



K.S.R.M.

COLLEGE OF ENGINEERING

(UGC - Autonomous)

Accredited by NAAC with A+ Grade & B.Tech. (EEE, ECE, CSE, CE and ME) Programs by NBA

An ISO 9001:2015, 14001: 2015 & 50001: 2018 Certified Institution

ACADEMIC REGULATIONS (R25PG) COURSE STRUCTURE AND SYLLABI

(Effective for the students admitted into I year
from the academic year 2025 -2026 onwards)

MASTER OF TECHNOLOGY (M.Tech.) ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

(Regular, Full-time)



K.S.R.M. COLLEGE OF ENGINEERING

VISION:

To evolve as a centre of repute for providing quality academic programs amalgamated with creative learning and research excellence to produce graduates with leadership qualities, ethical and human values to serve the nation.

MISSION:

- M1.** Provide high quality education with enriched curriculum blended with impactful Teaching-Learning practices.
- M2.** Promote Research, Entrepreneurship and Innovation through industry collaborations.
- M3.** Produce highly competent professional leaders for contributing to socio-economic development of the region and the nation.

**DEPARTMENT
OF
COMPUTER SCIENCE AND ENGINEERING**

VISION:

To evolve as a recognized center of excellence in the area of Computer Science and Engineering and other related inter-disciplinary fields.

MISSION:

- M1.** To produce competent and industry ready professionals through well balanced curriculum and innovative pedagogy.
- M2.** To provide conducive environment for research by establishing centre of excellence and industry collaborations.
- M3.** To instill leadership qualities, ethical values among students through various co-curricular and extracurricular activities.

M.Tech ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- PEO1.** Equip graduates with advanced knowledge in AI, machine learning, and data science to solve complex problems and drive innovation.
- PEO2.** Enable postgraduates to contribute effectively in industries, academia, research, and startups using modern AI tools and methodologies.
- PEO3.** Promote innovation, entrepreneurship, and lifelong learning in emerging areas like deep learning, NLP, computer vision, and big data.
- PEO4.** Develop ethical responsibility, communication, and leadership skills for collaborative work and sustainable AI solutions.

PROGRAM OUTCOMES (POs)

After completion of the Program, graduates will be able to

- PO1.** Apply advanced AI and data science concepts to solve complex problems using modern tools and techniques.
- PO2.** Conduct research to address challenges in AI domains like NLP, computer vision, and predictive analytics.
- PO3.** Design scalable, efficient, and ethical AI systems that meet performance and societal requirements.
- PO4.** Use programming languages, software frameworks, and project management tools to develop and deploy AI solutions.
- PO5.** Communicate technical insights effectively and uphold ethical standards in data and AI practices.
- PO6.** Engage in lifelong learning and assess the global and societal impact of AI technologies.

K.S.R.M. COLLEGE OF ENGINEERING

(AUTONOMOUS)

Academic Regulations of M.Tech. (Full Time/Regular) Programme

(Effective for the students admitted into I year from the Academic Year 2025-26 and onwards)

K.S.R.M. College of Engineering (KSRMCE) offers **Two Years (Four Semesters)** full-time Master of Technology (M.Tech.) Degree programme, under Choice Based Credit System (CBCS) in different branches of Engineering and Technology with different specializations.

The affiliating university Jawaharlal Nehru Technological University Anantapur shall confer M.Tech. degree on candidates who are admitted to the programme and fulfill all the requirements for the award of the degree.

1. Award of the M.Tech. Degree

A student will be declared eligible for the award of the M.Tech. degree if he/she fulfils the following:

- 1.1 Pursues a course of study for not less than two academic years and not more than four academic years.
 - 1.2 Registers for 75 credits and secures all 75 credits.
2. Students, who fail to fulfil all the academic requirements for the award of the degree within four academic years from the year of their admission, shall forfeit their seat in M.Tech. course and their admission stands cancelled.

3. Programme of Study:

The following M.Tech. Specializations are offered at present in different branches of Engineering and Technology and are as follows:

Discipline	Name of the Specialization	Code
Civil Engineering	Geo Technical Engineering	12
Electrical and Electronics Engineering	Power Systems	52
Mechanical Engineering	Renewable Energy	99
Computer Science and Engineering	Artificial Intelligence and Data Science	98
Electronics & Communication Engineering	Embedded Systems & VLSI	84

4. Eligibility for Admissions:

- 4.1 Admission to the M. Tech Program shall be made subject to the eligibility, qualification and specialization prescribed by the A.P. State Government/University from time to time.
- 4.2 Admissions shall be made either on the basis of either the merit rank or Percentile obtained by the qualified student in the relevant qualifying GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by A.P. State Government (APPGECET) for M.Tech. programmes an entrance test conducted by University/on the basis of any other exams approved by the University, subject to reservations as laid down by the Govt. from time to time.

5. Programme related terms:

5.1 **Credit:** 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 teaching (Lecture/Tutorial) or two hours of practical work/field work per week.

Credit definition:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit

5.2 **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.

5.3 **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed courses.

6. Programme Pattern:

6.1 Total duration of the of M.Tech. programme is two academic years

6.2 Each academic year of study is divided into two semesters.

6.3 Each Semester shall be of 22 weeks duration (inclusive of Examinations), with a minimum of 90 instructional days per semester.

6.4 The student shall not take more than four academic years to fulfill all the academic requirements for the award of M.Tech. degree from the date of commencement of first year first semester, failing which the student shall forfeit the seat in M.Tech. programme.

6.5 The medium of instruction of the programme (including examinations and project reports) will be in English only.

6.6 All subjects/courses offered for the M.Tech. degree programme are broadly classified as follows:

S. No.	Broad Course Classification	Course Category	Description
1.	Core Courses	Foundational & Professional Core Courses (PC)	Includes subjects related to the parent discipline / department / branch of Engineering/specialization.
2.	Elective Courses	Program Elective Courses (PE)	Includes elective courses related to the parent discipline / department / branch of Engineering
		Open Elective Courses (OE)	Elective courses which include inter-disciplinary courses or courses in an area outside the parent discipline which are of importance in the context of special skill development
3.	Mandatory Courses	Quantum Technology and Application	To understand importance of latest technologies, research and process of creation of patents through research
		Research methodology & IPR	
4.	Integrated Experiential Learning Courses	Skill Enhancement courses (SE)	Interdisciplinary / job-oriented / domain courses which are relevant to the industry
		Comprehensive Viva	To test the overall domain knowledge
		Short Term Industry Internship	To provide real time exposure
		Dissertation	To provide application of domain knowledge to solve real problems

S. No.	Broad Course Classification	Course Category	Description
5.	Audit Courses	Mandatory non-credit courses	Covering courses of developing desired attitude among the learners.

- 6.7 The college shall take measures to implement Virtual Labs (<https://www.vlab.co.in>) which provide remote access to labs in various disciplines of Engineering and will help student in learning basic and advanced concept through remote experimentation. Student shall be made to work on virtual lab experiments during the regular labs.
- 6.8 A faculty advisor/mentor shall be assigned to each specialization to advise students on the programme, its Course Structure and Curriculum, Choice of Courses, based on his competence, progress, pre-requisites and interest.
- 6.9 Preferably 25% course work for the theory courses in every semester shall be conducted in the blended mode of learning.

7. Attendance Requirements:

- 7.1 A student shall be eligible to appear for the Semester-End examinations if he/she acquires i) a minimum of 50% attendance in each course and ii) 75% of attendance in aggregate of all the courses.
- 7.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.
- 7.3 Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence
- 7.4 Students whose shortage of attendance is not condoned in any semester are not eligible to take their semester-end examination of that class.
- 7.5 A stipulated fee shall be payable towards condonation of shortage of attendance.
- 7.6 A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester. They may seek re-admission into that semester when offered next.
- 7.7 If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.
- 7.8 If the learning is carried out in blended mode (both offline & online), then the total attendance of the student shall be calculated considering the offline and online attendance of the student.

8. Evaluation – Distribution and Weightage of Marks:

The performance of a student in each semester shall be evaluated course - wise (irrespective of credits assigned), for a maximum of 100 marks for theory and 100 marks for practical, based on Internal Evaluation and Semester-End Examination.

- 8.1 There shall be five units in each of the theory courses. For the theory courses 60 marks will be for the Semester-End Examination and 40 marks will be for Internal Evaluation.
- 8.2 Two Internal Examinations shall be conducted for 30 marks each, one in the middle of the Semester and the other immediately after the completion of instruction period. The other 10 marks is awarded for continuous assessment in the form of assignments, quizzes, open book examination, presentation, etc. First mid examination shall be conducted for I & II units of the syllabus and second mid examination for III, IV & V units. Each mid

exam shall be conducted for a total duration of 120 minutes with 3 questions (without choice) and each question carries 10 marks. Final Internal marks for a total of 40 marks shall be arrived at by considering the marks secured by the student in both the internal examinations with 80% weightage to the better internal exam and 20% to the other.

- 8.3 The following pattern shall be followed in the End Examination:
- i. Five questions shall be set from each of the five units with either/or type for 12 marks each.
 - ii. All the questions have to be answered compulsorily.
 - iii. Each question may consist of one, two or more sub-questions.
- 8.4 For practical courses, 60 marks shall be for the Semester-End Examinations and 40 marks will be for internal evaluation based on the day-to-day performance.
- The internal evaluation based on the day-to-day work-10 marks, record- 10 marks and the remaining 20 marks to be awarded by conducting an internal laboratory test. The semester-end examination shall be conducted by the examiners, with a breakup mark of Procedure-10, Experimentation-25, Results-10, Viva-Voce-15.
- 8.5 There shall be Mandatory **Audit courses** in I & II semesters for zero credits. There is no external examination for audit courses. However, attendance shall be considered while calculating aggregate attendance and student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations. In case, the student fails, a re-examination shall be conducted for failed candidates for 40 marks for every six months/semester satisfying the conditions mentioned in item 1 & 2 of the regulations.
- 8.6 A candidate shall be deemed to have secured the minimum academic requirement in a course if he secures a minimum of 40% of marks in the Semester-End Examination and a minimum aggregate of 50% of the total marks in the Semester-End Examination and Internal Evaluation taken together.
- 8.7 In case the candidate does not secure the minimum academic requirement in any of the courses he/she has to reappear for the Semester-End Examination either supplementary or regular in that course or repeat the course when next offered or do any other specified course as may be required.
- 8.8 The laboratory records and mid semester test papers shall be preserved for a minimum of 3 years in the respective institutions as per the University norms and shall be produced to the Committees of the University as and when the same are asked for.

9. Credit Transfer Policy

As per University Grants Commission (Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016, students are allowed to do up to a maximum of 40% of the Professional and Open Electives in a semester through SWAYAM/SWAYAM Plus.

- 9.1 The college offers credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online learning courses through SWAYAM platform.
- 9.2 The online learning courses available on the SWAYAM platform will be considered for credit transfer. SWAYAM course credits are as specified in the platform
- 9.3 Student registration for the MOOCs shall be only through the college, it is mandatory for the student to share necessary information with the college
- 9.4 The institution will list out the courses to be permitted for credit transfer through

SWAYAM. However, while selecting courses in the online platform institution would essentially avoid the courses offered through the curriculum in the offline mode.

- 9.5 The institution will notify at the beginning of semester the list of the online learning courses eligible for credit transfer in the forthcoming Semester.
- 9.6 Students may register for an 8-week (2 credits) or 12-week (3 credits) SWAYAM / SWAYAM plus course with the approval of the Head of the Department (HoD).
- 9.7 Examination fees, if applicable, shall be borne by the student. Pass marks and grading will be as per the JNTUA academic regulations.
- 9.8 A student must get minimum 40% marks for assignments and quizzes on the SWAYAM/ SWAYAM plus platform to be eligible for the semester-end examination. The students who are unable to get minimum internal marks in SWAYAM/ SWAYAM plus platform, they have to re-register for the course in subsequent semester through SWAYAM/ SWAYAM plus platform.
- 9.9 The semester-end exam may be conducted by the National Testing Agency (NTA), the National Programme on Technology Enhanced Learning (NPTEL) or the College during the regular term-end exams. Evaluation shall comprise 60% weightage for the semester-end examination and 40% for assignments and quizzes conducted by the SWAYAM/ SWAYAM plus course coordinator. The student has to get 50% marks for internal and external with minimum of 40% marks in the external examination to declare them as pass.
- 9.10 The institution also ensures that the student completes the course and produces the course completion certificate as per the academic schedule given for the regular courses in that semester. However, the credits will be transferred to the students who got minimum 50% marks with 40% marks in the external examination
- 9.11 The institution will designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.
- 9.12 The college will ensure no overlap of SWAYAM MOOC exams with that of the semester-end examination schedule. In case of delay in SWAYAM results, the college will re-issue the marks sheet for such students.
- 9.13 Student pursuing courses under MOOCs shall acquire the required credits only after successful completion of the course and submitting a certificate issued by the competent authority along with the minimum 50% of marks and grades.
- 9.14 The institution maintains the following in the examination section and submits as and when demanded by the university:
 - a) List of students who have passed MOOC courses in the current semester along with the certificates of completion.
 - b) Undertaking form filled by the students for credit transfer.
- 9.15 The college will resolve any issues that may arise in the implementation of this policy from time to time and shall review its credit transfer policy in the light of periodic changes brought by UGC, SWAYAM, NPTEL and state government.

Note: Students are also be permitted to register for MOOCs offered through online platforms other than SWAYAM NPTEL. In such cases, credit transfer shall be permitted only after seeking approval of the Principal with the recommendations of the concerned HoD and Dean, Academics at least three months prior to the commencement of the semester.

10. Re-registration for Improvement of Internal Evaluation Marks:

A candidate shall be given one chance to re-register for each course provided the internal marks secured by a candidate are less than 50% and has failed in the end examination

- 10.1 The candidate should have completed the course work and obtained examinations results for **I, II and III** semesters.
- 10.2 The candidate should have passed all the courses for which the Internal Evaluation marks secured are more than 50%.
- 10.3 Out of the courses the candidate has failed in the examination due to Internal Evaluation marks secured being less than 50%, the candidate shall be given one chance for each Theory course and for a maximum of **three** Theory courses for Improvement of Internal evaluation marks.
- 10.4 The candidate has to re-register for the chosen courses and fulfill the academic requirements.
- 10.5 For re-registration, the candidates have to apply to the Principal through the respective HoD by paying the requisite fees and get approval from the Principal before the start of the semester in which re-registration is required
- 10.6 In the event of availing the Improvement of Internal evaluation marks, the internal evaluation marks as well as the Semester-End Examinations marks secured in the previous attempt(s) for the reregistered courses stand cancelled.

11. Evaluation of Project/Dissertation Work:

The Project work shall be initiated at the beginning of the III-Semester and the duration of the Project is of two semesters. Evaluation of Project work is for 300 marks with 200 marks for internal evaluation and 100 marks for external evaluation. Progress of the project work is monitored through three reviews:

- Project review – I at the beginning of the III semester for zero marks
- Project review – II at the end of the third semester for 100 marks
- Project review – III before submission of the thesis i.e., end of the IV semesters for 100 marks

External evaluation of final Project work viva voce in IV semester shall be for 100 marks.

A Project Review Committee (PRC) shall be constituted with the Head of the Department as Chairperson, Project Supervisor and one faculty member of the department offering the M.Tech. programme.

- 11.1 A candidate is permitted to register for the Project Work in III Semester after satisfying the attendance requirements in all the courses, both theory and laboratory (in I & II semesters).
- 11.2 A candidate is permitted to submit Project dissertation with the approval of PRC. The candidate has to pass all the theory, practical and other courses before submission of the Thesis.
- 11.3 Project work shall be carried out under the supervision of teacher in the parent department concerned.
- 11.4 A candidate shall be permitted to work on the project in an industry/research organization on the recommendation of the Head of the Department. In such cases, one

- of the teachers from the department concerned would be the internal guide and an expert from the industry/research organization concerned shall act as co-supervisor/external guide. It is mandatory for the candidate to make full disclosure of all data/results on which they wish to base their dissertation. They cannot claim confidentiality simply because it would come into conflict with the Industry's or R&D laboratory's own interests. A certificate from the external supervisor is to be included in the dissertation.
- 11.5 Continuous assessment of Project Work - I and Project Work – II in III & IV semesters respectively will be monitored by the PRC.
 - 11.6 The candidate shall submit status report by giving seminars in three different phases (two in III semester and one in IV semester) during the project work period. These seminar reports must be approved by the PRC before submission of the Project Thesis.
 - 11.7 After registration, a candidate must present in Project Review - I, in consultation with his Project Supervisor, the title, objective and plan of action of his Project work to the PRC for approval within four weeks from the commencement of III Semester. Student shall initiate the project work, only after obtaining the approval of the PRC.
 - 11.8 The Project Review - II in III semester carries internal marks of 100. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate the work for the other 50 marks. The Supervisor and PRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Project Work.
 - 11.9 A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - II. Only after successful completion of Project Review – II, candidate shall be permitted for Project Work Review – III in IV Semester. The unsuccessful students in Project Review - II shall reappear after three months.
 - 11.10 The Project Review - III in IV semester carries 100 internal marks. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate it for the other 50 marks. The PRC will examine the overall progress of the Project Work and decide whether or not eligible for final submission. A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - III. If student fails to obtain the required minimum marks, he/she has to reappear for Project Review - III after a month.
 - 11.11 For the approval of PRC, the candidate shall submit the draft copy of dissertation to the Head of the Department and make an oral presentation before the PRC.
 - 11.12 After approval from the PRC, the student is permitted to submit a report. The dissertation report will be accepted only when the plagiarism is within 30% checked through Turnitin software (repository mode). The plagiarism report shall be submitted along with the dissertation report.
 - 11.13 Research paper related to the Project Work shall be published in an SCI / SCIE / ESCI / Scopus or in conference proceedings with ISBN number organized by professional societies such as IEEE, IET, etc.
 - 11.14 After successful plagiarism check and publication of research paper, three copies of the dissertation certified by the supervisor and HOD shall be submitted to the College.
 - 11.15 The dissertation shall be adjudicated by an external examiner selected by the College. For this, a panel of three examiners shall be submitted by the supervisor concerned and department head for each student. However, the dissertation will be adjudicated by one examiner nominated by the Principal.

- 11.16 If the report of the examiner is not satisfactory, the candidate shall revise and resubmit the dissertation, in the time frame as decided by the PRC. If report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate has to reregister for the project and complete the project within the stipulated time after taking the approval from the Principal.
- 11.17 If the report of the examiner is satisfactory, the Head of the Department shall coordinate and make arrangements for the conduct of Project Viva voce exam.
- 11.18 The Project Viva voce examinations shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who has adjudicated the dissertation. For Dissertation Evaluation (Viva voce) in IV Sem. there are external marks of 100 and it is evaluated by external examiner. The candidate has to secure a minimum of 50% marks in Viva voce exam.
- 11.19 If he fails to fulfill the requirements as specified, he will reappear for the Project Viva voce examination only after three months. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for the award of the degree.

12 Industry Internships:

Industry internship either onsite or virtual with a minimum of 06-08 weeks duration, done at the end of 1st year second semester. It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Power projects, software MNCs or any industries in the areas of concerned specialization of the PG program. The student shall register for the internship as per course structure after commencement of academic year.

Evaluation of the summer internships shall be through the departmental committee. A student will be required to submit a summer internship report to the concerned department and appear for an oral presentation before the departmental committee comprising of Head of the Department, Mentor/Supervisor of the internship and a senior faculty member of the department. A certificate of successful completion from industry shall be included in the report. Internship will be evaluated for 100 marks with 50 marks for the report evaluated by the mentor and 50 marks for oral presentation. A student should secure minimum 50% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the College.

13 Comprehensive Viva

A Comprehensive Viva shall be conducted after the II Semester examinations for 100 marks by a committee consisting of the Head of the Department, one senior faculty member of the same specialization, and an external subject expert appointed by the Principal. The student must secure a minimum of 50% marks to be declared as passed

14 Credits for Co-curricular Activities

A Student should earn 01 credits under the head of co-curricular activities, viz., attending Conference, Scientific Presentations and Other Scholarly Activities. The guidelines for awarding Credits for Co-curricular Activities are detailed in the following Table.

Name of the Activity	Maximum Credits / Activity
Participation in National Level Seminar / Conference / Workshop / Training programs (related to the specialization of the student)	0.5
Participation in International Level Seminar / Conference / Workshop / Training programs held outside India (related to the specialization of the student)	1
Academic Award/Research Award from State Level / National Agencies	0.5
Academic Award / Research Award from International Agencies	1
Research / Review Publication in National Journals (Indexed in Scopus / Web of Science)	0.5
Research / Review Publication in International Journals with Editorial board outside India (Indexed in Scopus / Web of Science)	1

Note:

- i) Credit shall be awarded only for the first author. Certificate of attendance and participation in a Conference/Seminar is to be submitted for awarding credit. A minimum participation of five days is required to earn the necessary credits. Alternatively, the student may attend five different one day programs to meet this requirement.
- ii) Certificate of attendance and participation in workshops and training programs (Internal or External) is to be submitted for awarding credit. The total duration should be at least one week.
- iii) Participation in any activity shall be permitted only once for acquiring required credits under cocurricular activities

15 Grading:

As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades and corresponding percentage of marks shall be followed:

After each course is evaluated for 100 marks, the marks obtained in each course will be converted to a corresponding letter grade as given below, depending on the range in which the marks obtained by the student fall.

Structure of Grading of Academic Performance

Range in which the marks in the course fall	Grade	Grade points Assigned
≥ 90	S (Superior)	10
≥ 80 < 90	A (Excellent)	9
≥ 70 < 80	B (Very Good)	8
≥ 60 < 70	C (Good)	7
≥ 50 < 60	D (Pass)	6
< 50	F (Fail)	0
Absent	Ab (Absent)	0

- i) A student obtaining Grade "F" or Grade "Ab" in a course shall be considered failed and will be required to reappear for that course when it is offered the next supplementary examination.
- ii) For noncredit audit courses, "Satisfactory" or "Unsatisfactory" shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA / CGPA / Percentage.

Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The Semester Grade Point Average (SGPA) is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$$SGPA = \frac{\sum (C_i \times G_i)}{\sum C_i}$$

where, C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course.

- i) The Cumulative Grade Point Average (CGPA) will be computed in the same manner considering all the courses undergone by a student over all the semesters of a program, i.e.,

$$CGPA = \frac{\sum (C_j \times S_i)}{\sum C_j}$$

where " S_i " is the SGPA of the i^{th} semester and C_j is the total number of credits up to that semester.

- ii) Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- iii) While computing the SGPA the courses in which the student is awarded Zero grade points will also be included.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters S, A, B, C, D and F.

16 Award of Class:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree, he shall be placed in one of the following three classes:

Class Awarded	CGPA to be secured
First Class with Distinction	≥ 7.5
First Class	$6.5 \leq < 7.5$
Pass Class	< 6.5

17 Exit Policy:

The student shall be permitted to exit with a PG Diploma based on his/her request to the university through the respective institution at the end of first year subject to passing all the courses in first year.

The Academic Council shall resolve any issues that may arise in the implementation of this policy from time to time and shall review the policy in the light of periodic changes brought by UGC, AICTE and State government.

18 Withholding of Results:

If the candidate has any case of in-discipline pending against him/her, the result of the candidate shall be withheld, and he/she will not be allowed/promoted into the next higher semester. The issue of degree is liable to be withheld in such cases.

19 Transitory Regulations

Discontinued, detained, or failed candidates are eligible for readmission as and when the semester is offered after fulfilment of academic regulations. Candidates who have been detained for want of attendance or not fulfilled academic requirements or who have failed after having undergone the course in earlier regulations or have discontinued and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent courses as and when courses are offered, subject to Section 2 and they will follow the academic regulations into which they are readmitted.

20 General:

- 20.1 The academic regulations should be read as a whole for purpose of any interpretation.
- 20.2 Disciplinary action for Malpractice / improper conduct in examinations is appended.
- 20.3 There shall be no places transfer within the constituent colleges and affiliated colleges of Jawaharlal Nehru Technological University Anantapur.
- 20.4 Where the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.
- 20.5 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.
- 20.6 The College may change or amend the academic regulations or syllabi at any time and the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the College.

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

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

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

S.No.	Nature of Malpractices / Improper conduct	Punishment
	<i>If the candidate:</i>	
	of the examination.	
7	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester / year. The candidate is also debarred and forfeits the seat. Person (s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester / year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that course only or in that course and all other courses the candidate has appeared including practical examinations and project work of that semester / year

S.No.	Nature of Malpractices / Improper conduct	Punishment
	<i>If the candidate:</i>	
		examinations, depending on the recommendation of the committee.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

1. Malpractices identified by squad or special invigilators
2. Punishments to the candidates as per the above guidelines.
3. Punishment for institutions: (if the squad reports that the college is also involved in encouraging malpractices)
4. A show cause notice shall be issued to the college.
5. Impose a suitable fine on the college.
6. Shifting the examination center from the college to another college for a specific period of not less than one year.

Note:

Whenever the performance of a student is cancelled in any course/courses due to Malpractice, he has to register for End Examinations in that course/courses consequently and has to fulfil all the norms required for the award of Degree.

COURSE STRUCTURE

M.Tech.

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

I-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	2598101	Artificial Intelligence and Intelligent Systems	PC	3	0	0	3
2.	2598102	Statistical Foundations for Data Science	PC	3	0	0	3
3.	Program Elective-I		PE	3	0	0	3
	2598103	Mining of Massive Datasets					
	2598104	Generative AI					
	2598105	Applied Machine Learning					
4.	Program Elective-II		PE	3	0	0	3
	2598106	Medical Imaging with AI					
	2598107	Smart Sensor Networks and IoT					
	2598108	Computing for Data Analytics					
5.	2598151	Artificial Intelligence and Intelligent Systems Lab	PC	0	0	4	2
6.	2598152	Statistical Foundations for Data Science using R Lab	PC	0	0	4	2
7.	2598153	Full Stack Development using MERN	SE	0	1	2	2
8.	2599171	Research Methodology and Intellectual Property Rights	MC	2	0	0	2
9.	Audit Course-I		AC	2	0	0	0
	2599181	English for Research Paper Writing					
	2512181	Disaster Management					
	2598181	Essence of Indian Traditional Knowledge					
TOTAL				16	1	10	20

II-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	2598201	Neural Networks and Deep Learning	PC	3	0	0	3
2.	2598202	Advances in Software Engineering	PC	3	0	0	3
3.	Program Elective-III		PE	3	0	0	3
	2598203	AI Enhanced Data Science					
	2598204	Social Network Analysis					
	2598205	Enterprise Cloud Concepts					
4.	Program Elective-IV		PE	3	0	0	3
	2598206	Reinforcement Learning					
	2598207	Machine Translation					
	2598208	Nature Inspired Computing					
5.	2598251	Neural Networks and Deep Learning Lab	PC	0	0	4	2
6.	2598252	Advances in Software Engineering Lab	PC	0	0	4	2
7.	2598253	Comprehensive Viva-Voce	PC	0	0	0	2
8.	2598281	Quantum Technologies and Applications	MC	2	0	0	2
9.	Audit Course-II		AC	2	0	0	0
	25HS201	Pedagogy Studies					
	25HS202	Personality Development through Life Enlightenment Skills					
	25HS203	Yoga for Stress Management					
TOTAL				16	0	8	20

* Students have to undergo an Industry Internship during Summer break in II-Semester for 06 to 08 weeks duration.

III-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	Program Elective-V		PE	3	0	0	3
	2598301	Big Data Curation					
	2598302	Multimodal AI					
	2598303	AI driven Software Engineering					
2.	2598351	Dissertation Phase-I	PR	0	0	20	10
3.	2598352	Industry Internship	PC	0	0	0	2
4.	2598353	Co-Curricular Activities	MC	0	0	0	1
5.		Open Elective	OE	3	0	0	3
TOTAL				6	0	20	19

OPEN ELECTIVE COURSES

S.No.	Course Code	Course Name	Offered by Dept.
1	2512381	Green Buildings	Civil
2	2512382	Road Safety Engineering	
3	2598381	Advanced Data Structures and Algorithms	CSE & Allied
4	2598382	Cloud Computing	
5	2598383	AI Tools	
6	2584381	IoT and its Applications	ECE
7	2552381	Photovoltaic Systems	EEE
8	2599381	Integrated Product Design and Development	ME
9	25HS381	Advanced Numerical Methods and Computational Mathematics	Mathematics
10	25HS382	Mathematics for Machine Learning and Data Science	
11	25HS383	Statistical Learning Theory and Mathematical Foundations of AI	
12	25HS384	Chemistry of Nanomaterials and Applications in Engineering	Chemistry
13	25HS385	Photonics For Engineers	Physics

IV-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	2598451	Dissertation Phase-II	PR	0	0	32	16
TOTAL				0	0	32	16

2598101	M.Tech., I-SEMESTER ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

CO1. Solve basic AI based problems.

CO2. Define the concept of Artificial Intelligence.

CO3. To apply logical and probabilistic reasoning techniques to design intelligent planning systems.

CO4. Apply AI techniques to real-world problems to develop intelligent systems.

CO5. Select appropriately from a range of techniques when implementing intelligent systems.

SYLLABUS:

UNIT-I: INTRODUCTION

(08 periods)

Overview of AI problems, AI problems as NP, NP-Complete and NP Hard problems. Strong and weak, neat and scruffy, symbolic and sub-symbolic, knowledge-based and data-driven AI.

UNIT-II: SEARCH STRATEGIES

(09 periods)

Problem spaces (states, goals and operators), problem solving by search, Heuristics and informed search, Min-max Search, Alpha-beta pruning. Constraint satisfaction (backtracking and local search methods).

UNIT-III: KNOWLEDGE REPRESENTATION AND REASONING

(09 periods)

Propositional and predicate logic, Resolution and theorem proving, Temporal and spatial reasoning. Probabilistic reasoning, Bayes theorem. Totally- ordered and partially-ordered Planning. Goal stack planning, Nonlinear planning, Hierarchical planning.

UNIT-IV: LEARNING AND NATURAL LANGUAGE PROCESSING

(09 periods)

Learning from example, learning by advice, Explanation based learning, learning in problem solving, Classification, Inductive learning, Naive Bayesian Classifier, decision trees.

Language models, n-grams, Vector space models, Bag of words, Text classification. Information retrieval.

UNIT-V: AGENTS, INTELLIGENT SYSTEMS AND KEY APPLICATION AREAS

(10 periods)

Definition of agents, Agent architectures (e.g., reactive, layered, cognitive), multi-agent systems- Collaborating agents, Competitive agents, Swarm systems and biologically inspired models. Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.

Expert system, decision support systems, Speech and vision, Natural language processing, Information Retrieval, Semantic Web.

Total Periods: 45

Textbooks:

T1. Artificial Intelligence: A Modern Approach, S. Russell and P. Norvig, Prentice Hall, 4th Edition, 2020.

Reference Books:

R1. Artificial Intelligence by Elaine Rich, Kevin Knight and Shivashankar B Nair, Tata McGraw Hill, 5th Edition. 2025.

R2. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Pearson Education, 1st Edition, 1990.

Web Resources:

1. <http://peterindia.net/AILinks.html>
2. <http://nptel.ac.in/courses/106106139>
3. <https://nptel.ac.in/courses/106/105/106105152/>

2598102	M.Tech., I-SEMESTER STATISTICAL FOUNDATIONS FOR DATA SCIENCE (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Course Outcomes:

After completion of the course, student will be able to

CO1. Apply the number theory concepts to cryptography domain

CO2. Apply the concepts of probability and distributions to some case studies

CO3. Analyze data using normal distributions and apply sampling techniques based on the Central Limit Theorem.

CO4. Perform statistical inference through estimation methods and hypothesis testing for various population parameters.

CO5. Model and analyze random systems using stochastic processes and Markov chains.

SYLLABUS:

UNIT-I: GREATEST COMMON DIVISORS AND PRIME FACTORIZATION

(08 Periods)

Greatest common divisors, The Euclidean algorithm, The fundamental theorem of arithmetic, Factorization of integers and the Fermat numbers
 Congruences: Introduction to congruences, Linear congruences, The Chinese remainder theorem, Systems of linear congruences

UNIT-II: SIMPLE LINEAR REGRESSION AND CORRELATION

(10 Periods)

Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators, Inferences Concerning the Regression Coefficients, Prediction, Simple Linear Regression Case Study
 Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Statistical Independence. Discrete Probability Distributions: Binomial Distribution, Poisson distribution.

UNIT-III: CONTINUOUS PROBABILITY DISTRIBUTIONS

(09 Periods)

Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Fundamental Sampling Distributions: Random Sampling, Sampling Distributions, Sampling, Distribution of Means and the Central Limit Theorem, Sampling Distribution of S^2 , t-Distribution, F Distribution.

UNIT-IV: ESTIMATION & TESTS OF HYPOTHESES

(09 Periods)

Introduction, Statistical Inference, Classical Methods of Estimation. Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Tolerance Limits, Estimating the Variance, Estimating a Proportion for single mean, Difference between Two Means, between Two Proportions for Two Samples and Maximum Likelihood Estimation.

UNIT-V: STOCHASTIC PROCESSES AND MARKOV CHAINS

(09 Periods)

Introduction to Stochastic processes- Markov process. Transition Probability, Transition Probability Matrix, First order and Higher order Markov process, n step transition probabilities, Markov chain, Steady state condition, Markov analysis.

Textbooks:

- T1.** Elementary number theory & its applications Kenneth H. Rosen, 7th Edition, Addison Wesley, ISBN 978 0-321-50031-1.2019.
- T2.** Probability & Statistics for Engineers & Scientists Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, , 9th Edition 2021. Pearson Publishers.
- T3.** Operations Research ,S. D. Sharma, , Kedarnath and Ramnath Publishers, Meerut, Delhi 4th Edition 2009

Reference Books:

- R1.** Fundamentals of Mathematical statistics, S C Gupta and V K Kapoor, Khanna publications 12th Edition 2020.
- R2.** Fundamentals of Probability and Statistics for Engineers, T.T. Soong, John Wiley & Sons Ltd, 1st Edition 2004.
- R3.** Probability and statistics for Engineers and scientists Sheldon M Ross, , Academic Press 6th Edition 2017.

Web Resources:

- 1. <https://nptel.ac.in/courses/106/105/106105152/>
- 2. <http://nptel.ac.in/courses/106106139>
- 3. <http://peterindia.net/AILinks.html>

2598103	M.Tech., I-SEMESTER MINING OF MASSIVE DATASETS (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-I)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the Course, student will be able to

- CO1.** Handle massive data using MapReduce.
- CO2.** Develop and implement algorithms for massive data sets and methodologies in the context of data mining.
- CO3.** Demonstrate the algorithms for extracting models and information from large Datasets.
- CO4.** Develop recommendation systems.
- CO5.** Demonstrate experience in matching various algorithms for particular classes of problems.

SYLLABUS:

UNIT-I: DATA MINING MAPREDUCE AND THE NEW SOFTWARE STACK

(09 Periods)

Introduction-Definition of Data Mining-Statistical Limits on Data Mining, Distributed File Systems, MapReduce, Algorithms Using MapReduce

UNIT-II: SIMILARITY SEARCH AND STREAMING DATA

(09 Periods)

Finding Similar Items-Applications of Near-Neighbor Search, Shingling of Documents, Similarity-Preserving Summaries of Sets, Distance Measures.

Mining Data Streams-The Stream Data Model, Sampling Data in a Stream, Filtering Streams

UNIT-III: LINK ANALYSIS, FREQUENT ITEM SETS AND CLUSTERING (09 Periods)

PageRank, Efficient Computation of PageRank, Link Spam

Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream.

The CURE Algorithm, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism

UNIT-IV: ADVERTISING ON THE WEB AND RECOMMENDATION SYSTEMS

(10 Periods)

Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, The AdWords Problem, AdWords Implementation.

A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction, The Netflix Challenge.

UNIT-V:

(08 Periods)

Mining Social-Network Graphs-Social Networks as Graphs, Clustering of Social-Network Graphs, Partitioning of Graphs, Sim rank, Counting Triangles.

Total Periods: 45

Textbooks:

T1. Mining of Massive Datasets Jure Leskovec, Anand Rajaraman, Jeff Ullman, 3rd. Edition.

Reference Books:

R1. Data Mining — Concepts and Techniques, Jiawei Han & Micheline Kamber, 3rd Edition Elsevier.

R2. Data Mining Introductory and Advanced topics, Margaret H DunhamPEA 2006.

R3. Data Mining: Practical Machine Learning Tools and Techniques,Ian H. Witten and Eibe Frank, Morgan Kaufmann 5th Edition 2025.

Web Resources:

1. <http://infolab.stanford.edu/~ullman/mmds.html>
2. <https://nptel.ac.in/courses/106/105/106105174/>
3. <https://www.geeksforgeeks.org/data-mining/>

2598104	M.Tech., I-SEMESTER	L	T	P	C
	GENERATIVE AI (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-I)	3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

- CO1.** Demonstrate knowledge of AI foundations, generative models, and advanced neural architectures.
- CO2.** Apply generative AI techniques to create solutions for text, image, video, and multimodal tasks.
- CO3.** Design, fine-tune, and optimize Large Language Models for specific applications.
- CO4.** Design and apply multi-agent systems and generative AI tools for collaborative problem-solving and creative applications.
- CO5.** Evaluate ethical, social, and legal implications of Generative AI deployments and propose mitigation strategies.

SYLLABUS:

UNIT-I: FOUNDATIONS OF AI AND GENERATIVE MODELS (09 Periods)

Introduction and historical evolution to Artificial Intelligence (AI), Machine Learning (ML), Natural Language Processing (NLP) and Deep Learning (DL), Structure of Artificial Neural Networks (ANNs), Mathematical and computational foundations of generative modeling, Overview of generative models and their applications across various domains; Importance of Generative AI in modern applications, Transfer learning and in advancing Generative AI

UNIT-II: ADVANCED NEURAL ARCHITECTURES FOR GENERATIVE AI (09 Periods)

Variational Autoencoders (VAEs): principles and applications, Generative Adversarial Networks (GANs): architecture and working principles; Transformer architecture and attention mechanisms (in detail); Long Short-Term Memory Networks (LSTMs) and the limitations of traditional RNNs/LSTMs, Advanced Transformer architectures and techniques, Pre-training and transfer learning strategies for generative models

UNIT-III: LARGE LANGUAGE MODELS AND PROMPT ENGINEERING (09 Periods)

Overview of Large Language Models (LLMs), GPT architecture, variants, and working principles, Pré- training and fine-tuning GPT models for applications (e.g., chatbots, text generation), Case study: GPT-based customer support chatbot, BERT architecture, pre-training objectives, and fine-tuning, Prompt Engineering: Designing effective prompts, controlling model behavior, and improving output quality, Fine-tuning language models for creative writing and chatbot development.

UNIT-IV: MULTI-AGENT SYSTEMS AND GENERATIVE AI APPLICATIONS (09 Periods)

Introduction to Multi-Agent Systems (MAS), Types of agents: reactive, deliberative, hybrid, and learning agents, Multi-agent collaboration and orchestration for generative tasks, Use cases: autonomous research assistants, cooperative creative generation, distributed problem-solving,

Frameworks and tools: AutoGen, CrewAI, Hugging GPT for LLM-powered multi-agent systems, Generative AI applications: Art, Creativity, Image/Video generation, Music composition, Healthcare, Finance, Real-world case studies and deployment challenges.

UNIT-V: FRAMEWORKS, MULTIMODAL APPLICATIONS, AND ETHICS (09 Periods)

Lang Chain framework: components and LLM application development, Retrieval- Augmented Generation (RAG), Embeddings, Indexing networks, and Vector databases, Generative AI across modalities: Text, Code, Image, and Video generation, Image and Video generation using GANs and VAEs, Multimodal Generative AI: integration and training strategies, Ethical considerations: bias, fairness, trust, and responsible AI deployment, Social and legal implications of Generative AI, Risk mitigation strategies and real-world ethical case studies

Total Periods: 45

Textbooks:

- T1.** Understanding the Essentials and Applications of This Breakthrough Technology Altaf Rehmani, Generative AI for Everyone: 1st Edition.
- T2.** Neural Networks and Deep Learning:Charu C. Aggarwal, A Textbook.
- T3.** Generative AI with Python and Tensor Flow 2, Joseph Babcock, Raghav Bali, 2nd Edition 2024.

Reference Books:

- R1.** Generative Adversarial Networks Cookbook Josh Kalin, 1st Edition 2021.
- R2.** Generative AI in Software Development: Beyond the Limitations of Traditional Coding, Jesse Sprinter, 1st Edition 2024.

Online References:

Better & Faster Large Language Models via Multi-token Prediction, Fabian Gloeckle et al., arXiv:2404.19737v1, 2024. Vaswani et al., Attention Is All You Need, Neur IP

Web Resources:

1. Generative AI Tutorial – Geeks for Geeks
2. Mining Massive Data Sets (Stanford University – Ullman, Rajaraman, Leskovec)
3. Generative AI Learning Collection – GitHub

2598105	M.Tech., I-SEMESTER	L	T	P	C
	APPLIED MACHINE LEARNING (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-I)	3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

- CO1.** Demonstrate the fundamental concepts of machine learning
- CO2.** Apply machine learning techniques for classification, regression, and unsupervised learning tasks.
- CO3.** Apply linear, distance based, and decision tree-based models
- CO4.** Implement distance-based and probabilistic models for classification and clustering tasks.
- CO5.** Analyze probabilistic, neural network models

SYLLABUS:

UNIT-I: INTRODUCTION TO MACHINE LEARNING (09 Periods)

Introduction. Different types of learning, Examples of Machine Learning Applications Supervised Learning: Learning a Class from Examples, Probably Approximately Correct Learning, Learning multiple classes, Model selection and generalization Regression: Linear regression, Multiple Linear regression, Logistic Regression.

UNIT-II: THE INGREDIENTS OF MACHINE LEARNING (09 Periods)

Tasks, Models, Features Binary classification and related tasks: Classification, Assessing classification performance, Visualizing classification performance Beyond binary classification: multi-class classification, Regression, Unsupervised and descriptive learning

UNIT-III: DECISION TREE LEARNING (09 Periods)

Introduction, Decision tree representation, Appropriate problems for decision tree learning, the basic decision tree learning algorithm, Inductive bias in decision tree, Issues in decision tree learning. Linear models: The least-squares method, Multivariate linear regression, the perceptron, Support vector machines, soft margin SVM, Going beyond linearity with kernel methods.

UNIT-IV: DISTANCE BASED MODELS (09 Periods)

Introduction, Neighbours and exemplars, Nearest Neighbours classification, K-Means algorithms, Clustering around medoids Probabilistic Models: Using Naïve Bayes Model for classification, Expectation Maximization, Gaussian Mixture models

UNIT-V: ARTIFICIAL NEURAL NETWORKS (09 Periods)

Introduction, Neural network representation, appropriate problems for neural network learning, Multilayer networks and the back propagation, Advanced topics in Artificial Neural Networks Reinforcement Learning: Introduction, Learning tasks, Q-learning

Total Periods: 45

Textbooks:

- T1.** Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 1st Edition 2012.
- T2.** Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education 1st Edition.

Reference Books:

- R1.** Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems Aurélien Géron, 3rd Edition 2022.
- R2.** Machine Learning – An Algorithmic Perspective, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series Stephen Marsland, , 2nd Edition, 2014
- R3.** Introduction to machine learning, Ethem Alpaydın, second edition, MIT press 4th Edition 2020.
- R4.** Elements of Statistical Learning, Springer Series T. Hastie, R. Tibshirani and J. Friedman, , 2nd edition 2009.

Web Resources:

1. <https://stanford.edu/~shervine/teaching/cs-229/>.
2. https://scikit-learn.org/stable/user_guide.html
3. <https://developers.google.com/machine-learning/crash-course>

2598106	M.Tech., I-SEMESTER	L	T	P	C
	MEDICAL IMAGING WITH AI (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-II)	3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

- CO1.** Explain medical imaging modalities and their fundamental characteristics.
- CO2.** Apply preprocessing and feature extraction techniques to medical images.
- CO3.** Implement deep learning architectures for classification, segmentation, and anomaly detection.
- CO4.** Evaluate AI methods for medical imaging tasks such as cancer detection, brain analysis, and organ segmentation.
- CO5.** Analyze ethical, privacy, and regulatory challenges in deploying AI for healthcare.

SYLLABUS:

UNIT-I: INTRODUCTION TO MEDICAL IMAGING (08 Periods)

Overview of imaging modalities: MRI, CT, X-ray, Ultrasound, PET, Basic principles of image acquisition and reconstruction, Characteristics of medical images: resolution, contrast, artifacts, and noise, Clinical importance of imaging in diagnosis and treatment, File formats in medical imaging (DICOM, NIFTI), Limitations and challenges in medical image analysis, Role of AI in clinical decision support and imaging workflows.

UNIT-II: PREPROCESSING AND FEATURE EXTRACTION (09 Periods)

Image enhancement: filtering, denoising, histogram equalization, Noise reduction techniques: Gaussian, median, and non-local means filtering, Normalization and standardization of medical image datasets, Feature extraction: shape, texture, intensity, and edge-based features, Dimensionality reduction: PCA, LDA, t-SNE (overview), Data augmentation strategies for medical imaging datasets, Introduction to medical imaging datasets: BraTS, CheXpert, LIDC-IDRI, ISLES, Hands-on: preprocessing pipeline for MRI/CT images.

UNIT-III: SEGMENTATION AND DETECTION (09 Periods)

Traditional segmentation methods: thresholding, region growing, clustering, Watershed algorithm and morphological segmentation, AI-based segmentation: U-Net, Mask R-CNN, DeepLab, Tumor and lesion detection techniques in MRI/CT images, Object detection in medical images using Faster R-CNN, YOLO, Evaluation metrics: Dice coefficient, Jaccard index, sensitivity/specificity, Case study: brain tumor segmentation (BraTS challenge), Hands-on: segmentation workflow for lung X-rays or MRI scans.

UNIT-IV: DEEP LEARNING IN MEDICAL IMAGING (09 Periods)

CNN architectures for classification: VGG, ResNet, DenseNet, Transfer learning and fine-tuning on medical datasets, Multi-modal deep learning: combining imaging with clinical data, Generative models (GANs, VAEs) for synthetic medical image generation, Applications: cancer detection,

organ segmentation, COVID-19 diagnosis, Explainability in deep learning models for medical imaging, Deployment of AI models in clinical settings, Case study: deep learning for chest X-ray anomaly detection

UNIT-V: ETHICS, REGULATIONS & ADVANCED TOPICS (09 Periods)

Ethical issues in AI for healthcare: bias, transparency, and fairness, Data privacy and patient confidentiality challenges, Regulatory frameworks: HIPAA, GDPR, and FDA guidelines, Explainable AI and interpretability in medical decision-making, Federated learning for privacy-preserving medical AI, Emerging trends: digital twins, precision medicine, personalized AI diagnosis, Role of AI in treatment planning and prognosis prediction, Research challenges and future directions in AI for healthcare imaging.

Total Periods: 45

Textbooks:

- T1.** Deep Learning for Medical Image Analysis, Academic Press S. Kevin Zhou, Hayit Greenspan, Dinggang Shen, 2nd Edition, 2023.
- T2.** Big Data in Multimodal Medical Imaging, Ayman El-Baz, Jasjit S. Suri, CRC Press 1st Edition 2019.
- T3.** Guide to Medical Image Analysis, Springer Klaus D. Toennies, 2nd Edition 2017.

References:

- R1.** Deep Learning in Medical Image Analysis, Medical Image Analysis, Geert Litjens et al., A Survey on Volume 42, Pages 60–88, 2017.
- R2.** Networks for Biomedical Image Segmentation, Ronneberger Convolutional et al., U-Net: Volume 9351, Pages 234–241, 2015.
- R3.** Deep Learning in Healthcare, Nature Medicine, Esteva et al., A Guide to Volume 25, Issue 1, Pages 24–29, January 2019.
- R4.** Kaggle datasets and grand challenges: BraTS, ISLES, CheXpert.
- R5.** Online resources: Medical Imaging with Deep Learning (MIDL) conference papers.

Web Resources:

- 1. <https://github.com/open-dicom/awesome-dicom>
- 2. <https://dynamicduniya.com/tutorials/machine-learning/feature-engineering-data-preprocessing/dimensionality-reduction-techniques>
- 3. <https://apxml.com/courses/cnns-for-computer-vision/chapter-4-image-segmentation-techniques>

2598107	M.Tech., I-SEMESTER SMART SENSOR NETWORKS AND IOT (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-II)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

- CO1.** Explain the fundamental concepts, applications, and research areas of IoT across various domains.
- CO2.** Analyse IoT reference architectures, functional and deployment views, and real-world design constraints including hardware, technical, and operational limitations.
- CO3.** Demonstrate practical knowledge of IoT devices, programming, operating systems, communication protocols, network security, and database management.
- CO4.** Apply IoT principles to industrial automation and enterprise integration using frameworks such as SOCRADES and IMC-AESOP.
- CO5.** Evaluate case studies in commercial building automation and emerging IoT trends, including edge/fog computing, predictive maintenance, and digital twin technologies.

SYLLABUS:

UNIT-I: INTRODUCTION AND APPLICATIONS (10 Periods)

smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT-II: REAL-WORLD DESIGN CONSTRAINTS (08 Periods)

Introduction, Technical Design constraints, hardware, Data representation and visualization, Interaction and remote control.

UNIT-III: IOT PHYSICAL DEVICES & ENDPOINTS (09 Periods)

What is an IOT Device, Exemplary Device Board, Linux on Raspberry, Interface and Programming & IOT Device. Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, **Routing:** Transport Protocols, Network Security, Middleware, Databases

UNIT-IV: INDUSTRIAL AUTOMATION (08 Periods)

Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation-Introduction.

UNIT-V: CASE STUDY (08 Periods)

Phase one-commercial building automation today.

Phase two commercial building automation in the future. Recent trends in sensor network and IOT architecture, Automation in Industrial aspect of IOT.

Total Periods: 45

Textbooks:

- T1.** Internet of Things. IoT Infrastructures, Mandler, B., Barja, J., Mitre Campista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Springer International Publication 2016.
- T2.** Internet of Things: A Hands-On Approach Arsheep Bahga, Vijay Madiseti, , Orient Blackswan Private Limited - New Delhi, 1st Edition, 2015.
- T3.** IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob, Pearson Paperback, 1st Edition, 2017.

Web Resources:

1. [Cyber-Physical Systems and Smart Cities – ResearchGate \(PDF\)](#)
2. [IoT Data Visualization and Dashboards – ThingsBoard](#)
3. [IMC-AESOP Project: Service-Oriented Industrial IoT](#)

2598108	M.Tech., I-SEMESTER COMPUTING FOR DATA ANALYTICS (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-II)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

- CO1.** Demonstrate the data analytics lifecycle and identify the roles and responsibilities of data scientists in business analytics projects.
- CO2.** Apply statistical techniques such as measures of central tendency, variation, skewness, and kurtosis for data summarization and interpretation.
- CO3.** Analyze probability distributions (binomial, Poisson, normal, exponential, gamma, etc.) and apply them in modeling uncertain events.
- CO4.** Perform hypothesis testing and predictive analytics using t-tests, chi-square tests, regression, correlation, and multiple correlation methods.
- CO5.** Design forecasting models (moving average, exponential smoothing, seasonal trends) and conduct design of experiments (ANOVA, Latin square, factorial design) for analytical problem solving.

SYLLABUS:

UNIT-I: DATA ANALYTICS LIFE CYCLE (09 Periods)

Introduction to Big data Business Analytics - State of the practice in analytics role of data scientists
 Key roles for successful analytic project - Main phases of life cycle - Developing core deliverables for stakeholders.

UNIT-II: STATISTICS (10 Periods)

Sampling Techniques - Data classification, Tabulation, Frequency and Graphic representation - Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median, Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.

UNIT-III: PROBABILITY AND HYPOTHESIS TESTING (09 Periods)

Random variable, distributions, joint probability function, marginal density function. Random vectors - Some special probability distribution - Binomial, Poisson, Geometric, uniform, exponential, normal, gamma and Erlang - Normal distribution.

UNIT-IV: PREDICTIVE ANALYTICS (09 Periods)

Sampling distribution – Estimation - point, confidence - Test of significance, 1 & 2 tailed test, uses of t-distribution, F-distribution, χ^2 distribution - Predictive modeling and Analysis - Regression Analysis, Correlation analysis, Rank correlation coefficient, Multiple correlation.

UNIT-V: TIME SERIES FORECASTING AND DESIGN OF EXPERIMENTS (08 Periods)

Forecasting Models for Time series: MA, SES, TS with trend, season - Design of Experiments, one way classification, two-way classification, ANOVA, Latin square, Factorial Design.

Total Periods: 45

Textbooks:

- T1.** Understanding Big Data Chris Eaton, Dirk Deroos, Tom Deutsch et al., , Mc Graw Hill, 2012 1st Edition.
- T2.** Understanding the Predictive Analytics Lifecycle Alberto Cordoba, , Wiley, 1st Edition 2014.
- T3.** Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Eric Siegel, Thomas H. Davenport, Wiley, 2016.

Reference Books:

- R1.** Business Analytics – Methods, Models and Decisions James R Evans –, 3rd Edition Pearson 2013.
- R2.** Seema Acharya - Fundamentals of Business Analytics R. N. Prasad, , Wiley, 2nd Edition 2015.
- R3.** Introduction to Probability and Statistics for Engineers and Scientists, Academic Foundation, S M Ross - 6th Edition 2011.
- R4.** Principles of Data Mining, David Hand, Heiki Mannila, Padhria Smyth - PHI 2013 1st Edition.
- R5.** Forecasting methods and applications Spyros Makridakis, Steven C Wheelwright, Rob J Hyndman - Wiley 3rd Edition 2013 (Reprint).

Web Resources:

- 1.** Data Analytics Lifecycle – Tutorialspoint
- 2.** Statistics & Probability – OpenStax Introductory Statistics
- 3.** Time Series Forecasting & Experimental Design – StatsDirect

2598151	M.Tech., I-SEMESTER ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS LAB (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		0	0	4	2

Pre-Requisites: Nil

COURSE OUTCOMES:

After the completion of the course, student will be able to

- CO1.** install and work with various AI tools and environments.
- CO2.** preprocess data and create annotated datasets for AI applications
- CO3.** implement search and knowledge representation techniques in AI.
- CO4.** develop programming solutions for given problem scenario.
- CO5.** apply machine learning algorithms for classification and clustering tasks.
- CO6.** use Python libraries for data science and parallel algorithm development.

LIST OF PROGRAMS:

1. Installation and working on various AI tools viz. Python, R tool, GATE, NLTK, MATLAB, etc.
2. Data preprocessing and annotation and creation of datasets.
3. Learn existing datasets and Treebanks
4. Implementation of searching techniques in AI.
5. Implementation of Knowledge representation schemes.
6. Natural language processing tool development.
7. Application of Machine learning algorithms.
8. Application of Classification and clustering problem.
9. Working on parallel algorithms.
10. Scientific distributions used in python for Data Science - Numpy, scifi, pandas, scikit learn, statsmodels, nltk.

Web Resources:

1. AI Lab Manual – Studocu
2. Open Source Data Annotation Tools – Data Stack Hub
3. GitHub – NLP Datasets (Treebanks & Corpora)
4. Sanfoundry – Search Algorithms in AI
5. Sanfoundry – Knowledge Representation in AI
6. GitHub – NLP Explorer
7. GeeksforGeeks – Supervised & Unsupervised Learning
8. Kaggle – Clustering Datasets
9. Krython – Parallel Algorithms: MapReduce Pattern
10. AlmaBetter – Popular Python Libraries

2598152	M.Tech., I-SEMESTER STATISTICAL FOUNDATIONS FOR DATA SCIENCE USING R LAB (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		0	0	4	2

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

- CO1.** write and execute basic R programs using RStudio.
- CO2.** Perform descriptive and inferential statistical analysis on datasets.
- CO3.** Visualize data using various graphical techniques in R.
- CO4.** Conduct hypothesis testing and regression modeling using R.
- CO5.** Interpret statistical outputs and summarize insights for decision making.
- CO6.** analyze real-world datasets and present findings using R Markdown.

LIST OF EXPERIMENTS:

1. **Introduction to R and RStudio**
Basic syntax, variables, data types, operators, and RStudio interface
2. **Data Structures in R**
Use vectors, lists, matrices, arrays, and data frames
3. **Data Import and Cleaning**
Read data from CSV, Excel, JSON, databases; handling missing values and outliers
4. **Descriptive Statistics**
Mean, median, mode, variance, standard deviation, correlation, covariance
5. **Data Visualization in R**
Use base R and ggplot2 for histograms, boxplots, scatter plots, bar charts
6. **Probability Distributions**
Implement and visualize Binomial, Poisson, Normal, and Exponential distributions
7. **Sampling and Central Limit Theorem**
Random sampling, sample mean distribution, and verifying CLT through simulation
8. **Hypothesis Testing – I**
t-test, z-test, chi-square test for mean and proportion
9. **Hypothesis Testing – II**
ANOVA and post-hoc analysis using R
10. **Correlation and Regression Analysis**
Simple and multiple linear regression modeling
11. **Non-Linear and Logistic Regression**
Implement logistic regression for binary classification
12. **Case Study / Mini Project**
Apply statistical analysis to a real-world dataset (e.g., COVID, finance, healthcare, education) and prepare a report in R Markdown

Software & Tools:

- R (≥ 4.0 version)
- RStudio IDE
- Libraries: ggplot2, dplyr, tidyr, readr, caret, stats, MASS

Reference Books:

- R1.** R for Data Science, Garrett Grolmund & Hadley Wickham, O'Reilly Media 2nd Edition.
- R2.** The Art of R Programming, Norman Matloff, No Starch Press 1st Edition.
- R3.** Introductory Statistics with R, Peter Dalgaard, Springer 2nd Edition.
- R4.** Using R for Introductory Statistics, John Verzani, CRC Press 2nd Edition.

Web Resources:

- 1. RStudio Cloud Guide
- 2. R Data Structures – Tutorials Point
- 3. R for Data Science – Data Import
- 4. Quick-R Descriptive Statistics
- 5. ggplot2 Reference
- 6. R Probability Distributions
- 7. R Sampling Tutorial
- 8. R Hypothesis Tests – Quick-R
- 9. R ANOVA Tutorial
- 10. R Regression Models
- 11. R Logistic Regression Guide
- 12. R Markdown Guide

2598153	M.Tech., I-SEMESTER FULL STACK DEVELOPMENT USING MERN (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		0	1	2	2

Pre-Requisites: Nil

COURSE OUTCOMES:

After completion of the course, student will be able to

- CO1.** Apply fundamental web technologies (HTML, CSS, JavaScript, ES6) to design responsive web pages
- CO2.** Develop server-side applications using Node.js and Express.js with REST API integration.
- CO3.** Perform database operations using MySQL and MongoDB and integrate them with backend services
- CO4.** Design and implement dynamic, component-based user interfaces using ReactJS
- CO5.** Demonstrate problem-solving, debugging, and version control skills in web development projects.

SYLLABUS:

MODULE 1: WEB DEVELOPMENT FUNDAMENTALS

Fundamentals of Web Design, Webpage and Website, Web application HTML Typography, Images, Tables, Lists, Hyperlinks etc. CSS Syntax and usage, CSS Selectors, CSS on body, CSS on Text, CSS on Links, CSS on Tables, CSS on Lists, CSS on Forms, CSS on Images, CSS on DIV, W3.CSS Framework

LIST OF EXPERIMENTS:

- **HTML & CSS Basics** – Create a personal portfolio webpage using HTML (headings, lists, tables, hyperlinks, forms) and style it with CSS selectors.
- **Responsive Layout** – Develop a responsive webpage using DIV, CSS box model, and W3.CSS framework.
- **Styled Components** – Design a webpage for a college event with images, tables, and styled navigation menu using CSS.

MODULE 2: JAVASCRIPT AND ECMA SCRIPT 6

JavaScript Fundamentals - Grammar and types, Control flow and error handling - Loops, Function - Objects, Arrays, Promises - ES6 Let and const, Template literals - Arrow Function, Default parameter, Async Await

LIST OF EXPERIMENTS:

- **JavaScript Fundamentals** – Build a simple calculator app using functions, loops, and control flow.
- **Array & Object Manipulation** – Write a program using ES6 features (let/const, arrow functions, template literals) to manage student records.
- **Async Programming** – Create a webpage that fetches and displays random user data from a public API using Promises and Async/Await.

Module 3: Node.js

overview, Node.js - basics and setup - Node.js console, Node.js command utilities - Node.js modules, concepts - Node.js events, database access - Node.js with Express.js, Express.js

Request/Response - Express.js Get, Express.js Post - Express.js Routing, Express.js Cookies - Express.js File Upload, Middleware - Express.js Scaffolding, Template

LIST OF EXPERIMENTS:

- **Node.js Basics** – Write a Node.js script to create a local server and display “Hello World” in the browser.
- **Express.js Routing** – Build a REST API with Express.js that handles GET and POST requests for a student information system.
- **File Handling** – Develop a Node.js application to upload, read, and display a text/JSON file using Express middleware.

Module 4: MySQL and MongoDB

MySQL Concepts - Create, Read, Update, Delete Operation - SQL and NoSQL concepts - Create and manage MongoDB - Migration of data into MongoDB - MongoDB with NodeJS - Services offered by MongoDB

LIST OF EXPERIMENTS:

- **MySQL CRUD** – Create a MySQL database for employee records and perform Create, Read, Update, Delete (CRUD) operations.
- **MongoDB CRUD with Node.js** – Build a Node.js application that connects to MongoDB and manages student data.
- **Migration Project** – Write a script to migrate data from MySQL to MongoDB and display it through a Node.js API.

Module 5: React JS

ReactJS introduction and overview - ReactJS installation and environment setup - Introducing JSX, Rendering Elements - Components and Props - State and Lifecycle - Handling Events - Conditional Rendering - Lists and Keys, Forms - Lifting State Up

List Of Experiments:

- **React Components** – Build a React app to display a list of courses using functional components and props.
- **State & Events** – Create a counter and a form component in React using useState and event handling.
- **Conditional Rendering & Lists** – Develop a React to-do list application with add/delete functionality and conditional rendering of completed tasks.

Textbooks:

- T1.** Alex Banks, Eve Porcello – Learning React: Modern Patterns for Developing React Apps, O’Reilly 2nd Edition 2020.
- T2.** Stoyan Stefanov – React Up & Running: Building Web Applications, O’Reilly 2nd Edition 2021.
- T3.** Mario Casciaro, Luciano Mammino – Node.js Design Patterns, Packt 4th Edition 2023.
- T4.** Seyed M.M. Iravani – Learning Web Design: A Beginner’s Guide to HTML, CSS, JavaScript, and Web Graphics, O’Reilly 5th Edition 2018.

Reference Books:

- R1.** Robin Wieruch – The Road to React, Leanpub 2025.
- R2.** Carl Rippon – React 18 Design Patterns and Best Practices, Packt 4th Edition.
- R3.** Kirupa Chinnathambi – Learning React: A Hands-On Guide to Building Web Applications, Addison-Wesley 2nd Edition.
- R4.** Ethan Brown – Web Development with Node and Express: Leveraging the JavaScript Stack, O’Reilly 2nd Edition.
- R5.** Kristina Chodorow – MongoDB: The Definitive Guide, O’Reilly 3rd Edition.
- R6.** Ben Forta – SQL in 10 Minutes, Sams Teach Yourself, Sams Publishing 5th Edition.

Web Resources:

- 1.** Build a Responsive Portfolio Website Using HTML & CSS – Geeks for Geeks
- 2.** Async/Await Tutorial – JavaScript.info
- 3.** Node.js Express File Upload REST API Example – Bezkoder
- 4.** Node.js CRUD Operations Using Mongoose & MongoDB – Geeks for Geeks
- 5.** React State and Lifecycle – Official Docs

2599171	M.Tech., I-SEMESTER	L	T	P	C
	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (MANDATORY COURSE) (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	2	0	0	2

Pre-Requisites Nil

COURSE OUTCOMES:

After successful completion of the course, student will be able to

- CO1.** Demonstrate the research process, types and methods, use data correctly, follow ethical rules, and use proper citation styles.
- CO2.** Apply appropriate data collection methods, identify data types and sources, ensure quality, and follow ethical practices using suitable tools.
- CO3.** Apply multivariate analysis and experimental design to study cause-effect relationships, ensure measurement validity, and write structured research papers and proposals.
- CO4.** Demonstrate the concept, evolution, and types of Intellectual Property Rights (IPR), recognize global IPR practices and institutions like WIPO, WTO, and UNESCO, and identify key agreements, trade secrets, and biodiversity-related rights.
- CO5.** Demonstrate the concept, features, and benefits of patents; identify types of patent applications and the filing process; and explain the roles of patent agents, licensing, and patent regulations.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF RESEARCH METHODOLOGY (09 Periods)

Overview of research process and design - Types of Research - Approaches to Research (Qualitative vs Quantitative) - Observation studies, Experiments and Surveys - Use of Secondary and exploratory data to answer the research question - Importance of Reasoning in Research and Research ethics - Documentation Styles (APA/IEEE etc.) - Plagiarism and its consequences.

UNIT-II: DATA COLLECTION AND SOURCES (09 Periods)

Importance of Data Collection - Types of Data - Data Collection Methods - Data Sources - primary, secondary and Big Data sources - Data Quality & Ethics - Tools and Technology for Data Collection.

UNIT-III: DATA ANALYSIS AND REPORTING (09 Periods)

Overview of Multivariate analysis - Experimental research, cause-effect relationship, and development of hypotheses- Measurement systems analysis, error propagation, and validity of experiments - Guidelines for writing abstracts, introductions, methodologies, results, and discussions - Writing Research Papers & proposals.

UNIT-IV: UNDERSTANDING INTELLECTUAL PROPERTY RIGHTS (09 periods)

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT-V: PATENTS

(09 Periods)

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification
Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation,
Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent
agents

Total Periods: 45

Textbooks:

- T1.** An introduction for Science & Engineering students, Stuart Melville and Wayne Goddard, Research Methodology: Juta and Company Ltd, 2004
- T2.** Intellectual property: Patents, Trademarks, Catherine J. Holland, Copyrights, Trade Secrets, Entrepreneur Press, 2007.

Reference Books:

- R1.** Business Research Methods, Cooper Donald R, Schindler Pamela S and Sharma JK, Tata McGraw Hill Education, 2012, Eleventh Edition,
- R2.** Research Methodology: A Step-by-Step Guide for Beginners, David Hunt, Long Nguyen, Matthew Rodgers, Wiley, 2007.
- R3.** Intellectual Property: The Law of Trademarks, Deborah E. Bouchoux, Copyrights, Patents, and Trade Secrets, Cengage, 2024, Sixth Edition,
- R4.** The Craft of Research, Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, University of Chicago Press, 2024, Fifth Edition.
- R5.** Professional Programme Intellectual Property Rights, Law and practice, The Institute of Company Secretaries of India, Statutory body under an Act of parliament, September, 2013.

Web Resources:

1. Research Methodology and Data Analysis courses, Coursera / edX
2. Latest journals on research design and statistics, Springer Link & ScienceDirect
3. Free access to research papers Google Scholar
4. Open-access research methodology resources, NCBI Bookshelf
5. For fundamentals of hypothesis testing, regression, and ANOVA. Khan Academy (Statistics & Probability)

2599181	M.Tech., I-SEMESTER	L	T	P	C
	ENGLISH FOR RESEARCH PAPER WRITING (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE-I) (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	2	0	0	0

Pre-Requisites: Nil

COURSE OUTCOMES:

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

- CO1.** Demonstrate proficiency in academic English by applying MAP principles, using clear, precise, and objective language, structuring coherent paragraphs, integrating references, and employing paraphrasing and appropriate tone in writing.
- CO2.** Exhibit critical reading skills to analyze academic texts, differentiate between article types, identify arguments and methodologies, evaluate findings, and make effective notes.
- CO3.** Apply advanced grammar and punctuation to construct clear, accurate, and complex sentences with proper voice, tense consistency, subject-verb agreement, and unambiguous references.
- CO4.** Revise and refine written work by editing for clarity, coherence, and grammar; proofread for accuracy; and apply effective strategies for professional correspondence and creative writing.
- CO5.** Demonstrate digital literacy by critically evaluating online content, using AI tools ethically in research writing, generating accurate citations, and practicing plagiarism-free writing with awareness of fair practices.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF ACADEMIC ENGLISH (05 Periods)

Academic English - MAP (Message-Audience-Purpose) - Language Proficiency for Writing - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References - Word order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Structuring Paragraphs - Paraphrasing Skills – Framing Title and Sub-headings

UNIT-II: READING SKILLS FOR RESEARCHERS (06 Periods)

Reading Academic Texts - Critical Reading Strategies - Skimming and Scanning - Primary Research Article vs. Review Article - Reading an Abstract - Analyzing Research Articles - Identifying Arguments - Classifying Methodologies - Evaluating Findings - Making Notes

UNIT-III: GRAMMAR REFINEMENT FOR RESEARCH WRITING (06 Periods)

Advanced Punctuation Usage - Grammar for Clarity - Complex Sentence Structures - Active-Passive Voice - Subject-Verb Agreement - Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences.

UNIT-IV: MASTERY IN REFINING WRITTEN CONTENT/EDITING SKILLS

(07 Periods)

Effective Revisions - Restructuring Paragraph - Editing vs Proofreading, Editing for Clarity and Coherence - Rectifying Sentence Structure Issues - Proofreading for Grammatical Precision – Spellings - Tips for Correspondence with Editors - Critical and Creative Phases of Writing.

UNIT-V: TECHNOLOGY AND LANGUAGE FOR RESEARCH

(06 Periods)

Digital Literacy and Critical Evaluation of Online Content - Technology and Role of AI in Research Writing – Assistance in Generating Citations and References - Plagiarism and Ethical Considerations – Tools and Awareness – Fair Practices

Total Periods: 30

Textbooks:

- T1.** Routledge, Bailey. S. Academic Writing: A Handbook for International Students. London and New York: 2015.
- T2.** Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Reference books:

- R1.** Writing for Academic Success Craswell, G., , Sage Publications, 2004.
- R2.** Writing With Power Peter Elbow, , E-book, Oxford University Press, 2007
- R3.** Writing Academic English, Addison Oshima, A. & Hogue, A -Wesley, New York, 2005
- R4.** Academic Writing for Graduate Students Swales, J. & C. Feak,: Essential Skills and Tasks, Michigan University Press, 2012.
- R5.** Writing for Science Goldbort R., Yale University Press (available on Google Books), 2006
- R6.** Day R., How to Write and Publish a Scientific Paper, Cambridge University Press, 2006

Web Resources:

1. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ge04/>
2. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview
3. "Writing in the Sciences" – Stanford University (MOOC on Coursera)
<https://www.coursera.org/learn/sciwrite>
4. Academic Phrasebank – University of Manchester
<http://www.phrasebank.manchester.ac.uk>
5. OWL (Online Writing Lab) – Purdue University,
<https://owl.purdue.edu>
(Resources on APA/MLA formats, grammar, structure, paraphrasing)
6. Zotero or Mendeley (Reference Management Tools) – Useful for managing citations and sources.

2512181	M.Tech., I-SEMESTER	L	T	P	C
	DISASTER MANAGEMENT (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE - I) (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	2	0	0	0

Pre-Requisites: Nil

COURSE OUT COMES:

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

- CO1.** Identify and map disaster-prone areas and understand the epidemiological consequences of disasters.
- CO2.** Define and distinguish between hazards and disasters, and explain their types, nature, and impacts.
- CO3.** Assess the economic, social, and ecological repercussions of major natural and man-made disasters.
- CO4.** Apply risk assessment methods and propose disaster risk reduction strategies at local, national, and global levels.
- CO5.** Demonstrate knowledge of disaster preparedness tools such as remote sensing, meteorological data, risk evaluation, and community awareness.

SYLLABUS:

UNIT-I: INTRODUCTION

(06 Periods)

Disaster Prone Areas in India - Study of Seismic Zones - Areas Prone to Floods and Droughts, Landslides and Avalanches - Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami - Post-Disaster Diseases and Epidemics.

UNIT-II: REPERCUSSIONS OF DISASTERS AND HAZARDS

(06 Periods)

Economic Damage - Loss of Human and Animal Life - Destruction of Ecosystem - Natural Disasters - Earthquakes, Volcanism, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster - Nuclear Reactor Meltdown - Industrial Accidents - Oil Slick and Spills - Outbreaks of Disease and Epidemics War and Conflicts

UNIT-III: DISASTER PREPAREDNESS AND MANAGEMENT

(06 Periods)

Preparedness - Monitoring of Phenomena - Triggering a Disaster or Hazard - Evaluation of Risk- Application of Remote Sensing - Data from Meteorological and Other Agencies -Media Reports Governmental and Community Preparedness

UNIT-IV: RISK ASSESSMENT

(06 Periods)

Disaster Risk -Concept and Elements, Disaster Risk Reduction - Global and National Disaster Risk Situation -Techniques of Risk Assessment – Global Co-Operation in Risk Assessment and Warning - People’s participation Risk Assessment – Strategies for Survival

UNIT-V: DISASTER MITIGATION

(06 Periods)

Meaning, Concept and Strategies of Disaster Mitigation – Emerging Trends in Mitigation - Structural Mitigation and Non- Structural Mitigation - Programs of Disaster Mitigation in India

Total Periods: 30

Textbooks:

- T1. Disaster Management Gupta, H. K. , Universities Press, 2003
- T2. Natural Hazards and Disaster Management, Singh, R. B., Rawat Publications, 2006.

Reference Books:

- R1. Introduction to International Disaster Management, Elsevier, Coppola, D. P., 4th ed., 2020.
- R2. Science and Technology in Disaster Risk Reduction in Asia, Shaw, R., & Izumi, T., Springer, 2022.
- R3. Handbook of Hazards and Disaster Risk Reduction and Management, Wisner, B., Gaillard, J. C., & Kelman, I., Routledge, 2nd ed., 2021.
- R4. Disaster Management in India: Policy, Issues and Perspectives Saini, V. K., , Sage India, 2021.
- R5. Disaster by Choice: How Our Actions Turn Natural Hazards into Catastrophes Kelman, I., Oxford University Press, 2022
- R6. Disaster Mitigation: Experiences and Reflections Sahni, P. & Dhameja, A., Prentice Hall of India, 2004.

Web Resources:

1. <https://ndma.gov.in> – official guidelines, reports, and policy frameworks.
2. <https://www.undrr.org> – Sendai Framework, global risk reduction strategies.
3. <https://www.gdacs.org> – real-time disaster alerts
4. <https://www.undrr.org> – Sendai Framework, global risk reduction strategies.

2598181	M.Tech., I-SEMESTER ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE - I) (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		2	0	0	0

Pre-Requisites: Nil

COURSE OUTCOMES:

After successful completion of the course, student will be able to

- CO1.** Illustrate traditional knowledge, its nature, characteristics, and scope
- CO2.** Demonstrate the need for protecting traditional knowledge and its significance in the global economy
- CO3.** Explain the legal framework and policies related to traditional knowledge protection
- CO4.** Apply traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology
- CO5.** Analyze the importance of traditional knowledge in various contexts, including its historical impact and social change, relationship between traditional knowledge and intellectual property rights, including patents and non-IPR mechanisms

SYLLABUS:

UNIT-I: INTRODUCTION TO TRADITIONAL KNOWLEDGE (06 Periods)

Definition, Nature and characteristics, scope and importance - Kinds of traditional knowledge - Physical and social contexts in which traditional knowledge develop - Historical impact of social change on traditional knowledge systems - Indigenous Knowledge (IK) – Characteristics - traditional knowledge vis-à-vis indigenous knowledge -Traditional knowledge Vs western knowledge, traditional knowledge vis-à-vis formal knowledge

UNIT-II: PROTECTION OF TRADITIONAL KNOWLEDGE (06 Periods)

Need for protecting traditional knowledge - Significance of TK Protection - Value of TK in global economy - Role of Government to harness TK.

UNIT-III: LEGAL FRAME WORK AND TRADITIONAL KNOWLEDGE (06 Periods)

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 - Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act).
The Biological Diversity Act 2002 and Rules 2004 - the protection of traditional knowledge bill, 2016 Geographical Indicators Act 2003.

UNIT-IV: TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY (06 Periods)

Systems of traditional knowledge protection - Legal concepts for the protection of traditional knowledge - Certain non-IPR mechanisms of traditional knowledge protection - Patents and traditional knowledge - Strategies to increase protection of traditional knowledge -Global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT-V: TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS (06 Periods)

Traditional knowledge and Engineering - Traditional medicine system - TK and Biotechnology - TK in Agriculture - Traditional societies depend on it for their food and healthcare needs - Importance of conservation and sustainable development of environment - Management of biodiversity, Food security of the country and protection of TK

Total Periods: 30

Textbooks:

- T1.** Introduction to Indian Knowledge System: Concepts and Applications, Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. PHI Learning Pvt. Ltd. Delhi, 2022 1st Edition.
- T2.** Traditional Knowledge System and Technology in India, Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012 1st Edition.

Reference Books

- R1.** Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi 2006.
- R2.** On Astronomy in Ancient India", Indian Journal of History of Science Kak, S.C. ", 22(3), 1987
- R3.** Indian Astronomy: A Source Book, Subbarayappa, B.V. and Sarma, K.V. Nehru Centre, Mumbai, 1985.
- R4.** History of Technology in India, Vol. I, Indian National Science Academy Bag, A.K. , New Delhi, 1997.
- R5.** Indian Architecture, Acarya, P.K. Munshiram Manoharlal Publishers, New Delhi, 1996.
- R6.** Administration in Ancient India, Macmillan Banerjea, P. Public, London, 1961.
- R7.** Indian Knowledge Systems Vol – I & II, Indian Institute of Advanced Study, Kapoor Kapil, Singh Avadhesh, Shimla, H.P., 2022

Web Resources:

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/12110600>

2598201	M.Tech., II-SEMESTER NEURAL NETWORKS AND DEEP LEARNING (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

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

CO1. Demonstrate the concepts of Neural Networks.

CO2. Apply optimization strategies for large scale applications.

CO3. Use an efficient algorithm for Deep Models.

CO4. Select the right ANN architecture for the real-world problems.

CO5. Evaluate models, optimize performance, and troubleshoot deep learning systems effectively.

SYLLABUS:

UNIT-I: ARTIFICIAL NEURAL NETWORKS (09 Periods)

Artificial Neural Networks Introduction, Basic models of ANN, important terminologies, Supervised Learning Networks, Perceptron Networks, Adaptive Linear Neuron, Back-propagation Network. Associative Memory Networks. Training Algorithms for pattern association, BAM and Hopfield Networks.

UNIT-II: REGULARIZATION FOR DEEP LEARNING (09 Periods)

Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under- Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multi- Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, Tangent Prop, and Manifold Tangent Classifier, Optimization for Training Deep Models, Learning vs Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates.

UNIT-III: CONVOLUTIONAL NETWORKS (09 Periods)

The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features

UNIT-IV: RECURRENT AND RECURSIVE NETS (09 Periods)

Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long- Term Dependencies, Explicit Memory

UNIT-V: PRACTICAL METHODOLOGIES AND APPLICATIONS (09 Periods)

Practical Methodology: Performance Metrics, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters, Debugging Strategies, Example: Multi-Digit Number Recognition

Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications.

Total Periods: 45

TEXT BOOKS:

T1. Artificial Neural Networks B. Yegnanarayana, PHI

T2. Deep Learning: An MIT Press Book By Ian Goodfellow and Yoshua Bengio and Aaron Courville

2598202	M.Tech., II-SEMESTER ADVANCES IN SOFTWARE ENGINEERING (ARTIFICIAL INTELLEGEENCE AND DATA SCIENCE)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil.

COURSE OUTCOMES:

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

- CO1.** Demonstrate understanding of advanced software process models and project management practices.
- CO2.** Apply requirement engineering and advanced modelling techniques to software system design.
- CO3.** Develop robust designs using object-oriented, component-based, and aspect-oriented approaches.
- CO4.** Evaluate software quality through systematic testing, reviews, and maintenance strategies.
- CO5.** Analyze emerging research challenges and apply metrics, configuration management, and agile practices in modern software engineering.

SYLLABUS:

UNIT-I: SOFTWARE PROCESS AND PROJECT MANAGEMENT (09 Periods)

Software Engineering – A Layered Technology, Process Models: Waterfall, Incremental, Evolutionary, Spiral, Agile Development, Unified Process Framework.

Software Project Management Concepts: Estimation, Scheduling, Risk Analysis, Process Improvement and Capability Maturity (CMMI, ISO Standards).

UNIT-II: REQUIREMENTS ENGINEERING AND MODELING (09 Periods)

Requirement Engineering Tasks: Inception, Elicitation, Elaboration, Negotiation, Specification, Validation.

System Modeling with UML, Scenario-based, Flow-oriented, Behavioral and Class-based modelling, Design Concepts and Principles, Architectural Design – Styles and Patterns

UNIT-III: ADVANCED DESIGN AND DEVELOPMENT CONCEPTS (09 Periods)

Component-level Design, Object-Oriented Design using UML, Design Patterns and Frameworks, Aspect-Oriented Software Engineering, Reuse-oriented Software Engineering.

UNIT-IV: SOFTWARE QUALITY, TESTING AND MAINTENANCE (09 Periods)

Quality Concepts and Quality Assurance, Software Reviews, Formal Technical Reviews, Software Testing Strategies: Unit, Integration, System, Regression Testing, Black-box and White-box Testing, Software Maintenance and Reengineering.

UNIT-V: ADVANCED TOPICS AND EMERGING TRENDS (09 Periods)

Software Configuration Management (SCM) and Version Control, Software Reliability and Safety Engineering, Agile Software Development and DevOps, Software Metrics and Measurement.

Emerging Areas: AI in Software Engineering, Cloud-based SE, Secure Software Development.

Total Periods: 45

Text Books:

- T1.** Software Engineering A Practitioner's Approach, Roger S. Pressman, 9th Edition McGrawHill International Edition.
- T2.** Fundamentals of Software Engineering, Rajib Mall, Fifth Edition, PHI.

Reference Books:

- R1.** Software Engineering, Ian Sommerville, Tenth Edition, Pearson education.
- R2.** Software Engineering : A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008
- R3.** Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India,2010.
- R4.** Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

2598203	M.Tech., II-SEMESTER AI ENHANCED DATA SCIENCE (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-III)	L	T	P	C
		3	0	0	3

Pre-Requisites: Statistical Foundations for Data Science.

COURSE OUTCOMES:

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

- CO1.** Perform intelligent data wrangling and feature engineering using AI techniques.
- CO2.** Apply Auto ML frameworks for efficient model selection and hyper parameter tuning.
- CO3.** Integrate explainable AI (XAI) techniques into data science workflows.
- CO4.** Design and implement AI-driven automated data pipelines for real-time analytics.
- CO5.** Evaluate and analyze real-world data-centric AI case studies for decision support.

SYLLABUS:

UNIT - I: INTELLIGENT DATA WRANGLING AND FEATURE ENGINEERING (09 Periods)

Automated data preprocessing using ML-based imputation and cleaning, Handling missing data, noise, and outliers using predictive models, AI-driven feature extraction and transformation (auto encoders, embeddings), Feature selection using mutual information, L1 regularization, and SHAP values, Data normalization, encoding, and dimensionality reduction with PCA/t SNE/UMAP, Integration of feature stores and metadata management for reuse, Automation tools – PyCaret, Feature Tools, and Scikit-learn pipelines.

UNIT- II: AUTOML FRAMEWORKS FOR MODEL SELECTION AND OPTIMIZATION (09 Periods)

Overview of Automated Machine Learning (AutoML) and its workflow, AutoML frameworks – Auto-sklearn, Google AutoML, H2O.ai, and TPOT, Neural Architecture Search (NAS) and Bayesian optimization methods, Hyperparameter optimization – grid search, random search, and genetic tuning, Model ensemble automation and stacking in AutoML, Cross-validation and automatic metric selection, Automated pipeline creation for end-to-end ML

UNIT - III: EXPLAINABLE AI (XAI) IN DATA SCIENCE (09 Period)

Need for interpretability in AI-driven data science, Global vs local interpretability approaches, Model-agnostic methods: LIME, SHAP, and surrogate models, Counterfactual explanations and causal interpretability, Fairness, bias detection, and algorithmic accountability, Visualization tools for explainable data insights, integration of XAI with AutoML and data pipelines.

UNIT - IV: AI PIPELINES FOR REAL-TIME ANALYTICS (09 Periods)

AI workflow orchestration and automation using pipelines, Data ingestion and streaming using Kafka and Spark Streaming, Real-time model serving and deployment – Tensor Flow Serving, FastAPI, Flask, MLOps for continuous integration and delivery (CI/CD) in AI pipelines, Scalable data architectures for AI analytics (Snowflake, Databricks), Monitoring and feedback loops in deployed models.

UNIT- V: CASE STUDIES WITH DATA-CENTRIC AI (09 Periods)

AI-driven anomaly detection and predictive analytics in IoT. Fraud detection and financial transaction analysis using AutoML, Customer churn prediction with explainable AI insights, Healthcare analytics – disease prediction and diagnostic support, Supply chain optimization with data-centric AI, Edge-based AI analytics for smart environments, Data-centric AI evaluation: data quality, diversity, and labeling accuracy.

Text Books:

- T1.** Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow, Aurélien Géron, O'Reilly..
- T2.** AutoML: Automated Machine Learning on the Cloud with Tensor Flow, Mark Daoust & Yufeng Guo
- T3.** Interpretable Machine Learning, Christoph Molnar, Leanpub.
- T4.** Data-Centric AI Principles, Andrew Ng –(online resources).

Reference Books:

- R1.** Machine Learning for Time Series Forecasting with Python Francesca Lazzeri, Wiley.
- R2.** The Machine Learning Engineering Book Andriy Burkov .
- R3.** Data Analytics with Python and AI Techniques T. K. Sarkar et al.

Web Resources:

- 1. PyCaret, H2O.ai, Google Cloud AI Hub, MLflow documentation.

2598204	M.Tech., II-SEMESTER SOCIAL NETWORK ANALYSIS (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-III)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil.

COURSE OUTCOMES:

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

CO1. The student will be able to understand a Networks relations and attributes.

CO2. Analyze relational data.

CO3. Solve problems related to cliques and their intersections.

CO4. Infer the regular structure equivalence.

CO5. Make use of accessing twitter.

SYLLABUS:

UNIT-I: FOUNDATIONS OF SOCIAL NETWORK ANALYSIS (09 Periods)

Networks and Relations, Relations and Attributes, Analysis of Network Data, Interpretation of Network Data, An Overview. The Development of Social Network Analysis, Sociometric analysis and Graph Theory, Interpersonal Configurations and cliques.

UNIT-II: FOUNDATIONS OF SOCIAL NETWORK ANALYSIS (09 Periods)

Analysing Relational Data, Collecting Relational Data, Selection and Sampling of Relational Data, Preparation of Relational Data, Organizing Relational Data. Lines, Neighbourhoods and Densities, Sociometric and Graph Theory, Density: Ego-centric and Socio-centric, A Digression on absolute density, Community Structure and density

UNIT-III: CENTRALITY, COMPONENTS, AND CLIQUES (09 Periods)

Centrality Peripherality and Centralization, Centrality: Local and Global, Centralization and Graph Centres, bank Centrality in Corporate Networks, Components, Cores and Cliques, Components, Cycles and Knots, The Contours of components, Cliques and their intersections

UNIT-IV: POSITIONS, CLUSTERS, AND STRUCTURAL EQUIVALENCE (08 Periods)

Positions, sets and clusters, the structural equivalence of points, Clusters: Combining and dividing points, Block Modelling with CONCERT, Towards Regular Structure Equivalence

UNIT-V: NETWORK DYNAMICS AND VISUALIZATION (10 Periods)

Network Dynamics and Change over Time, Modelling change in Network Structure, Testing Explanations. Dimensions and displays, Distance, space and metrics, principal components and factors, Non-metric methods, Advances in Network Visualization, Elites, Communities and influence. Accessing twitter.

Total Periods: 45

Text Books:

T1. Social Network Analysis John Scott, , 3/e, SAGE Publications, 2017

T2. Mining the Social Web, Matthew A. Russell, 2/e, O'Reilly Media, 2011.

Reference Books:

R1. Understanding Social Networks: Theories, Concepts, and Findings, Charles Kadushin, Oxford University Press, 2012.

R2. Social Network Analysis for Startups, Maksim Tsvetovat, Alexander Kouznetsov

2598205	M.Tech., II-SEMESTER	L	T	P	C
	ENTERPRISE CLOUD CONCEPTS (ARTIFICIAL INTELLIANGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-III)	3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

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

- CO1.** demonstrate importance of cloud architecture
- CO2.** Illustrating the fundamental concepts of cloud security
- CO3.** Analyze various cloud computing mechanisms
- CO4.** explain the architecture and working of cloud computing.
- CO5.** detail cloud infrastructure, service models, and strategies for enterprise transformation and continuity in cloud environments.

SYLLABUS:

UNIT – I: FOUNDATIONS OF CLOUD COMPUTING: (08 Periods)

Understanding Cloud Computing:

Origins and influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges.

Fundamental Concepts and Models:

Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models.

UNIT-II: CLOUD-ENABLING TECHNOLOGIES AND INFRASTRUCTURE (09 Periods)

Cloud-Enabling Technology:

Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology, Cloud Computing Mechanisms, Cloud Infrastructure Mechanisms: Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud Usage Monitor, Resource Replication.

UNIT-III: CLOUD MANAGEMENT AND ARCHITECT (09 Periods)

Cloud Management Mechanisms: Remote Administration System, Resource Management System, SLA Management System, Billing Management System, Case Study Example.

Cloud Computing Architecture

Fundamental Cloud Architectures: Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture, Case Study Example.

UNIT: IV: CLOUD-ENABLED SMART ENTERPRISES (09 Periods)

Introduction, Revisiting the Enterprise Journey, Service-Oriented Enterprises, Cloud Enterprises, Smart Enterprises, The Enabling Mechanisms of Smart Enterprises Cloud-Inspired Enterprise Transformations Introduction, The Cloud Scheme for Enterprise Success, Elucidating the Evolving Cloud Idea, Implications of the Cloud on Enterprise Strategy, Establishing a Cloud-Incorporated Business Strategy.

UNIT-V: TRANSITIONING TO CLOUD-CENTRIC ENTERPRISES (09 Periods)

The Tuning Methodology, Contract Management in the Cloud Cloud-Instigated IT Transformations Introduction, Explaining Cloud Infrastructures, A Briefing on Next-Generation Services, Service Infrastructures, Cloud Infrastructures, Cloud Infrastructure Solutions, Clouds for Business Continuity, The Relevance of Private Clouds, The Emergence of Enterprise Clouds.

Total Periods: 45

TEXT BOOKS:

- T1.** Cloud Computing: Concepts, Technology & Architecture Erl Thomas, Puttini Ricardo, Mahmood Zaigham, 1st Edition,
- T2.** Cloud Enterprise Architecture Pethuru Raj, CRC Press

REFERENCE:

- R1.** The Enterprise Cloud,James Bond, O'Reilly Media, Inc.

2598206	M.Tech., II-SEMESTER REINFORCEMENT LEARNING (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

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

CO1. Understand basics of RL

CO2. Understand RL Framework and Markov Decision Process

CO3. Analyzing through the use of Dynamic Programming and Monte Carlo

CO4. Understand TD(0) algorithm,

CO5. Understand(λ) algorithm

SYLLABUS:

UNIT-I: STOCHASTIC BANDITS AND REGRET MINIMIZATION (10 Periods)

Basics of probability and linear algebra, Definition of a stochastic multi-armed bandit, Definition of regret, Achieving sublinear regret, UCB algorithm, KL-UCB, Thompson Sampling.

UNIT-II: MARKOV DECISION PROCESSES AND VALUE FUNCTIONS (09 Periods)

Markov Decision Problem, policy, and value function, Reward models (infinite discounted, total, finite horizon, and average), Episodic & continuing tasks, Bellman's optimality operator, and Value iteration & policy iteration

UNIT-III: REINFORCEMENT LEARNING FUNDAMENTALS AND MONTE CARLO METHODS (09 Periods)

The Reinforcement Learning problem, prediction and control problems, Model-based algorithm, Monte Carlo methods for prediction, and Online implementation of Monte Carlo policy evaluation

UNIT-IV: TEMPORAL DIFFERENCE LEARNING AND MODEL-FREE CONTROL (08 Periods)

Bootstrapping; TD(0) algorithm; Convergence of Monte Carlo and batch TD(0) algorithms; Model-free control: Q-learning, Sarsa, Expected Sarsa.

UNIT-V: ADVANCED RL: FUNCTION APPROXIMATION AND POLICY SEARCH (09 Periods)

n-step returns; TD(λ) algorithm; Need for generalization in practice; Linear function approximation and geometric view; Linear TD(λ). Tile coding; Control with function approximation; Policy search; Policy gradient methods; Experience replay; Fitted Q Iteration; Case studies.

Total Periods: 45

Textbooks:

T1. Reinforcement learning: An introduction, First Edition, Sutton, Richard S., and Andrew G. Barto, MIT press 2020

T2. Statistical reinforcement learning, modern machine learning approaches,” First Edition, Sugiyama, Masashi. CRC Press 2015

References:

R1. Bandit algorithms, First Edition, Lattimore, T. and C. Szepesvári. Cambridge University Press. 2020

- R2.** Reinforcement Learning Algorithms: Analysis and Applications, Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021
- R3.** Alexander Zai and Brandon Brown Deep Reinforcement Learning in Action, First Edition, Manning Publications 2020

2598207	M.Tech., II-SEMESTER MACHINE TRANSLATION (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-IV)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

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

- CO1.** Understand machine translation approaches.
- CO2.** Apply and assess manual and automatic evaluation methods for machine translation.
- CO3.** Build machine translation model using existing tools for machine translation.
- CO4.** Understand RBMT approaches including Interlingua, Transfer methods, and UNL-based translation techniques.
- CO5.** Learn EBMT processes, text similarity methods, and its integration with case-based reasoning and translation memory.

SYLLABUS:

UNIT- I: INTRODUCTION TO MACHINE TRANSLATION (09 Periods)

Introduction to Machine Translation, MT Approaches: vauqueos Triangle, Three major paradigms of Machine Translation, MT Evaluation

UNIT- II: LEARNING BILINGUAL WORD MAPPINGS (09 periods)

A Combinatorial Argument, Deeper look at one- one alignment, Heuristic based Computation of the VE *VF Table, Iterative Computation of the VE *VF Table, EM: Study of progress in Parameter values

UNIT – III: PHRASE BASED MACHINE TRANSLATION (09 periods)

Need for phrase alignment, An example to illustrate phrase alignment technique, Phrase table, Mathematics of Phrase based SMT, Decoding, Moses.

UNIT- IV: RULE BASED MACHINE TRANSLATION (RBMT) (09 periods)

Two kinds of RBMT: Interlingua and Transfer, Universal networking Language (UNL), UNL expressions as binary predicates, Interlingua and Word Knowledge, Translation using Interlingua, Details of english to UNL Conversion: with illustration, Transfer based MT.

UNIT-V: EXAMPLE BASED MACHINE TRANSLATION (09 Periods)

Essential steps of EBMT, EBMTs working, EBMT and case based reasoning, Text similarity computation, EBMT and Translation Memory, EBMT and SMT.

Total Periods:45

Textbooks:

T1. Pushpak Bhattacharyya, Machine Translation, CRC Press

References:

- R1.** Statistical Machine Translation by Philipp Koehn, Cambridge University Press.
- R2.** Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
- R3.** Linguistic Fundamentals for Natural Language Processing by Emily Bender, Morgan & Claypool.

2598208	M.Tech., II-SEMESTER	L	T	P	C
	NATURE INSPIRED COMPUTING (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-IV)	3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

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

- CO1.** Familiar with Genetic algorithm and its applications.
- CO2.** explain the mathematical basis, mechanisms, and applications of genetic algorithms in problem solving and optimization.
- CO3.** Compare different Ant Colony Optimization algorithmic models.
- CO4.** Compare different Artificial Bee Colony Optimization algorithmic models.
- CO5.** Explore various nature-inspired algorithms and their applications in solving complex optimization problems.

SYLLABUS:

UNIT-I: FOUNDATION OF BIO-INSPIRED COMPUTING AND OPTIMIZATION

(10 Periods)

Models of Life and Intelligence-Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-organization, swarm and evolutionary algorithms. Optimization problems — single and multi-objective optimization, heuristic, meta-heuristic and hyper heuristic functions.

UNIT-II: GENETIC ALGORITHMS AND APPLICATIONS

(08 Periods)

Genetic algorithms-Mathematical foundation, Genetic problem solving, crossover and mutation. genetic algorithms and Markov process, applications of genetic algorithms

UNIT-III: ANT COLONY OPTIMIZATION TECHNIQUES

(08 Periods)

Ant Colony Algorithms-Ant colony basics, hybrid ant system, ACO in combinatorial optimization, variations of ACO, case studies.

UNIT-IV: SWARM INTELLIGENCE: PSO AND BEE COLONY ALGORITHMS

(09 Periods)

Particle Swarm algorithms-particles moves, particle swarm optimization, variable length PSO, applications of PSO, case studies. Artificial Bee Colony algorithms-ABC basics, ABC in optimization, multi-dimensional bee colony algorithms, applications of bee algorithms, case studies.

UNIT-V: ADVANCED NATURE-INSPIRED ALGORITHMS

(10 Periods)

Selected nature inspired techniques-Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Firey algorithm, SDA algorithm, bat algorithm, case studies. Other nature inspired techniques-Social spider algorithm, Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm, Artificial immune system, Flower pollination algorithm, case studies.

Total Periods: 45

Textbooks:

- T1.** Handbook of Nature-Inspired and Innovative Computing, Albert, Y. Zomaya, Springer, 2006.
- T2.** Bio-Inspired Artificial Intelligence: Theories methods, and Technologies, Floreano, D. and C. Mattiussi, IT Press, 2008.

References:

- R1.** Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications, Leandro Nunes de Castro Chapman & Hall/ CRC, Taylor and Francis Group, 2007
- R2.** Ant Colony Optimization, Marco Dorigo, Thomas Stutzle, Prentice Hall of India, New Delhi, 2005
- R3.** Machine Learning: A Practitioner's Approach, Vinod Chandra S S, Anand H S, Prentice Hall of India, New Delhi, 2020.

2598251	M.Tech., II-SEMESTER NEURAL NETWORKS AND DEEP LEARNING LAB (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		0	0	4	2

Pre-Requisites: NIL

COURSE OUTCOMES:

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

- CO1.** Understand the fundamental concepts of neural networks and deep learning models.
- CO2.** Design and implement various ANN architectures such as Perceptrons, Multi-Layer Networks, CNNs, and RNNs for different tasks.
- CO3.** Apply optimization and regularization techniques (e.g., SGD, adaptive learning rates, L1/L2 penalties, dropout, early stopping) to train deep models effectively.
- CO4.** Evaluate and analyze neural network models using relevant performance metrics to ensure accuracy and reliability.
- CO5.** Select and deploy appropriate architectures for solving complex real-world problems in computer vision, NLP, speech recognition, and large-scale data processing.
- CO6.** To design and implement deep learning models for image recognition, speech processing, and sentiment analysis.

LIST OF PROGRAMS

1. Write a program to create and train a single-layer perceptron to separate linearly separable data.
2. Build a multi-layer neural network from scratch to solve the XOR problem using backpropagation.
3. Implement a 2-layer MLP (input-hidden-output) for MNIST digit classification.
4. Train a Multi-Layer Perceptron (MLP) on the CIFAR-10 dataset using the following configurations:
 - a. L1/L2 regularization
 - b. Dropout
 - c. Early stopping
5. Build and train a simple CNN (e.g., on fashion-MNIST or CIFAR-10 dataset).
6. Implement an RNN to predict the next character in a string sequence.
7. Compare performances of RNN and LSTM on sequential data such as stock prices or word sequences.
8. Build a bidirectional RNN for sentiment analysis.
9. Train an encoder-decoder RNN for sequence translation
10. Build a deep CNN model to recognize multi-digit numbers from images similar to SVHN dataset.
11. Write a program to implement RNN/LSTM for simple speech-to-text conversion.
12. Build a deep learning model to classify sentiment from movie reviews or tweets.

References:

- R1.** Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow Géron A., O'Reilly Media, Inc.; 2022 Oct 4.
- R2.** Dive into deep learning Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J., Cambridge University Press, 2023.

R3. Deep learning with Python, Chollet, Francois. Simon and Schuster, 2021.

Web Resources:

1. <https://nptel.ac.in/courses/106106184>
2. <https://github.com/Gaurav0502/deep-learning-lab>
3. <https://github.com/roatienza/Deep-Learning-Experiments>

2598252	M.Tech., II-SEMESTER ADVANCES IN SOFTWARE ENGINEERING LAB (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		0	0	4	2

Pre-Requisites: NIL

COURSE OUTCOMES:

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

- CO1.** Apply various software process models and project management techniques (estimation, scheduling, risk management) to plan and manage software development effectively.
- CO2.** Perform requirements elicitation, documentation, and system modeling using UML to capture, analyze, and validate software requirements.
- CO3.** Design software systems using object-oriented principles, design patterns, and component-based approaches for modularity, reusability, and maintainability.
- CO4.** Implement software testing strategies, maintenance techniques, and reengineering practices to ensure software quality, reliability, and evolution.
- CO5.** Tools such as version control and DevOps pipelines to streamline development workflows
- CO6.** Use software metrics and AI-based analysis techniques to improve software quality and ensure effective testing and validation

List of Experiments:

Experiment 1: Comparative Study of Process Models

Implement a simple project using Waterfall and Incremental models; compare effort, defects, and time taken.

Experiment 2: Agile Development Simulation

Develop a small software system using Scrum methodology with sprints, product backlog, sprint backlog, and daily scrums.

Experiment 3: Project Estimation and Scheduling

Perform Function Point Analysis (FPA) or Use Case Points (UCP) to estimate size and effort, then prepare a Gantt chart and PERT chart.

Experiment 4: Risk Analysis in Software Projects

Conduct risk identification, qualitative/quantitative assessment, and develop a risk mitigation plan for a given case study.

Experiment 5: Requirement Elicitation and SRS Document

Conduct requirement gathering for a mini-project and prepare a Software Requirement Specification (SRS) document.

Experiment 6: UML Modeling (Scenario-based & Structural)

Create Use Case diagrams, Activity diagrams, and Sequence diagrams for a given problem domain.

Experiment 7: UML Modeling (Class & Behavioral)

Create Class diagrams, State machine diagrams, and Component diagrams to represent system architecture.

Experiment 8: Object-Oriented Design Using UML

Design a software module using OO principles (encapsulation, inheritance, polymorphism) and illustrate with UML diagrams.

Experiment 9: Design Patterns Implementation

Implement at least three design patterns (e.g., Singleton, Factory, Observer) in Java/Python.

Experiment 10: Reuse-Oriented Software Engineering

Use existing open-source libraries/frameworks to develop a component-based application (e.g., web app using Django/Flask).

Experiment 11: Black-box and White-box Testing

Perform equivalence partitioning and boundary value analysis (black-box) and basis path testing (white-box) for a given program.

Experiment 12: Software Maintenance and Reengineering

Take an existing open-source project (small module), analyze it, and perform refactoring / reengineering for improvement.

Experiment 13: Version Control and DevOps Pipeline

Use Git & GitHub/GitLab for version control and demonstrate CI/CD pipeline setup with Jenkins/GitHub Actions.

Experiment 14: Software Metrics and AI in SE

Compute software metrics (complexity, coupling, cohesion) for a given project and explore an AI tool (e.g., GitHub Copilot, SonarQube) for software quality analysis.

Textbooks:

- T1.** Software Engineering A Practitioner's Approach, Roger S. Pressman, McGrawHill International Edition, 9th Edition.
- T2.** Fundamentals of Software Engineering, Rajib Mall, PHI, Fifth Edition,

References:

- R1.** Software Engineering, Ian Sommerville, Tenth Edition, Pearson education.
- R2.** Software Engineering: A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008
- R3.** Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India,2010.
- R4.** Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

2584253	M.Tech., II-SEMESTER COMPREHENSIVE VIVA VOCE (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE)	L	T	P	C
		0	0	0	2

Pre-Requisites: All Courses

Course Outcomes:

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

- CO1.** Demonstrate comprehensive understanding of core concepts learned throughout the program.
- CO2.** Apply theoretical knowledge to analyze and solve discipline-specific problems.
- CO3.** Communicate technical ideas, concepts, and project outcomes clearly and effectively during oral examination.
- CO4.** Integrate knowledge from various subjects to justify solutions and decisions.
- CO5.** Exhibit critical thinking, professional ethics, and confidence while responding to technical and situational questions.

2598281	M.Tech., II-SEMESTER	L	T	P	C
	QUANTUM TECHNOLOGIES AND APPLICATIONS (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (MANDATORY COURSE-II)	2	0	0	2

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Demonstrate the basic principles and technological importance of quantum physics.
- CO2.** Explain the basic concepts of qubits, quantum states, entanglement, and differences between classical and quantum information systems..
- CO3.** Analyze the key challenges and requirements in developing stable and scalable quantum hardware systems.
- CO4.** Explain the basic concepts of quantum communication and computing, including QKD, quantum parallelism, and related challenges.
- CO5.** Demonstrate the major applications, industry developments, and future opportunities of quantum technologies along with their societal and practical challenges.

SYLLABUS:

UNIT-I: FOUNDATIONS OF QUANTUM THEORY AND TECHNOLOGIES (05 Periods)

Transition from classical to quantum physics. Key conceptual principles: Superposition, Entanglement, Uncertainty, Wave-particle duality. Quantum states and measurement; the role of the observer. Representative quantum systems: electrons, photons, atoms. Concept of quantization and discrete energy levels. Strategic relevance of quantum technologies.

Overview of major domains: Computing, Communication, Sensing. Global quantum initiatives: India's National Quantum Mission, EU Quantum Flagship, USA, China.

UNIT-II: CONCEPTUAL STRUCTURE OF QUANTUM INFORMATION (07 Periods)

Qubits: qualitative understanding using spin and polarization. Classical bits vs quantum bits: distinctions and implications. Quantum systems (non-engineering perspective): trapped ions, superconducting qubits, photonics. Coherence and decoherence mechanisms. Abstract notions: quantum states, measurement operators, Hilbert space—interpretation without mathematics. Entanglement and non-locality as foundational resources. Quantum vs classical information principles; philosophical considerations.

UNIT-III: BUILDING A QUANTUM COMPUTER – CHALLENGES AND REQUIREMENTS (06 Periods)

Conceptual prerequisites for functional quantum hardware. Fragility of quantum states: decoherence, noise, stability issues. Requirements: isolation, error resilience, scalability, control. Why maintaining entanglement is difficult; theoretical necessity of quantum error correction. Comparative overview of hardware platforms (superconducting circuits, trapped ions, photonics). Current progress vs scientific constraints; conceptual view of quantum software's role.

UNIT-IV: QUANTUM COMMUNICATION AND COMPUTING (06 Periods)

Quantum vs classical communication paradigms. Essentials of Quantum Key Distribution (QKD) and its security rationale. Entanglement-enabled communication protocols. Concept of the Quantum Internet and secure global networking. Introduction to quantum computing and quantum

parallelism.

Conceptual comparison of classical and quantum gate operations. Challenges: decoherence, noise, and the necessity of error correction frameworks.

UNIT-V: APPLICATIONS, INDUSTRY, AND FUTURE DIRECTIONS (06 Periods)

Application domains: Healthcare and drug discovery, Material science and chemistry, Optimization and logistics, Quantum sensing and precision timing. Case studies: IBM, Google, Microsoft, PsiQuantum. Ethical, societal, and policy considerations. Barriers to adoption: cost, skilled workforce, standards. Emerging research and career landscapes; India's strategic opportunity in the global quantum ecosystem.

Total Periods: 30

Textbooks:

- T1. Quantum Computation and Quantum Information, Nielsen & Chuang, Cambridge University Press, 2010.
- T2. Quantum Computing: A Gentle Introduction, Rieffel & Polak, MIT Press, 2011.
- T3. Quantum Computing for Everyone, Chris Bernhardt, MIT Press, 2019.

Reference Books:

- R1. Quantum Computing Explained, David McMahon, Wiley, 2008.
- R2. An Introduction to Quantum Computing, Kaye, Laflamme, Mosca, OUP, 2007.
- R3. Quantum Computing Since Democritus, Scott Aaronson, CUP, 2013.
- R4. Quantum Mechanics: The Theoretical Minimum, Susskind & Friedman, Basic Books, 2014.
- R5. Quantum Enigma, Rosenblum & Kuttner, OUP, 2011.
- R6. Principles of Quantum Computation and Information, Benenti et al., World Scientific, 2004.
- R7. DST India and MeitY: Official Quantum Mission Reports, 2020 onwards.
- R8. Quantum Flagship EU: Roadmaps and Strategy Documents.

Online Learning Resources

1. IBM Quantum Experience & Qiskit Textbook Coursera – Quantum Mechanics and Quantum Computation (UC Berkeley) edX – Quantum Internet & Quantum Computers
2. YouTube – Quantum Computing for the Determined (Michael Nielsen)

25HS201	M.Tech., II-SEMESTER PEDAGOGY STUDIES	L	T	P	C
	(Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE-II)	2	0	0	0

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Apply pedagogy, learning theories, and technology to design learner-centered education.
- CO2.** Design and implement effective lesson plans and curriculum using appropriate teaching strategies and technology tools to enhance the teaching–learning process.
- CO3.** Analyze and apply instructional design models, emerging e-learning trends, and ICT tools to design and implement effective technology-integrated teaching–learning systems.
- CO4.** Apply pedagogical analysis and appropriate assessment methods, including technology-based tools and reflective practices, to improve teaching–learning effectiveness.
- CO5.** Apply pedagogical analysis and appropriate assessment methods, including technology-based tools and reflective practices, to improve teaching–learning effectiveness.

SYLLABUS:

UNIT-I: FOUNDATIONS OF PEDAGOGY (05 Periods)

Introduction to pedagogy and its importance in education - Historical and philosophical foundations of pedagogy - Theories of learning and teaching (behaviorist, cognitive, constructivist) - Role of pedagogy in shaping educational practices - Role of technology in modern pedagogy (ICT, e-learning, blended learning)

UNIT-II: TEACHING-LEARNING PROCESSES (06 Periods)

Understanding the teaching-learning process - Lesson planning and curriculum design - Strategies for effective teaching and learning (expository, collaborative, experiential) - Use of technology to enhance teaching-learning processes (multimedia, simulations, gamification)

UNIT-III: TECHNOLOGY INTEGRATION IN EDUCATION (07 Periods)

Educational technology and system design - Instructional design models (ADDIE, ASSURE, Dick and Carey Model) - Emerging trends in e-learning (social learning, MOOCs, mobile learning) - ICT tools for teaching and learning (Learning Management Systems, online resources)

UNIT-IV: PEDAGOGY AND ASSESSMENT (06 Periods)

Pedagogy, pedagogical analysis, and assessment - Types of assessment (placement, formative, diagnostic, summative) - Technology-based assessment tools (online quizzes, polls, discussions) - Rubrics for self and peer evaluation- Reflective Practices

UNIT-V: CONTEMPORARY ISSUES AND TRENDS (06 Periods)

Inclusive education and technology (assistive technology, accessibility) - Change management and innovation in education - Quality assurance and evaluation in education (TQM, Six Sigma) - Future trends in pedagogy and technology (AI, AR, VR in education) - Personalized learning and adaptive teaching

Total Periods: 30

Text Books:

- T1. Essays on Pedagogy, Alexander, R. J., Routledge, 2008.
- T2. The Wisdom of Practice: Essays on Teaching, Learning, and Learning to Teach, Shulman, L. S., Jossey-Bass, 2004

Reference Books:

- R1. Teaching for the Future: Effective Teacher Education and Pedagogical Practices. OECD Publishing., 2021
- R2. System Change in Education: Sustainability and Impact, Fullan, M., & Edwards, M, Routledge, 2022.
- R3. Great Teaching Toolkit: Evidence Review, Coe, R., Rauch, C., Kime, S., & Singleton, D., Evidence Based Education., 2020
- R4. The Struggle for the Soul of Teacher Education, Zeichner, K. M., Routledge, 2024
- R5. UNESCO. Global Education Monitoring Report: Pedagogy, Teachers and Learning. UNESCO Publishing, 2024
- R6. Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement, Hattie, J., Routledge., 2009
- R7. Teacher Education Around the World: What Can We Learn from International Practice?, Darling-Hammond, L. , Routledge, 2007

Online Resources:

1. UNESCO Education Resources – <https://www.unesco.org/education>
2. OECD Education and Skills – <https://www.oecd.org/education>
3. ERIC (Education Resources Information Center) – <https://eric.ed.gov> (peer-reviewed papers, reports).
4. World Bank Education – <https://www.worldbank.org/en/topic/education> (research reports on teacher development in developing countries).
5. NPTEL/SWAYAM MOOCs – Teacher education and pedagogy-focused courses.
6. Google Scholar Alerts – set alerts for "pedagogical practices", "teacher education", "curriculum research" for the latest academic papers.

25HS202	M.Tech., II-SEMESTER	L	T	P	C
	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE-II)	2	0	0	0

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Practice self-awareness and personal effectiveness by analyzing strengths, weaknesses, opportunities, and challenges (SWOC), setting SMART goals, and practicing reflection, journaling, and self-care strategies.
- CO2.** Evince emotional intelligence by developing self-awareness, self-regulation, motivation, communication, interpersonal, and conflict-resolution skills for personal and professional effectiveness.
- CO3.** Exhibit a positive mindset, resilience, and emotional well-being by cultivating growth-oriented thinking, gratitude, mindfulness, and strategies to overcome negative thoughts and behaviors.
- CO4.** Enhance personal and professional effectiveness by developing verbal, non-verbal, and presentation skills, while building confidence and competence in public speaking.
- CO5.** Demonstrate leadership capabilities by understanding styles and qualities, enhancing teamwork, collaboration, and problem-solving skills for effective team management.

SYLLABUS:

UNIT-I: SELF-AWARENESS AND PERSONAL GROWTH (06 Periods)

Understanding personality and its development- Identifying strengths, weaknesses, opportunities, and challenges (SWOC analysis)- Setting personal and professional goals- Practicing Self-Reflection and Journaling

(Activities: Personality assessments, self reflection exercises, group discussions, SWOC analysis worksheet, Action Plan, SMART goal activities, Reflective journaling, Self-care Planning)

UNIT-II: EMOTIONAL INTELLIGENCE AND INTERPERSONAL SKILLS (06 Periods)

Understanding emotional intelligence and its importance - Developing self-awareness, self-regulation, and motivation - Building effective communication and interpersonal skills - Conflict resolution and negotiation strategies.

(Activities: Emotional Intelligence Quiz, Self-Reflection exercises, feedback sessions, mindfulness exercises, Positive self-talk, Active Listening exercises, conflict-resolution Role-play, Case studies & Group activities)

UNIT-III: POSITIVE THINKING AND ATTITUDE (06 Periods)

Understanding the power of positive thinking- Developing a growth mindset and resilience - Practicing gratitude and mindfulness- Overcoming negative thoughts and behaviors

(Activities on positive thinking, growth mindset, mindfulness and self-care plan for overcoming negative thoughts)

UNIT-IV: EFFECTIVE COMMUNICATION AND PRESENTATION SKILLS (06 Periods)

Understanding the importance of effective communication- Developing verbal and non-verbal communication skills- Preparing and delivering effective presentations- Building confidence and public speaking skills

(Activities: Group discussions, Case studies, Role-Play, Non-verbal communication exercises, Practice presentations, Peer feedback, Public speaking exercises, Storytelling, Debates)

UNIT-V: LEADERSHIP AND TEAMWORK (06 Periods)

Understanding leadership styles and qualities - Developing leadership skills and qualities- Building effective teams and teamwork strategies- Practicing collaboration and problem-solving

(Activities: Case studies, Group discussions, Debates, Leadership role-playing, team building activities, Group projects, Collaborative problem-solving exercises, feedback sessions)

Total Periods: 30

Text Books:

- T1. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ, Bantam Books, 2017.
- T2. Stephen R. Covey, The 7 Habits of Highly Effective People, Simon & Schuster, 2020

Reference Books:

- R1. Dale Carnegie, How to Win Friends and Influence People, Simon & Schuster, 2020.
- R2. Brian Tracy, Goals!: How to Get Everything You Want Faster Than You Ever Thought Possible, Berrett-Koehler Publishers, 2021.
- R3. Robin Sharma, The 5 AM Club: Own Your Morning, Elevate Your Life, HarperCollins, 2020.
- R4. Carol S. Dweck, Mindset: The New Psychology of Success, Random House, 2016.
- R5. Daniel H. Pink, Drive: The Surprising Truth About What Motivates Us, Riverhead Books, 2018.
- R6. John C. Maxwell, Leadershift: 11 Essential Changes Every Leader Must Embrace, Harper Collins, 2019.

Online Resources:

1. Coursera – *Personal Development Specialization* (<https://www.coursera.org>)
2. edX – *Leadership and Emotional Intelligence Courses* (<https://www.edx.org>)
3. FutureLearn – *Mindfulness and Resilience Training* (<https://www.futurelearn.com>)
4. MindTools – Practical resources on leadership, communication, and emotional intelligence (<https://www.mindtools.com>)
5. Positive Psychology – Articles and tools on resilience, gratitude, and well-being (<https://positivepsychology.com>)
6. TED Talks – Inspirational talks on leadership, communication, and self-growth (<https://www.ted.com>)
7. Harvard Business Review (HBR) – Leadership, negotiation, and workplace communication (<https://hbr.org>)

25HS203	M.Tech., II-SEMESTER YOGA AND MEDITATION (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE-II)	L	T	P	C
		2	0	0	0

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Explain the eight limbs of Ashtanga Yoga and their significance in achieving physical, mental, and spiritual well-being.
- CO2.** Explain the principles of Yama and Niyama and their role in ethical and personal discipline in yoga practice.
- CO3.** Practice the principles of Yama and Niyama as ethical guidelines for disciplined and harmonious living.
- CO4.** Explain the role of Asana and Pranayama in promoting physical fitness and mental well-being.
- CO5.** Practice yoga poses and pranayama techniques and their benefits for mind and body.

SYLLABUS:

UNIT-I: ASHTANGA YOGA

(05 Periods)

Definitions of Eight parts of yoga - Yama (Restraints / Moral Disciplines), Niyama (Observances / Personal Disciplines), Asana (Postures / Physical Exercises), Pranayama (Breath Control / Life Force Regulation), Pratyahara (Withdrawal of Senses / Sense Control), Dharana (Concentration / Focus), Dhyana (Meditation / Contemplation), Samadhi (Absorption / Liberation)

UNIT-II: YAMA AND NIYAMA IN ASHTANGA YOGA

(07 Periods)

Yama (Moral Restraints) - Ahimsa (Non-violence), Satya (Truthfulness), Asteya (Non-stealing), Brahmacharya (Moderation / Celibacy), Aparigraha (Non-possessiveness / Non-greed).
Niyama (Personal Disciplines / Observances) - Shaucha (Cleanliness / Purity), Santosha (Contentment), Tapas (Discipline / Austerity), Swadhyaya (Self-study / Study of Scriptures), Ishwar Pranidhana (Surrender to God / Devotion).

UNIT-III: DO'S AND DON'TS IN LIFE – YAMA AND NIYAMA

(06 Periods)

Do's and Don'ts in life.

UNIT-IV: ASANA AND PRANAYAM

(06 Periods)

Asana - Body development and steadiness; Pranayam - Breath control and energy regulation

UNIT-V: YOGA POSES AND PRANAYAMA – BENEFITS AND TYPES

(06 Periods)

Various yoga poses and their benefits for mind and body
Regularization of breathing techniques and its effects-Types of pranayama

Total Periods: 30

Text Books:

- T1. Swami Prabhavananda and Christopher Isherwood (translation & commentary), Patanjali Yoga Sutras, Sri Ramakrishna Math, 1953.
- T2. B.K.S. Iyengar, Light on Yoga, Thorsons, 2003.

Reference Books:

- R1. T.K.V. Desikachar, The Heart of Yoga: Developing a Personal Practice, Inner Traditions 2nd Edition, 1999.
- R2. Acharya Yatendra, Yoga & Stress Management, Fingerprint Publishers, 2019
- R3. Yamini Muthanna, The Power of Yoga, Om Books International, 2015.
- R4. Nayaswami Devarshi, Kriya Yoga: Spiritual Awakening for the New Age, Ananda Sangha Publications, 2023.

Online Resources:

1. NPTEL / SWAYAM Online Courses – Yoga and Physical Education modules.
2. AYUSH Ministry Website: <https://yoga.ayush.gov.in> – official yoga resources, protocols, and research.
3. Yoga Journal: <https://www.yogajournal.com> – practical guides, research updates, asana tutorials.
4. Art of Living Foundation: <https://www.artofliving.org> – pranayama, meditation, and wellness practices.
5. YouTube Channels (scholarly & practice-based):
 - a. Sivananda Yoga Vedanta Centre
 - b. Yoga with Adriene (for practical asana guidance)

2598301	M.Tech., III-SEMESTER BIG DATA CURATION (ARTIFICIAL INTELLEGEENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

- CO1.** Explain the need, architecture, and life cycle of big data curation systems.
- CO2.** Apply data wrangling, cleaning, and integration methods to large datasets.
- CO3.** Design scalable curation workflows using distributed data processing frameworks.
- CO4.** Evaluate data quality, provenance, and metadata standards in big data ecosystems.
- CO5.** Implement data governance, reproducibility, and FAIR data principles in real-world curation projects.

SYLLABUS:

UNIT-I: INTRODUCTION TO BIG DATA CURATION (10 Periods)

Definition and importance of data curation, Big data life cycle: acquisition, storage, processing, and archiving, Data curation vs. data management, Architecture of a big data curation system, Data formats, schemas, and heterogeneity challenges, Role of metadata and ontologies in curation.

UNIT-II: DATA INGESTION, CLEANING, AND INTEGRATION (09 Periods)

Data ingestion pipelines – batch and streaming, Data cleaning techniques: missing values, outlier detection, normalization, Schema alignment, entity resolution, and semantic integration, ETL (Extract, Transform, Load) processes and tools, Frameworks for scalable data preprocessing – Apache Spark, Flink, and Beam.

UNIT-III: METADATA MANAGEMENT AND PROVENANCE (09 Periods)

Metadata standards (Dublin Core, JSON-LD, schema.org), Provenance models – W3C PROV-DM and Open Provenance Model, Lineage tracking and reproducibility in big data workflows, Metadata repositories and catalogs (Apache Atlas, Amundsen), FAIR principles (Findable, Accessible, Interoperable, Reusable).

UNIT-IV: SCALABLE DATA CURATION FRAMEWORKS (09 Periods)

Distributed and cloud-based data curation architectures, Workflow orchestration tools – Apache Airflow, Prefect, Luigi, Data versioning and incremental updates, Big data storage solutions – HDFS, NoSQL, object stores.

UNIT-V: DATA GOVERNANCE, QUALITY, AND ETHICS (08 Periods)

Principles of data governance and stewardship, Data quality assessment metrics, Privacy, security, and ethical considerations in data curation, Legal frameworks – GDPR, data sharing policies, Emerging trends – automated curation, AI-driven data management, and data observability.

Total Periods: 45

Textbooks:

- T1.** The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences, Kitchin, R., Sage, 2014.

T2. Enterprise Knowledge Management: Loshin, D., The Data Quality Approach, Morgan Kaufmann, 2010.

References:

R1. Hai, R., et al., Data Curation in the Era of Big Data and Data Science, Springer, 2021.

R2. Ward, J. S., & Barker, A., Undefined By Data: A Survey of Big Data Definitions, arXiv, 2013.

2598302	M.Tech., III-SEMESTER MULTIMODAL AI (ARTIFICIAL INTELLIGENCE AND DATA SCIENCE) (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

CO1: Explain the fundamental concepts and importance of multimodal AI.

CO2: Apply deep learning methods for processing and fusing multimodal data.

CO3: Design multimodal systems for perception, understanding, and generation tasks.

CO4: Analyze challenges in alignment, representation, and transfer across modalities.

CO5: Evaluate multimodal AI systems in terms of efficiency, interpretability, and societal impact.

SYLLABUS:

UNIT-I: INTRODUCTION TO MULTIMODAL AI (09 Periods)

Overview of multimodal learning and its significance, Modalities: text, vision, speech, audio, and sensor data, Challenges: heterogeneity, temporal synchronization, and missing modalities, Early, late, and hybrid fusion strategies, Applications in computer vision, NLP, and robotics.

UNIT-II: MULTIMODAL REPRESENTATION LEARNING (09 Periods)

Representation learning for individual modalities, Joint and aligned representations, Embedding spaces and contrastive learning, Canonical Correlation Analysis (CCA), autoencoders, and cross-modal transformers, Pretraining approaches using multimodal data (e.g., CLIP, ALIGN, Flamingo).

UNIT-III: MULTIMODAL FUSION AND ALIGNMENT (09 Periods)

Data-level, feature-level, and decision-level fusion, Attention mechanisms for multimodal integration, Temporal and spatial alignment of modalities, Multimodal transformers (e.g., ViLT, LXMERT, BLIP), Cross-modal reasoning and retrieval.

UNIT-IV: MULTIMODAL GENERATION AND UNDERSTANDING (09 Periods)

Generative multimodal models (Diffusion models, DALL·E, Stable Diffusion), Text-to-image, text-to-video, and speech synthesis, Visual Question Answering (VQA) and Image Captioning, Emotion and affect recognition using multimodal inputs, Evaluation metrics for multimodal understanding and generation.

UNIT-V: APPLICATIONS, ETHICS, AND FUTURE DIRECTIONS (09 Periods)

Applications in healthcare, education, autonomous systems, and human–AI interaction, Bias, fairness, and interpretability in multimodal models, Data privacy and consent issues in multimodal datasets, Responsible and trustworthy multimodal AI.

Total Periods: 45

Textbooks

T1. Multimodal Machine Learning: A Survey and Taxonomy, IEEE Transactions on Pattern Analysis and Machine Intelligence, Baltrušaitis, T., Ahuja, C., & Morenci, L. P., 2019.

T2. Foundations and Advances in Multimodal Learning Li, Q., & Yang, Y., Springer, 2022.

References

R1. Multimodal Transformer for Unaligned Multimodal Language Sequences, Tsai, Y. H., et al., ACL, 2019.

R2. Learning Transferable Visual Models from Natural Language Supervision (CLIP), OpenAI, Radford, A., et al., 2021.

2598303	M.Tech., III-SEMESTER AI DRIVEN SOFTWARE ENGINEERING (ARTIFICIAL INTELLEGEANCE AND DATA SCIENCE) (PROGRAM ELECTIVE-V)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

COURSE OUTCOMES:

- CO1.** Explain the role and impact of AI in modern software engineering processes.
- CO2.** Apply machine learning and NLP techniques to automate software development tasks.
- CO3.** Design AI-driven tools for software analysis, testing, and defect prediction.
- CO4.** Evaluate data-centric methods for project estimation, code generation, and software quality assurance.
- CO5.** Discuss ethical, explainability, and human–AI collaboration aspects in software development.

SYLLABUS:

UNIT-I: INTRODUCTION TO AI IN SOFTWARE ENGINEERING (09 Periods)

Overview of AI and its applications in software engineering, Data-driven software engineering and intelligent automation, AI-assisted SDLC: requirements, design, coding, testing, and maintenance, Role of knowledge-based systems, ML, and NLP in software development, AI tools and frameworks in software engineering.

UNIT–II: AI FOR REQUIREMENTS AND DESIGN ENGINEERING (10 Periods)

Natural language processing for requirement extraction and analysis, Semantic models for requirement validation and traceability, AI-based software design optimization, Generative design patterns and architecture synthesis, Intelligent decision support systems in early SDLC phases.

UNIT-III: AI IN CODING AND CODE GENERATION (09 Periods)

Machine learning and deep learning models for code generation, Large Language Models (LLMs) in software development (e.g., GitHub Copilot, ChatGPT), Program synthesis and auto-completion techniques, Code review, refactoring, and bug localization using AI, Knowledge graphs and embeddings for code understanding.

UNIT-IV: AI FOR TESTING, DEBUGGING, AND MAINTENANCE (08 Periods)

Automated test case generation and prioritization, Predictive models for defect detection and software reliability, Root cause analysis and intelligent debugging, AI-driven regression testing and impact analysis, Evolutionary and reinforcement learning techniques for maintenance optimization.

UNIT-V: PROJECT MANAGEMENT, ETHICS, AND FUTURE DIRECTIONS (09 Periods)

AI for software project estimation, planning, and risk management, Predictive analytics for team productivity and effort estimation, Software analytics dashboards and visualization, Ethical and explainable AI in software engineering.

Total Periods: 45

Textbooks:

- T1.** AI for Software Engineering: Current and Future Directions, Menzies, T., & Pecheur, C., IEEE Intelligent Systems, 2021.
- T2.** Artificial Intelligence for Software Engineering: Techniques and Applications Jha, S., & Kumar, A., CRC Press, 2023.

References:

- R1.** Search-Based Software Engineering Harman, M., & Clark, J. Springer, 2020.
- R2.** AI-Powered Software Development: Tools and Best Practices Soni, D. Apress, 2022.

2598351	M.Tech., III-SEMESTER DISSERTATION PHASE-I (ARTIFICIAL INTELLEGENCE AND DATA SCIENCE)	L	T	P	C
		0	0	20	10

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Identify and formulate a research problem in the chosen area of specialization through comprehensive literature review.
- CO2.** Analyze existing methods and technologies related to the problem and identify research gaps.
- CO3.** Design a suitable methodology, framework, or experimental setup to address the identified research problem.
- CO4.** apply appropriate tools and techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.
- CO5.** prepare and present a detailed project proposal and preliminary results effectively through technical reports and seminars.
- CO6.** make decisions to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

2598352	M.Tech., III-SEMESTER INDUSTRY INTERNSHIP (ARTIFICIAL INTELLEGEENCE AND DATA SCIENCE)	L	T	P	C
		0	0	0	2

Pre-Requisites: Nil

Course Outcomes:

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

- CO1.** Demonstrate the organizational structure, workflow, and professional practices followed in industry.
- CO2.** Apply engineering knowledge and technical skills to solve real-world industrial problems.
- CO3.** Develop professional competencies such as teamwork, communication, time management, and work ethics in an industrial environment.
- CO4.** Prepare and present a comprehensive report reflecting practical learning, observations, and outcomes.

2598353	M.Tech., III-SEMESTER CO-CURRICULAR ACTIVITIES (ARTIFICIAL INTELLEGENCE AND DATA SCIENCE)	L	T	P	C
		0	0	0	1

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Demonstrate participation and engagement in technical and professional co-curricular activities such as seminars, workshops, competitions, and technical events.
- CO2.** Develop problem-solving, analytical, and innovation skills through active involvement in technical activities.
- CO3.** Enhance communication, leadership, teamwork, and organizational skills through collaborative participation in co-curricular programs.
- CO4.** Apply acquired knowledge and skills to improve overall professional competence and lifelong learning abilities.

2512381	M.Tech., III-SEMESTER GREEN BUILDINGS (Common to AIDS, PS, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Apply principles of green building design to plan and evaluate sustainable buildings by integrating energy efficiency, water conservation, eco-friendly materials, and sustainable construction practices.
- CO2.** Explain green building concepts, rating systems, and sustainable practices for energy, water, and materials efficiency.
- CO3.** Apply green building design principles to reduce energy demand and integrate renewable and onsite energy systems efficiently.
- CO4.** Apply energy-efficient HVAC design principles for sustainable air conditioning and green building performance.
- CO5.** Apply material conservation strategies and indoor environmental quality principles to promote sustainable and healthy buildings.

SYLLABUS:

UNIT-I: INTRODUCTION TO GREEN BUILDING AND SUSTAINABLE FEATURES

(08 Periods)

Introduction to Green Building – Necessity of Green Buildings, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites for Constructing a Green Building, Important Sustainable Features for Green Buildings.

UNIT-II: GREEN BUILDING CONCEPTS AND SUSTAINABLE PRACTICES

(09 Periods)

Green Building Concepts and Practices – Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities and Benefits: Opportunities of Green Buildings, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy-Saving Approaches in Buildings, LEED India Rating System, and Energy Efficiency.

UNIT-III: GREEN BUILDING DESIGN AND ENERGY OPTIMIZATION

(09 Periods)

Green Building Design – Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximizing System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources, Eco-friendly Captive Power Generation for Factories, Building Requirements.

UNIT-IV: AIR CONDITIONING AND ENERGY-EFFICIENT BUILDING SYSTEMS

(09 Periods)

Air Conditioning – Introduction, CII Godrej Green Business Centre, Design Philosophy, Design Interventions, Energy Modeling, HVAC System Design, Chiller Selection, Pump Selection, Selection of Cooling Towers, Selection of Air Handling Units, Pre-cooling of Fresh Air, Interior

Lighting Systems, Key Features of the Building, Eco-friendly Captive Power Generation for Factories, Building Requirements.

**UNIT-V: MATERIAL CONSERVATION AND INDOOR ENVIRONMENTAL QUALITY
(09 Periods)**

Material Conservation – Handling of Non-Process Waste, Waste Reduction During Construction, Materials with Recycled Content, Local Materials, Material Reuse, Certified Wood, Rapidly Renewable Building Materials and Furniture. Indoor Environment Quality and Occupational Health – Air Conditioning, Indoor Air Quality, Sick Building Syndrome, Tobacco Smoke.

Total Periods: 45

Text Books:

- T1.** Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
- T2.** Green Building Hand Book , Tomwoolley and Samkimings, 2009.

References:

- R1.** Complete Guide to Green Buildings, Trish riley
- R2.** Standard for the design for High Performance Green Buildings, Kent Peterson, 2009
- R3.** Energy Conservation Building Code –ECBC-2020, BEE.

2512382	M.Tech., III-SEMESTER ROAD SAFETY ENGINEERING (Common to AIDS, PS, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Analyze accident data to identify causes and recommend safety improvements.
- CO2.** Apply statistical methods to analyze traffic data and improve accident prevention measures.
- CO3.** Analyze vehicle, human, and geometric design factors to recommend safe road design and traffic control measures.
- CO4.** Classify traffic signs and road markings and evaluate their design and role in enhancing road safety.
- CO5.** Evaluate traffic management systems, road safety audit processes, and ITS applications to improve road safety performance.

SYLLABUS:

UNIT-I: ACCIDENT INVESTIGATION AND ROAD SAFETY RISK MANAGEMENT

(08 Periods)

Accident Investigations and Risk Management, Collection of Accident Data, Assessment of Road Safety, Methods to Identify and Prioritize Hazardous Locations and Elements, Determine Possible Causes of Crashes, Crash Reduction Capabilities and Countermeasures, Effectiveness of Safety Design Features, Accident Reconstruction, Condition and Collision Diagram.

UNIT-II: TRAFFIC ENGINEERING AND STATISTICAL ANALYSIS IN ROAD SAFETY

(09 Periods)

Traffic Engineering Studies; Statistical Methods In Traffic Safety Analysis – Regression Methods, Poisson Distribution, Chi- Squared Distribution, Statistical Comparisons- Traffic Management Measures And Their Influence On Accident Prevention.

UNIT-III: ROAD SAFETY IN TRANSPORT PLANNING AND GEOMETRIC DESIGN

(09 Periods)

Road Safety in ` Transport Planning and Geometric Design: Vehicle and Human Characteristics, Road Design and Safety Elements, Redesigning Junctions, Cross Section Improvements, Traffic Control, Traffic Calming Measures, Road Safety Furniture

UNIT-IV: ROLE OF SIGNS AND MARKINGS IN SAFETY

(08 Periods)

Types of Signs – Design Specifications – Guidelines for Installation – Role of Signs in Safety; Types of Road Markings – Design Specifications – Role of Road Markings in Safety.

UNIT-V: TRAFFIC MANAGEMENT SYSTEMS AND ROAD SAFETY AUDIT

(10 Periods)

Traffic Management Systems for Safety, Road Safety Audits and Tools for Safety Management Systems, Road Safety Audit Process, Road Safety Improvement Strategies, ITS and Safety.

Total Periods: 45

Text Books:

T1. Traffic Engineering and Transportation Planning, L.R. Kadiyali, Khanna Publishers

T2. Fundamentals of Transportation Engineering, C.S.Papacostas, Prentice Hall India.

T3. Road Safety by NCHRP

References:

R1. Transportation Engineering - An Introduction, C.Jotin Khisty, B. Kent Lall

R2. Fundamentals of Traffic Engineering, Richardo G Sigua

R3. Handbook of Road Safety Measures, Second Edition, Rune Elvik, Alena Hoye, TrulsVaa,
Michael Sorenson

2598381	M.Tech., III-SEMESTER ADVANCED DATA STRUCTURES AND ALGORITHMS (Common to PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Implement and manipulate linear data structures like singly/doubly linked lists, circular lists, stacks, and queues using dynamic memory allocation.
- CO2.** Apply and analyze searching and sorting algorithms including linear, binary search, bubble, selection, insertion, quick, and merge sort.
- CO3.** Design and implement dictionaries and hashing techniques to efficiently store and retrieve data.
- CO4.** Construct and operate on trees and priority queues, performing insertion, deletion, and traversal operations.
- CO5.** Compare and implement balanced search trees (AVL, Red-Black, Splay, B-Trees) for optimized data access and storage.

SYLLABUS:

UNIT-I: INTRODUCTION

(09 Periods)

Introduction to Data Structures, Singly Linked Lists, Doubly Linked Lists, Circular Lists- Algorithms. Stacks and Queues: Algorithm Implementation using Linked Lists.

UNIT-II: SEARCHING AND SORTING

(09 Periods)

Linear and Binary Search Methods, Sorting: -Basic sorting techniques, Radix Sort, Bucket Sort, Shell Sort Trees- Binary trees, Properties, Representation and Traversals, Expression Trees (Infix, prefix, postfix). Graphs-Basic Concepts, Storage structures and Traversals.

UNIT-III: DICTIONARIES AND HASHING

(09 Periods)

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing

UNIT-IV: PRIORITY QUEUES

(09 Periods)

Definition, ADT, Realizing a Priority Queue Using Heaps, Definition, Insertion, Deletion .Search Trees- Binary Search Trees, Definition, ADT, Implementation, Operations-Searching, Insertion, Deletion.

UNIT-V: SEARCH TREES

(09 Periods)

AVL Trees, Definition, Height of AVL Tree, Operations-, Insertion, Deletion and Searching, Introduction to Red-Black and Splay Trees, B-Trees, Height of B-Tree, Insertion, Deletion and Searching, Comparison of Search Trees.

Total Periods: 45

Text Books:

- T1.** Data Structures: A Pseudo Code Approach, Richard F.Gilberg, Behrouz A. Forouzon and Cengage, 2/e.
- T2.** Data Structures, Algorithms and Applications in java, SartajSahni, University Press, 2/e.

Reference Books:

- R1.** Data Structures and Algorithm Analysis, Mark Allen Weiss, Pearson, 2/e.
- R2.** Data Structures and Algorithms, Adam Drozdek, Cengage, 3/e,
- R3.** C and Data Structures: A Snap Shot Oriented Treatise using Live Engineering Examples, N.B.Venkateswarulu, E.V.Prasad and S Chand & Co.

2598382	M.Tech., III-SEMESTER	L	T	P	C
	CLOUD COMPUTING (Common to PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Explain cloud computing fundamentals including characteristics, deployment and service models, multitenancy, cloud economics, networking role, and platforms such as Amazon EC2, Google App Engine, and Microsoft Azure.
- CO2.** Demonstrate virtualization concepts including server, storage, network and service virtualization, virtual machines, virtualization management, performance measurement, and hypervisors such as KVM, Xen, and VMware ESXi.
- CO3.** Explain relational databases, cloud file systems such as Google File System and Hadoop Distributed File System, data models including Bigtable, Apache HBase, Amazon Dynamo, and the MapReduce model with its parallel computing efficiency.
- CO4.** Explain cloud security fundamentals, including security architecture, vulnerability assessment, privacy, trusted computing, secure execution environments, identity and access management, and autonomic security.
- CO5.** Analyze issues in cloud computing including real-time application deployment, inter-cloud challenges, QoS and monitoring, dependability, data migration, streaming, and the role of cloud middleware.

SYLLABUS:

UNIT-I: CLOUD COMPUTING FUNDAMENTALS (09 Periods)

Definition, characteristics, components, Cloud service provider, the role of networks in Cloud computing, Cloud deployment models- private, public & hybrid, Cloud service models, multitenancy, Cloud economics and benefits, Cloud computing platforms - IaaS: Amazon EC2, PaaS: Google App Engine, Microsoft Azure, SaaS.

UNIT-II: VIRTUALIZATION TECHNOLOGIES (09 Periods)

Virtualization concepts, Server virtualization, Storage virtualization, Storage services, Network virtualization, Service virtualization, Virtualization management, Virtualization technologies and architectures, virtual machine, Measurement and profiling of virtualized applications. Hypervisors: KVM, Xen, VMware hypervisors and their features.

UNIT-III: DISTRIBUTED DATA MANAGEMENT AND PROCESSING (09 Periods)

Relational databases, Cloud file systems: GFS and HDFS, Bigtable, HBase and Dynamo. MapReduce and extensions: Parallel computing, the map -Reduce model, Parallel efficiency of Map Reduce.

UNIT-IV: CLOUD SECURITY (09 Periods)

Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud. Cloud computing security architecture: General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro - architectures; Identity Management and Access control, Autonomic security.

UNIT-V: ADVANCED CLOUD COMPUTING ISSUES**(09 Periods)**

Issues in cloud computing Implementing real time application over cloud platform, Issues in Inter - cloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment. Cloud Middleware.

Total Periods: 45**Text Books:**

- T1.** Enterprise Cloud Computing, Gautam Shroff, Cambridge publication.
- T2.** Enterprise Cloud Computing Technology Architecture Applications, Gautam Shroff, Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.

Reference Books:

- R1.** Cloud Security, Ronald Krutz and Russell Dean Vines, Wiley -India.
- R2.** Cloud Computing, Dr. Kumar Saurabh, Wiley Publication.
- R3.** Cloud Computing Strategies, Dimitris N. Chorafas, CRC Press; 1 edition [ISBN: 1439834539],2010
- R4.** Cloud Computing, A Practical Approach, Toby Velte, Anthony Velte, Robert Elsenpeter, McGraw Hill Osborne Media; 1 edition [ISBN: 0071626948], 2009.
- R5.** Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley Publication, 2011.
- R6.** Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly Media Inc, 2009.

2598383	M.Tech., III-SEMESTER AI TOOLS (Common to PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Explain the fundamentals and evolution of AI tools.
- CO2.** Use AI tools for text, language, and communication tasks.
- CO3.** Apply AI tools for image, audio, and video generation.
- CO4.** Utilize AI tools for coding, research, and productivity enhancement.
- CO5.** Analyze ethical, security, and application-oriented aspects of AI tools.

SYLLABUS:

UNIT-I: INTRODUCTION TO AI TOOLS (09 Periods)

Definition of Artificial Intelligence, Evolution of AI and Intelligent Systems, Categories of AI Tools (Generative, Analytical, Assistive), Rule-based vs Learning-based AI Tools, Overview of Machine Learning & Deep Learning Tools, AI Tool Ecosystem (OpenAI, Google, Meta, Microsoft), Cloud-based AI Tools, Future Trends in AI Tool Development.

UNIT-II: TEXT & LANGUAGE AI TOOLS (09 Periods)

Natural Language Processing (NLP) Basics, ChatGPT – Architecture and Capabilities, Prompt Engineering Concepts, AI Tools for Content Writing, AI Tools for Email, Resume & Report Generation, AI-based Translation and Summarization Tools, AI Chatbots and Virtual Assistants, Limitations and Bias in Language AI Tools.

UNIT-III: IMAGE, AUDIO & VIDEO AI TOOLS (09 Periods)

Image Generation Tools (DALL·E, Midjourney, Stable Diffusion), Image Editing and Enhancement using AI, AI Tools for Graphic Design & Posters, Text-to-Speech AI Tools (ElevenLabs, Google TTS), Speech-to-Text AI Tools, AI-based Video Creation Tools, Avatar and Animation AI Tools, Applications in Media, Education & Healthcare.

UNIT-IV: AI TOOLS FOR CODING, RESEARCH & PRODUCTIVITY (09 Periods)

AI Tools for Programming Assistance, Code Generation and Debugging using AI, AI Tools for Data Analysis, AI Tools for Research Paper Writing, AI Tools for Literature Survey and Citations, AI in Project Management, AI Tools for Presentation Creation, AI Tools for Automation and Workflow Optimization.

UNIT-V: ETHICAL, SECURITY & APPLIED AI TOOLS (09 Periods)

Ethical Issues in AI Tool Usage, Data Privacy and Security Concerns, AI Tool Regulations and Policies, AI Tools in Education, AI Tools in Healthcare, AI Tools in Finance and Business, AI Tools in Smart Cities and Governance, Responsible and Sustainable AI Practices.

Total Periods: 45

Text Books:

- T1.** Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, Pearson Education, 4th Edition, 2021.
- T2.** AI for Everyone, Michael Miller, Pearson, 2020.
- T3.** Artificial Intelligence for Business, Liam Ottley, Wiley, 2022.

Reference Books:

- R1.** AI Superpowers: China, Silicon Valley, and the New World Order, Kai-Fu Lee, Houghton Mifflin Harcourt, 2018.
- R2.** Artificial Intelligence in Practice, Bernard Marr, Wiley, 2020.
- R3.** Ethical Guidelines for Trustworthy AI, European Commission, 2019.

2584381	M.Tech., III-SEMESTER	L	T	P	C
	IOT AND ITS APPLICATIONS (Common to AIDS, PS, Geo-Tech, RE) (OPEN ELECTIVE)	3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Apply the Knowledge in IOT Technologies and Data management.
- CO2.** Determine the values chains Perspective of M2M to IOT.
- CO3.** Implement the state of the Architecture of an IOT.
- CO4.** Compare IOT Applications in Industrial & real world.
- CO5.** Demonstrate knowledge and understand the security and ethical issues of an IOT.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF IOT (09 Periods)

Evolution of Internet of Things, Enabling Technologies, IoT Architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards.

UNIT-II: IOT PROTOCOLS (09 Periods)

IT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT.

UNIT-III: DESIGN AND DEVELOPMENT (09 Periods)

Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino, Board details, IDE programming, Raspberry Pi, Interfaces and Raspberry Pi with Python Programming.

UNIT-IV: DATA ANALYTICS AND SUPPORTING SERVICES (09 Periods)

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning – No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Python Web Application Framework, Django, AWS for IoT, System Management with NETCONF-YANG.

UNIT-V: CASE STUDIES/INDUSTRIAL APPLICATIONS (09 Periods)

IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipments. Use of Big Data and Visualization in IoT, Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino).

Total Periods: 45

Text Books:

- T1.** IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.
- T2.** Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.

Reference Books:

- R1.** The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit 2).
- R2.** From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.
- R3.** Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer, 2011.

2552381	M.Tech., III-SEMESTER PHOTOVOLTAIC SYSTEMS (Common to AIDS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Understand solar radiation principles, measurement techniques, and solar cell characteristics and performance.
- CO2.** Explain solar cell manufacturing technologies, PV module design, encapsulation, power rating, hotspot effect, and design qualification standards.
- CO3.** Explain flat plate arrays, mounting structures, module interconnection, lightning protection, and performance evaluation including temperature coefficients, series resistance, and curve correction factors.
- CO4.** Explain photovoltaic system types, design considerations, system, battery and inverter sizing, and balance of system components.
- CO5.** Explain maximum power point tracking techniques, instrument design, and grid-interactive photovoltaic systems.

SYLLABUS:

UNIT-I: SOLAR ENERGY

(09 Periods)

Sun and Earth, Solar Spectrum, Solar Geometry, Solar radiation on horizontal and inclined planes, Instruments for measurement of solar radiation, Solar cell, Equivalent circuit, V-I characteristics, Performance improvement.

UNIT-II: SOLAR CELLS

(09 Periods)

Manufacture of Solar Cells-Technologies, Design of Solar cells, Photovoltaic modules, Design requirements, Encapsulation systems, Manufacture, Power rating, Hotspot effect, Design qualifications.

UNIT-III: PROTECTION AND MEASUREMENTS

(09 Periods)

Flat plate arrays, Support structures, Module interconnection and cabling, Lightning protection, Performance measurement using natural sun light and simulator, Determination of temperature coefficients, Internal series resistance, Curve correction factor.

UNIT-IV: PHOTOVOLTAIC SYSTEMS

(09 Periods)

Photovoltaic systems, Types, General design considerations, System sizing, Battery sizing, Inverter sizing, Design examples, Balance of PV systems.

UNIT-V: MAXIMUM POWER POINT TRACKERS

(09 Periods)

Maximum power point trackers, Perturb and observe, Incremental conductance method, Hill climbing method, Hybrid and complex methods, Data based and other approximate methods, Instrument design, Other MPP techniques, Grid interactive PV system.

Total Periods: 45

Text Books:

- T1.** Generating electricity from Sun, F.C.Treble, Pergamon Press.
- T2.** Photovoltaic systems: Analysis and design, A.K.Mukherjee, Nivedita Thakur, PHI, 2011.

Reference Books:

R1. Solar Photovoltaics: Fundamentals, Technologies and applications, C.S.Solanki, PHI, 2009.

Online Learning Resources:

1. <https://nptel.ac.in/courses/117108141>

2599381	M.Tech., III-SEMESTER INTEGRATED PRODUCT DESIGN AND DEVELOPMENT (Common to AIDS, PS, Geo-Tech, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

CO1. Explain design concepts, product development planning and customer requirements

CO2. Generate the concept using creative problem solving methods, concept generation and testing.

CO3. Realize Product Teardown, Specifications, Portfolios and Architecture, configurations and prototyping.

CO4. Demonstrate and classify The Design aspects for Risk, Reliability and Safety and environments.

CO5. Do industrial design, understand intellectual property, robust design and product development economics.

SYLLABUS:

UNIT-I: PRODUCT DEVELOPMENT CONCEPTS

(09 Periods)

Design Concepts: Design process – Considerations of a good design – Description of good design process – Design codes and standards. Product Development and Planning Process: Characteristics and challenges of product development – Concept development – Generic product development – Product development process flows –Tyco product development – Product development organizations – Organizational structure and design – Product and process cycles – Technological innovation – Structure of opportunity – Opportunity identification – Product planning process – Types of product development projects. **Identifying Customer Needs:** Process of identifying customer needs – Customer requirements.

UNIT-II: CONCEPT SELECTION, GENERATION AND TESTING

(09 Periods)

Concept Generation: Activity – Concept generation process – Creativity and problem solving – Creative thinking methods and design – Functional decomposition and synthesis – Morphological methods – Axiomatic design.

Concept Selection and Testing: Development process – Choosing a concept – Concept screening and scoring – Decision making and evaluation – Methods for testing product concepts.

UNIT-III: EMBODIMENT AND DETAIL DESIGN

(09 Periods)

Product Teardown, Specifications, Portfolios and Architecture: Teardown process, methods and applications – Post teardown report – Benchmarking approach and support tools for benchmarking process – Product portfolios architecture – Architecture type – Platform architecture – Target Specifications – Setting the final specifications – Modularity – Implications of the architecture – Establishing the architecture – Delayed differentiation – Platform planning – Related system-level design.

Configuration and Detail Design: Generating, analyzing and evaluating configuration design – Best practices for configuration design – Design for X – Design and manufacturing information – Final design review – Activities beyond detail design.

Prototyping: Principles, types and technologies – Understanding prototypes and planning.

UNIT-IV: DESIGN FOR ENVIRONMENT, MANUFACTURING AND SAFETY

(09 Periods)

Design for Manufacture and Environment: Cross-functional team – Overview of DFM process – Life cycles – Environmental impacts – Design for environment process.

Design for Risk, Reliability and Safety: Classification of societal hazards – Standards – Risk assessment – Design for reliability – Causes of unreliability – Minimizing failure – FMEA – Fault tree analysis – Defects and failure modes – Potential dangers – Guidelines for design for safety – Warning labels.

UNIT-V: INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ECONOMICS

(09 Periods)

Industrial Design: Need – Impact – Industrial design process – Management of the industrial design process – Assessing the quality of industrial design. **Robust Design:** Robust design process.

Intellectual Property: Disclosure – Process of pursuing a patent.

Product Development Economics: Elements of economic analysis and process.

Managing Projects: Understanding and representing tasks – Baseline project planning – Accelerating projects – Project execution – Postmortem project evaluation - Project Portfolio Management (PPM) - Earned Value Management (EVM) - Sustainability and ESG in Project Management.

Total Periods: 45

Text Books:

- T1.** Product Design and Development, Karl T Ulrich, Steven D Eppinger and Maria C. Yang, 7/e, 2020, McGraw-Hill Education Pvt.Ltd., Noida.
- T2.** Engineering Design, George E.Dieter and Linda C.Schmidt, 4/e, 2013, McGraw-Hill Education Pvt., Ltd., Noida.

Reference Books:

- R1.** Product Design, Kevin Otto and Kristin Wood, 1/e, 2003, Pearson Education, India.
- R2.** Product Development, Anil Mital, Anoop Desai, Anand Subramanian and Aashi Mital, 1/e, 2007, Butterworth-Heinemann, Elsevier.
- R3.** Integrated Product and Process Design and Development: the Product Realization Process (Special Indian Edition), Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, 2/e, 2010, CRC Press, Taylor & Francis Group, LLC.
- R4.** Product Design for Engineers, Devdas Shetty, 1/e, 2016, Cengage Learning, India.
- R5.** Introduction to Product Design and Development for Engineers, Ali Jamnia, 2018, CRC Press, Taylor & Francis Group, LLC.

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc25_me121/preview
2. https://onlinecourses.swayam2.ac.in/imb25_mg123/preview

25HS381	M.Tech., III-SEMESTER	L	T	P	C
	ADVANCED NUMERICAL METHODS AND COMPUTATIONAL MATHEMATICS (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Analyze conditioning, stability, and error behavior of numerical linear algebra routines for dense and sparse problems.
- CO2.** Derive and apply finite difference for BVP for linear and nonlinear models.
- CO3.** Derive and apply finite difference for PDE models; assess consistency and stability with Lax equivalence and CFL ideas.
- CO4.** Optimize engineering models via unconstrained/constrained methods; justify algorithm selection and tuning using theory and diagnostics.
- CO5.** Integrate GPU/MPI paradigms and the SciPy stack to build scalable, reproducible computational workflows; profile and validate results.

SYLLABUS:

UNIT-I: NUMERICAL LINEAR ALGEBRA (09 Periods)

Floating- point arithmetic, conditioning, stability, backward/forward error; Direct solvers: LU/Cholesky/QR; pivoting and orthogonality; SVD, low- rank approximations, pseudoinverses; Iterative solvers: Jacobi/Gauss–Seidel/CG/GMRES; basic preconditioning; Sparse matrix formats and operations for large- scale systems; Krylov subspace and Arnoldi/Lanczos overviews.

UNIT-II: DISCRETIZATION OF LINEAR AND NONLINEAR ODEs (09 Periods)

Numerical solutions of initial value problems: (single step and multi -step methods); Stability of the numerical methods for initial value problems; Boundary value problems; shooting method; Finite difference for BVP (second and higher order methods), for linear and nonlinear problems Consistency–stability–convergence.

UNIT-III: DISCRETIZATION OF LINEAR AND NONLINEAR PDEs (09 Periods)

Finite difference methods for parabolic problems explicit and implicit methods, Finite difference for hyperbolic explicit and implicit methods; Elliptic PDE; Consistency, Stability and convergence; Lax equivalence and CFL (Courant–Friedrichs–Lewy) ideas; Iterative solvers and multigrid overview for discretized systems.

UNIT-IV: NUMERICAL OPTIMIZATION AND INVERSE PROBLEMS (09 Periods)

Unconstrained methods: gradient, Newton, quasi- Newton, trust- region; Constrained methods: KKT conditions, interior- point, SQP principles; Nonlinear least squares: Gauss–Newton and Levenberg–Marquardt; Regularization (Tikhonov/L1) and model selection concepts; Scientific Python stack:scipy.optimize.minimize, scipy.optimize.linprog, and scipy.optimize.curve_fit; solver choice and diagnostics.

UNIT-V: HIGH- PERFORMANCE SCIENTIFIC COMPUTING (09 Periods)

Parallel paradigms: data/task parallelism; domain decomposition fundamentals; GPU programming model: threads/warps/memory hierarchy; CUDA libraries; MPI and PETSc for scalable sparse linear

algebra and time- steppers; Performance engineering: profiling, locality, and roofline- style thinking; Python at scale: NumPy/SciPy sparse and vectorization; brief Numba/CuPy ecosystem; end-to-end case sketches in CFD/structures/machine learning numerics.

Total Periods: 45

Text Books:

- T1.** Numerical Linear Algebra, Trefethen, L. N., and D. Bau III, Twenty- Fifth Anniversary Edition, SIAM, 2023.
- T2.** Finite Difference Methods for Ordinary and Partial Differential Equations: Steady- State and Time-Dependent Problems, LeVeque, R. J., SIAM, 2007.
- T3.** Numerical Optimization, Nocedal, J., and S. J. Wright, 2nd ed., Springer, 2006.

Reference Books:

- R1.** Programming Massively Parallel Processors: A Hands- on Approach, Hwu, W.- M. W., and D. B. Kirk, 4th ed., Elsevier, 2022.
- R2.** Numerical linera algebra and Application, B. N. dutta, Springer Publications.
- R3.** SciPy Project, Optimization (scipy.optimize), SciPy Manual and Optimization and Root Finding, SciPy 1.16.2 (stable) Reference.
- R4.** PETSc/TAO Users Manual, Balay, S., et al. Argonne National Laboratory, ANL-21/39 Rev 3.18release documentation.
- R5.** Automated Solution of Differential Equations by the Finite Element Method: The FEniCS Book. Logg, A., K.- A. Mardal, and G. N. Wells (eds.). Berlin: Springer, 2012.
- R6.** Numerical analysis Mathematics of scientific computing, David Kincaid Ward Chenery, AMS Book publishers.
- R7.** Computational Methods for Partial Differential Equations, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age publications.

25HS382	M.Tech., III-SEMESTER	L	T	P	C
	MATHEMATICS FOR MACHINE LEARNING AND DATA SCIENCE (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Analyze linear models and matrix factorizations for dimensionality reduction and feature representation.
- CO2.** Formulate and solve convex and constrained optimization problems; compare first- and second-order methods.
- CO3.** Apply probabilistic modeling, Bayesian inference, and information- theoretic measures to estimation and generalization.
- CO4.** Prove convergence properties or error bounds for selected learning algorithms such as SGD and regularized estimators.
- CO5.** Evaluate and integrate methods into applications such as PCA, SVMs, and neural networks with appropriate regularization.

SYLLABUS:

UNIT-I: LINEAR ALGEBRA FOUNDATIONS

(09 Periods)

Vector spaces, norms, inner products, orthogonality, and projections; Eigenvalues/eigenvectors, spectral theorem, and invariant subspaces; Singular value decomposition, low- rank approximations, and Eckart–Young; Matrix calculus for ML; gradients/Jacobians/Hessians in matrix form; Numerical linear algebra: conditioning, stability, power/QR methods; Feature whitening and centering; PCA link to covariance eigen structure.

UNIT-II: OPTIMIZATION FOR LEARNING

(08 Periods)

Unconstrained methods: gradient descent, line search, Newton/quasi- Newton; Constrained optimization: Lagrange multipliers, projected and barrier methods; Convex sets/functions, KKT conditions for nonlinear programming problems; Regularization: l_1/l_2 penalties, bias–variance trade-offs in risk minimization; Convergence rates and step- size strategies in deterministic models.

UNIT-III: PROBABILITY AND STATISTICAL LEARNING

(10 Periods)

Random variables, expectations, covariance; exponential family basics; Bayesian inference: conjugacy, MAP vs. MLE, posterior predictive analysis; Hypothesis testing and confidence intervals for model comparison; Information measures: entropy, KL divergence, mutual information in learning; Generalization, overfitting, and model selection criteria (e.g., AIC/BIC/VC-style capacity); Concentration and uncertainty quantification for predictions.

UNIT-IV: MODELS AND ALGORITHMS

(09 Periods)

Linear and kernel methods: least squares, logistic regression, and SVMs; Dimensionality reduction: PCA, kernel PCA, and manifold intuition; Probabilistic models: Naive Bayes, Gaussian mixtures, EM overview; Neural network mathematics: backpropagation, initialization, normalization; Regularization schemes: weight decay, early stopping, dropout perspectives.

UNIT-V: INTEGRATIVE APPLICATIONS AND WORKED EXAMPLES (09 Periods)

End-to-end ML pipelines: preprocessing, scaling/whitening, and feature engineering; PCA- based exploration and anomaly detection in high- dimensional data; SVMs and convex models for fault diagnosis and predictive maintenance; Bayesian A/B testing and decision- making under uncertainty; Neural network design trade-offs: capacity, optimization, and generalization; Model evaluation: calibration, ROC/PR analysis, and uncertainty reporting.

Total Periods: 45

Text Books:

- T1.** Mathematics for Machine Learning. Deisenroth, M. P., Faisal, A. A., & Ong, C. S. Cambridge University Press, 2020
- T2.** Probabilistic Machine Learning: An Introduction, Murphy, K. P., MIT Press, 2022.
- T3.** Convex Optimization, Boyd, S., & Vandenberghe, L., Cambridge University Press, 2004.

Reference Books:

- R1.** Deep Learning, Goodfellow, I., Bengio, Y., & Courville, A., MIT Press, 2016
- R2.** Understanding Machine Learning: From Theory to Algorithms. Shalev- Shwartz, S., & Ben- David, S., Cambridge University Press, 2014
- R3.** Principal component analysis: a review and recent developments. Jolliffe, I. T., & Cadima, J., Phil. Trans. R. Soc. A, 2016
- R4.** Elements of Information Theory, Cover, T. M., & Thomas, J. A. 2nd ed. Wiley, 2006.
- R5.** Probabilistic Machine Learning: Advanced Topic, Murphy, K. P. MIT Press, 2023.

25HS383	M.Tech., III-SEMESTER	L	T	P	C
	STATISTICAL LEARNING THEORY AND MATHEMATICAL FOUNDATIONS OF AI (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Analyze probabilistic models, convergence theorems, and stochastic processes underlying learning algorithms.
- CO2.** Formulate and prove generalization bounds using VC dimension, Rademacher complexity, and stability.
- CO3.** Derive and optimize loss/regularization for linear, kernel, and deep models; justify selections by convexity and smoothness properties.
- CO4.** Evaluate algorithms via bias–variance, PAC guarantees, and information- theoretic criteria such as KL and mutual information.
- CO5.** Integrate theory to design robust AI solutions for multi- domain engineering applications and communicate findings effectively.

SYLLABUS:

UNIT-I: PROBABILITY AND MEASURE FOUNDATIONS (09 Periods)

Probability spaces, σ - algebras, random variables; expectation and conditional expectation; Inequalities and concentration: Markov, Chebyshev, Hoeffding; LLN and CLT; Modes of convergence and Borel–Cantelli; almost sure vs in- probability convergence; Random processes and martingale basics; optional stopping; Doob’s inequality (overview); Markov chains: ergodicity, mixing, stationary distributions for modeling sequences.

UNIT-II: STATISTICAL LEARNING THEORY (09 Periods)

PAC learning model, realizable/agnostic cases; sample complexity and no- free- lunch; VC dimension, shattering, Sauer’s lemma; uniform convergence guarantees; Empirical risk minimization and structural risk minimization; capacity control; Rademacher/Gaussian complexities and symmetrization for data- dependent bounds; Algorithmic stability and generalization; regularization and early stopping as capacity control; PAC- Bayes bounds and posterior- based generalization certificates.

UNIT-III: OPTIMIZATION FOR LEARNING (09 Periods)

Convex analysis: Lipschitzness, smoothness, strong convexity; implications for rates; Gradient, stochastic, and variance- reduced methods; step- size and convergence trade-offs; Proximal methods and projected gradients; sparsity via ℓ_1 (Lasso) and shrinkage via ℓ_2 (ridge); Duality and KKT conditions; constrained learning formulations; Nonconvex landscapes in deep networks—saddle points, over-parameterization, and implicit regularization; Generalization–optimization interplay: implicit bias of optimizers.

UNIT-IV: KERNEL AND PROBABILISTIC MODELS (09 Periods)

Reproducing kernel Hilbert spaces, kernel trick, representer theorem; Large- margin methods: SVMs, soft margins, hinge loss; primal–dual views; Gaussian processes: kernels as priors; posterior prediction and uncertainty quantification; Graphical models—Bayesian networks and

Markov/conditional random fields for structured prediction; exact inference (variable elimination, junction tree) and approximate methods (loopy belief propagation, variational); Hidden Markov models; EM for latent- variable learning; Variational inference and message passing for scalable probabilistic AI.

UNIT-V: DEEP LEARNING AND INFORMATION THEORY (09 Periods)

Backpropagation (chain rule), initialization, normalization, and activation design; Loss functions and calibration; cross- entropy, margin losses, and robust objectives; Generalization in deep nets: margins, flat minima, compression, and stability views; Information- theoretic tools: entropy, mutual information, KL divergence; Information bottleneck and representation learning, with links to PAC- Bayes; Worked examples: applying theory to vision, language, and control tasks in engineering.

Total Periods: 45

Text Books:

- T1.** Understanding Machine Learning: From Theory to Algorithms, Shalev- Shwartz, S., Ben- David, S., Cambridge University Press, first edition, 2014.
- T2.** Deep Learning, Goodfellow, I., Bengio, Y., Courville, A., MIT Press, 2016.
- T3.** Pattern Recognition and Machine Learning, Bishop, C. M., Springer, 2006.

Reference Books:

- R1.** The Nature of Statistical Learning Theory, Vapnik, V. N., Springer, 1995/1998.
- R2.** Elements of Information Theory, Cover, T. M., Thomas, J. A., 2nd ed., Wiley, 2006.
- R3.** Foundations of Machine Learning, Mohri, M., Rostamizadeh, A., Talwalkar, A., 2nd ed., MIT Press, 2018.
- R4.** Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond, Schölkopf, B., Smola, A. J., MIT Press, 2002.
- R5.** Gaussian Processes for Machine Learning, Rasmussen, C. E., Williams, C. K. I., MIT Press, 2006.

25HS384	M.Tech., III-SEMESTER CHEMISTRY OF NANOMATERIALS AND APPLICATIONS IN ENGINEERING (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

COURSE OUTCOMES:

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

- CO1.** Explain the basic concepts, scope, natural occurrence, classification, and importance of nanoscience and nanomaterials.
- CO2.** Explain the top-down and bottom-up synthetic methods used for the preparation of nanomaterials.
- CO3.** Understand the principles and applications of various characterization techniques used for analyzing nanomaterials.
- CO4.** Explain the synthesis, properties, and applications of important nanomaterials.
- CO5.** Understand the applications of nanomaterials such as nanoparticles, nanorods, and nanowires in various engineering and technological fields.

SYLLABUS:

UNIT-I: BASICS OF NANOMATERIALS

(08 Periods)

Introduction, Scope of nanoscience and nanotechnology, nanoscience in nature, classification of nanostructured materials, importance of nanomaterials.

UNIT-II: SYNTHESIS OF NANOMATERIALS

(10 Periods)

Top-Down approach, Inert gas condensation, arc discharge method, aerosol synthesis, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis, and chemical vapor deposition method, electrode position method, high-energy ball milling method.

Synthetic Methods: Bottom-Up approach, Sol-gel synthesis, microemulsions or reverse micelles, co-precipitation method, solvothermal synthesis, hydrothermal synthesis, microwave heating synthesis and sonochemical synthesis.

UNIT-III: TECHNIQUES FOR CHARACTERIZATION

(09 Periods)

Diffraction techniques, spectroscopy techniques, electron microscopy techniques for the characterization of nanomaterials, BET method for surface area analysis, dynamic light scattering for particle size determination.

UNIT-IV: STUDIES OF NANO-STRUCTURED MATERIALS

(09 Periods)

Synthesis, properties and applications of the following nanomaterials: fullerenes, carbon nanotubes, 2D-nanomaterial (Graphene), core-shell, magnetic nanoparticles, thermoelectric materials, non-linear optical materials.

UNIT-V: ADVANCED ENGINEERING APPLICATIONS OF NANOMATERIALS

(09 Periods)

Applications of nanoparticles, nanorods, nano wires in Water treatment, sensors, electronic devices, medical domain, civil engineering, chemical engineering, metallurgy and mechanical engineering, food science, agriculture, pollutants degradation.

Total Periods: 45

Text Books:

- T1.** NANO: The Essentials, T Pradeep, MaGraw-Hill, 2007.

T2. Textbook of Nanoscience and nanotechnology, B S Murty, P Shankar, Baldev Rai, BB Rath and James Murday, Univ. Press, 2012.

Reference Books:

R1. Concepts of Nano chemistry; LudovicoCademrtiri and Geoffrey A. Ozin & Geoffrey A. Ozin, Wiley-VCH, 2011.

R2. Nanostructures & Nanomaterials; Synthesis, Properties & Applications, Guozhong Cao, Imperial College Press, 2007.

R3. Nanomaterials Chemistry, C. N. R. Rao, Achim Muller, K.Cheetham, Wiley-VCH, 2007.

25HS385	M.Tech., III-SEMESTER PHOTONICS FOR ENGINEERS (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (OPEN ELECTIVE)	L	T	P	C
		3	0	0	3

Pre-Requisites: NIL

Course Outcomes:

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

- CO1.** Describe how light behaves and propagates in optical media.
- CO2.** Explain light–matter interaction mechanisms and analyze the working, characteristics, and applications of LEDs, laser diodes, quantum well lasers and various photodetectors.
- CO3.** Explain key nonlinear effects and analyze the operation of optical modulators and switches such as the Mach–Zehnder Interferometer.
- CO4.** Analyse fiber parameters and explain the functioning of transmitters, receivers, WDM systems, couplers and resonator-based communication devices.
- CO5.** Describe the working of photonic sensors and emerging quantum and ultrafast photonic technologies used in sensing, computation and communication.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF PHOTONICS (09 Periods)

Nature of light: wave-particle duality, polarization, coherence. Maxwell’s equations and wave propagation in dielectric media. Reflection, refraction, (vector notation) interference, diffraction, dispersion and birefringence.

UNIT-II: PHOTONIC DEVICES AND COMPONENTS – I (09 Periods)

Absorption, spontaneous and stimulated emission. Einstein coefficients, population inversion, optical gain. Semiconductor light sources: LEDs, laser diodes, quantum well lasers. Photodetectors: PIN, avalanche photodiodes, photomultiplier tubes.

UNIT-III: PHOTONIC DEVICES AND COMPONENTS – II (09 Periods)

Nonlinear optical effects – second-harmonic generation, Kerr effect, four-wave mixing. Electro-optic Magneto optic and acousto-optic modulation principles. Optical modulators and switches (Mach Zehnder Interferometer).

UNIT-IV: OPTICAL WAVEGUIDES AND APPLICATIONS (09 Periods)

Optical fibers – numerical aperture, V-number, modes, attenuation, dispersion. Fiber-optic communication systems: transmitters, receivers, multiplexing (WDM), optical couplers, ring resonators.

UNIT-V: PHOTONIC SYSTEMS AND APPLICATIONS (09 Periods)

Photonic sensors – interferometric, fiber Bragg gratings, biosensing. Optical signal processing and computing.

Introduction to quantum photonics: single-photon sources, entanglement, and photonic qubits. Plasmonics and metamaterials, Ultrafast and terahertz photonics.

Total Periods: 45

Text Books:

- T1.** Fundamentals of Photonics, B.E.A. Saleh & M.C. Teich., Wiley.
- T2.** Semiconductor Optoelectronics: Physics and Technology, J. Singh, McGraw Hill Edition.
- T3.** Photonics: Optical Electronics in Modern Communications, A. Yariv & P. Yeh, Oxford Series.
- T4.** Optical Fiber Communications, G. Keiser, McGraw Hill Edition.

Reference Books:

- R1.** Optoelectronics: An Introduction, J. Wilson & J.F.B. Hawkes.
- R2.** Nonlinear Optics, R.W. Boyd.
- R3.** Electromagnetic waves and radiating systems E. Jordan.

2598451	M.Tech., IV-SEMESTER DISSERTATION PHASE-II (ARTIFICIAL INTELLEGEANCE AND DATA SCIENCE)	L	T	P	C
		0	0	32	16

Pre-Requisites: Nil

Course Outcomes:

After successful completion of the course, student will be able to

- CO1.** Implement the proposed methodology or design to develop a functional solution or prototype for the identified research problem.
- CO2.** Analyze and evaluate the results using appropriate tools, techniques, or experimental methods.
- CO3.** Interpret results and draw meaningful conclusions with respect to the objectives of the research work.
- CO4.** Prepare a comprehensive project report and effectively present the research findings through seminars and viva voce.
- CO5.** make decisions to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

