maximum stipulated period. Such candidate is not eligible to be considered for the award of rank.

22NMT9.0	**ADD/ DROP/ AUDIT OPTIONS:** 1. ADD-option: A student has the option to ADD courses for registration till the date specified for late registration. 2. DROP-option: A student has the option to DROP courses from registration until one week after the mid-semester examination. AUDIT-option: A student can register for auditing a course, or a course can even be converted from credit to audit or from audit to credit, with the consent of faculty advisor and course instructor until one week after the mid-semester exam. However, CORE courses shall not be made available for audit. It is not mandatory for the student to go through the regular process of evaluation in an audit course. However, the student has to keep the minimum attendance requirement, as stipulated by the corresponding DPGC for getting the 'U' grade awarded in a course, failing which that course will not be listed in the Grade Card.
22NMT10.0	**ABSENCE DURING THE SEMESTER:** **Leave of Absence** (a) If the period of leave is more than two days and less than three weeks, prior application for leave shall have to be submitted to the Head of the Department concerned, with the recommendation of the Faculty-Advisor stating fully the reasons for the leave request along with supporting documents. It will be the responsibility of the student to intimate the course instructors, Head of the Department and also Chief Warden of the hostel, regarding his absence before availing leave.
22NMT10.1	**Absence during Mid-Semester Examinations:** A student who has been absent from a Mid-Semester Examination (MSE) due to illness and other contingencies may give a request for additional MSE within two working days of such absence to the office of the respective Head of the Department (HOD) with necessary supporting documents and certification from authorized personnel. The HOD may consider such requests depending on the merits of the case, may permit the additional Mid-Semester Examination for the concerned student.

22NMT10.2	**Absence during Semester End Examination:** In case of absence for a Semester End Examination, on medical grounds or other special circumstances the student can apply for 'I' grade in that course with necessary supporting documents and certifications by authorized personnel to the Controller of Examination through Chairman of The Department. The Controller of Examination may consider the request depending on the merits of the case and permit the make-up Semester End Examination for the concerned student. The student may subsequently complete all course requirements within the date stipulated by DPGC (which may be extended till first week of next semester under special circumstances) and 'I' grade will then be converted to an appropriate letter grade. If such an application for the 'I' grade is not made by the student, then a letter grade will be awarded based on his in-semester performance.
22NMT11.0	**WITHDRAWAL FROM THE PROGRAM:** **Temporary Withdrawal:** A student who has been admitted to a Post Graduate Degree program of the College may be permitted to withdraw temporarily, for a period of one semester or more on the grounds of prolonged illness or grave calamity in the family etc. The student should abide by the applicable rules and regulations of the college/University at the time of Temporary Withdrawal.
22NMT11.1	**Permanent Withdrawal:** Any student who withdraws admission before the closing date of admission for the Academic Session is eligible for the refund of the deposits only. Fees once paid will not be refunded on any account. Once the admission for the year is closed, the following conditions govern withdrawal of admissions: a) A student who wants to leave the College for good, will be permitted to do so (and can take Transfer Certificate from the College, if needed), only after remitting the Tuition fees as applicable for all the remaining semesters and clearing all other dues, if any. b) Those students who have received any scholarship, stipend or other forms of assistance from the College shall repay all such amounts in addition to those mentioned in (a) above.

	The decision of the Principal of the Institute regarding withdrawal of a student is final and binding.
22NMT12.0	**EVALUATION SYSTEM:** **Continuous Internal Evaluation (CIE) and Semester End Evaluation (SEE)**
22NMT12.1	For all the theory and laboratory courses, the CIE marks shall be 50. For Research Experience through Practice-I, Research Experience through Practice-II, seminar, Industrial Training/Mini Project, the CIE marks shall be 100. For Project Phase-I, the CIE Marks shall be 200 For Project Phase-II, the CIE Marks shall be 200 and for SEE 200
22NMT12.2	CIE Marks for courses shall be based on a) Tests MSE-I and MSE-II (for 30 Marks): MSE in a theory course, for 30 marks, shall be based on two tests covering the entire syllabus. Assignments, Quizzes, Simulations, Experimentations, Mini project, oral examinations, field work etc., (for 20 Marks) conducted in respective courses.
22NMT12.3	a) An additional MSE may be conducted for those students absent for valid reasons/ with prior permission. b) For those students who could not score minimum required CIE marks (25 marks), an additional MSE may be conducted, however the maximum CIE marks shall be restricted to 25 out of 50.
22NMT12.4	The candidates shall write the Tests in Blue Book/s. The Blue book/s and other documents relating to award of CIE marks shall be preserved by the Head of the Department for at least six months after the announcement of University results and made available for verification at the directions of the Controller of Examination.
22NMT12.5	Every page of the CIE marks list shall bear the signatures of the concerned Teacher and Head of the Department.
22NMT12.6	The CIE marks list shall be displayed on the Notice Board and corrections, if any, shall be incorporated before submitting to the office of the Controller of Examination (COE).
22NMT12.7	The CIE marks shall be sent to the office of the COE well in advance before the commencement of Semester End Examinations. No corrections of the CIE

	marks shall be entertained after the submission of marks list to the Office of the COE.
22NMT12.8	Candidates obtaining less than 50% of the CIE marks in any course (Theory /Laboratory/ Seminar/ Internship/ Project) shall not be eligible to appear for the Semester end examination in that course/s. In such cases, the Head of the Department shall arrange for the improvement of CIE marks in the course/ Laboratory when offered in the subsequent semester subject to the maximum duration allowed for completion of a M.Tech. program.
22NMT12.9	**Semester End Evaluation:** There shall be a Semester End Examination at the end of each semester.
22NMT12.10	There shall be double valuation of theory papers. The theory Answer booklets shall be valued independently by two examiners appointed by the Controller of Examination.
22NMT12.11	If the difference between the marks awarded by the two examiners is not more than 15 per cent of the maximum marks, the marks awarded to the candidate shall be the average of two evaluations.
22NMT12.12	If the difference between the marks awarded by the two examiners is more than 15 per cent of the maximum marks, the answer booklet shall be evaluated by a third Examiner appointed by the Controller of Examination. The average of the marks of nearest two valuations shall be considered as the marks secured by the candidate. In case, if one of the three marks falls exactly midway between the other two, then the highest two marks shall be taken for averaging.
22NMT12.13	**Summer Semester:** Summer semester is primarily to assist weak and/or students having N/F grade in courses, for a duration of 4 weeks after the completion of regular even SEE. The institute may also offer Add-on/ Audit Courses during this semester.
22NMT12.14	Each candidate shall obtain not less than 50% of the maximum marks (25 marks) prescribed for the CIE of each subject, including seminars. CIE Marks shall be based on assignments, tests, oral examinations and seminar (minimum of two are compulsory) conducted in respective subjects. The candidates obtaining less than 50% of the CIE marks in any subject shall not be eligible to appear for the SEE in that subject(s). Only in such cases, the Controller of Examination may arrange for reregistering the subject(s) in

	subsequent semester or may refer to DPGC for necessary remedial measures. The candidates shall write the Internal Assessment Test in Blue Books, and this shall be maintained by the Head of the Department for at least six months after the announcement of result and is available for verification. The CIE marks sheet shall bear the signature of the concerned Teacher and the Chairman of the Department. The CIE marks list shall be displayed on the Notice Board and corrections, if any, shall be incorporated before sending to the Controller of Examinations.
22NMT12.15	The Academic Performance Evaluation of a student shall be according to a Letter Grading System, based on the Class Performance Distribution. The Letter grades O, A+, A, B+, B, C and F indicate the level of academic achievement, assessed on a decimal (0-10) scale. The Letter grade awarded to a student in a course, for which he has registered shall be based on his performance in quizzes, tutorials, assignments etc., as applicable, in addition to two mid-semester examination and one semester end examination. The distribution of weightage among these components may be as follows: Semester End Examination (SEE) 50% Continuous Internal Evaluation (CIE) (i) Quizzes, Tutorials, Assignments etc., 20% (ii) Mid-semester Examination: 30% Any variation, other than the above distribution, requires the approval of the pertinent DPGC and Academic Council. The letter grade awarded to a student in a 0-0-P (Practical) course, is based on an appropriate continuous evaluation scheme that the course instructor shall evolve, with the approval of the pertinent DPGC. The course Instructor shall announce in the class, and/or display in the display boards or at the website, the details of the Evaluation Scheme, including the distribution of the weightage for each of the components, and method of conversion from the raw scores to the letter-grades; within the first week of the semester in which the course is offered, so that there are no ambiguities in communicating the same to all the students concerned.

22NMT12.16	**The Transitional Grades** 'I', 'W' and 'X' would be awarded in the following cases. These would be converted into one or the other of the letter grades (O-F) after the student completes the course requirements. **Grade "I":** To a student having attendance ≥85% and CIE ≥ 70%, in a course, but remained absent from SEE for valid & convincing reasons acceptable to the College, like: i. Illness or accident, which disabled him/her from attending SEE. ii. A calamity in the family at the time of SEE, which required the student to be away from the College. iii. However, the committee chaired by the Principal is authorized to relax the requirement of CIE ≥ 70% if the student is hospitalized or advised long term rest after discharge from the hospital by the Doctor. iv. Students who remain absent for Semester End Examinations due to valid reasons and those who are absent due to health reasons are required to submit the necessary documents along with their request to the Controller of Examinations to write Make up Examinations within 2 working days of that examination for which he or she is absent, failing which they will not be given permission. • **Grade "W":** To a student having satisfactory attendance at classes but withdrawing from that course before the prescribed date in a semester as per Faculty Advice. • **Grade "X":** To a student having attendance ≥85% and CIE ≥ 70%, in a course but SEE performance could result in a 'F' grade in the course. (No "F" grade awarded in this case, but student's performance record will be maintained separately).
22NMT12.17	**The Make Up Examination** facility would be available to students who may have missed to attend the SEE of one or more courses in a semester for valid reasons and given the 'I' grade. Also, students having the 'X' grade shall also be eligible to take advantage of this facility. The makeup examination would be held as per dates notified in the Academic Calendar. However, it should be made possible to hold a make-up examination at any other time in the semester with the permission of the Academic Council of the College. In all these cases, the standard of SEE would be the same as the normal SEE.

22NMT12.18	All the 'W' grades awarded to the students would be eligible for conversion to the appropriate letter grades only after the concerned students re-register for these courses in a main/summer semester and fulfil the passing standards for their CIE and (CIE+SEE).
22NMT12.19	The suggested passing standards are CIE to have >=50% and CIE+SEE to have a grade better or at least equal to C. For maintaining high standards, the students scoring less than 50% in CIE are advised to withdraw and to reregister for the course when offered next. The letter grade 'W' to be entered in the grade card against the subject and not to be taken into account while calculating SGPA & CGPA
22NMT12.20	**Rules for grace marks** a) Grace marks up to 1% of the maximum total marks in the examination or 10 marks whichever is less shall be awarded to the failed course(s), provided on award of such grace marks the candidate passes in that course(s) and examination. For the students who have secured a minimum pass grade in all the courses without any grace marks, there shall be a provision to award grace marks of 0.5% of maximum marks or 5 marks whichever is less in a semester for improvement of Grade Point (GP) in the course(s) registered in that semester. (Excluding Project work and Internship)
22NMT13.0	**LETTER GRADES AND GRADE POINTS:** The Institute adopts absolute grading system wherein the marks are converted to grades, and every semester result will be declared with semester grade point average (SGPA) and Cumulative Grade Point Average (CGPA). The CGPA will be calculated for every semester, except for the first semester. The grading system with the letter grades and the assigned range of marks under absolute grading system are as given below:

Letter Grade	**Grade- Points**	**Raw Scores %**	**Level of Academic Achievement**
O	10	≥90	Out standing
A+	09	80-89	Excellent
A	08	70-79	Very Good

	<table><tr><td>B+</td><td>07</td><td>60-69</td><td>Good</td></tr><tr><td>B</td><td>06</td><td>55-59</td><td>Above average</td></tr><tr><td>C</td><td>05</td><td>50-54</td><td>Average</td></tr><tr><td>F</td><td>00</td><td><50</td><td>Fail</td></tr><tr><td>U</td><td></td><td></td><td>Audited</td></tr></table> A student obtaining Grade F in a Course shall be considered fail and is required to reappear in subsequent SEE. Whatever the letter grade secured by the student during his /her reappearance shall be retained. However, the number of attempts taken to clear a Course shall be indicated in the grade cards/ transcripts. **Earned Credits:** This refers to the credits assigned to the course in which a student has obtained any one of the letter grades O, A+ A, B+, B and C
22NMT14.0	**PROMOTION AND ELIGIBILITY:**
22NMT14.1	**Promotion:** **a)** All students are promoted to their next semester or year of their program, irrespective of the academic performance. However, for submission for M.Tech. Major Project report in 4th semester, student should have completed all the courses up to 3rd semester
22NMT14.2	**The mandatory non-credit courses,** if any, shall not be considered for the award of class, calculation of SGPA and CGPA. However, a pass grade (PP) in the above courses is mandatory for the award of Degree.
22NMT15.0	**ELIGIBILITY FOR PASSING AND AWARD OF DEGREE:**
22NMT15.1	1. A student who obtains any grade O to C shall be considered as passed and if a student secures F grade in any of the head of passing, he/she has to reappear in that head for SEE 2. A student shall be declared successful at the end of the program for the award of Degree only on obtaining CGPA≥5.00, with none of the courses remaining with F grade. In case, the CGPA falls below 5.00, the student shall be permitted to appear again for SEE for required number of courses (other than seminar and practical) and times, subject to the provision of University, to make up CGPA≥5.0. The

	student should reject the SEE results of previous attempt and obtain written permission form the Controller of Examinations to reappear to the subsequent SEE.
22NMT15.2	For a pass in a theory course, the student shall secure a minimum of 40% of the maximum marks prescribed in the Semester End Examination and 50% of marks in CIE and 50% in the aggregate of CIE and SEE marks. The minimum passing grade in a course is C.
22NMT15.3	For a pass in Internship/ Practical/ Project/ Dissertation/ Viva-voce examination, a student shall secure a minimum of 50% of the maximum marks prescribed for the SEE in Internship/ Practical/ Project/ Dissertation/ Viva-voce. The minimum passing grade in a course is C.
22NMT15.4	For a pass, a candidate shall obtain a minimum of 50% of maximum marks in Seminar.
22NMT15.5	IV Semester full time candidates having backlog courses are permitted to upload the dissertation report and to appear for SEE. The IV semester grade card shall be released only when the candidate completes all the backlog courses and become eligible for the award of Degree.
22NMT15.6	**Eligibility for Award of Degree:** A student shall be declared to have completed the Degree of Master of Technology, provided the student has undergone the stipulated course work as per the regulations and has earned the prescribed credits, as per the scheme of teaching and examination of the program
22NMT16.0	**EVALUATION OF PERFORMANCE:** **Computation of SGPA and CGPA** SGPA and CGPA: The credit index can be used further for calculating the Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA), both being important academic performance indices of the student. While SGPA is equal to the credit index for a semester divided by the total number of credits registered by the student in that semester, CGPA gives the sum total of credit indices of all the previous semesters divided by the total number of credits registered in all these semesters. Both the equations together facilitate the declaration of academic performance of a student, at the end of a semester and at the end of successive semesters respectively

	SGPA is computed as follows: $$SGPA = \frac{\sum[(\text{Course credit})x(\text{Grade point})] \text{ for all courses with Letter grades including F in that semester}}{\sum[(\text{Course credits})] \text{ for all courses with Letter grades ncluding F in that semester}}$$ **CGPA is computed as follows:** $$CGPA = \frac{\sum[(\text{Course credit})x(\text{Grade point})] \text{ for all courses with Letter grades except F}}{\sum[(\text{Course credits})] \text{ for all courses with Letter grades except F}}$$
22NMT16.1	**Communication of Grades:** • The SGPA and CGPA respectively, facilitate the declaration of academic performance of a student at the end of a semester and at the end of successive semesters. Both of them would be normally calculated to the second decimal position, so that the CGPA, in particular, can be made use of in rank ordering the students' performance in the Institute. If two students get the same CGPA, the tie could be resolved by considering the number of times a student has obtained higher SGPA, But, if it is still not resolved, the number of times a student has obtained higher grades like O, A, B etc. could be taken into account.
22NMT16.2	**Appeal for Review of Grades:** a) The entire process of evaluation shall be made transparent, and a mechanism for review of grade is incorporated in the evaluation system. The student shall apply for the revaluation of the answer paper within the prescribed time after announcement of the results and by paying the prescribed fees. The respective DPGC conducts the revaluation process and submits a report to the office of the controller. Based on the revaluation results, the modifications of the grades obtained if any is announced and is incorporated in the grade card. If the student obtains improved grade points, then the fee amount will be refunded to the student.
22NMT16.3	**Grade Card:** Based on the secured letter grades, grade points, SGPA and CGPA, a grade card for each semester shall be issued. On specific request on paying prescribed fee, a transcript indicating the performance in all semesters may be issued.

22NMT16.4	**Conversions of Grades into Percentage and Class Equivalence** Conversion formula for the conversion of CGPA into percentage is given below: Percentage of marks secured, P = CGPA Earned × 10 **Illustration: for CGPA of 8.18**: P = CGPA Earned 8.18 × 10 = 81.8 %
22NMT17.0	**DEGREE REQUIREMENTS:** The Degree requirements of a student for the M.Tech Degree program are as follows: 1. College Requirements: i) Minimum Earned Credit Requirement for M.Tech. Degree is 80 ii) Satisfactory completion of all Mandatory Learning courses 2. Program Requirements: i) Minimum Earned Credit Requirements on all core courses, ii) Elective Courses and major project as specified by the DPGC. The maximum duration for a student for complying to the Degree requirements is 8 semesters from the date of first registration for his first semester.
22NMT18.0	**TERMINATION FROM THE PROGRAM/READMISSION:** A student shall be required to leave the College without the award of the Degree, under the following circumstances: ii) Failing to complete the degree requirements in double the duration of the program Based on disciplinary action suggested by the Academic Council/Governing Council.
22NMT19.0	**GRADUATION REQUIREMENTS AND CONVOCATION:** 1. A student shall be declared to be eligible for the award of the Degree if he has a) Fulfilled Degree Requirements b) No Dues to the College, Departments, Hostels, Library Central Computer Centre and any other center c) No disciplinary action pending against him. 2. The award of the Degree must be recommended by the Academic council and approved by Governing Council of Nitte (DU)

Convocation: Degree will be awarded in person for the students who have graduated during the preceding academic year. Degrees will be awarded in absentia to such students who are unable to attend the Convocation. Students are required to apply for the Convocation along with the prescribed fees, after having satisfactorily completed all the Degree requirements within the specified date in order to arrange for the award of the Degree during convocation.

22NMT20.0

AWARD OF CLASS, PRIZES, MEDALS & RANKS:

- **Award of Class:** Sometimes, it would be necessary to provide equivalence of SGPA and CGPA with the percentages and/or Class awarded as in the conventional system of declaring the results of University examinations. This can be done by prescribing certain specific thresholds in these averages for Distinction, First Class and Second Class as described below.

Percentage Equivalence of Grade Points (For a 10-Point Scale)

GPA	Percentage of Marks*	Class
≥ 7.00	≥ 70%	Distinction
≥ 6.00	≥ 60%	First Class
5.0 ≥ GPA <6.00	50≥ Percentage < 60%	Second Class

Percentage * = (GPA) x 10

- **For the award of Prizes, Medals and ranks**: The conditions stipulated by the Donor may be considered as per the statutes framed by the University for such awards.
  - An attempt means the appearance/registration of a candidate for an examination in one or more courses either in part or failing a particular examination.
  - A candidate who fails/remaining absent (after submitting exam application) in the main examination and passes one or more subjects/courses or all subjects/courses in the supplementary/Make-up examination such candidates shall be considered as taken more than an attempt.
  - Merit Certificates and University Medals/ will be awarded on the basis of overall CGPA, governed by the specific selection criteria that may be formulated by the University for such Medals / Awards

	○ Only those candidates who have completed the Program and fulfilled all the requirements in the minimum number of years prescribed (i.e., 2 years) and who have passed each semester in the first attempt are eligible for the award of Merit Certificates and /or Ranks and University Medals. Candidates who pass the subjects in the supplementary/make-up examinations are not eligible for the award of Ranks, Medal or Merit Certificate.
22NMT21.0	**CONDUCT AND DISCIPLINE:** 1. Students shall conduct themselves within and outside the premises of the Institute, in a manner befitting the students of an Institution of National Importance 2. **As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned, any form of ragging will be severely dealt with**. 3. The following acts of omission/ or commission shall constitute gross Violation of the code of conduct and are liable to invoke disciplinary measures: a) Ragging b) Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus. c) Willful damage or stealthy removal of any property /belongings of the Institute /Hostel or of fellow students/ citizens d) Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs. e) Mutilation or unauthorized possession of Library books. f) Noisy and unseemly behavior, disturbing studies of fellow Students. g) Hacking in computer systems (such as entering into other Person's area without prior permission, manipulation and/or Damage of computer hardware and software or any other Cybercrime etc.,). h) Plagiarism of any nature. i) Any other act of gross indiscipline as decided by the University from time to time. j) Smoking in College Campus and supari chewing. k) Unauthorized fund raising and promoting sales

	4. Commensurate with the gravity of offense, the punishment may be: reprimand, expulsion from the hostel, debarment from an examination, disallowing the use of certain facilities of the College, rustication for a specified period or even outright expulsion from the College, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances. i) For an offence committed in a) A hostel b) A department or in a classroom c) Elsewhere, the Chief Warden, the Head of the Department and the Dean (Students Welfare), respectively, shall have the authority to reprimand or impose fine. ii) All cases involving punishment shall be reported to the Principal. 5. Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Controller of Examination. ○ **Note:** Students are required to be inside the examination hall 20 minutes before the commencement of examination. This is applicable for all examinations (Semester end/Supplementary/makeup) henceforth. Students will not be allowed inside the examination hall after the commencement, under any circumstances.

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Scheme & Syllabus for
M. Tech. (Computer Science and Engineering)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

2022-24

M. Tech. in Computer Science and Engineering

CREDIT DISTRIBUTION

No.	Course Category	Suggested Credits
1.	Professional Courses (PCC) – core	16
2.	Professional Courses (PEC) – elective	18
3.	Research Methodology & IPR/RETP	04
4.	Labs	04
5.	Project Work (UCC) (Phase 1 & 2)	08+20
6.	Audit Courses	00 (2 Audit Courses)
7.	Seminar on Current Topic (UCC)	02
8.	Internship (UCC)	08
	Total Credits to be earned:	**80**

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Established under Section 3 of UGC Act 1956 Accredited with 'A+' Grade by NAAC

Off-Campus Center, NMAM Institute of Technology, Nitte

M.Tech. (CSE): Scheme of Teaching and Examinations 2022-24

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022 - 23)

1st Year Scheme

I SEMESTER												
Sl. No	**Course Type**	**Course Code**	**Course Title**	Teaching Department	**Teaching Hours /Week**			**Examination**				Credits
					Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIEMarks	SEEMarks	Total Marks	
					L	**T**	**P**					
1	PCC	22CSE101	Wireless Networks	CSE	4	0	0	3	50	50	100	4
2	PCC	22CSE102	Artificial Intelligence and Machine Learning	CSE	4	0	0	3	50	50	100	4
3	PCC	22CSE103	Machine Learning Lab	CSE	0	0	2	3	50	50	100	1
4	PCC	22CSE104	Computer Networks Lab	CSE	0	0	2	3	50	50	100	1
5	PEC	22CSE11X	Elective – I	CSE	3	0	0	3	50	50	100	3
6	PEC	22CSE12X	Elective - II	CSE	3	0	0	3	50	50	100	3
7	PEC	22CSE13X	Elective - III	CSE	3	0	0	3	50	50	100	3
8	AUDIT	22CSEAUX	Audit Course-I	CSE	2	0	0	0	0	0	0	0
9	RETP	22CSE105	Research Experience Through Practice -I	CSE	Four contact hours /week for carrying out Research and Interaction between the faculty and students			-	100	0	100	2
				Total	**19**	**0**	**4**	**21**	**450**	**350**	**800**	**21**

II SEMESTER												
Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	22CSE201	Parallel Computing Architecture	CSE	4	0	0	3	50	50	100	4
2	PCC	22CSE202	Operating Systems and Virtualization	CSE	4	0	0	3	50	50	100	4
3	PCC	22CSE203	Parallel computing Lab	CSE	0	0	2	3	50	50	100	1
4	PCC	22CSE204	Operating Systems and Virtualization Lab	CSE	0	0	2	3	50	50	100	1
5	RETP	22CSE205	Research Experience Through Practice -II	CSE	Four contact hours /week for carrying out Research and Interaction between the faculty and students			-	100	0	100	2
6	PEC	22CSE21X	Elective – IV	CSE	3	0	0	3	50	50	100	3
7	PEC	22CSE22X	Elective – V	CSE	3	0	0	3	50	50	100	3
8	PEC	22CSE23X	Elective - VI	CSE	3	0	0	3	50	50	100	3
9	AUDIT	22CSEAUX	Audit Course-II	CSE	2	0	0	0	0	0	0	0
				Total	**19**	**0**	**4**	**21**	**450**	**350**	**800**	**21**

Note: PCC: Professional Core Course, PEC: Professional Elective Course, AUDIT (AU): Non-credit Audit course, RETP: Research Experience Through Practice. L –Lecture, T – Tutorial, P- Practical/ Drawing, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

2nd Year Scheme

III SEMESTER												
Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawin	Duration in hours	CIEMarks	SEEMarks	Total Marks	
					L	T	P					
1	UCC	22CSE301	Industry Internship/ Research Internship/Mini Project	CSE	8 Weeks Full Time [32Hrs/week]			3	100	0	100	8
2	UCC	22CSE302	Seminar on Special Topic	CSE	0	0	2	3	100	0	100	2
3	UCC	22CSE303	Project Part -1	CSE	8 Weeks Full Time [32Hrs/week]			3	200	0	200	8
				Total	**0**	**0**	**2**	**9**	**400**	**0**	**400**	**18**
Note: L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.												
Internship: CIE Evaluation is for 100 Marks where 50 Marks is for Report and 50 Marks for the Presentation												
Project Part-1: CIE Evaluation is for 200 Marks where 100 Marks is for Report and 100 Marks for the Presentation												

IV SEMESTER												
Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory	Tutorial	Practical/ Drawin	Duration in hours	CIEMarks	SEEMarks	Total Marks	
					L	T	P					
1	UCC	22CSE401	Project Part -2	CSE	20 Weeks Full Time [40Hrs/week]			3	200	200	400	20
				Total	**0**	**0**	**0**	**3**	**200**	**200**	**400**	**20**
Note: L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.												
Project Part-2: CIE Evaluation is for 200 Marks having Project Progress Evaluation (PPE)-1 and PPE-2 each for 100 Marks.												

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M.Tech (CSE): Scheme of Teaching and Examinations 2022-24

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022 - 23)

ELECTIVE –I		ELECTIVE –II		ELECTIVE –III	
22CSE111	Advanced Database Management Systems	22CSE121	Advanced Algorithms	22CSE131	Cloud computing
22CSE112	Compiler Optimization & Multi-core Architecture	22CSE122	Advances in Computer Vision	22CSE132	Business Intelligence
22CSE113	Cyber Security & Forensics	22CSE123	Natural Language Processing	22CSE133	Big Data Analytics
22CSE114	Design Thinking	22CSE124	Security Analytics	22CSE134	Social & Web Analytics

ELECTIVE –IV		ELECTIVE – V		Elective - VI	
22CSE211	Distributed Operating System	22CSE221	Advanced Software Testing	22CSE231	Blockchain Technology
22CSE212	Deep Learning	22CSE222	General Purpose Computation on GPU	22CSE232	Speech Processing
22CSE213	Object Oriented Design	22CSE223	Analysis of Computer Networks	22CSE233	Software Engineering and Modelling
22CSE214	Distributed Systems	22CSE224	Image Processing and Analysis	22CSE234	Web Services

Program Outcomes (PO)

PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. (The mastery should be at a level higher than the requirements in the appropriate bachelor program)
PO4	Identify, formally model, define, and solve computing problems by applying the knowledge of mathematical principles, theoretical foundations, and limits of computing.
PO5	An ability to apply the computational concepts and logics to address a real time problem and to develop software systems, products and processes that are practically feasible to implement using modern tools
PO6	An ability to function effectively individually or as a part of a team to accomplish a stated goal.
PO7	An ability to communicate effectively with a wide range of audience.
PO7	Recognize the need to engage in self-governing and life-long learning by making use of professional and ethical principles.

Program Specific Outcomes (PSO)

PSO1	Proficiency in analysis, design, development, and implementation of efficient solutions for real time computational problems applying problem solving skills and turn out to be employable in product-oriented Industry.
PSO2	An understanding of the modern tools, technologies, and architecture of computation to carry out research to design and improve the solution for any computational problems.

WIRELESS NETWORKS

Course Code:	**22CSE101**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**4+0+0+0**	**Credits**	**04**
Total Teaching Hours	**50**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To Study the different types of Wireless services and requirements for the services, the basics of 802.11 Networks, MAC fundamentals and challenges.
2.	To familiarize with 802.11 data frame, control frames, Management frames and Management operations
3.	To study security issues for wireless networks starting with WEP, then EAP, TKIP, CCMP
4.	To familiarize with 802.11 physical layer- Frequency Hopping transmission and Direct sequence transmission.
5.	To understand Wireless LAN/PAN, Wireless MAN/WAN, Wireless Internet, TCP in Wireless domain and Wireless Application Protocol

UNIT-I

Applications and Requirements of Wireless Services: Introduction; Types of Services: Broadcast, Paging, Cellular Telephony, Wireless Local Area Networks, Personal Area Networks, Fixed Wireless Access, Ad Hoc Networks and Sensor Networks; Requirements for the Services; Technical Challenges of Wireless Communications: Multipath Propagation; Spectrum Limitations; Limited Energy; User Mobility. Overview of 802.11 Networks - IEEE 802 Network technology family tree, Nomenclature and design, types of Network, The distribution system and Network boundaries., 802.11 MAC fundamentals- Challenges for MAC, Hidden node and exposed node problems. Basics of CSMA/CA, Back off procedure. MAC Access Modes and Timing, Contention-Based Access Using the DCF, Fragmentation and Reassembly, Frame Format, Contention-Based Data Service, Frame Processing and Bridging.	**10 Hours**

UNIT-II

802.11 Framing: Generic Data Frame. Control Frames: Generic Structure, RTS, CTS, ACK, PS-Poll, Beacon. Management Frames: Generic Structure, Fixed- length components, Information elements: SSID, TIM, ERP, RSN. Management Operations: Management Architecture, Scanning, Authentication, Association, Power Conservation, Timer Synchronization.	**10 Hours**

UNIT-III

Security: Wired Equivalent Privacy: Operations, Problems with WEP. 802.1x: The Extensible Authentication Protocol, EAP Methods, 802.1x Network Port Authentication, 802.1X on Wireless LANs. 802.11i: Robust Security Networks, Temporal Key Integrity Protocol (TKIP), Counter Mode with CBC-MAC (CCMP), Robust Security Network (RSN) Operations.	**10 Hours**

UNIT-IV	
802.11 Physical Layer: Overview, the Radio Link, RF propagation. Frequency-Hopping (FH) PHY: Frequency-Hopping Transmission, GFSK, PLCP frame format.Direct Sequence PHYs: Direct Sequence Transmission, DPSK, PLCP frame format, Complementary Code Keying, HR/DSSS PLCP framing.	**10 Hours**
UNIT-V	
Wireless LAN/PAN: HIPERLAN Standard: HIPERLAN/1, HIPERLAN/2. Bluetooth: Transport Protocol Group, Bluetooth Profiles. Wireless WAN/MAN: Cellular Concept: Capacity Enhancement, Channel Allocation, Handoffs. Wireless Internet: MobileIP: Basics, Route Optimization, Variations, handoffs, IPv6 Advancements. TCP in Wireless domain: Traditional TCP, Link Layer Solutions, Split approach based solutions, end-to-end solutions. Wireless Application Protocol: WAP Model and protocol stack.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain different types of Wireless services and requirements for the services, the basics of 802.11 Networks, MAC fundamentals and challenges.
2.	Illustrate the 802.11 data frame, control frames, Management frames and Management operations
3.	Explain the security issues for wireless networks starting with WEP, then EAP, TKIP, CCMP
4.	To work with 802.11 physical layer- Frequency Hopping transmission and Direct sequence transmission.
5.	Explain the Wireless LAN/PAN, Wireless MAN/WAN, Wireless Internet, TCP in Wireless domain and Wireless Application Protocol

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3		1		1			1		1
2	1		1		1			1		1
3	1		1		1			1		1
4	1		1		1			1		1
5	3		1		1			1		1

1: Low, 2: Medium, 3: High

TEXTBOOKS:

1.	MatthewGast,802.11Wireless Networks: The Definitive Guide,2nd Edition, O'ReillyPublisher,2005.
2.	C. Siva Ram Murthy and B S Manoj, Ad Hoc Wireless Networks: Architectures and Protocols,2nd edition, Pearson Education, 2005.
3.	Andreas F. Molisch, Wireless Communications,2nd Edition, John Wiley&Sons, 2011.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Course Code:	**22CSE102**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**4+0+0+0**	**Credits**	**04**
Total Teaching Hours	**50**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To understand the basics of AI.
2.	To work with the problem-solving issues of AI.
3.	To study planning and knowledge Engineering.
4.	To apply the AI concepts to various applications.
5.	To understand and apply the ML concepts like SVM, BBN to solve problems.

UNIT-I	
Introduction to Artificial Intelligence and machine learning, Applications of AI. Examples of Various Learning Paradigms, Perspectives and Issues, Version Spaces, Finite and Infinite Hypothesis Spaces. Problem Solving: state space search and control strategies. Informed Search Methods: Best-First Search, Heuristic Functions, Memory Bounded Search, and Iterative Improvement Algorithms.	**10 Hours**
UNIT-II	
Problem reduction and Game playing, Logic concepts and logic programming. Building a Knowledge Base; Properties of Good and Bad Knowledge Bases, Knowledge Engineering. The Electronic Circuits Domain, General Ontology, The Grocery Shopping World. Inference in First-Order Logic: Inference Rules Involving Quantifiers, An Example Proof. Generalized Modus Ponens, Forward and Backward, Chaining & Completeness, Resolution: A complete Inference Procedure, Completeness of Resolution.	**10 Hours**
UNIT-III	
Planning A Simple Planning Agent Form Problem Solving to Planning. Planning in Situation Calculus. Basic Representations for Planning. A Partial-Order planning Example, A partial Order planning algorithm, Planning With partially Instantiated Operators, Knowledge Engineering for Planning. Advanced problem-solving paradigm: planning Knowledge representation	**10 Hours**
UNIT-IV	
Uncertainty Measure: Probability Theory, Bayesian Belief Networks, Machine Learning Paradigms: Machine learning system, supervised and unsupervised learnings, Inductive, deductive learning, Clustering.	**10 Hours**
UNIT-V	
Support vector Machine, case-based reasoning and learning. ANN: Single Layer, Multilayer. RBF, Design issues in ANN, Recurrent Network.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Define Artificial intelligence and identify problems for AI. Characterize the search techniques to solve problems and recognize the scope of classical search techniques
2.	Define knowledge and its role in AI. Demonstrate the use of Logic in solving AI problems
3.	Demonstrate handling of uncertain knowledge and planning in AI.
4.	Understanding of probability theory and learning methods.
5.	Analyze the given problem to apply a suitable method of AI to solve the engineering problem.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2	3	1				1	2	1	1
2	3	2	1			1		2		1
3	3	2	2	2				2	2	
4	3	2		2				2	2	
5	3	3	2	2	2			2	1	3

TEXTBOOKS:

1.	Eliane Rich, Artificial Intelligence, McGraw Hill International student edition, 1984.
2.	Machine Learning, Tom Mitche, McGraw Hill, 1997

REFERENCE BOOKS:

1.	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundation of Machine MIT Press,2012.

MACHINE LEARNING LAB

Course Code:	**22CSE103**	**Course Type:**	**PCC Lab**
Teaching Hours/Week (L: T: P: S):	**0+0+2+0**	**Credits:**	**01**
Total Teaching Hours:	**2**	**CIE + SEE Marks:**	**50+50**

Course Objectives:

1.	To implement ML concepts.
2.	To apply the ML concepts to solve problems.

List of Experiments

	Implement
1.	K-NN, NB, SVM, DT, and Clustering.
2.	Adaboost and Bagging using Random Forests.
3.	Logistic Regression
4.	NEURAL NETWORK Graphs for different activation functions: sigmoid, Tanh, ReLu Parameter Initialization: Simple neural network for Iris dataset.
5.	DEEP LEARNING Caffe: for different deep learning architectures like DBN, CNN, RNN, LSTM, DSN Application:

Course Outcomes: At the end of the course student will be able to

1.	Implement the ML concepts using python programming
2.	Design solutions to given problem by using appropriate concepts

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	1	2	2	1			1	2		
2	3	2	2	2			1	2		

REFERENCE BOOKS:

1.	Abhishek Vijayvargiya, Machine Learning for Python: An Approach to Applied Machine Learning, BPB Publications.

Computer Networks Lab			
Course Code:	**22CSE104**	**Course Type:**	**PCC Lab**
Teaching Hours/Week (L: T: P: S):	**0+0+2+0**	**Credits:**	**01**
Total Teaching Hours:	**24**	**CIE + SEE Marks:**	**50+50**

Course Objectives:

1.	To learn the usage of network simulator NS2 for wired and wireless network topologies and to extract results from trace file.
2.	To learn the usage of network simulator NS3 for wired and wireless network topologies
3.	To understand the NetAnim tool and observe the results on the screen.

List of Experiments

	Conduct the following experiments using NS2: **Students should be able to install NS2 under Linux Platform and configure to conduct following experiments**
1.	Implement 5 nodes point to point network with a duplex link with 10 Mbps,10ms and packet size of 512 bytes from n0-n, n1-n2, n2-n3, n3-n4. Taking node no as source for TCP and UDP, n4 as sink, simulate traffic from 0 to 6sec TCP, from 3 to 6 sec UDP for proper application. Find out throughput and packets dropped.
2.	Implement an Ethernet LAN with 7 nodes and set multiple traffic in nodes and measure performance of the network.
3.	Implement simple ESS with transmitting nodes in Wireless LAN and determine the performance of Network with respect to transmission of packets.
4.	Simulate the wireless environments for various node mobility speeds and analyze the quality of the communication in terms of throughput and Packet Delivery Ratio.
	Conduct the following experiments in NS3 installed in Linux platform
1.	Create a wireless network with 10 nodes and establish TCP and UDP communication. Compare the performances of the communication for varied bandwidth and application layer data rate.
2.	Simulate the wireless environments for various node mobility speeds and analyze the quality of the communication in terms of throughput and Packet Delivery Ratio.
3.	Create a wireless ad-hoc network scenario and check the energy consumption for varied network conditions such as node mobility, data-rate, and network coverage area.
4.	Create a wireless ad-hoc network scenario that consists of 50 static nodes. The nodes are communicating using UDP and the size of a packet is 512 bytes. Vary the number of source nodes from 5, to 20 with increment of 5 and create a network scenario. Consider the various routing algorithms such as AODV, DSDV, and DSR to analyze the system performance. Plot the graph based on simulation results of different routing algorithms and analyze performances.

5.	Create a wireless ad-hoc network scenario that consists of 50 mobile nodes. The nodes are communicating using TCP and the size of the packet is 250bytes. Vary the number of source nodes from 5, to 20 with increment of 5 and create a network scenario. Consider the various routing algorithms such as AODV, DSDV, and DSR to analyze the system performance. Plot the graph based on simulation results of different routing algorithms and analyze its performance.
6.	Create the vehicular movement file using SUMO tool. Configure the vehicular movement to ad-hoc nodes. Understand the ad-hoc network and examine the performance of the network.

Course Outcomes: At the end of the course student will be able to

1.	Explain the method of implementing solutions in NS2 and NS3 platforms.
2.	Create network simulations using the NS2 platform.
3.	Simulate different network algorithms using the NS3 platform.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	3		3		3			1		3
2	3		3		3			1		3
3	3		3		3			1		3

RESEARCH EXPERIENCE THROUGH PRACTICE -1			
Course Code:	**22CSE105**	**Course Type**	**RETP**
Teaching Hours/Week (L: T: P: S)	**0:0:4:0**	**Credits**	**2**
Total Teaching Hours	**24**	**CIE + SEE Marks**	**50+50**

Teaching Department: CSE

Course Objectives: The research purposes are

- To foresee future problems through pursuit of truth as a "global center of excellence for intellectual creativity".
- To respond to current social demands, and to contribute to the creation and development of scientific technologies with the aim of realizing an affluent society and natural environment for humanity.
- At the same time, the course aims to create excellent educational resources and an excellent educational environment through frontline research
- To Understand professional writing and communication contexts and genres, analyzing quantifiable data discovered by researching, and constructing finished professional workplace documents.

Individual PG Students are to be allotted to the individual faculty members based on student's area of research interest, specialization of faculty members in the beginning of the first semester.

MODULE -1

Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - Reviews, treatise, monographs patents - web as a source - searching the web - Identifying gap areas from literature review - Development of working hypothesis, systematic way of conducting
research, write a review / research paper, research proposal, preparation of research report.

MODULE-2

- Introduction various simulation tools related to Computer Science
- Use of latest software tools that is related to the domain of the research.
- Introduction to typesetting tool (Latex).
- At the end of the course students should submit a research proposal and should present the idea.

The Research proposal report prepared based on the work carried out by the PG Student is evaluated for 50 marks and 20 minutes presentation on the research work carried out will be evaluated for 50 marks jointly by the examiners.

Course Outcomes: At the end of the course student will be able to

1.	Identify and define the problem statement based on the literature reviewed.
2.	Formulate the objectives specific to the defined problem statement.
3.	Develop the methodology for achieving the objectives.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	PSO↓ 1	PSO↓ 2
1	3	2	2						2	
2	3		2						2	
3	3		3							3

REFERENCE BOOKS:

1. The Undergraduate Research Handbook. Gina Wisker · 2018

Advanced Database Management Systems

Course Code:	**22CSE111**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To understand the different methods in storing data in disks as files.
2.	To familiarize with different types of Indexing.
3.	To understand the Query evaluation process and evaluating operators.
4.	To understand the working of a typical query optimizer.
5.	To Familiarize with Distributed database concept, distributed database Architecture, Query processing and optimization in distributed database

UNIT-I

Storage and Indexing: Overview of storage and indexing - Data on External Storage, File Organizations and Indexing, Index Data Structures, Comparison of File Organizations. Storing data: disks and files: The Memory Hierarchy, Redundant Arrays of Independent Disks, Disk Space Management, Buffer Manager, Buffer Replacement Policies, Files of Records, Page Formats, Record Formats. Tree-structured indexing: Intuition for Tree Indexes, Indexed Sequential Access Method (ISAM). B+ Trees: A Dynamic Index Structure, Search, Insert, Delete, Duplicates, B+ Trees in Practice. Hash-based indexing: Static Hashing, Extendible Hashing, Linear Hashing, Extendable vs. Linear Hashing	**15 Hours**

UNIT-II

Query Evaluation: Overview of query evaluation: The System Catalog, Introduction to Operator Evaluation, Algorithms for Relational Operations, Introduction to Query	
Optimization, Alternative Plans: A Motivating Example, What a Typical Optimizer Does? External sorting: When Does a DBMS Sort Data?, A Simple Two-Way Merge Sort, External Merge Sort, Minimizing I/O Cost versus Number of I/Os, Using B+ Trees for Sorting. Evaluating relational operators: The Selection Operation, General Selection Conditions, The Projection Operation, The Join Operation, The Set Operations, Aggregate Operations, The Impact of Buffering. A typical relational query optimizer: Translating SQL Queries into Algebra, Estimating the Cost of a Plan	**15 Hours**

UNIT-III

Distributed Database Concepts: Distributed Database Concepts, Data Fragmentation, Replication, and Allocation Techniques for Distributed Database Design, Overview of Concurrency Control and Recovery in Distributed Databases, Overview of Transaction Management in Distributed Databases, Query Processing and Optimization in Distributed Databases, Types of Distributed Database Systems, Distributed Database Architectures, Distributed Catalog Management	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain the different methods in storing data in disks as files.
2.	Illustrate with different types of Indexing.
3.	Perform the Query evaluation process and evaluate operators.
4.	Explain the working of a typical query optimizer.
5.	Explain the Distributed database concept, distributed database Architecture, Query processing and optimization in distributed database

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	3		2						3	
2	3		2		2				2	3
3	3		2						3	
4	3		2						2	3
5	3		2		2				2	3

TEXTBOOKS:

1.	Database management systems / Raghu Ramakrishnan, Johannes Gehrke.3rd Edition Mc Graw Hill

REFERENCE BOOKS:

1.	Fundamental Database Systems Ramez Elmasri and Shamkant B. Navathe, 7th Edition., Pearson Publication
2.	Database System Concepts A. Silberschatz, Henry F. Korth ,S. Sudarshan Sixth Edition McGraw Hill Publication

COMPILER OPTIMIZATION AND MULTI-CORE ARCHITECTURES

Course Code:	**22CSE112**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To familiarize principles of parallel programming
2.	To understand compiler optimizations
3.	To comprehend the parallel architectures
4.	To familiarize parallel programming paradigms

UNIT-I

Programming principles:
Reactive parallel programming. Synchronization strategies, critical regions, atomic updates, races, deadlock avoidance, prevention, livelock, starvation, scheduling fairness, virtualization, speculative parallelization, transactional memories.
Optimizations:
Basic compiler optimizations, Control and data flow analysis, Enhancing parallelism, dependence analysis. Tiling for locality and communication, Aggregation for communication, Load balancing strategies, Register Allocation: Coloring, Spilling & IPA, Pointer alias Analysis ,Dynamic Code
Optimizations and garbage collection,

16 Hours

UNIT-II

Automatic Programming:
Program transformation by pattern matching, Partial evaluation, Object-oriented and Aspect-oriented programming, Automatic Parallelization I and II.
Overview of architectures:
Architectural characterization of most important Parallel systems today. Issues in effective programming of parallel architectures: exploitation of parallelism, locality (cache, registers), load balancing, communication,
overhead, consistency, coherency, latency avoidance

14 Hours

UNIT-III

Programming paradigms:
By the data: Partitioned data, global view of data, and no state. By control: Partitioned control, global view of control, functional control. Survey of programming languages/APIs: OpenMP and MPI.

10 Hours

Course Outcomes: At the end of the course student will be able to

1.	To explain the principles of parallel programming
2.	To perform different compiler optimizations
3.	To illustrate automatic parallelization

4.	To comprehend the parallel architectures
5.	To explain the parallel programming paradigms

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2		2	3	2			2	1	3
2	2		2	3	2			2	1	3
3	2		2	3	2			2	1	3
4	2		2	3	2			2	1	3
5	2		2	3	2			2	1	3

TEXTBOOKS:

1.	Muchnick, StevenS., Advanced Compiler Design and Implementation. MorganKaufmann,1997
2.	Lowry and McCartney, Automating Software Design, AAAIPress, 1991.
3.	John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann; 5 edition, 2011.

REFERENCE BOOKS:

1.	Czarnecki,K. and Eisenecker, U., Generative Programming: Methods, Tools and Applications, Pearson,2000.
2.	Maurice Herlihy and Nir Shavit, The Art of Multiprocessor Programming, Morgan Kaufmann, Morgan Kaufmann; 1stedition, 2012.
3	Niranjan N. Chiplunkar and Raju K., Introduction to Parallel Computing. Wiley India,2020.

CYBER SECURITY & FORENSICS			
Course Code:	**22CSE113**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To understand the basics of cyber security.
2.	To understand the concepts of firewalls.
3.	To analyze the intrusion detection system and Hash authentication.
4.	To analyze phishing and identify the theft.
5.	To Understand the computer forensics.

UNIT-I	
Cyber security Overview: Introduction, Security from Global Perspective, Trends in the Types of Attacks and Malware, The types of Malware, Vulnerability Naming Schemes and security configuration schemes, The attackers motivation and tactics, Zero-Day Vulnerability, Attacks on the power grids and Utility networks, Network and Infrastructure Overview. Fire Walls : Firewalls, Stateless Packet Filtering, Stateful or session Filtering, Application-level Gateways, Circuit level Gateways, A Comparison of Four types of gateways.	**15 Hours**
UNIT-II	
Intrusion Detection / Prevention System : Overview, The approaches used for IDS/ IPS, Network Based IDS/IPS, Host Based IDS/IPS, The detection of Polymorphic and metamorphic worms, Distributed Intrusion Detection system and standard. Hash and Authentication: Authentication overview, Hash Functions, The Hash Message Authentication Code, Password Based Authentication, Password Based Encryption Standard, Password Based Security Protocols, One time password and tokens (only two factor authentication), Open Identification and Open Authorization.	**15 Hours**
UNIT-III	
Phishing and Identity theft: Introduction, Phishing, Identity theft (ID) Cyber Crime and Cyber Security: Introduction, Why do we need cyber laws: Indian context, The Indian IT Act, Challenges to Indian Law and cybercrime scenarios in India, Consequences of not addressing the weakness in information technology Act. Digital Signatures and Indian Act. Cyber Crime and Punishment	

Understanding Computer Forensics: Introduction, Digital forensics science, The need of computer forensics, Cyber forensics and digital evidence, Digital forensics life cycle, Network Forensics, Computer forensics and steganography	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	To understand the basics of cyber security.
2.	To understand the concepts of firewalls.
3.	To analyze the intrusion detection system and Hash authentication.
4.	To analyze phishing and identify the theft.
5.	Understand the computer forensics.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2		1						3	1
2	2		1						2	3
3	2		1		3				3	2
4	2		1						2	3
5	2		1						3	1

TEXTBOOKS:

1.	Chwan-Hwa (John) Wu, J. David Irwin, Introduction to Computer Networks and Cyber security, publication: : CRC press, Taylor and Francis group, 2013.
2.	Cyber Security –Nina Godbole, Sunit Belapure, Publication :John Wiley, 2012.
3.	Cyber security essentials -Edited by James Graham, Richard Howard, Ryan Olson, publication: CRC press, Taylor and Francis group, 2011.

DESIGN THINKING

Course Code:	**22CSE114**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To provide a basic conceptual design thinking
2.	To explore customer need analysis.
3.	To understand the translation of customer needs.
4.	To work on problem decomposition.
5.	To understand product development process.

UNIT-I

Introduction and problem discovery: Introduction to Design Thinking, People Centered Design &Evoking the Right problem, Skills expected of design thinking practitioners. Identifying Customer Needs: Product development process and concept, development phase in design planning and analysis, Customer needs and markets, Types of product users Customer needs analysis.	**15 Hours**

UNIT-II

Translating customer needs into measurable specifications: Bench marking needs vs. Specifications,Quality function deployment (house of quality), Dynamics of product specifications. Applied Creativity: Problem decomposition techniques and solution concepts, Brainstorming principles and their efficacy in creative thinking, System exploration and concept / down-selection	**15 Hours**

UNIT-III

Design for Environment: DFE principles and decision making, How DFE integrates with the product development process,Product life cycle and environmental impacts, Herman Miller story.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Examine Design Thinking concepts and principles
2.	Practice the methods, processes, and tools of customer need analysis.
3.	Apply the Design Thinking approach and model to real world situations and translate the needs to specifications.
4.	Analyze the role of primary and secondary research in the discovery stage of Design Thinking

5.	Apply the design thinking to real world problems.

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3		2						3	2
2	3		2	3					3	2
3	3		2		3				3	2
4	3		2						3	2
5	3		2						3	2

TEXTBOOKS:

1	Karl T. Ulrich, Steven. D. Eppinger, "Product design and development", Mcgraw hill publications, 5th ed., 2011.
2	Nanua Singh, "Systems approach to computer integrated design and manufacturing", Wiley India Pvt. Ltd., 4435-36/7, Ansari Road, Daryaganj, 1999.
3	Wake, Warren K., Design Paradigms A Source for Creative Visualization, New York: John Wiley & Sons, 2000.
4	Rowe, Peter G. Design Thinking, Cambridge, MA: MIT Press 1987.

ADVANCED ALGORITHMS

Course Code:	**22CSE121**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To analyze the efficiency of recursive and non-recursive algorithms and to understand the concepts of amortized analysis of algorithms.
2.	To analyze the various graph algorithms and evaluate its efficiency.
3.	To understand parallel algorithms and apply them on various real-time problems.
4.	To analyze various string-matching algorithms.
5.	To analyze randomized, probabilistic, Monte Carlo and Las Vegas algorithms.

UNIT-I

Review of Analysis Techniques: Growth of Functions: Asymptotic Notations; Standard notations and common functions; Recurrences and Solution of Recurrence equations - The Substitution Method, The Recurrence tree method, The master method; Amortized Analysis: Aggregate, Accounting and Potential Methods. Graph Algorithms: Bellman - Ford Algorithm; Single source shortest paths in a DAG; Johnson's Algorithm for sparse graphs; Flow networks and Ford- Fulkerson method; Maximum bipartite matching.	**16 Hours**

UNIT-II

Parallel Algorithms: Parallel Algorithm Models; Performance Metrics for Parallel Systems; Matrix Multiplication; Image Dithering; Parallel Merge Sort; Searching A Random Sequence. String-Matching Algorithms: Naïve string Matching; Rabin - Karp algorithm; String matching with finite automata; Knuth-Morris-Pratt algorithm; Boyer– Moore Algorithm.	**14 Hours**

UNIT-III

Probabilistic And Randomized Algorithms: Probabilistic algorithms; Randomizing Deterministic Algorithms, Monte Carlo and Las Vegas algorithms; Probabilistic Numerical Algorithms.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	To analyze the efficiency of recursive and non-recursive algorithms and to understand the concepts of amortized analysis of algorithms.
2.	To analyze the various graph algorithms and evaluate its efficiency.
3.	To understand parallel algorithms and apply them on various real-time problems.

4.	To analyze various string-matching algorithms.
5.	To analyze randomized, probabilistic, Monte Carlo and Las Vegas algorithms.

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3		2						3	2
2	3		2						3	2
3	3		2						3	2
4	3		2						3	2
5	3		2		3				3	2

TEXTBOOKS:

1.	TCormen,C Leiserson and Rivest,IntroductiontoAlgorithms,3rdedition,PHI,2007.
2.	M.J.Quinn,"DesigningEfficientAlgorithmsforParallelComputer",McGrawHill,2007.
3.	Kenneth A.Berman, Jerome L.Paul: Algorithms, Cengage Learning, 2002.

REFERENCE BOOKS:

1.	Ellis Horowitz, Sartaj Sahni, Fundamentals of Computer Algorithms, 2nd edition, Galgotia Publications, 2008
2.	S.G.Akl,"Design and Analysis of Parallel Algorithms", Prentice Hall,1992.

ADVANCES IN COMPUTER VISION

Course Code:	**22CSE122**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To explain the need of spatial and frequency domain techniques for image compression
2.	Identify, formulate and solve problems in image processing and computer vision.
3.	Critically review and assess scientific literature in the field and apply theoretical knowledge to identify the novelty and practicality of proposed methods
4.	Design and develop practical and innovative image processing and computer vision applications or systems

UNIT-I

Introduction to Computer Vision:

Goal, areas, Human Vision, Segmentation, Perception, Semantic information, Special effects, Modeling, Applications; Linear Algebra: Vectors Matrices, Transformation matrices, Matrix inverse, Matrix rank, SVD.

Pixels, Features, and Cameras: Pixels and Filters: Images as functions, Linear Systems (filters),Convolution & Correlation. Edge detection: Simple, Canny, RANSAC; Feature detector: Local invarient, Harris, DOG, SIFT; Camera Models

15 Hours

UNIT-II

Camera: Pinhole Cameras, Cameras & lenses, Projection matrix, Intrinsic parameters, Extrinsic parameters; Stereo Vision: Epipolar Geometry, Parallel images, Image Rectification, Solving correspondence problem, Active Stereo Vision System;

15 Hours

UNIT-III

Regions of Images, and Segmentation: Basic Concepts of Segmentation: Gestalt Theory; Agglomerative, K-means & Mean-shift Clustering; Optical flow, Feature tracking, Applications; Advanced Image Parsing Topic and Applications: Binary, Image Matting; Figure-ground Segmentation Using Clustering Algorithms.

Recognizing Faces and Objects: Basic Concepts in Recognition & its pipeline, Nearest Neighbor Match;PCA and Eigenfaces; Tracking Millions of People: Detection, Tracklet Generation Association;

10 Hours

Course Outcomes: At the end of the course student will be able to

1.	Explain the need of spatial and frequency domain techniques for image compression.

2.	Identify, formulate and solve problems in image processing and computer vision.
3.	Critically review and assess scientific literature in the field and apply theoretical knowledge to identify the novelty and practicality of proposed methods
4.	Design and develop practical and innovative image processing and computer vision applications or systems
5.	Solve problems using the concepts of image segmentation, object recognition.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2								3	2
2	1	2			3				3	2
3	2								3	2
4	2								3	2
5	2				3				3	2

TEXTBOOKS:

1.	Richard Szeliski, Computer Vision: Algorithms and Applications, Microsoft Research, Electronic draft,2010.
2.	David A.Forsyth &Jean Ponce, Computer Vision: A Modern Approach, Prentice Hall; 2 edition,2011.
3.	Hartley & Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press;2 edition,2004.

REFERENCE BOOKS:

1.	Machine vision, Jain, Ramesh and Rangachar Kasturiand Brian G.Schunck; McGraw-Hill ,Edition-1995.
2.	Introductory Computer Vision And Image Processing, Low, Adrian; McGraw-Hill, Edition-1991. Digital Image Processing, Gonzalez, Rafael C. and Richard E.Woods; Addison-Wesley, Edition: 3rd, Year:1998.

NATURAL LANGUAGE PROCESSING

Course Code:	**22CSE123**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To understand the basic concepts of natural language processing.
2.	To study the semantics and paradigms.
3.	To understand the algorithms used in NLP
4.	To know the implementation of NLP in python.

UNIT-I

Introduction: What is Natural Language Processing, Motivation, Words - Regular Expressions and Automata, Words and Transducers, N-grams-Part–of-Speech Tagging, Hidden Markov Models, Maximum Entropy Model. Syntax: Syntactic Parsing, Statistical Parsing, Features and Unification- Languages and Complexity, Language Modelling.	**15 Hours**

UNIT-II

Semantics and Pragmatics: Semantics and Pragmatics: The Representation of Meaning, Computational Semantics, Lexical Semantics: Computational Lexical Semantics, Computational Discourse. Applications: Applications, Information Extraction, Question Answering and Summarization, Dialogue And Conversational Agents, Machine Translation.	**15 Hours**

UNIT-III

NLP Using Python : Language Processing and Python - Accessing Text Corpora and Lexical Resources-Processing Raw Text-Writing Structured Programs-Categorizing and Tagging Words-Learning to Classify Text-Extracting Information from Text–Case Study.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Analyze the natural language text to extract it into different parts of speech.
2.	Understand the syntax and the features of natural language text with respect to languages.
3.	Analyze the text to understand the various semantics and pragmatics
4.	Apply information retrieval techniques to natural language text.
5.	Implement the NLP concepts using python.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1				1					1	
2				1					1	

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

1

TEXTBOOKS:	
1.	Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2.	Jurafsky, D. and J. H. Martin. Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Second Edition, Prentice Hall,2008.
3.	Steven Bird, S., Klein, E., Loper, E, Natural Language Processing with Python-Analyzing Text with the Natural Language Toolkit, O'ReillyMedia, 2010.

SECURITY ANALYTICS

Course Code:	**22CSE124**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To understand fundamentals of Security Analytics solution.
2.	To understand the role of SIEM product.
3.	To analyze system (Windows, Linux, Firewall, Routers etc) logs
4.	To understand the core components of a Security Operations Center (SOC) setup.
5.	To understand how correlation rules are designed and implemented.

UNIT-I

Introduction to Security Operations and the SOC, Cybersecurity Challenges, Threat Landscape, Business Challenges, Overview of SOC Technologies. Lab – Deploy SIEM solution.	**13 Hours**

UNIT-II

Assessing Security Operations Capabilities SOC Strategy, The SOC Infrastructure, Security Event Generation and Collection, Vulnerability Management, Identifying Vulnerabilities, People and Processes, Technologies to Consider During SOC Design, Firewalls, Preparing to Operate. Lab - Integrate SIEM solution with Security control devices.	**15 Hours**

UNIT-III

The Operate Phase, Reacting to Events and Incidents Maintain, Review, and Improve. Practical labs on OSSIM. Lab – Generate attacks and analyze packets on SIEM solution.	**12 Hours**

Course Outcomes: At the end of the course student will be able to

1.	To understand the core components of SOC (Security Operation Center).
2.	To understand the architecture of SIEM solution.
3.	To analyze security logs on SIEM solution.
4.	To analyze co-relation rules and alerts.
5.	To understand various dashboards of a SIEM solution.

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	PSO↓ 1	PSO↓ 2
1	3		3	2				2	3	
2	3		3	2				2		2
3	2		1	2				2		2
4	3		1	1				2		1
5	3			1				2		1

TEXTBOOKS:

1.	Blue Team Handbook: Incident Response Edition: A condensed field guide for the Cyber Security Incident Responder by Don Murdoch GSE
2.	Think Like a Hacker: A Sysadmin's Guide to Cybersecurity by Michael J. Melone and Dr. Shannon Zinck

REFERENCE BOOKS:

1.	Operating and maintaining your SOC by Joey Muniz, Gary McIntyre, Nadhem AlFardan https://linoxide.com/install-configure-alienvault-siem-ossim/

CLOUD COMPUTING

Course Code:	**22CSE131**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**0+3+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Outline the fundamental ideas behind Cloud computing, and the evolution of theparadigm, its applicability; benefits as well as current and future challenges.
2.	Get the basic idea and principles in Datacenter design and Management and findthe importance of Virtualization in Cloud.
3.	Get the idea of different Cloud deployment models and Cloud Delivery Modelsand their security issues.
4.	Outline the fundamental ideas behind Cloud computing, and the evolution of theparadigm, its applicability; benefits as well as current and future challenges.
5.	Tell how Cloud Computing solves different problems in the present by on side ring different Cloud Vendors and their Cloud Design architecture.

UNIT-I

Eras of computing, Parallel vs. Distributed Computing, Elements of Parallel Computing- (What is parallel computing, hardware architecture for Parallel processing, approaches to parallel programming, levels of parallelism, Laws of caution). Elements of Distributed Computing- (General concepts and definitions, components of a distributed system,Architectural styles for distributed computing, models for inter-process communication, Technologies for distributed Computing- Remote procedure call, Service orientedcomputing). Classic data center, its elements, challenges and benefits. Data center management Steps in transitioning to cloud- consolidation, automation, IT as a service. Cloud computing Architecture: - Introduction, Cloud reference models- (Architecture, Infrastructure/Hardware as a service, Platform as a service, Software as a service), Types of cloud – (Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds), Economics of cloud, Open challenges.	**15 Hours**

UNIT-II

Virtualization: –characteristics of virtualized environments, taxonomy of virtualization technique, Virtualization and cloud computing, Pros and Cons of virtualization, Technology examples- XEN, VMware, Microsoft Hyper-V. Application and Desktop virtualization - Application virtualization – different layers, user profile virtualization, application streaming and encapsulation, benefits. Desktop virtualization- methods –client based and computer based. Security Concerns, Risk Issues: - Cloud Computing- Security Concerns. A Closer	

Examination: Virtualization, A Closer Examination: Provisioning. Securing the Cloud: Key Strategies and Best Practices: - Overall Strategy: Effectively Managing Risk-Risk Management: Stages and Activities. Overview of Security Controls, Cloud Security Controls Must Meet Your Needs, NIST Definitions for Security Controls, Unclassified Models, Classified Model the Cloud Security Alliance Approach. The Limits of Security Controls - Security Exposure Will Vary over Time, Exploits Don't Play Fair. Best Practices: Best Practices for Cloud Computing- First Principals, Best Practices across the Cloud Community. Other Best Practices for Cloud Computing- Cloud Service Consumers, Cloud Service Providers. Security Monitoring. The Purpose of Security Monitoring, Transforming an Event Stream, The Need for C.I.A. in Security Monitoring, the Opportunity for MaaS.	**15 Hours**

UNIT-III

Cloud Platforms in Industry, Amazon Web Services, Compute Services, Storage Services, Communication Services, Additional Services, Google App Engine, Architecture and Core Concepts, Application Life-Cycle, Cost Model, Observations, Microsoft Azure, Azure Core Concepts, SQL Azure, Windows Azure Platform Appliance. Cloud Applications Scientific Applications, Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Biology: Gene Expression Data Analysis for Cancer Diagnosis, Geo-science: Satellite Image Processing, Business and Consumer Applications, CRM and ERP, Productivity, Social Networking, Media Applications, Multiplayer Online Gaming.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Define the concept of cloud computing business need and various networkingmethods.
2.	Express the infrastructure management for cloud environment.
3.	Describe the Virtualization at all levels used by XEN, Vmware, Hyper-v
4.	Explain the security concepts in cloud computing.
5.	Practice the case studies of public cloud such as AWS, Google App Engine andprivate cloud such as Open Stack.

Table-2: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3										2		3	
CO2	3	3										2		3	
CO3	3	3										1		3	
CO4	3	3										2		3	
CO5	3	3										1		3	1

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXTBOOKS:	
1.	Buyya, Rajkumar, Christian Vecchiola and ThamaraiSelvi, "Mastering Cloud Computing Fundamentals and Applications Programming", McGraw Hill, 2013.
2.	Winkler, Vic (J.R), "Securing the Cloud - Cloud Computer Security Techniques and Tactics.",Elsevier Inc, 2012.
REFERENCE BOOKS:	
1.	Hurwitz, Judith, "Cloud computing for dummies.", Wiley India Pvt Ltd, 2011.
2	Rittinghouse, John,"Cloud computing – implementation, management and security",CRC Press, First edition, 2009.
3	Velte, Toby, Anthony Velte and Robert Elsenpete. "Cloud Computing, A Practical Approach.",Tata McGraw-Hill Authors, 2010.

BUSINESS INTELLIGENCE

Course Code:	**22CSE132**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Identify various sources of data and identify the methods to process them.
2.	Explain the ETL process and carry out the ETL process for a given data set.
3.	Design a suitable schema for a given problem.
4.	Illustrate the concepts of data mining and Demonstrate the Classification and clustering methods.

UNIT-I

INTRODUCTION TO BUSINESS INTELLIGENCE: Types of digital data – Structured, semi structured and unstructured – sources, characterizes, challenges; Introduction to OLTP, OLAP and Data Mining; BI Definitions & Concepts; BI Framework, Who is BI for, BI Users, BI Applications; BI Roles & Responsibilities, Need for data warehouse – definition, data mart, Approaches for data warehouse, ETL(Extraction Transformation Loading) **Basics of Data Integration**: Concepts of data integration; Need and advantages of using data integration; Introduction to common data integration approaches; **Introduction to data quality**: data profiling concepts and applications, Introduction to SSIS Architecture, Introduction to ETL using SSIS tool.	**15 Hours**

UNIT-II

A Multidimensional Data Model - Concepts of dimensions, facts, cubes, attributes, hierarchies, star and snowflake schema; Data Warehouse Architecture. Introduction to data and dimension modeling, multidimensional data model, ER Modeling vs. multidimensional modeling; **Introduction to business metrics and KPIs**- Measure, metrics, KPIs and performance management, salient attributes of a good metric, SMART test. **Introduction to enterprise reporting** – perspectives, standardization and presentation, balanced scorecards. Concepts of dashboards- types, steps, Applications of Data mining and Case studies of BI.	
	15 Hours

UNIT-III

Data Mining—On What Kind of Data? Data Mining Functionalities—What Kinds of Patterns Can Be Mined? Mining Association rules Basic concepts, frequent itemset mining methods. **Classification And Prediction**: Issues regarding Classification and Prediction, classification by Decision tree induction, Bayesian classification, and prediction. **Cluster Analysis** -What is Cluster Analysis? Types of data in cluster Analysis,	**10 Hours**

Partitioning Methods, and hierarchical clustering Methods.	

Course Outcomes: At the end of the course student will be able to

1.	Identify the sources of data based on its type for a business application and apply OLTP, OLAP operations.
2.	Apply the knowledge of BI operation to determine various roles in a BI application and design the ETL process for handling the data from a given application.
3.	Relate the data warehousing concepts for a real-time business application to model a star, snowflake schema for a multi-dimensional data of a given problem.
4.	Explain data quality and profiling methods, identify the quality of the data using data profiling techniques. Apply the measures and metrics to the data to design an enterprise report.
5.	Apply the concepts of mathematics and computer algorithm to illustrate the data mining concepts using association rules.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	3		2	2				2	2	2
2	3		2	2				2	2	2
3	3		2	2	2			2	3	3
4	3		2					2	2	2
5	3		2	2	2			2	3	3

TEXTBOOKS:

1.	RN Prasad and Seema Acharya", Fundamentals of Business Analytics", Wiley-India,2011
2.	Larissa T Moss and Shaku Atre – Business Intelligence Roadmap: The Complete Project Life cycle for Decision Support Applications, Addison Wesley Information TechnologySeries,2003.
3.	Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 2000 (ISBN: 1-55860-489-8).

BIG DATA ANALYTICS

Course Code:	**22CSE133**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Study and comprehend in depth the fundamental issues behind the Big Data problem.
2.	Understand various Big Data technologies and different NoSQL databases. Learn MongoDB NoSQL database.
3.	Understand various Big Data technologies and Hadoop Components such as HDFS, MapReduce. Learn MapReduce Programming
4.	Determine various techniques for analyzing the data such as Spark, P,ig and Hive.

UNIT-I

Introduction to Big Data: Types of digital Data, Characteristics of Data, Evolution of Big Data, Definition of Big Data, Challenges with Big Data, What Is Big Data? Why Big data? Traditional BI versus Big data. Big Data Analytics: What is Big Data Analytics? Why this sudden Hype around Big Data analytics? Data Science, Terminologies used in Big Data environments **Introduction to NoSQL**: Where it is used, Types of NoSQL databases, Why NoSQL, Advantages of NoSQL, **Introduction to MongoDB**: What is MongoDB? Why MongoDB? Using JSON, Creating or generating a unique key, Data types in MongoDB, MongoDB Query Language: Insert method, Save method, Update method, Remove method, Find method, Dealing with Null values, Count, Limit, Sort, Skip.	**15 Hours**

UNIT-II

Introduction to Hadoop: Introducing Hadoop, need of Hadoop, limitations of RDBMS, RDBMS versus Hadoop, Distributed Computing Challenges, History of Hadoop , Hadoop Overview, Use Case of Hadoop, Hadoop Distributors, HDFS (Hadoop Distributed File System) , Processing Data with Hadoop, Managing Resources and Applications with Hadoop YARN (Yet another Resource Negotiator). **Writing Hadoop MapReduce Programs**: Understanding the basics of MapReduce, Introducing Hadoop MapReduce, Understanding the different Java concepts used in Hadoop programming, Writing a Hadoop MapReduce example, Understanding several possible MapReduce definitions to solve business problems. **SPARK:** Spark applications, Jobs, stages and Tasks, Resilient Distributed Datasets(RDD), Anatomy of SPARK Job Run; SPARK on YARN	**15 Hours**

UNIT-III	
Hadoop Ecosystem: Understanding Hadoop subprojects: Mahout, Apache HBase, Hive, Pig, Apache Sqoop, Apache Zookeeper, Apache Solr, Ambari. **HBase:** What is HBase? Storage Mechanism in HBase, Features of HBase, HBase and RDBMS, HBase and HDFS. **Introduction to Pig**: What is Pig? Pig on Hadoop, Pig Philosophy, Pig Latin overview; Pig Data Types; Running Modes of Pig; Execution Modes of PIG, Relational operators, EVAL function, Complex data types. **Introduction to Hive**: What is Hive? Architecture; HIVE Data Types; HIVE File Format; Hive Query Language(HQL).	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Outline the theory of big data and explain applications of big data.
2.	Get the idea of NoSQL databases, different types of NoSQL datastores.
3.	Analyse the technological foundations for Big data with hadoop and design of hadoop distributed file system.
4.	Understand the concept of MapReduce programming and Spark workflow.
5.	Understand the need of Big Data Analytics and Analyze Hadoop Ecosystem

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3		2					2	1	1
2	3		2		2			2	1	1
3	3		2	2	2			2	2	2
4	3		2	2	2			2	3	3
5	3		2		2			2	1	1

TEXTBOOKS:

1.	Seema Acharya, Subhashini Chellappan, "Big Data Analytics", 1st Edition, Wiley, 2015.
2.	Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packet Publishing 2013.
3.	Tom White, Hadoop: The Definitive Guide, 4th Edition, O'Reilley, 2012.

REFERENCE BOOKS:

1.	Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.
2.	Chris Eaton, Dirk derooset al. , "Understanding Big data ", McGraw Hill, 2012.
3.	E. Capriolo, D. Wampler, and J. Rutherglen, Programming Hive, O'Reilley, 2012.
4.	Lars George, HBase: The Definitive Guide, O'Reilley, 2011.
5.	Alan Gates, Programming Pig, O'Reilley, 2011

E Books / MOOCs/ NPTEL

1.	https://www.upgrad.com/big-data-analytics-
2.	https://www.coursera.org/courses?query=big%20data%20analytics.
3.	https://www.edx.org/micromasters/big-data

SOCIAL AND WEB ANALYTICS

Course Code:	**22CSE134**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To understand social media, web and social media analytics, and their potential impact.
2.	To model and visualize the social network.
3.	To understand the evolution of the social network.
4.	To mine the interest of the user.

UNIT-I

Introduction to Web and Social Analytic: Overview of web & social media (Web sites, web apps, mobile apps and social media), Impact of social media on business, Social media environment, , How to leverage social media for better services, Usability, user experience, customer experience, customer sentiments, web marketing, conversion rates, ROI, brand reputation, competitive advantages. Introduction- Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks. Need of use analytics, Web analytics technical requirements., current analytics platforms, Open Sources licensed platform, choosing right specifications &	**15 Hours**
The optimal solution, Web analytics and a Web Analytics 2.0 framework, Data Mining, Data Mining Techniques-Association ,Classification, Clustering.	

UNIT-II

Data Modeling and Mining Communities Data (Structured data, unstructured data, metadata, Big Data and Linked Data), Modeling And Visualization- Visualizing Online Social Networks - A Taxonomy of 26 Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships. Mining Communities- Aggregating and reasoning with social network data- Advanced Representations - Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks	**15 Hours**

UNIT-III

Text and Opinion Mining- Text Mining in Social Networks -Opinion extraction – Sentiment classification and clustering - Temporal sentiment analysis - Irony detection in opinion mining - Wish analysis - Product review mining – Review Classification – Tracking sentiments towards topics over time. Tools for Social Network Analysis- UCINET – PAJEK – ETDRAW – StOCNET – Splus – R – NodeXL – SIENA and RSIENA – Real world Social Networks (Facebook- Twitter Etc.)	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Understand social media, web and social media analytics, and their potential impact.
2.	Identify the need of using analytics and explain data mining techniques.
3.	Recognize types of data and visualize the social network.
4.	Determine the evolution of social networks.
5.	Explain text mining and mine the opinion of the user.

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	2	3					2	2		1
2	3	3		1				2	2	1
3	2	3						2		3
4	3	3						2		2
5	2	3	2	1		2		2	2	3

TEXTBOOKS:

1.	Matthew A.Russell, Mining Social web, O'Reilly;2 edition, 2013, ISBN-13:978-1449367619.
2.	Charu C Aggarwal, Social Network Data Analytics, Springer; 2014,978-1489988935
3.	Peter Mika, "Social Networks and the Semantic Web", 1st edition, Springer, 2007.
4.	BorkoFurht, "Handbook of Social Network Technologies and Applications", 1st edition, Springer, 2010.

REFERENCE BOOKS:	
1.	Hand, Mannila, and Smyth. Principles of Data Mining. Cambridge, MA: MIT Press, 2001.ISBN:026208290X.
2.	Avinash Kaushik,Web Analytics2.0:The Art of Online Accountability and Science of Customer Centricity, John Wiley & Sons; Pap/Cdr Edition, 2009.
3.	GuandongXu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", 1st edition, Springer, 2011.
4.	Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.
5.	Ajith Abraham, Aboul Ella Hassanien, VáclavSnáel, "Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2009.
6.	Toby Segaran, "Programming Collective Intelligence'', O'Reilly, 2012. 8. Sule Gündüz-Öğüdücü, A. Şima Etaner-Uyar, "Social Networks: Analysis and Case Studies'', Springer, 2014.
7.	Hand, Mannila, and Smyth,"Principles of Data Mining", Cambridge, MA: MIT Press, ISBN: 026208290X, 2001.
E Books / MOOCs/ NPTEL	
1.	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
2.	https://www.coursera.org/learn/social-media-data-analytics
3.	https://www.coursera.org/learn/text-mining

PARALLEL COMPUTING ARCHITECTURE

Course Code:	**22CSE201**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**4+0+0+0**	**Credits**	**04**
Total Teaching Hours	**50**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Know the principles of computer design and way in which arithmetic operations are carried out in a processor
2.	Understand the concepts like instruction scheduling (dynamic and static), branch prediction, out-of-order execution with respect to pipelined and superscalar processors.
3.	Comprehend various Cache optimization techniques and discuss the hardware and software support for VLIW and EPIC systems.
4.	Identify the concepts of High-Performance Computing, Distributed-Memory Parallelism and Shared-Memory Parallelism.

UNIT-I	
Fundamentals of Computer Design: Introduction, Classes of Computers, Measuring, reporting and summarizing performance, quantitative principles of computer design. **Computer Arithmetic:** Introduction, Basic Techniques of Integer Arithmetic, Floating Point: Floating-Point Multiplication, Floating-Point Addition, Division and Remainder.	**10 Hours**
UNIT-II	
Instruction Level Parallelism, Its Exploitation and Limits on ILP: Introduction To Pipelining, the major hurdle of pipelining-pipeline hazards, How is pipelining implemented.	
ILP and its exploitation: Concepts and Challenges, Basic compiler techniques for exposing ILP, Reducing branch cost with prediction, overcoming data hazards with dynamic scheduling, hardware based speculation, exploiting ILP using multiple issues and static scheduling, exploiting ILP using Dynamic scheduling, multiple issue and speculation, advanced techniques for instruction delivery and speculation. Case study of Pentium 4.Introduction to limits on ILP	**10 Hours**
UNIT-III	
Title: Memory Hierarchy Design, Storage Systems: Review of basic concepts; Cross cutting issues in the design of memory hierarchies; Case study of AMD Opteron memory hierarchy. **Hardware and Software for VLIW and EPIC: Introduction:** Exploiting Instruction-Level Parallelism Statically, Detecting and Enhancing Loop-Level Parallelism, Scheduling and Structuring Code for Parallelism, Hardware Support for	

Exposing Parallelism: Predicated Instructions, Hardware Support for Compiler Speculation, The Intel IA-64 Architecture and Itanium Processor.	**10Hours**
UNIT-IV	
Introduction to High Performance Computing: What is high performance computing? -Motivation, Applications, Challenges. **HPC Computer architecture models:** SIMD, MIMD,SPMD; **HPC Communication models:** Shared Address Space vs. Message Passing. **Distributed-Memory Parallelism:** Parallel Algorithm Design, Parallel Programming with MPI, The Message Passing Programming Model, blocking vs. Non-blocking communications, MPI program Anatomy & communicators, MPI program to Parallel Matrix Multiplication	**10 Hours**
UNIT-V	
Shared-Memory Parallelism: Basic Patterns in Pthreads, Mutual Exclusion in Pthreads, Basic Patterns in OpenMP, Mutual Exclusion in OpenMP. **Hybrids and Accelerators:** Hybrid Architectures, MPI+ OpenMP – Use MPI and OpenMP in the same application, Introduction to GPGPU computing with CUDA, Coprocessors – Overview of Intel's Xeon Phi architecture, introduction to programming Intel's XeonPhi.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the fundamental principles of computer design and topics of computer arithmetic.
2.	Knowledge of Instruction level parallelism, hurdles in ILP, and techniques to exploit ILP.
3.	Analyze various techniques to improve cache performance and identify the hardware and software needed for VLIW and EPIC architecture.
4.	Identify and explore the concepts of high-performance computing and distributed memory parallelism.
5.	Realize the shared memory parallelism and GPU programming

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	2		3	3	3			2	3	
2	2		3	2	2			2	2	
3	2		3	2	2			2	2	
4	3		2	3	3			2	3	2
5	3		2	3	3			2	3	2

TEXTBOOKS:	
1	JohnL. Hennessey and David A. Patterson, Computer Architecture, A Quantitative Approach, 4th Edition, Elsevier, 2007.
2	Niranjan N. Chiplunkar and Raju K., Introduction to Parallel Computing. Wiley India,2020.
3	Michael J.Quinn, Parallel Programming in C with MPI and OpenMP,McGraw-Hill Higher Education 2003.
4	Jason Sanders and Edward Kandrot, CUDA by Example: An Introduction to General-PurposeGPU Programming, 2010.
REFERENCE BOOKS:	
1.	Ananth Grama , Introduction to parallel computing, Addison-Wesley 2nded.,2003.
2.	VictorEijkhout,IntroductiontoHigh-PerformanceScientificComputing,2011.
3.	http://web.stanford.edu/class/cme213/lecture.html: MPI,OpenMP,CUDAandXeonPhiprogramming.

OPERATING SYSTEMS AND VIRTUALIZATION

Course Code:	**22CSE202**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**4+0+0+0**	**Credits**	**04**
Total Teaching Hours	**50**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To introduces Virtualization, operating systems fundamental concepts and its technologies
2.	To provides skills to write programs that interact with operating systems components such as Processes, Thread, Memory during concurrent execution
3.	To provide the skills and knowledge necessary to implement, provisioning and administer server and desktop virtualization

UNIT-I	
Computer system architecture a layered view with interfaces – Glenford Myer, Monolithic Linux Hybrid Windows10 kernels Layered architecture of operating system and core functionalities, Process Operations, States, Context switching, Data Structures (Process Control Block(PCB), Process Scheduling: Multilevel Feedback Queue, Multiprocessor Scheduling, Deadlocks and its detection	**10 Hours**
UNIT-II	
Memory - Introduction, Address Spaces, Memory API, Address Translation, Paging-Faster Translations (TLB), Smaller Tables. Virtual Memory System inx86 Concurrency - Introduction, Thread Models, Thread API, Building Evaluating a Lock, Test And Set, Two phase lock, Classical problems handling using semaphore. Persistence- File Organization: The i-node, Crash Consistency, file security.	**10 Hours**
UNIT-III	
Virtual Machines - Process and System VMs Taxonomy of VMs, Types of Virtualization, Hardware Emulation, Full Virtualization with binary translation, Hardware assisted, Operating System Virtualization, OS assisted /Para virtualization.	**10 Hours**
UNIT-IV	
Mass storage structures: storage device management, swap-space management. Implementing file system: file system concepts, file system structure and operations., Hypervisor - Type 1, Type 2, Para virtualization, Server Virtualization, Desktop Virtualization.	**10 Hours**

UNIT-V

Security: Program threats, System and network threats. Protection: Principles of protection, role based access control, Mandatory access control. Overview VM portability- Clones, Templates, Snapshots, OVF, Hot And Cold Cloning Protecting Increasing Availability, Lightweight Virtual machine: Container /Docker.

10 Hours

Course Outcomes: At the end of the course student will be able to

1.	Study operating system layers and kernel architectures
2.	Design various techniques for process management
3.	Construct various address translation mechanism
4.	Perform process threading and synchronization
5.	Study various methods of virtualization and perform desktop and server virtualization
6.	Classify the light-weight virtual machines with dockers and containers
7.	Develop programs related to the simulations of operating systems and virtualization concepts

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	2	3	1				1	3	1	1
2	3	3				1		3		1
3	3	3	2					2	2	
4	3	3		2				3	2	
5	3	3	2	2	2			3	1	3

TEXTBOOKS:

1.	Thomas Anderson, Michael Dahlin, Operating Systems: Principles and Practice, Second Edition, Recursive Books,2014
2.	Matthew Portnoy, Virtualization Essentials, John Wiley Sons Inc; 2nd Edition, 2016
3.	

REFERENCE BOOKS:

1.	William Stallings, Operating Systems: Internals and Design Principles, 8thEdition
2.	A.Silberschatz and P.Galvin. Operating System Concepts. Eight Edition, John Wiley Sons, 2008
3.	Smith, Nair, Virtual Machines: Versatile Platforms for Systems and Processes, Morgan Kaufmann Publishers(2005)

Parallel Computing Lab

Course Code:	**22CSE203**	**Course Type:**	**PCC Lab**
Teaching Hours/Week (L: T: P: S):	**0+0+2+0**	**Credits:**	**01**
Total Teaching Hours:	**2**	**CIE + SEE Marks:**	**50+50**

Course Objectives:

1.	To develop OpenMP programs.
2.	To develop MPI programs.
3.	To develop CUDA programs.
4.	To profile parallel programs.

List of Experiments

1.	OpenMP Sample Programs Time estimation
2.	Develop a sample program using Execution Environment Routines and write interesting observations by comparing various routines
3.	Develop a program using following construct and describe scenario for the need of construct Parallel Construct
4.	Determining the Number of Threads for a parallel Region Work-sharing Constructs
5.	Loop construct Sections construct Single construct Schedule clause Static Dynamic Guided
6.	Data Environment Constructs Shared Clause Critical Construct Reduction Clause Master Construct No Wait Clause Barrier Construct Atomic Construct
7.	Analysis through any one of profiling tools (ITAC/VTune/EEP/IIP) Experimental setup
8.	Parallelizing given serial program into parallel
9.	Analyzing parallel programs
10.	CUDA programming
11.	Write a CUDA C/C++ program that add two array of elements and store the result in third array
12.	How to Reverse Single Block in an Array using CUDA C/C++
13.	CUDA C program for Matrix addition and Multiplication using Shared memory
14.	Write CUDA C/C++ program for Vector Addition. Modify your program so that it can add two vector of arbitrary size

Course Outcomes: At the end of the course student will be able to

1.	Develop shared memory parallel programs using OpenMP directives.
2.	Develop distributed memory parallel programs using MPI APIs.
3.	Develop GPU parallel programs using CUDA-C APIs.
4.	Profile parallel programs using VTune
5.	Analyze parallel programs

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	PSO↓ 1	PSO↓ 2
1	2	2	2	3	3	2		2	3	2
2	2	2	2	3	3	2		2	3	2
3	2	2	2	3	3	2		2	3	2
4	2	2	2	3	3	2		2	3	2
5	2	2	2	3	3	2		2	3	2

REFERENCE BOOKS:

1.	Niranjan N. Chiplunkar and Raju K., Introduction to Parallel Computing. Wiley India,2020.
2	David Kirk and Wen-Mei W.Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 2010.
3	Jason Sanders and Edward Kandrot, CUDA by Example: An Introduction to General-Purpose GPU Programming, 2010.

E Resources

1.	http://web.stanford.edu/class/cme213/lecture.html: MPI, OpenMP, CUDA and Xeon Phi programming.
2	Introduction to MPI (SHARCNET). Online: https://www.youtube.com/watch?v=RoQJNx5npF4
3	Introduction to MPI programming, by Hristo Iliev, HPC Group, RWTH Aachen University. Online: https://www.youtube.com/channel/UCtdrEoe46tD2IvJJRs_JH1A/videos
4	Introduction to OpenMP - Tim Mattson (Intel). Online: https://www.youtube.com/playlist?list=PLLX-Q6B8xqZ8n8bwjGdzBJ25X2utwnoEG
5	CUDA Training Resources by NVIDIA. Online: https://developer.nvidia.com/educators/existing-courses

Operating Systems and Virtualization Lab

Course Code:	**22CSE204**	**Course Type:**	**PCC Lab**
Teaching Hours/Week (L: T: P: S):	**0+0+2+0**	**Credits:**	**01**
Total Teaching Hours:	**2**	**CIE + SEE Marks:**	**50+50**

Course Objectives:

1.	To study basics of linux commands and execution of shell scripts.
2.	To study various scheduling algorithms and bankers algorithms.
3.	To analyse various dynamic memory allocation algorithms.
4.	To implement various page replacement algorithms.

List of Experiments

1.	Study of Basic Linux Commands
2.	Shell Programming (I/O, Decision making, Looping, Multi-level branching)
3.	Creating child process using fork() system call, Orphan and Zombie process creation
4.	Simulation of CPU scheduling algorithms (FCFS, SJF, Priority and Round Robin)
5.	Simulation of Banker's algorithm to check whether a given system is in safe state or not. Also check whether addition resource requested can be granted immediately
6.	Parallel Thread management using pthread library. Implement a data parallelism using multi-threading
7.	Dynamic memory allocation algorithms - First-fit, Best-fit, Worst-fit algorithms
8.	Page Replacement Algorithms FIFO, LRU and Optimal
9.	Virtualization Setup: Type-1, Type-2 Hypervisor
10.	Implementation of OS / Server Virtualization

Course Outcomes: At the end of the course student will be able to

1.	Study various shell scripts and command usage.
2.	Design various scheduling algorithms.
3.	Construct memory allocation algorithms based on first fit, best fit and worst fit algorithms.
4.	Develop various page replacement algorithms.
5.	

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2	3	1				1	3	1	1
2	3	3	1			1		3		1
3	3	3	2	2				3	2	
4	3	3		2				3	2	

RESEARCH EXPERIENCE THROUGH PRACTICE -2			
Course Code:	**22CSE205**	**Course Type**	**RETP**
Teaching Hours/Week (L: T: P: S)	**0:0:4:0**	**Credits**	**2**
Total Teaching Hours	**52**	**CIE**	**100**

Teaching Department:

Course Objectives: The research purposes are

- To foresee future problems through pursuit of truth as a "global centre of excellence for intellectual creativity".
- To respond to current social demands, and to contribute to the creation and development of scientific technologies with the aim of realizing an affluent society and natural environment for humanity.
- At the same time, the course aims to create excellent educational resources and an excellent educational environment through frontline research.
- To Understand professional writing and communication contexts and genres, analyzing quantifiable data discovered by researching, and constructing finished professional workplace documents.

The students are expected to carry out Mathematical modeling/Design calculations/computer simulations/Preliminary experimentation/testing of the research problems identified during Research Experience through Practice-I carried out in the first semester.

At the end of the second semester, students are expected to submit a full research paper based on the Mathematical modelling/ Design calculations/computer simulations/Preliminary experimentation/testing carried out during second semester.

The research paper prepared based on the work carried out by the PG Student is evaluated for 50 marks and 20 minutes presentation on the research work carried out will be evaluated for 50marks jointly by the examiners.

Course Outcomes: At the end of the course student will be able to

1.	Create a model/prototype through fabrication, simulation, data analysis, Experimentation for the proposed problem.
2.	Analyse and validate the results obtained.
3.	Compose a technical paper as per the given format.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3	2							3	2
2	3	2			3				2	
3	3	2						3		1

REFERENCE BOOKS:

1. The Undergraduate Research Hand book. Gina Wisker · 2018

DISTRIBUTED OPERATING SYSTEM

Course Code:	**22CSE211**	**Course Type:**	**PEC**
Teaching Hours/Week (L: T: P: S):	**3+0+0+0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Course Objectives:

1.	To understand the concept of a distributed operating system.
2.	To know about the distributed file system and shared memory.
3.	To understand the security issues in distributed systems.
4.	To make a case study of some real-time systems.

UNIT-I

Distributed System management: Introduction, Resource management, Task Assignment Approach, Load-Balancing Approach, Load-Sharing Approach, Process management in a Distributed Environment, Process Migration, Threads, Fault Tolerance. **Distributed Shared Memory:** Introduction, Basic Concepts of DSM, Hardware DSM, Design Issue in DSM Systems, Issue in Implementing DSM Systems, Heterogeneous and other DSM Systems, Case Studies.	**15 Hours**

UNIT-II

Distributed File System: Introduction to DFS, File Models, Distributed File System Design, Semantics of File Sharing, DFS Implementation, File Caching in DFS, Replication in DFS, Case studies. Naming: Introduction, Desirable features of a good naming system, Basic concepts, System- oriented names, Object-locating mechanisms, Issues in designing human-oriented names, Name caches, Naming and security, Case study: Domain name service.	**15Hours**

UNIT-III

Security in distributed systems: Introduction, Cryptography, Secure channels, Access control, Security Management, Case studies **Real-Time Distributed Operating Systems:** Introduction, Design issues in real-time distributed systems, Realtime communication, Real- time scheduling, Case study: Real-time communication in MAR.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain the DS concepts.
2.	Explain the working of distributed shared memory.
3.	Demonstrate the application of a distributed file system.
4.	Explain the security issues in distributed systems.
5.	Make a case study of distributed systems.

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	PSO↓ 1	PSO↓ 2
1	3		3	3	3				3	
2	3		3	3	3				3	
3	3		3	3	3				3	
4	3		3	3	3				3	
5	3		3	3	3				3	

TEXTBOOKS:

1. Pradeep. K. Sinha: Distributed Operating Systems: Concepts and Design, PHI, 2007.

REFERENCE BOOKS:

1. Andrew S. Tanenbaum: Distributed Operating Systems, Pearson Education, 2013.

DEEP LEARNING

Course Code:	**22CSE212**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3 Hours**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Computer Science & Engineering

Course Objectives:

1.	Understand the context of neural networks and deep learning
2.	Understand the data needs of deep learning
3.	Have a working knowledge of neural networks and deep learning
4.	Explore the parameters for neural networks

UNIT-I

Introduction: What is Deep Learning? What are Neural Networks? Neural networks basics: cost functions, hypotheses and tasks; training data; maximum likelihood-based cost, cross entropy, MSE cost; feed-forward networks; MLP, sigmoid units; neuroscience inspiration;	**15 Hours**
Neural Networks Training: Learning in neural network: output vs hidden layers; linear vs nonlinear networks; Backpropagation: learning via gradient descent; recursive chain rule (backpropagation); if time: bias-variance tradeoff, regularization; output units: linear, softmax; hidden units: tanh, RELU; Deep learning strategies: GPU training, regularization, RLUs, dropout.	

UNIT-II

Convolution Neural Networks: Invariance, stability, Variability models (deformation model, stochastic model), Scattering networks, Group Formalism, Properties of CNN representations: invertibility, stability, invariance, covariance/invariance: capsules and related models, Connections with other models: dictionary learning, LISTA, localization, regression, Embeddings (DrLim), inverse problems, Extensions to non-Euclidean domains.	**15 Hours**

UNIT-III

Deep Neural Networks for Sequences: Recurrent Neural Networks: RNN for language modelling and other tasks, GRUs and LSTMs -- for machine translation, LSTM, GRU	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
2.	Implement deep learning algorithms and solve real-world problems.
3.	Execute performance metrics of Deep Learning Techniques.
4.	Explore the parameters for neural networks.

5.	Apply the CNN and RNN for solving the engineering problems.

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3								3	
2			3	2					3	3
3	3		2		3					3
4	3		2							3
5	3	1	2	2	3					3

TEXTBOOKS:

1.	Ian Goodfellow, Yoshua Bengio, Aaron Courville. Deep Learning, The MIT Press, 2016.

REFERENCE BOOKS:

1.	Duda, R.O., Hart, P.E., and Stork, D.G. , Pattern Classification, Wiley-Interscience. 2nd Edition. 2001.
2.	Theodoridis, S. and Koutroumbas, K., Pattern Recognition. Edition 4, Academic Press, 2008.
3.	Russell, S. and Norvig, N, Artificial Intelligence: A Modern Approach, Prentice Hall Series in Artificial Intelligence. 2003.
4.	Bishop, C. M., Neural Networks for Pattern Recognition, Oxford University Press. 1995.
5.	Hastie, T., Tibshirani, R. and Friedman, J., The Elements of Statistical Learning, Springer. 2001.

E Books / MOOCs/ NPTEL

1.	http://cs224d.stanford.edu/syllabus.html https://www.cs.colorado.edu/~mozer/Teaching/syllabi/DeepLearningFall2017

OBJECT ORIENTED DESIGN

Course Code:	**22CSE213**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3 Hours**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Identify the heuristics of the object-oriented programming
2.	Explain the fundamentals of OOP
3.	Examine fine object-oriented relations
4.	Explain the role of Physical Object-Oriented Design,
5.	Make use of Heuristics in The Use of Heuristics in Object-Oriented Design

UNIT-I	
The Motivation for Object-Oriented Programming, Classes and Objects: The Building Blocks of the Object-Oriented Paradigm, Topologies of Action-Oriented Versus Object- Oriented Applications, The Relationships Between Classes and Objects the Inheritance Relationship	**15 Hours**
UNIT-II	
Multiple Inheritance, The Association Relationship, Class-Specific Data and Behavior, Physical Object-Oriented Design.	**15 Hours**
UNIT-III	
The Relationship Between Heuristics and Patterns, The Use of Heuristics in Object-Oriented Design	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Identify and make use of the heuristics in object-oriented programming.
2.	To explain the fundamentals of OOP and the role of Physical object oriented design.
3.	To examine the object-oriented relations between heuristics and patterns.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2	1	1			2		1	1	1
2	3	2	1			2		1	1	1
3	3	2	1			2		1	1	1

TEXTBOOKS:

1.	Object Oriented Design Heuristics, Arthur J Riel, Addison-Wesley 1996.

REFERENCE BOOKS:

1.	Elements of Reusable Object- Oriented Software
2.	John Vlissides Pearson Object - Oriented Modeling and Design with UM Paperback, Michael R. Blaha)

DISTRIBUTED SYSTEMS

Course Code:	**22CSE214**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3 Hours**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To learn the principles, architectures, algorithms and programming models used in distributed systems.
2.	To examine state-of-the-art distributed systems, such as Google File System.
3.	To design and implement sample distributed systems.

UNIT-I	
Overview of distributed system – examples of distributed systems: client -server architecture – WWW peer to peer – Napster –Bit torrent - mobile and ubiquitous computing –System Model: Physical model – architectural model – fundamental models External data representation- marshalling – un-marshalling- Message passing- group communication: Publish-subscribe system – message queues – shared memory approach. Remote procedure call – distributed objects-communication between distributed objects – RMI – JSON-RMI Process – Events- states – partial and total ordering – Synchronizing- physical clock synchronization- Christians algorithm- Berkeley algorithm – NTP – logical clocks – scalar and vector clock – lamport logical clock for partial and total ordering – consistent cut – inconsistent cut – global states – lamport global snapshot algorithm.	**15Hours**
UNIT-II	
Distributed deadlock – Resource allocation model - requirements and performance metrics - classification of distributed deadlock detection algorithm – Lamport - Haas- Misra Edge chasing distributed deadlock detection algorithm. Distributed Mutual exclusion – requirements and performance metrics of distributed mutual exclusion algorithm- Distributed mutual exclusion algorithm: token based –Raymond tree algorithm– quorum based : mekawa' svoting algorithm message based – Ricart Agrawala algorithm – Election – ring based election – bully election algorithm – Multicast communication.	**15 Hours**
UNIT-III	
Optimistic and pessimistic transactions -Two – phase commit protocol – three phase commit protocol – Transaction recovery - Replication – fault tolerant services- the gossip architecture- Name services: DNS – Directory Services: X.500 protocol – Distributed file System –File service Architecture- NFS - GFS –Distributed locking mechanism- Distributed shared memory – Sequential and Release consistency	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Identify the core concepts of distributed systems: the way in which several machines orchestrate to correctly solve problems in an efficient, reliable and scalable way.
2.	Examine how existing systems have applied the concepts of distributed systems in designing large systems.
3.	Apply these concepts to develop sample systems.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	3	2	1					1	2	2
2	3	1	1					1	2	2
3	3	2	2					1	2	2

TEXTBOOKS:

1.	Randy Chow and Theodore Johnson, "Distributed Operating Systems and Algorithms", Addison - Wesley, - Fourth Impression - 2012.

REFERENCE BOOKS:

1.	G. Coulouris, J. Dollimore , and T. Kindberg , "Distributed Systems : Concepts and Designs", 5th edition, Addison Wesley, 2011.
2.	Mukesh singhal and N.G. Shivaratri, "Advanced Concept sin Operating Systems, Distributed, Database, and Multiprocessor Operating Systems ", 1st edition, McGraw Hill, 1994.
3.	Vijay K. Garg, "Elements of Distributed Computing", 1st edition, Wiley & Sons, 2002.

ADVANCED SOFTWARE TESTING

Course Code:	**22CSE221**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3 Hours**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To Explain the overview of the testing technique and create test plans , test Cases and test Scenarios
2.	To Generate test Scripts, test requirements specification and test plan for given project
3.	To Illustrate the use of functional testing, nonfunctional testing and develop test cases in object-oriented testing
4.	To Make use of various modern engineering testing tools and techniques for automation testing
5.	To Evaluate the software quality using empirical software testing process

UNIT-I

Overview of Testing Techniques–Creating Test Plans and Test Cases – Test Scenarios – Test Data – Test Scripts, Test Requirements Specification and gathering – Creating TRS and Test Procedure Pre-Planning Activities: Success Criteria/Acceptance Criteria, Test Objectives, Assumptions, Entrance Criteria/Exit Criteria Test Planning: Test Plan, Requirements/Traceability, Estimating, Scheduling, Staffing, Approach, Test Check Procedures	**15 Hours**
Post-Planning Activities: Change Management, Versioning (change control/change management / configuration management) Software Test Management : Risk and Testing - Test Organization – Test progress monitoring and control.	

UNIT-II

Functional Testing: Automated Unit Testing – Test Plan & Scripts – Creating Automated Test Procedures and Reports – Integration Testing – Order of Integration – Creating & Maintaining Tested Databases- Test Metrics Non-Functional Testing : Performance Testing – Load Testing – Endurance Testing – Scalability Testing –Internationalization Testing– Performance Analysis and Reporting , Developing Test Cases in Object-oriented Testing - Object-oriented Testing Methods: Fault-based Testing, Scenario based Testing – Challenges. Creating an environment supportive of software testing – Building Software Testing Process – Selecting and Installing Software Testing Tools – Building Software Tester Competency.	**15 Hours**

UNIT-III

Automated Testing Tools – Functional Testing - Rational Functional Tester – Selenium – Cucumber - JUnit, Performance Testing Tools - Rational Performance Tester – HP Load runner, Test Management Tools - Quality Center, Performance Center Reports and Control Issues – Types of Review – Component of Review Plans – Reporting Review Results – Evaluation of Software Quality, Test Process Optimization, Empirical Software Testing and Analysis, Mobile Testing, SOA Testing , Data Warehouse Testing, Cloud Testing, BigData Testing, WebApps Testing, IoT Testing.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	**Explain** the overview of testing technique and create test plans , test Cases and test Scenarios
2.	**Generate** test Scripts, test requirements specification and test plan for given project
3.	**Illustrate** the use of functional testing , non functional testing and develop test cases in object-oriented testing
4.	**Make** use of various modern engineering testing tools and techniques for automation testing
5.	**Evaluate** the software quality using empirical software testing process

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3		3		2				2	
2	3		3		2				2	
3	3		3		3				2	
4	2		3		2				2	
5	2		3		2				2	

TEXTBOOKS:

1.	Srinivasan Desikan, Gopalaswamy Ramesh "Software Testing – Principles and practices ",Pearson Education, 2006
2.	Nick Jenkins "A Software Testing Primer – An Introduction to Software Testing" 2008. Scott W. Ambler "The Object Primer: Agile Model-Driven Development with UML 2.0" Third Edition, Cambridge University Press, March 2010.

REFERENCE BOOKS:

1.	"Software Testing – An ISTQB-BCS Certified Tester Foundation Guide", Third Edition,BCS,2015

E Books / MOOCs/ NPTEL

1.	https://www.coursera.org/specializations/software-testing-automation
2.	https://onlinecourses.nptel.ac.in/noc19_cs71/preview
3.	https://nptel.ac.in/courses/106105150

GENERAL PURPOSE COMPUTATION ON GPU

Course Code:	**22CSE222**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Know the architecture of GPUs.
2.	Understand the execution and memory model of CUDA and OpenCL.
3.	Understand the Programming Model of CUDA and OpenCL.
4.	To write GPU programs on CUDA and OpenCL frameworks.

UNIT-I

Heterogeneous Architecture and Parallel Computing: Introduction to parallel programming, Introduction to heterogeneous architecture-GPU in particular. Introduction to GPU computing, Why GPU, evolution of GPU pipeline and general purpose computation on GPU, GPU architecture case studies:NVIDIA G80,GT200, Fermi, AMD Radeon, AMDFusion APU etc. Execution Model: Features CUDA and OpenCL, Comparison CUDA and OpenCL, Thread organization, Kernel, error handling, and execution in CUDA and OpenCL.	**16 Hours**

UNIT-II

Programming Model: CUDA Introduction, basics of CUDA C, Complete CUDA structure, basic details of API and libraries, OpenCL overview, OpenCL basic specification, OpenCL C language, Vectorization. Memory Model: Introduction to memory model and GPU interaction with CPU, Memory model of CUDA and OpenCL, Memory Hierarchy (local/register, shared global) and optimizations, memory optimized programming, coding tips.	**14 Hours**

UNIT-III

Tools And Programming: Introduction to installation and compilation process, usage of tools, profiler and debugger. CUDA by Examples and OpenCL by Examples, Future Directions.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain the architecture of GPUs
2.	Describe the execution model of CUDA and OpenCL
3.	Illustrate the programming model of CUDA and OpenCL
4.	Explain the memory model of CUDA and OpenCL
5.	To develop GPU programs on CUDA and OpenCL frameworks

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	3	2	2	3	3	2		2	3	2

	2	3	2	2	3	3	2		2	3	2
	3	3	2	2	3	3	2		2	3	2
	4	3	2	2	3	3	2		2	3	2
	5	3	2	2	3	3	2		2	3	2

TEXTBOOKS:

1.	David Kirk and Wen-Mei W.Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 2010.
2.	Jason Sanders and Edward Kandrot, CUDA by Example: An Introduction to General-Purpose GPU Programming, 2010.
3	Niranjan N. Chiplunkar and Raju K., Introduction to Parallel Computing. Wiley India,2020.

REFERENCE BOOKS:

1.	T.Mattson,et al.Patterns Of ParallelProgramming,AddisonWesley,2005
2.	NVIDIACUDAProgrammingGuideV3.0,NVIDIA
3.	Benedict R. Gaster, Timothy G. Mattson and James Fung, OpenCL Programming GuidebyAaftabMunshi,2011.
4.	Benedict Gaster, David R. Kaeli, Lee Howes and Perhaad Mistry, Heterogeneous Computing with OpenCL, 2011.
5.	GPUGems3,H. Nguyen(ed.),Addison Wesley, 2007.
6.	GPUGems 2,M. Pharr(ed.),Addison Wesley, 2005.
7.	NVIDIA and OpenCL:http://www.nvidia.com/content/cudazone/download/ OpenCL/NVIDIA_Open CL_Programming Guide.pdf
8.	http://www.nvidia.com/content/cudazone/CUDABrowser/do
9.	Open CL at Khronos:http://www.khronos.org/developers/library/overview/ opencl_overview.pdf http://www.khronos.org/registry/cl/specs/opencl-1.0.48.pdf
10	http://developer.amd.com/zones/OpenCLZone/courses/pages/Introduction-OpenCL Programming2010.
11	http://developer.amd.com/gpu/amdappsdk/documentation/pages/TutorialopenCL .aspx

ANALYSIS OF COMPUTER NETWORKS

Course Code:	**22CSE223**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To understand and analyze the efficient usage available resources in transporting the voice packets.
2.	To understand the efficient sharing of the channel among the competing flow streams.
3.	To analyze the stream session in specific to deterministic network analysis.
4.	To analyze the stream session in specific to stochastic analysis.
5.	To understand the dynamic bandwidth sharing in elastic traffic.

UNIT-I

Introduction: Two examples of analysis: Efficient transport of packet voice calls, Achievable throughput in an input-queuing packet switch; The importance of quantitative modeling in the Engineering of Telecommunication Networks. **Multiplexing:** Network performance and source characterization; Stream sessions in a packet network: Delay guarantees; Elastic transfers in a packet network; Packet multiplexing over Wireless networks.	**15 Hours**

UNIT-II

Stream Sessions: Deterministic Network Analysis: Events and processes in packet multiplexer models: Universal concepts; Deterministic traffic models and Network Calculus; Scheduling; Application to a packet voice example; Connection setup: The RSVP approach. **Stream Sessions: Stochastic Analysis:** Deterministic analysis can yield loose bounds; Stochastic traffic models; Additional notation; Performance measures; Little's theorem, Brumelle's theorem, and applications; Multiplexer analysis with stationary and ergodic traffic; The effective bandwidth approach for admission control; Application to the packet voice example; Stochastic analysis with shaped traffic; Multihop networks; Long-Range-Dependent traffic.	**15 Hours**

UNIT-III

Adaptive Bandwidth Sharing for Elastic Traffic: Elastic transfers in a Network; Network parameters and performance objectives; Sharing a single link; Rate-Based Control; Window-Based Control: General Principles; TCP: The Internet's Adaptive Window Protocol; Bandwidth sharing in a Network.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain and analyze the efficient usage available resources in transporting the voice packets.
2.	Illustrate the efficient sharing of the channel among the competing flow streams.
3.	Analyze the stream session in specific to deterministic network analysis.

4.	Analyze the stream session in specific to stochastic analysis.
5.	Explain the dynamic bandwidth sharing in elastic traffic.

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3		2	2				3		3
2	3	2						2		3
3	3	2						2	2	
4	3		2					1	2	
5	3	2						1	1	

TEXTBOOKS:

1.	Anurag Kumar, D. Manjunath, Joy Kuri: Communication Networking and Analytical Approach, Elsevier, 2004.

REFERENCE BOOKS:

1.	M. Schwartz: Broadband Integrated Networks, Prentice Hall PTR, 1996.
2.	J. Walrand, P. Varaiya: High Performance Communication Networks, 2nd Edition, Morgan Kaufmann, 1999.

IMAGE PROCESSING AND ANALYSIS

Course Code:	**22CSE224**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Explain the concept and steps included in Digital Image Processing. Describe Image Sampling and Image Quantization techniques and Apply the knowledge of 4-8 and M pixel adjacency to illustrate some basic relationships between pixels
2.	Explain Frequency domain, illustrate Smoothing Frequency-Domain Filters and Sharpening frequency-Domain Filters.
3.	Comprehend different methods, models for video processing and motion estimation
4.	Apply the process of image enhancement for optimal use of resources.

UNIT-I

Image Basics Basic steps of Image processing system – Pixel relationship- Image Transforms-.Image Enhancement- Spatial filtering, Frequency Domain filtering – Image Segmentation – Image Compression. Binary object feature - Area, Centroid, Axis of Least Second Moment, Projections, Euler Number, Thinness Ratio, Eccentricity, Aspect Ratio, Moments, Boundary Descriptors - Chain Code, Freeman Code, and Shape Number, Signatures, Fourier Descriptors. Histogram-based (Statistical) Features, Intensity features- Hough transforms.	**15 Hours**

UNIT-II

Concepts and classification: statistical, structural and spectral analysis, Co-occurrence matrices - Edge frequency - Multiscale texture description - wavelet domain approaches, Texture categorization and Texture segmentation. **Colour Image Processing** – Gray Level to Color Transformations Histogram Processing- Color Image Smoothing and Sharpening Color Noise Reduction Color-Based Image Segmentation Color Edge Detection Patterns and pattern class, Bayes' Parametric classification, Feature Selection and Boosting, Template-Matching – based object recognition, Scene and Object Discrimination, Object Modelling, Model based object recognition	**15 Hours**

UNIT-III

VIDEO PROCESSING:

Basic Concepts and Terminology, Monochrome Analog Video, Analog Video Raster, Blanking Intervals, Synchronization Signals, Spectral Content of Composite Monochrome Analog Video, Color in Video Analog Video Standards, NTSC, PAL, SECAM, HDTV, Digital Video Basics: Advantages of Digital Video, Parameters of a Digital Video Sequence, The Audio Component.

Analog-to-Digital Conversion : Color Representation and Chroma Subsampling: Digital Video Formats and Standards, The Rec. 601 Digital Video Format, The Common Intermediate Format, The Source Intermediate Format,

Video Compression Techniques and Standards, Video Compression Standards, Codecs, and Containers, Video Processing in MATLAB, Reading Video Files, Processing Video Files, Playing Video Files, Writing Video Files, Problems

10 Hours

Course Outcomes: At the end of the course student will be able to

1.	Explain the concept and steps included in Digital Image Processing. Describe Image Sampling and Image Quantization techniques and Apply the knowledge of 4-8 and M pixel adjacency to illustrate some basic relationships between pixels
2.	Explain Frequency domain, illustrate Smoothing Frequency-Domain Filters and Sharpening frequency-Domain Filters.
3.	Comprehend different methods, models for video processing and motion estimation
4.	Apply the process of image enhancement for optimal use of resources.

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	3		2	2					3	2
2	3		2						3	2
3	2	2	2						2	3
4	2	3			3			2	2	3

TEXTBOOKS:

1.	Oge Marques, "Practical Image and Video Processing Using MATLAB", Wiley-IEEE, Press,2011
2.	Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Ed., Prentice- Hall, 2008.

REFERENCE BOOKS:

1.	Yu Jin Zhang, "Image Engineering: Processing, Analysis and Understanding", Tsinghua University Press, 2009
2.	Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012
3.	Bogusław Cyganek,"Object Detection and Recognition in Digital Images: Theory and Practice", Wiley, 2013

4.	Chanamallu Srinivasa Rao, Samayamantula Srinivas Kumar, "Content Based Image Retrieval Fundamentals & Algorithms - Basics, Concepts, and Novel Algorithms", Lap Lambert Academic Publishing, 2012

BLOCKCHAIN TECHNOLOGY

Course Code:	**22CSE231**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Understand conceptual working of block chain technology
2.	Devise the block chain technology to innovate and improve business processes.
3.	Get the idea of working with Ethereum and Smart Contracts in Block Chain Environment.
4.	Solving real-world problems using Remix IDE and Truffle
5.	Describe and illustrate the idea of Hyperledger Fabric.

UNIT-I

Introduction: What Is the Blockchain? What is Bitcoin? The Connected World and Blockchain: The Fifth Disruptive Computing Paradigm. How does blockchain work ? How does blockchain accumulate blocks? Tiers of blockchain technology, Features of a blockchain, Types of blockchain. Blockchain Currency: Technology Stack: Blockchain, Protocol, Currency, The Double-Spend and Byzantine Generals' Computing Problems, How a Cryptocurrency Works. Benefits and limitations of blockchain : Technical Challenges, Business Model Challenges, Scandals and Public Perception, Government Regulation, Privacy Challenges for Personal Records, Overall: Decentralization Trends Likely to Persist. Consensus: Consensus mechanism, Types of consensus mechanisms, Consensus in blockchain, CAP theorem and blockchain	**15 Hours**

UNIT-II

Decentralization: Decentralization using blockchain, Methods of decentralization, How to decentralize, Computing power and decentralization, DO, DAO, DAC ,DAS, Dapps, Ethereum and Smart Contracts: Definition, Ricardian contracts, Deploying smart contracts on a blockchain, Ethereum Blockchain, Ethereum Network, Components of the Ethereum, ecosystem, Ether cryptocurrency, Introducing Solidity, Global Variables and Functions, Expressions and Control Structures, Writing Smart Contracts, Truffle Basics and Unit Testing, Debugging Contracts Remix IDE: Programs execution.	**15 Hours**

UNIT-III

Hyperledger: Fabric, The reference architecture, Requirements and design goals of Hyperledger Fabric, Membership services, Blockchain services, Components of the fabric, Chain code implementation, The application model, Consensus in Hyperledger Fabric, The transaction life cycle in Hyperledger Fabric.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain the block chain technology
2.	Illustrate the significance of Consensus and working of cryptocurrency.
3.	Develop block chain-based solutions and write smart contract using Remix IDE and Ethereum frameworks.
4.	Build and deploy block chain application using Truffle Suite.
5.	Create and deploy a block chain network using Hyperledger Fabric SD

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2								1	2
2	2		3						1	2
3	2			2	2				3	2
4	2		3		3				2	3
5	2	2	3		3			2	2	3

TEXTBOOKS:

1.	Melanic Swan, "Block Chain: Blueprint for a New Economy", O'Reilly, 2015.
2.	Imran Bashir, "Mastering BlockChain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Packt Publishing.
3.	Ritesh Modi, "Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and BlockChain", Packt Publishing

REFERENCE BOOKS:

1.	Anshul Kaushik, "BlockChain and Crypto Currencies", Khanna Publishing House, Delhi.
2.	Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer", Import, 2018.
3.	Josh Thompsons, "Block Chain: The BlockChain for Beginners-Guide to Block chain Technology and Leveraging BlockChain Programming".
4.	Daniel Drescher, "BlockChain Basics", Apress; 1st edition, 2017.

SPEECH PROCESSING

Course Code:	**22CSE232**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	Understand the fundamentals of speech processing.
2.	Study the models of speech processing.
3.	Explain the linear predictive coding.
4.	Illustrate the application of speech processing.

UNIT-I

Introduction, Fundamentals of Digital Speech Processing, Digital models for the speech signals, Time domain models for speech processing, Digital representation of the speech waveform, short term Fourier analysis.	**15Hours**

UNIT-II

Homomorphic speech processing, Linear predictive coding of speech: Introduction, Basic principles of LP analyse, Computation of gain for the model, solution of LPC equation, Comparison between the methods of solution of the LPC analysis equation, the prediction error signal.	**15 Hours**

UNIT-III

Linear predictive coding of speech: Frequency domain interpretation of LP analysis, Relation of LP analysis, Relations between various speech parameters, applications Digital speech for man machine communication by voice	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain the fundamentals of speech processing.
2.	Understand the various models of speech processing.
3.	Infer the linear predictive coding.
4.	Illustrate the application of speech processing.

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	**7**	**8**	**PSO↓** 1	2
1	1		2	2					1	
2	1		2	2					1	
3	1		2	2					1	
4	1		2	2					1	

TEXTBOOKS:

1.	Digital Processing of Speech Signals, Lawrence R. Rabiner , Ronald W. Schafer, Pearson

REFERENCE BOOKS:

1.	Speech and Audio Signal Processing, A.R. JAYAN, PHI
2.	Speech and Audio Processing, Apte Shaila D, Wiley India Pvt. Ltd

SOFTWARE ENGINEERING AND MODELING

Course Code:	**22CSE233**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To explain the overview of fundamentals of software process models and principles of engineering concepts related to requirements and architectures
2.	To describe the process of modeling, distributed architecture, software validation and reuse
3.	To establish the foundation on object oriented design principles and patterns
4.	To recognize the importance of software testing and describe the intricacies involved in software maintenance.
5.	To analyze the process of software reuse and explain the importance of distributed software engineering.

UNIT-I

Software Process Models and Principles Software Process Models: Waterfall, V-model, Spiral iterative and Incremental-Component- based development, Fourth Gen Techniques, Introduction to Agile Software Development, Agile Principles and Practices, Extreme Programming **Modelling Requirements** Software Requirements Engineering, Software Architecture: Architectural Tactics and Patterns- Architecture in the Life Cycle: Architecture and Requirements.	**15 Hours**

UNIT-II

Modelling Design Designing Architecture. Object Oriented Design, Design principles DFD, UML tools, OOD metrics, Overview of Design Patterns **Software Validation** Introduction to Software Verification Validation, levels of testing, types of testing, Black box design techniques, White box design techniques, statement coverage, decision coverage, condition coverage, Static Review process. Functional non-functional testing. Software Maintenance - Software Maintenance, Software Configuration Management.	**15Hours**

UNIT-III

Software Reuse Reuse based Software Engineering Approaches, supporting software reuse application frameworks Commercial-Of-The-Shelf(COTS) systems: COTS Solution Systems, COTS Integrated Systems. Component-Based Software Engineering (CBSE) Components, Component Models, CBSE Processes: CBSE for Reuse, CBSE with Reuse, Component-based Development: **Distributed Software Engineering** Distributed Software Engineering, Distributed system characteristics, Design Issues, Middleware Client-Server Computing, Client-Server Interaction, Architectural Patterns for Distributed Systems: Master/Slave, Two-tier, Multi-tier, Distributed component, and Peer-to-Peer Software as a Service (SaaS) Key elements Implementation factors, Configuration of a system offered as a service.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	**Explain** the overview of fundamentals of software process models and principles of engineering concepts related to requirements and architectures
2.	**Describe** the process of modeling, distributed architecture, software validation and reuse
3.	**Establish** the foundation on object oriented design principles and patterns
4.	**Recognize** the importance of software testing and describe the intricacies involved in software maintenance.
5.	**Discuss** the process of software reuse and explain the importance of distributed software engineering.

Program Outcomes→	1	2	3	4	5	6	**7**	**8**	**PSO↓**	
↓ Course Outcomes									1	2
1	2	3	2		2			2		2
2	2	3	2		2			2		2
3	2	3	2		2			2		2
4	2	3	2		2			2		2
5	2	3	2		2			2		2

TEXTBOOKS:

1.	Roger Pressman, Software Engineering: A Practitioner's Approach, 7th Edition, McGrawHill,2010.

REFERENCE BOOKS:

1.	Ian Sommerville, Software Engineering, 9th Edition, , Addision-Wesley, 2010.
2.	Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice, 3rd Edition, , Addison- Wesley Professional, 2012 (SEI Series in Software Engineering).
3.	Robert E. Filman, Tzilla Elrad, Siobhn Clarke, Mehmet Aksit ,Aspect-Oriented Software Development, Addison-Wesley Professional, 2004.

4.	Martin Fowler, Refactoring: Improving the design of existing code, Addison Wesley, 1999. 5.Robert C. Martin ,Agile Software Development, Principles, Patterns, and Practices, Pearson, 2011.
5.	Ian Sommerville, Software Engineering, 9th Edition, , Addision-Wesley, 2010.
E Books / MOOCs/ NPTEL	
1.	https://www.coursera.org/specializations/software-engineering
2.	https://nptel.ac.in/courses/106105182

WEB SERVICES

Course Code:	**22CSE234**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Course Objectives:

1.	To provide a basic conceptual understanding of web enterprise architectures.
2.	To explore distributed remote communication.
3.	To understand the basic concepts of Service Oriented Architecture.
4.	To explore XML, web services, web service security and its implementation.
5.	To understand micro services and enterprise application patterns.

UNIT-I

Web Architecture: MVC, middleware - Design considerations, Issues in web application design: Security issues and interoperability issues (WS-I). RPC, Java RMI, message queuing, Data Serialization - MQTT, RabbitMQ, JMS-JSON - AVRO, Thrift, protocol buffer.	**15 Hours**

UNIT-II

Introducing SOA- SOA triangle, layered architecture of SOA, BPO - Business Process Outsourcing - Web service composition and coordination.	**15 Hours**
Web service creation and accessing - WSDL, SOAP, UDDI, XINS, JSON-RPC, JSON-WSP, REST- full web services, mashup, SEMANTIC WEB Services - RDF, RDFS, OWL, SPARQL	

UNIT-III

Evolution, Modeling services, Integration, Deployment, Testing, Monitoring, Security. Implementation of micro services. Concurrency patterns, Session state patterns. Web service security – protocols.	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	To identify issues in web applications architecture
2.	To apply Service oriented architecture to provide services to components using communication protocols
3.	To build service-oriented architecture for a given application
4.	To identify appropriate enterprise application patterns
5.	To implement different web services architectures
6.	To identify issues in web applications architecture
7.	To apply Service oriented architecture to provide services to components using communication protocols

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	PSO↓ 1	PSO↓ 2
1	3		2						3	2
2	3		2						3	2
3	3		2		3				3	2
4	3		2						3	2
5	3		2						3	2

TEXTBOOKS:

1.	J.D.Meier, Alex Homer,"Web Application Architecture guide, Patterns and Practices", Microsoft 2008.

REFERENCE BOOKS:

1.	ThomasErl," Service-Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005.
2.	Andrew S. Tenenbaum, Marteen Van Steen," Distributed Systems, Principles and Paradigms", Second Edition, Pearson, Prentice Hall,2007.
3.	Sam Newman," Building Microservices", O'Reilly,2015.
4.	Martin Fowler, David Rice, Matthew Foemmel, Edward Hieatt, RobertMee, RandyStafford," Patterns of Enterprise Application Architecture",Addison-Wesleyy,2002.7.Sacha Krakowiak," Middleware Architecture with Patterns and Frameworks",2009
5.	Leonard Richardson, Sam Ruby, "Restful Web Services", O'Reilly Media; First Edition edition (May 15, 2007)
6.	Ben Smith," Beginning JSON", Apress,2015
7.	Mark O' Neill," Web services security" , McGraw Hill,2003
8.	Kapil Pant, "Business Process Orchestration for SOA using BPMN and BPEL", Packt publishing,2008
10.	Gustavo Alonso,Fabio Casatii, Harumi Kuno, VijayMachiraju, "WebServices-Concepts, Architectures and Applications", Springer Verlag,2004

MOOC Course			
Course Code:	**22CSE**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

- Any MOOC course that is having contact hours in the range of 35-45 has to be selected.
- The selected subject is to be approved by the DPGC.
- The MOOC course is to be completed during the time frames of the running semester.
- Student must pass the exam and produce the certificate of clearing the exam.

DATA ANALYTICS USING R PROGRAMMING			
Course Code:	**22CSEAU1**	**Course Type**	**Audit**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**0**
Total Teaching Hours	**26**	**CIE + SEE Marks**	**50+50**

Unit – I

- Introduction to R: Handling Packages in R: Installing a R Package, Input and Output – Entering Data from keyboard – Printing fewer digits or more digits,
- R Data Types, R – Variables, R Operators, R Decision Making, R Loops.
- R-Function, R-Strings, R Vectors, R List, R Matrices, R Arrays.
- Data Frames, Expand Data Frame, Loading and handling Data in R
- R-CSV Files, R -Excel File
- Descriptive Statistics: Data Range, Frequencies, Mode, Mean and Median
- Standard Deviation – Correlation - Spotting Problems in Data with Visualization
- R –Pie Charts
- R Histograms

26 Hours

TEXTBOOKS:

1. Tilman M. Davies, "The Book of R: A First Course in Programming and Statistics", No Starch Press; 1st edition ,2016.
2. Introduction to Linear Regression Analysis by Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining (Wiley).

REFERENCE BOOKS:

1. Andrie de Vries and Joris Meys. "R For Dummies", 2nd Edition, John Wiley & Sons; 2nd edition, 2015.
2. Hadley Wickham, Garrett Grolemund, "R for data science: Import, Tidy, Trans-form, Visualize, And Model Data" ,O'Reilly; 1st edition, 2017.
3. Linear Models and Generalizations - Least Squares and Alternatives by C.R. Rao, H. Toutenburg, Shalabh, and C. Heumann (Springer, 2008)

MOOCs:

1. Data Science: Foundations using R Specialization
   https://www.coursera.org/specializations/data-science-foundations-r

Full stack Web Development			
Course Code:	**22CSEAP1/2**	**Course Type**	**Audit**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

All-in-One JavaScript Development Suite

Fundamentals Of JavaScript, JavaScript for Beginning Web Developers, JavaScript for Absolute Beginners, Fundamentals of jQuery, Fundamentals of Ajax Development, Create a node.js Real Time Chat Application

All-In-One HTML/HTML5 And CSS/CSS3 Suite, Applying Designs to Wire Frames with HTML5 and CSS3, Build Your Own HTML5 Video Player, Building Responsive Websites with HTML5 and CSS.

Node.Js - Introduction and Foundation, working with shrink-wrap to lock the node modules versions Working with asynchronous programming Building a HTTP Server with Node.JS using HTTP APIs File System Buffers, Streams, and Events Multi-Processing in NodeJS ExpressJS Express JS with MongoDB and Sqlite

Angular - What is Angular? Preparing for TypeScript Angular-4 new features Building with A4 Components Bootstrap Scaffolding Angular 4 Binding and Events Dependency Injection and services Directives Pipes Forms HTTP, Promises, and Observables

MongoDB Developer and Administrator -

Introduction to NoSQL databases, CRUD Operations in MongoDB, Indexing and Aggregation Replication and Sharding, Developing Java and Node JS Application with MongoDB

React.js - Welcome to Starting with React, React Components, React State and Prop, React Event Handling Routing in React flux Styling React

26 Hours

MOOC Course			
Course Code:	**22CSEAP1/2**	**Course Type**	**Audit**
Teaching Hours/Week (L: T: P: S)	**3+0+0+0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Syllabus as defined by the course provider. Duration should be 25-30 hours.