Gandhinagar Institute of Technology

Academic Regulation & Curriculum

for

MTech

in

Computer Science and Engineering –
Artificial Intelligence and Machine Learning
(CSE-AI)

MTech PROGRAMME

***w.e.f.* 2026-27**

Preamble

We, the members of the Computer Science and Engineering Department, are committed to promoting knowledge, innovation, and technical excellence in the field of Computer Science and Engineering. We aim to create a positive learning environment where students are encouraged to think creatively, work collaboratively, and develop practical skills for real-world challenges.

The curriculum for the M.Tech-AI . in Computer Science and Engineering program has been revised according to the guidelines of UGC, AICTE and NCrF along with the New Education Policy (NEP) under Academic Regulation 2022 and blended with IEEE effective from the academic session 2026–2027. The program follows an Outcome-Based Curriculum (OBC) with a Choice-Based Credit System (CBCS), helping students build strong professional and technical skills through a multidisciplinary approach that meets the needs of industry, higher studies, and accreditation bodies such as NBA and NAAC.

To match current trends and technological advancements, several modern subjects have been included in the syllabus, such as Artificial Intelligence and Intelligent Systems, Advanced Machine Learning, Statistical Methods, Research Methodology and IPR, Genetic Algorithm & Application, Advance Computer Vision, Big Data Analysis, Advanced Image Analysis and Pattern Recognition, Advanced Natural Language Processing & LLM Architectures, Neural Networks & Optimization Techniques, Advance Generative Models (GANs, Diffusion Models), Advanced Signal Processing for AI, Time Series Analysis & Forecasting, and Advanced Data Mining & Knowledge Discovery. These subjects are designed to provide students with in-depth knowledge of emerging technologies and advanced AI-driven applications across various domains.

Students are encouraged to take MOOC courses of their choice to earn honors and gain additional knowledge in advanced technologies.

The course coding system has been updated from the respective academic sessions, as suggested by the Office of the Controller of Examinations. This change helps clearly distinguish the revised curriculum from previous versions.

The curriculum and syllabi are continuously updated through a structured feedback mechanism involving stakeholders such as faculty members, experts, industry experts, alumni and parents. This ensures that the program remains relevant, practical, and future-oriented.

With a focus on continuous learning, innovation, research, and adaptability, the department aims to develop skilled AI professionals, researchers, and future leaders who can contribute effectively to society and the rapidly evolving world of Artificial Intelligence, Machine Learning, Data Science, Computer Vision, Natural Language Processing, Generative AI, and intelligent technologies.

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1.Institutional Vision & Mission

VISION:

To create a flexible and learner-focused engineering ecosystem that builds strong technical skills, practical knowledge, and innovative thinking, preparing graduates to adapt, perform, and lead in a rapidly evolving technological and societal environment.

MISSION:

To provide a holistic learning environment that develops technical skilled, innovative, and socially responsible engineers capable of addressing industrial, technological, and societal needs.

2.**Program Objectives**

PEO 1 – Technical Excellence Graduates will demonstrate advanced proficiency in AI, Machine Learning, and related computing domains, applying state-of-the-art algorithms, tools, and frameworks to solve complex real-world problems.

PEO 2 – Research & Innovation Graduates will engage in cutting-edge research, contribute to the advancement of AI/ML knowledge, and develop novel solutions through creative and analytical thinking.

PEO 3 – Industry Readiness & Leadership Graduates will effectively apply their technical and managerial skills to lead projects, teams, and initiatives in industry, research labs, or entrepreneurial ventures in a rapidly evolving technological landscape.

PEO 4 – Societal & Ethical Responsibility Graduates will design and deploy AI/ML systems responsibly, with sensitivity to ethical, legal, environmental, and societal implications, contributing to inclusive and sustainable development.

PEO 5 – Lifelong Learning & Adaptability Graduates will pursue continuous professional development, adapt to emerging technologies, and remain relevant in a dynamic global environment through self-directed and collaborative learning

3.**Program Outcomes (POs)**

PO	Title	Description
PO1	Advanced Knowledge	Apply deep knowledge of mathematical foundations, computing theory, and AI/ML algorithms to analyze and solve complex engineering problems.
PO2	Problem Analysis	Identify, formulate, and critically analyze advanced research and engineering problems in AI/ML using first principles and domain-specific tools.
PO3	Design & Development	Design intelligent systems, models, and solutions for AI/ML applications considering societal, health, safety, legal, and cultural constraints.
PO4	Research Aptitude	Conduct independent and collaborative research — including literature review, hypothesis formulation, experimentation, and result validation — to generate new knowledge.
PO5	Modern Tools & Techniques	Select and apply modern AI/ML frameworks (e.g., TensorFlow, PyTorch, Scikit-learn), tools, and platforms for modeling, simulation, and data-driven decision-making.
PO6	Data-Driven Decision Making	Collect, process, and analyze large-scale datasets to extract meaningful insights and drive evidence-based engineering and business decisions.
PO7	Ethics & Responsible AI	Understand and apply principles of ethical AI including fairness, transparency, accountability, privacy, and bias mitigation in system design and deployment.
PO8	Societal & Environmental Impact	Evaluate the societal, environmental, and sustainability implications of AI/ML systems and contribute to solutions that address real-world challenges.
PO9	Communication & Collaboration	Communicate research findings, technical concepts, and project outcomes effectively through reports, presentations, and publications to diverse audiences.
PO10	Project Management & Leadership	Demonstrate the ability to manage multidisciplinary projects, lead technical teams, and deliver solutions within time, resource, and quality constraints.
PO11	Interdisciplinary Thinking	Apply AI/ML concepts across interdisciplinary domains such as healthcare, agriculture, finance, smart cities, and cybersecurity to create broad societal impact.
PO12	Lifelong Learning	Commit to continuous learning, self-improvement, and adaptation to emerging AI/ML trends, tools, and research paradigms throughout their professional career.

4. **Program Details**

4.1. Program Structure & Duration

- Duration & Intake:2 Years & 60 Seats
- Semesters: 4
- Mode: Full Time
- Credit Structure: As per NEP / University norms
- Medium of Instruction: English
- Intake: 18
- Fees: The fee structure prescribed by the University from time to time shall be applicable.

4.2 Eligibility Criteria for Admission

Candidates seeking admission to M.Tech must have completed a B.E./B.Tech degree or an equivalent qualification in the relevant branch from a recognized university. Generally, candidates belonging to the General category must secure at least 50% marks in the qualifying examination, while candidates from reserved categories such as SC, ST, SEBC, and EWS of Gujarat require a minimum of 45% marks. Admission is primarily based on a valid GATE score, and candidates without GATE qualification can apply through the Gujarat PGCET examination or on the basis of merit as per ACPC rules.

4.3 Admission Procedure

Admission to the M.Tech program shall be granted on the basis of merit obtained in the qualifying examination and/or valid GATE score and/or Gujarat PGCET score, as prescribed by the Admission Committee for Professional Courses (ACPC) and the University from time to time. Candidates must possess a Bachelor's degree in Engineering/Technology or an equivalent qualification in the relevant discipline from a recognized university. The admission process may also include document verification, centralized counseling, choice filling, and seat allotment as per ACPC norms. The University reserves the right to revise the eligibility criteria, admission procedure, and selection process from time to time.

4.4 Credit Framework

Sl. No.	Course Type	MTech-AI Credit
1.	Dissertation / Project Work (Ph I + II)	28
2.	Professional Core Courses	24
3.	Professional Elective Courses	16

4.	Internal Review (I + II)	04
5.	Mandatory Learning (RM & IPR)	03
6.	Technical Writing	00
	Total	**75**

Definition of Credit (as per UGC / AICTE):

- 1 Hour Lecture (L)per Week=1Credit
- 1 Hour Tutorial (T) per Week=1Credit
- 1 Hour Practical (P) per Week=0.5Credits
- 2 Hours Practical (Lab) per Week=1Credit

Range of Credits (as per UGC / AICTE):

✔ A total of 75 credits will be necessary for a student to be eligible to get MTech degree.

✔ These could be acquired through MOOCs.

✔ Any student completing any course through MOOC will have to submit an appropriate certificate to earn the corresponding credit.

✔ For any additional information , the student may contact the concerned HODs.

5. Curriculum Structure

Gandhinagar Institute of Technology (01)

Mtech AI (Sem - 1)

Program Name: Master of Technology (02) | **Program Code: AI(139)**

Semester / Year : Semester I / First Year | **Effective From Academic Year: 2026-27**

NCrf Level	Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
					L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
6.5	11390101	Professional Core	Artificial Intelligence and Intelligent Systems	4	3	0	2	5	60	40	30	20	150
	11390102	Professional Core	Applied Machine Learning	4	3	0	2	5	60	40	30	20	150
	11390108	Professional Core	Statistical Methods	4	3	1	0	4	60	40	0	0	100
	10000151	Mandatory Learning Course	Research Methodology and IPR	3	1	1	2	4	0	0	80	20	100
	-	Professional Elective	Professional Elective - I	4	3	0	2	5	60	40	30	20	150
	-	Professional Elective	Professional Elective - II	4	3	1	0	4	60	40	0	0	100
			Total	**23**	**16**	**3**	**8**	**27**	**300**	**200**	**170**	**80**	**750**

11390104	Professional Elective - I	Genetic Algorithm & Application
11390105	Professional Elective - I	Advance Computer Vision

11380106	Professional Elective - II	Big Data Analysis
11380109	Professional Elective - II	Advanced Image Analysis and Pattern Recognition

Gandhinagar Institute of Technology (01)

Mtech AI (Sem - 2)

Program Name: Master of Technology (02) | **Program Code: AI(139)**

Semester / Year : Semester II / First Year | **Effective From Academic Year: 2026-27**

NCrf Level	Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
					L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
6.5	11390201	Professional Core	Advanced Natural Language Processing & LLM Architectures	4	3	0	2	5	60	40	30	20	150
	11390202	Professional Core	Neural Networks & Optimization Techniques	4	3	0	2	5	60	40	30	20	150
	11390203	Professional Core	Advance Generative Models (GANs, Diffusion Models)	4	3	0	2	5	60	40	30	20	150
	10000251	Mandatory Learning Course	Technical Writing	0	2	0	0	2	0	50	0	0	50
	-	Professional Elective	Professional Elective - III	4	3	0	2	5	60	40	30	20	150
	-	Professional Elective	Professional Elective - IV	4	3	1	0	4	60	40	0	0	100
			Total	**20**	**17**	**1**	**8**	**26**	**300**	**250**	**120**	**80**	**750**

11390204	Professional Elective - III	Advanced Signal Processing for AI
11390205	Professional Elective - III	Time Series Analysis & Forecasting
11390206	Professional Elective - III	AI-Driven Remote Sensing & GIS

11390207	Professional Elective - IV	AI for Smart Healthcare & Medical Imaging
11390208	Professional Elective - IV	Data Engineering & Data Pipeline Systems
11390209	Professional Elective - IV	Advanced Data Mining & Knowledge Discovery

Gandhinagar Institute of Technology (01)

Mtech AI (Sem - 3)

Program Name: Master of Technology (02)	**Program Code: AI(139)**
Semester / Year : Semester III / Second Year	**Effective From Academic Year:2026-27**

NCrf Level	Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
					L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
7	11390301	Internal Review	Internal Review I	2	0	0	4	4	0	0	0	100	100
	11390302	Dissertation	Dissertation Phase I	14	0	0	28	28	0	0	100	0	100
			Total	**16**	**0**	**0**	**32**	**32**	**0**	**0**	**100**	**100**	**200**

Gandhinagar Institute of Technology (01)

Mtech AI (Sem - 4)

Program Name: Master of Technology (02)	**Program Code: AI(139)**
Semester / Year : Semester IV / Second Year	**Effective From Academic Year: 2026-27**

NCrf Level	Subject Code	Course Type	Subject Name	Credit	Hours per week				Theory (Marks)		Practical (Marks)		Total (Marks)
					L	T	P	Total	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
7	11390401	Internal Review	Internal Review II	2	0	0	4	4	0	0	0	100	100
	11390402	Dissertation	Dissertation Phase II	14	0	0	28	28	0	0	100	0	100
			Total	**16**	**0**	**0**	**32**	**32**	**0**	**0**	**100**	**100**	**200**

1stSem	750	**3rdSem**	200		
2ndSem	750	**4th Sem**	200	**TotalCredit:**	**75**
				TotalMarks:	**1900**

6. Teaching Learning and Evaluation

6.1 Teaching Methodology

The program shall adopt the following teaching methodologies:

- Classroom Teaching
- Case Studies
- Industry Interaction
- Site Visits
- Workshops
- Field Surveys
- Research Projects
- Research work
- Paper Publication
- AI-based Learning Tools
- Blended and Digital Learning

6.2 Attendance Rules

- Minimum 75% attendance shall be mandatory in each course.
- Students below the prescribed attendance may not be permitted to appear in examinations.
- Additional attendance requirements may apply for practical and research work and paper publication.

6.3 Examination and Evaluation System

6.3.1 Evaluation Components

The evaluation may consist of Continuous Internal Evaluation (CIE) and End Semester Examination (ESE).

Continuous Internal Evaluation (CIE) may include:

- Mid-Semester Examination
- Assignments
- Presentations
- Research work
- Paper Publication
- Class Tests

- AI Quiz & Viva Voce
- Dissertation
- Project Work

6.4 Suggested Weightage

- Continuous Internal Evaluation (CIE): 40%
- End Semester Examination (ESE): 60%

6.5 Passing Standards

- Minimum 50% marks in each component where applicable.
- Minimum 50% aggregate marks for passing the course/program.
- Separate passing may be required in theory and practical examinations.

6.6 Grading System

The program shall follow Gandhinagar University grading norms.

6.6.1 Grade Table

Grade	Grade Points	From Marks	To Marks
AA	10	80	100
AB	9	75	79
BB	8	70	74
BC	7	65	69
CC	6	60	64
CD	0	55	59
DD	-	50	54
DF	-	0	49

6.7 Dissertation / Project Work

Requirements may include:

- Proposal Presentation
- Periodic Review
- Final Report Submission
- Viva Voce Examination

The dissertation shall be evaluated by internal and external examiners.

7. Rules and Regulations

7.1 Rules for Promotion

A student shall be promoted to the next semester as per Gandhinagar University rules, subject to fulfilment of academic requirements, minimum attendance, and completion of required credits.

7.2 Maximum Duration for Completion

The maximum duration for completing the program shall be 2 years from the date of admission (or as prescribed by the University).

7.3 Dissertation Guidelines

7.3.1 Internal Review – I /II

Purpose

Internal Review – I and II is conducted before the formal submission of Dissertation Phase – I and II respectively to evaluate the early-stage research progress.

The review focuses on:

- Research problem identification
- Literature survey quality
- Research gap identification
- Feasibility and relevance of the selected topic
- Research methodology planning
- Implementation progress
- System/model architecture
- Experimental setup
- Preliminary results and analysis
- Performance evaluation
- Challenges faced and solutions adopted
- Future work and completion plan

Student Presentation Requirements

- Proposed research topic
- Problem statement
- Literature review
- Research gap identification
- Objectives of the research
- Proposed methodology/framework
- Expected outcomes
- Implementation status report
- Experimental methodology
- Preliminary results and analysis
- Graphs, tables, or comparative outputs
- Challenges faced and corrective actions
- Updated dissertation draft
- Final work completion plan

Submission Requirements

- Literature survey summary
- Research problem formulation document
- Proposed methodology/framework
- Preliminary research plan
- Timeline for Dissertation Phase – I
- Minimum 10–15 research paper references from reputed journals/conferences
- Implementation status report
- Experimental methodology
- Preliminary results and analysis
- Graphs, tables, or comparative outputs
- Challenges faced and corrective actions
- Updated dissertation draft
- Final work completion plan

7.3.2 Dissertation Phase – I/II

Purpose

Dissertation Phase – I and II focuses on research planning, methodology development, system/model design, and preliminary experimentation.

Students shall work under the guidance of an assigned faculty supervisor.

Activities to be Performed

- Identification of research problem
- Extensive literature review
- Definition of objectives and scope
- Selection of suitable methodology
- Dataset identification and collection
- Initial model/system design
- Tool and technology selection
- Preliminary experimentation and analysis
- Research proposal preparation
- Algorithm/model implementation
- AI model training and testing
- Simulation or deployment
- Experimental analysis
- Comparative performance evaluation
- Result validation
- Optimization and improvements
- Research paper preparation (if applicable)
- Final dissertation report preparation

Seminar and Review

The presentation may include:

- Research significance
- Technical approach
- Proposed framework
- Preliminary results
- Research plan for Phase – II

7.3.3 Final Dissertation Report Structure

The dissertation report shall contain the following chapters:

1. Title Page
2. Certificate
3. Declaration
4. Acknowledgement
5. Abstract
6. Table of Contents
7. List of Figures
8. List of Tables
9. Introduction
10. Literature Review
11. Problem Statement and Research Gap
12. Proposed Methodology / Model
13. System Design and Architecture
14. Implementation and Experimental Setup
15. Results and Analysis
16. Comparison with Existing Methods
17. Conclusion and Future Work
18. References
19. Appendices (if applicable)

7.3.4 Dissertation Submission Requirements

Students must submit:

- Final dissertation report (hard copy and soft copy)
- Plagiarism report as per UGC norms
- Source code/software/project files
- Dataset details (if applicable)
- Research paper/publication details (if any)
- Completion certificate signed by guide
- Presentation slides for viva voce
- Project demonstration (if applicable)

7.4 Discipline Rules

Students shall maintain discipline, professional ethics, and proper conduct within the institution, during industry interactions, examinations, and all academic activities.

Students are expected to:

- Attend classes regularly
- Follow institutional rules and regulations
- Respect faculty members, staff, fellow students, and institutional property
- Maintain academic integrity in assignments, projects, and examinations

Any form of misconduct, ragging, indiscipline, use of unfair means in examinations, damage to institutional property, harassment, or behavior affecting the academic environment shall be treated seriously and may result in disciplinary action including:

- Warning
- Suspension
- Cancellation of Examination
- Withholding of Results
- Expulsion from the Program

Such actions shall be taken as per University rules and UGC regulations.

Students shall also comply with all safety, ethical, and professional standards prescribed by the institution from time to time.

7.5 Anti-Ragging Policy

The program shall strictly follow:

- UGC Anti-Ragging Regulations
- Anti-Ragging Affidavit Requirements
- Institutional Disciplinary Procedures
- Ragging in any form is strictly prohibited.

7.6 Ethical Use of Technology and AI Tools

Students are encouraged to use:

- Various Software and AI Tools
- Data Analytics Tools
- AI-based Learning Platforms
- Valuation Software
- Digital Survey Tools

Use of AI tools shall be ethical and academic integrity must be maintained.

8. Student Support

8.1 Industry Collaboration

The department shall actively promote collaboration with IT industries, AI-based companies, research organizations, startups, technology firms, cloud service providers, cybersecurity organizations, healthcare technology companies, smart system industries, and government agencies to enhance practical exposure and industry relevance of the M.Tech (Artificial Intelligence and Machine Learning) program.

Such collaborations may include internships, industrial training, live projects, expert lectures, workshops, hackathons, industrial visits, consultancy assignments, collaborative research activities, certification programs, skill development initiatives, and placement support.

The institution may also establish Memoranda of Understanding (MoUs) with industries, research laboratories, and professional organizations for academic enrichment, technology support, innovation activities, startup incubation, and collaborative research aimed at improving employability, entrepreneurship, technical competency, and industry readiness among students.

8.2 Research and Consultancy

The department shall encourage faculty members and students to actively engage in research, consultancy, innovation, and applied studies related to Artificial Intelligence, Machine Learning, Deep Learning, Natural Language Processing, Computer Vision, Data Science, Cybersecurity, Intelligent Systems, IoT, Cloud Computing, and emerging technologies.

Students may undertake research projects, AI model development, data analysis, simulation studies, intelligent system design, and industry-oriented projects as part of their academic and professional training.

The institution may also undertake consultancy assignments and collaborative projects for industries, startups, government organizations, healthcare institutions, financial organizations, smart city projects, and technology

firms in areas such as AI solutions, predictive analytics, automation, intelligent systems, data-driven applications, and software development.

Participation in seminars, conferences, workshops, technical competitions, publications, funded projects, patent filing activities, and collaborative research initiatives shall be encouraged to promote academic excellence, innovation, and research-oriented learning.

8.3 Library and Laboratory Facilities

Adequate library, laboratory, computing, and digital learning facilities shall be made available to support effective teaching, practical training, research, and skill development under the M.Tech (Artificial Intelligence and Machine Learning) program.

The department shall facilitate access to relevant books, journals, research publications, e-resources, IEEE papers, digital libraries, datasets, AI repositories, cloud platforms, and online learning resources related to Artificial Intelligence and emerging technologies.

Necessary computing facilities, GPU-enabled systems, AI development platforms, cloud computing tools, data analytics software, simulation tools, internet access, and other technical resources required for practical and project-based learning shall also be provided to enhance industry-oriented education, research capability, innovation, and professional competency among students.

8.4 Student Support and Mentoring

A structured system for student support, academic mentoring, research guidance, and professional counselling shall be implemented for students enrolled in the M.Tech (Artificial Intelligence and Machine Learning) program.

The department shall facilitate academic counselling, dissertation guidance, career mentoring, research support, technical training, and skill development activities to assist students in academic progression and professional growth.

Students may also be provided opportunities for interaction with industry experts, researchers, alumni, and entrepreneurs through workshops, seminars, coding competitions, hackathons, technical events, training programs, industrial visits, and extracurricular activities aimed at enhancing employability, leadership qualities, communication skills, teamwork, innovation, and overall personality development.

Necessary support mechanisms for addressing academic and personal concerns shall also be made available as per institutional policies.

8.5 Placement and Career Development

The department shall promote placement assistance and career development activities for students through industry interaction, internships, research collaboration, professional networking, technical training programs, and campus engagement initiatives.

Efforts shall be made to establish linkages with AI companies, software industries, research organizations, startups, analytics firms, cloud computing companies, cybersecurity organizations, and technology-based enterprises to facilitate internships, live projects, industrial exposure, research opportunities, and employment opportunities for students.

Career development activities such as aptitude training, coding practice sessions, resume preparation, interview preparation, soft skill development, entrepreneurship guidance, certification programs, expert sessions, technical workshops, and placement-oriented training programs may also be organized to enhance professional competency, innovation capability, and employability of students.

9. Program Credibility

9.1 Executive Summary

The MTech (Artificial Intelligence and Machine Learning) program is designed to develop industry-ready professionals, researchers, and innovators with expertise in Artificial Intelligence, Machine Learning, Deep Learning, Data Science, Intelligent Systems, Automation, and emerging digital technologies aligned with current industry and research requirements.

The curriculum integrates strong theoretical foundations with practical implementation, research orientation, industry exposure, and advanced computing skills to prepare students for professional careers, higher studies, research, and entrepreneurship in AI-driven domains.

The program is delivered by experienced faculty members, researchers, industry experts, and professionals actively engaged in Artificial Intelligence, Data Analytics, Software Development, Cloud Computing, Cybersecurity, Intelligent Automation, and interdisciplinary AI applications, ensuring that students gain practical knowledge along with academic understanding.

Specialized modules related to Machine Learning, Deep Learning, Natural Language Processing, Computer Vision, Intelligent Systems, AI Ethics, Data Analytics, Cloud AI, and Research Methodology are delivered through laboratory practice, case studies, seminars, workshops, industry interaction, project-based learning, and research activities.

The program emphasizes innovation, problem-solving, research competency, and ethical use of AI technologies through dissertation work, live projects, hackathons, technical training, and collaborative learning activities.

The curriculum is aligned with current technological advancements, AI industry requirements, emerging research trends, and national educational guidelines, while integrating advanced computing, analytical, and research skills required in academia, industry, startups, and research organizations.

Graduates of the program shall be academically and professionally prepared for careers in Artificial Intelligence, Data Science, Machine Learning Engineering, Research and Development, Intelligent Automation, Software Development, Analytics, and emerging AI-driven industries, as well as for higher studies and doctoral research.

The program also encourages continuous exposure to modern AI tools, cloud platforms, open-source technologies, research publications, innovation ecosystems, startup culture, smart systems, and real-world AI applications as part of experiential and industry-oriented learning throughout the program duration.

9.2 Scope and Career Opportunities

- Artificial Intelligence Companies
- Software Development Industries
- Data Analytics and Data Science Firms
- Cloud Computing Organizations
- Cybersecurity Companies
- Healthcare Technology Organizations
- Research and Development Centers
- Smart System and IoT Industries
- Financial Technology (FinTech) Companies
- Automation and Robotics Industries
- Government and Public Sector Organizations
- Startups and Innovation Centers
- Consulting and Technology Service Firms
- Academic and Research Institutions

9.3 Potential Job Roles

- AI Engineer
- Machine Learning Engineer
- Data Scientist
- Deep Learning Engineer
- NLP Engineer
- Computer Vision Engineer
- AI Research Associate
- Data Analyst
- Business Intelligence Analyst

- AI Solution Architect
- Software Engineer
- Intelligent System Developer
- Cloud AI Engineer
- Robotics and Automation Engineer
- Cybersecurity Analyst
- Research Assistant
- AI Consultant
- AI Product Developer

9.4 Higher Study and Professional Opportunities

Students may pursue:

- Ph.D. in Artificial Intelligence and related disciplines
- Research Fellowships and Academic Research Programs
- Advanced Certifications in AI, ML, Data Science, Cloud Computing, and Cybersecurity
- International Professional Certifications
- Industry-based Research and Consultancy Opportunities
- Startup and Entrepreneurship Initiatives
- Patent Filing and Research Publication Activities
- Specialized Training Programs in Emerging Technologies

10. Collaborative Field Work / Experimental Work

10.1 AI Dataset Exploration & Analysis Exercise

During a supervised laboratory session, students shall explore publicly available AI and Machine Learning datasets from platforms such as Kaggle, UCI Repository, Hugging Face, and government open-data portals. Students shall analyze dataset structure, attributes, missing values, and statistical patterns using Python-based tools and prepare a structured dataset analysis report with observations and preprocessing requirements.

(Recommended Organizations / Platforms: Kaggle, UCI Machine Learning Repository, NITI Aayog AI Initiatives, Hugging Face)

10.2 Machine Learning Model Development Exercise

Students shall develop and evaluate supervised and unsupervised Machine Learning models using real-world datasets. The exercise shall include data preprocessing, feature engineering, model training, testing, performance evaluation, and result interpretation using tools such as Scikit-learn, TensorFlow, or PyTorch.

(Recommended Organizations / Platforms: Google AI, TensorFlow, Scikit-learn, OpenAI)

10.3 Deep Learning Experimental Work

Students shall design and implement Deep Learning models for applications such as image classification, object detection, speech recognition, or predictive analytics using neural network architectures including CNN, RNN, LSTM, or Transformers. Students shall compare model accuracy, loss functions, and optimization techniques through experimental analysis.

(Recommended Organizations / Platforms: TensorFlow, PyTorch, NVIDIA Deep Learning Institute)

10.4 Natural Language Processing (NLP) Laboratory Exercise

Students shall perform NLP-based tasks such as sentiment analysis, text classification, chatbot development, language translation, or document summarization using NLP libraries and transformer-based models. The submission shall include preprocessing steps, tokenization methods, model implementation, and performance analysis.

(Recommended Organizations / Platforms: Hugging Face, OpenAI, Google NLP, spaCy)

10.5 Computer Vision Application Development

Students shall develop Computer Vision applications involving image processing, face recognition, object detection, medical image analysis, or video analytics using OpenCV, YOLO, or deep learning frameworks. Students shall analyze model performance and real-time implementation challenges.

(Recommended Organizations / Platforms: OpenCV, NVIDIA, TensorFlow, PyTorch)

10.6 AI-Based Predictive Analytics Exercise

Students shall perform predictive analytics using Machine Learning techniques on datasets related to healthcare, finance, smart systems, cybersecurity, or business intelligence. Students shall evaluate prediction accuracy, feature importance, and model performance using statistical and visualization techniques.

(Recommended Organizations / Platforms: IBM, Microsoft Azure AI, Google Cloud AI)

10.7 Cloud AI and Deployment Exercise

Students shall deploy AI/ML models using cloud platforms and APIs. The exercise may include model hosting, API integration, cloud inference, and deployment using platforms such as AWS, Google Cloud, or Microsoft Azure.

(Recommended Organizations / Platforms: AWS, Google Cloud Platform, Microsoft Azure)

10.8 Cybersecurity and AI Security Analysis

Students shall perform AI-assisted cybersecurity analysis involving anomaly detection, intrusion detection, phishing detection, or malware classification using Machine Learning techniques. Students shall analyze security datasets and evaluate detection performance.

(Recommended Organizations / Platforms: CERT-In, IBM Security, Cisco, NASSCOM)

10.9 IoT and Smart System Experimental Work

Students shall develop AI-enabled IoT or smart system applications involving sensor data analysis, automation, predictive maintenance, or intelligent monitoring systems using edge devices, cloud integration, and AI algorithms.

(Recommended Organizations / Platforms: Arduino, Raspberry Pi, IoT Platforms, Smart India Mission)

10.10 Data Visualization and Analytics Exercise

Students shall perform data visualization and analytical reporting using tools such as Python, Power BI, Tableau, or Matplotlib. Students shall prepare dashboards, graphical reports, and insights from structured and unstructured datasets.

(Recommended Organizations / Platforms: Tableau, Microsoft Power BI, Python Foundation)

10.11 AI Research Paper Review and Presentation

Students shall review recent AI research papers published in reputed journals or conferences and present the methodology, experimentation, findings, and future scope. Students shall prepare a technical summary and presentation report.

(Recommended Organizations / Platforms: IEEE, Springer, Elsevier, ACM)

10.12 AI Ethics and Responsible AI Study

Students shall analyze ethical challenges related to Artificial Intelligence including bias, fairness, explainability, privacy, security, and responsible AI practices. Students shall prepare case studies and recommendation reports based on ethical AI guidelines.

(Recommended Organizations / Platforms: UNESCO AI Ethics, NITI Aayog, IEEE Standards Association)

10.13 AI Hackathon / Mini Project

Students shall participate in AI-based hackathons, coding competitions, innovation challenges, or mini-project development activities focused on solving real-world problems using Artificial Intelligence and Data Science techniques.

(Recommended Organizations / Platforms: Smart India Hackathon, AICTE, Kaggle, OpenAI)

10.14 Industry Internship / Industrial Training

Students shall undertake a research dissertation in Artificial Intelligence or related interdisciplinary domains. The dissertation work shall include problem identification, literature review, research methodology, implementation, experimentation, analysis, and final thesis submission under the supervision of a faculty guide.

Students shall present their work through seminars, reviews, dissertation reports, and viva-voce examinations as per University and UGC norms.

(Recommended Organizations / Platforms: IEEE, ACM, Springer, AI Research Labs)

10.16 Portfolio Presentation and Exit Viva

Students shall prepare a technical portfolio consisting of project work, research outputs, experimental studies, internship work, coding activities, and certifications completed during the program. Students shall deliver a final presentation and appear for an exit viva before a faculty and industry panel.

11. Market Survey

Strategic Feasibility for MTech (Artificial Intelligence & Machine Learning) in Ahmedabad(Gujarat)

11.1 Executive Summary

India is witnessing rapid growth in the fields of Artificial Intelligence (AI), Machine Learning (ML), Data Science, Automation, Cloud Computing, Cybersecurity, and Intelligent Systems due to increasing digital transformation across industries, government initiatives, smart technologies, Industry 4.0 adoption, and expansion of the IT sector.

Gujarat, especially Ahmedabad and Gandhinagar, is emerging as a major technology and innovation hub through the development of GIFT City, smart city initiatives, IT parks, startup ecosystems, fintech industries, digital governance projects, and AI-driven industrial applications.

Considering these emerging opportunities, a market survey and industry interaction were conducted among IT companies, AI startups, software industries, analytics firms, research organizations, and technology professionals to assess the need for professionally trained manpower in Artificial Intelligence and Machine Learning.

The survey confirmed a strong demand for skilled professionals with expertise in Machine Learning, Deep Learning, Data Analytics, Natural Language Processing, Computer Vision, Intelligent Automation, Cloud AI, Cybersecurity, and AI-based software development.

The industry also highlighted that there is a shortage of technically skilled graduates possessing practical exposure to AI frameworks, real-world datasets, cloud platforms, advanced programming, research methodologies, and industry-oriented project development.

Most organizations expressed willingness to support the proposed program through internships, live projects, industrial interaction, expert lectures, collaborative research activities, hackathons, technical training, and placement opportunities.

The survey findings clearly indicate that introducing an M.Tech program in Artificial Intelligence and Machine Learning will be highly beneficial and industry-relevant considering the increasing adoption of AI technologies, digital transformation initiatives, research opportunities, and employment growth in Gujarat and across India.

11.2 Market Demand and Industry Trends

Artificial Intelligence and Machine Learning are among the fastest-growing technology sectors contributing significantly to innovation, automation, productivity enhancement, and digital transformation across industries.

The demand for AI and ML professionals is continuously increasing due to:

- Growth of Artificial Intelligence and Automation Technologies
- Expansion of Data Science and Analytics Applications
- Smart City and Digital India Initiatives
- Industry 4.0 and Intelligent Manufacturing Systems
- Growth in FinTech, HealthTech, and EdTech Industries
- Cloud Computing and Big Data Technologies
- Cybersecurity and Intelligent Threat Detection Systems
- AI-driven Healthcare and Medical Applications
- Autonomous Systems and Robotics
- Increasing Research and Innovation in AI Technologies

Gujarat is attracting major investments in IT infrastructure, fintech services, startup ecosystems, digital governance, industrial automation, and smart technologies, creating substantial employment opportunities for trained AI and ML professionals.

Upcoming technological developments are expected to generate demand for manpower in areas such as:

- Artificial Intelligence and Machine Learning
- Data Science and Predictive Analytics
- Natural Language Processing
- Computer Vision and Image Processing

- Intelligent Automation and Robotics
- AI-based Cybersecurity
- Cloud AI and Edge Computing
- Smart Systems and IoT Applications
- AI Research and Development
- Software and Intelligent Application Development

11.3 Skill Gap Identified by Industry

The market survey and industry feedback revealed that many graduates lack practical and industry-oriented skills required in the Artificial Intelligence and Machine Learning sector.

The major gaps identified by industry professionals include:

- Limited practical exposure to AI and ML tools and frameworks
- Lack of hands-on experience with real-world datasets and projects
- Insufficient knowledge of Deep Learning and advanced AI models
- Limited understanding of cloud computing and AI deployment
- Poor exposure to research methodologies and experimentation
- Lack of practical implementation skills in NLP and Computer Vision
- Limited industry interaction and project-based learning experience
- Insufficient knowledge of AI ethics, security, and responsible AI practices
- Limited exposure to emerging technologies such as Generative AI, Edge AI, and Intelligent Systems

The industry emphasized the need for professionally trained graduates who can directly contribute to AI-driven projects, research activities, software development, and innovation ecosystems with minimal additional training.

11.4 Employment Opportunities

Graduates of the M.Tech (Artificial Intelligence & Machine Learning) program shall have employment opportunities in software industries, AI companies, analytics firms, cloud computing organizations, research laboratories, smart technology companies, healthcare technology organizations, fintech industries, automation sectors, startups, government agencies, and academic institutions.

Career opportunities may include roles in:

- Artificial Intelligence Engineering
- Machine Learning Engineering

- Data Science and Analytics
- Deep Learning Development
- NLP and Conversational AI
- Computer Vision Engineering
- Intelligent Automation
- AI Research and Development
- Cloud AI and Intelligent Systems
- Cybersecurity and Threat Analytics
- Robotics and Smart Applications
- Software and Product Development

The program shall also support entrepreneurship and innovation opportunities in AI-based startups, intelligent software development, analytics consulting, automation solutions, and technology-driven business applications.

11.5 Industry Support and Collaboration

The industry has shown strong support for the proposed program through internships, live projects, industrial training, hackathons, technical workshops, guest lectures, expert sessions, collaborative research, and placement assistance.

IT companies, AI startups, analytics firms, cloud service providers, and research organizations have also expressed interest in academic collaboration for providing practical exposure, research opportunities, certification programs, and industry-oriented learning to students.

The institution may establish collaborations and Memoranda of Understanding (MoUs) with industries, technology companies, innovation centers, and professional organizations to strengthen research, training, internships, and employability.

11.6 Research and Innovation Opportunities

The proposed program shall encourage research, innovation, patent development, publication activities, and interdisciplinary project work in areas related to Artificial Intelligence, Machine Learning, Data Science, Cybersecurity, Intelligent Systems, Smart Applications, and emerging technologies.

Students and faculty members shall be encouraged to participate in:

- Research publications
- Patent filing activities

- AI innovation projects
- Funded research proposals
- National and international conferences
- Technical competitions and hackathons
- Startup and incubation initiatives

11.7 Conclusion

The market survey and industry feedback clearly indicate strong demand for professionally trained manpower in the fields of Artificial Intelligence, Machine Learning, Data Science, Intelligent Systems, Automation, and AI-driven software technologies.

Considering the rapid technological growth, digital transformation, startup expansion, and increasing adoption of Artificial Intelligence across industries in Gujarat and India, the proposed M.Tech (Artificial Intelligence & Machine Learning) program will provide students with excellent academic, research, and career opportunities while fulfilling the growing manpower requirements of the technology sector.

The proposed program will therefore be academically relevant, research-oriented, industry-focused, and aligned with present and future technological requirements, innovation ecosystems, and UGC guidelines for higher technical education.

12. Review and Revision of Regulations

The University reserves the right to interpret, modify, revise, amend, or update any provision, rule, regulation, curriculum structure, evaluation scheme, academic requirement, course content, or operational guideline related to the M.Tech (Artificial Intelligence & Machine Learning) program from time to time in accordance with University regulations, UGC/AICTE guidelines, statutory requirements, technological advancements, industry developments, and academic needs.

In case of any ambiguity or dispute regarding the interpretation of any provision of this Academic Regulations and Curriculum document, the decision of the University and/or Competent Authority shall be final and binding on all stakeholders.

Any amendments, additions, revisions, or modifications approved by the appropriate academic, administrative, or statutory bodies of the University shall automatically become applicable to the program from the date of approval or implementation as notified by the University.

Annexure I: Detail Syllabus

GANDHINAGAR INSTITUTE OF TECHNOLOGY

MTech in Computer Science and Engineering

(Artificial Intelligence and Machine Learning)

(CSE-AI)

Semester 1

Subject Code: 11390101	**Subject Title:** Artificial Intelligence and Intelligent Systems
Pre-requisite: Familiarity with data structures and algorithms.	

Course Objective:

1. To provide a foundational understanding of the principles, history, and applications of Artificial Intelligence.
2. To introduce the concept of rational agents and their interaction with various environments.
3. To equip students with problem-solving and search techniques for complex AI problems.
4. To teach methods of knowledge representation and reasoning, including logical and probabilistic approaches.
5. To explore advanced topics in AI such as planning, learning, and various sub-areas of intelligent systems.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents

Sr. No	Topic	Total Hours	Weight (%)
1	**Introduction:** Introduction, History of Artificial Intelligence, Intelligent System Categorization, Components of AI, Foundations of AI, Applications of AI, Current trends in AI.	04	09
2	**Intelligent Agents:** Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.	04	09
3	**Problem Solving and Search:** Problem-Solving Agent, Formulating Problems, Example Problems, Uninformed Search Methods (BFS, DFS, Uniform-cost search), Informed Search Methods (Greedy best-first search, A* search), Local Search Methods (Hill-climbing, Simulated annealing), Genetic algorithms, Adversarial Search (Minimax, Alpha-beta pruning), Constraint Satisfaction Problems.	10	22
4	**Knowledge and Reasoning:** Knowledge-based Agents, The Wumpus World, The Propositional logic, First-Order Logic: Syntax and Semantics, Inference in FOL, Forward chaining, Backward Chaining, Knowledge Engineering in First-Order Logic, Unification, Resolution, Uncertain knowledge and reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network, Markov Decision Processes.	10	22
5	**Planning and Learning:**The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning. Learning: Forms of Learning, Inductive Learning, Learning Decision Tree, Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	09	20
6	**Sub-Areas of Intelligent Systems:**Machine Learning, Soft Computing, Deep Learning, Reinforcement Learning, Natural Language Processing, Robotics, Human Computer Interaction, Computer Vision.	08	18

Course Outcome:

1. **CO1:** Understand the fundamental principles and historical evolution of Artificial Intelligence.
2. **CO2:** Design and implement intelligent agents for various environments.
3. **CO3:** Apply problem-solving and search algorithms to solve complex AI problems.
4. **CO4:** Master techniques for knowledge representation and reasoning under both certain and uncertain conditions.
5. **CO5:** Develop skills in AI planning and foundational learning methods.

List of Textbooks:

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education.
2. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson Education.

List of Reference Books:

1. Elaine Rich, Kevin Knight, and Shivashankar B Nair, *Artificial Intelligence*, McGraw Hill.

2. Nils J. Nilsson, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann Publishers.
3. Deepak Khemani, *A First Course in Artificial Intelligence*, McGraw Hill.

List of Suggested Experiments:

- 10-12 experiments based on the syllabus covered as above will be performed and evaluated on a continuous basis.

Subject Code: 11390102	**Subject Title:** Applied Machine Learning
Pre-requisite: Familiarity with programming in Python, Linear Algebra, Probability and Statistics..	

Course Objective:

1. To provide foundational and advanced understanding of machine learning principles.
2. To explore probabilistic and statistical approaches for modeling and inference.
3. To study supervised and unsupervised learning methods, including regression, classification, clustering, and association rules.
4. To understand and implement neural networks, deep learning frameworks, and optimization strategies.
5. To investigate advanced ML topics such as generative models, reinforcement learning, and adversarial machine learning.
6. To apply machine learning techniques for real-world applications in diverse AI domains.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Machine Learning:** Human vs Machine Learning; Types of Learning (Supervised, Unsupervised, Reinforcement); Applications of ML across domains; Tools and Technologies (Python, Scikit-learn, TensorFlow, PyTorch).	02	05
2	**Mathematical and Statistical Foundations:** Probability theory, Random variables, Discrete & Continuous distributions, Central Limit Theorem, Sampling techniques, Hypothesis testing, Inductive bias, Cross-validation, Monte Carlo methods.	05	12
3	**Bayesian Learning Approaches:** Importance of Bayesian methods, Bayes' theorem in ML, Concept Learning with Bayesian methods, Bayesian Belief Networks, MAP and MLE estimation.	04	10
4	**Supervised and Unsupervised Learning:** Classification models, Learning workflow, Decision trees, k-NN, SVM, Naïve Bayes, Clustering (k-means, Hierarchical), Association rule mining, Regression models (Linear, Multivariate, Logistic).	13	30

5	**Neural Network Foundations:**Early models, Perceptron learning, Backpropagation, Initialization techniques, Training & validation strategies, Parameter estimation (MLE, MAP, Bayesian).	06	13
6	**Deep Learning Architectures:**Neural network optimization and regularization, Hyperparameter tuning, CNNs and their applications, RNNs and sequence modeling, Deep learning frameworks (TensorFlow, Keras, PyTorch).	07	15
7	**Frontiers in Machine Learning:**Generative Adversarial Networks (GANs), Deep Reinforcement Learning, Adversarial Machine Learning (attacks and defenses).	05	15

Course Outcome:

1. CO1 : Explain the fundamental principles, challenges, and tools of Machine Learning.
2. CO2 : Apply probabilistic and statistical methods to analyze and validate machine learning models.
3. CO3 : Implement and evaluate supervised and unsupervised learning algorithms on real datasets.
4. CO4 : Design, train, and optimize neural networks and deep learning architectures.
5. CO5 : Explore and apply advanced ML concepts like GANs, Reinforcement Learning, and Adversarial ML for research and practical applications.

List of Textbooks:

1. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning*.
4. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*.

List of Reference Books:

1. Michael Nielsen, *Neural Networks and Deep Learning*.
2. Sebastian Raschka & Vahid Mirjalili, *Python Machine Learning*.
3. Richard S. Sutton & Andrew G. Barto, *Reinforcement Learning: An Introduction*.
4. Latest Research Papers in Applied Machine Learning.

List of Suggested Experiments:

10-12 experiments based on the syllabus covered as above will be performed and evaluated on a continuous basis.

SubjectCode:10390108	Subject Title: Statistical Methods
Pre-requisite: Fundamental knowledge of Probability and Statistics ,Understanding of Linear Algebra and Calculus	

Course Objective:

1. To develop advanced statistical modeling and analytical skills for research and industrial applications.
2. To understand multivariate statistical techniques and probabilistic modeling.
3. To apply statistical inference, hypothesis testing, and predictive analytics on complex datasets.
4. To explore Bayesian statistics, stochastic processes, and time-series forecasting methods.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
3	1	0	4	60	40	-	-	100

	Subject Contents		
Sr. No.	Topic	Total Hours	Weight (%)
1	**Advanced Probability Theory and Statistical Foundations** Random variables and probability distributions, joint, marginal, and conditional probability distributions, expectation, covariance, correlation matrices, Central Limit Theorem and Law of Large Numbers, Maximum Likelihood Estimation (MLE).	10	25
2	**Multivariate Statistical Analysis and Dimensionality Reduction** Multivariate normal distribution, covariance structure and matrix algebra in statistics, Principal Component Analysis (PCA), Factor Analysis and Independent Component Analysis (ICA), cluster analysis and hierarchical clustering.	08	20
3	**Statistical Inference and Bayesian Modeling** Point and interval estimation, hypothesis testing for multivariate data, likelihood ratio tests, Bayesian inference and posterior distributions, Bayesian networks and graphical models, Markov Chain Monte Carlo (MCMC) methods.	08	15
4	**Time Series Analysis and Stochastic Processes** Stationary and non-stationary time series, autoregressive (AR), moving average (MA), ARIMA models, seasonal decomposition and forecasting techniques, Hidden Markov Models (HMM).	10	20
5	**Statistical Learning and Predictive Analytics** Regression and generalized linear models, regularization techniques: Ridge, Lasso, Elastic Net, Support Vector Machines and kernel methods, ensemble statistical learning methods.	08	20

Course Outcomes

1. Apply advanced statistical and probabilistic techniques for complex data analysis.
2. Perform multivariate analysis and dimensionality reduction for high-dimensional datasets.
3. Develop Bayesian and inferential statistical models for research applications.
4. Analyze and forecast sequential and time-dependent data using stochastic models.

List of Text Books

1. **Fundamentals of Mathematical Statistics —** S. C. Gupta and V. K. Kapoor, Sultan Chand Publications.
2. **Applied Multivariate Statistical Analysis —** Richard A. Johnson and Dean W. Wichern.
3. **The Elements of Statistical Learning —** Hastie, Tibshirani, and Friedman, Springer**.**
4. **Time Series Analysis and Its Applications —** Robert H. Shumway, Springer**.**
5. **Applied Statistics and Probability for Engineers —** Douglas C. Montgomery and George C. Runger, Wiley.

List of Reference Books

1. **Probability and Statistics for Engineers and Scientists —** Ronald E. Walpole.
2. **Probability and Statistical Inference —** Robert V. Hogg and Elliot Tanis.
3. **Machine Learning: A Probabilistic Perspective —** Kevin P. Murphy, MIT Press**.**
4. **Statistical Methods —** N. G. Das, McGraw Hill Education**.**
5. **Fundamentals of Statistics** — S. C. Gupta, Himalaya Publishing House.

Open e-Resources

1. NPTEL – Advanced Statistics and Data Analytics.
2. MIT Open Course Ware – Probability and Statistics.
3. Kaggle Datasets for Statistical Modeling.

SubjectCode:10000151	Subject Title: Research Methodology and IPR
Pre-requisite: Nil	

Course Objective:

1. To provide fundamental and advanced knowledge of the subject domain.
2. To develop analytical, problem-solving, and research-oriented skills among students.
3. To enable students to understand modern tools, techniques, and emerging technologies relevant to the course.
4. To enhance practical implementation abilities for solving real-world industrial and research problems.
5. To encourage innovation, critical thinking, and continuous learning in the respective field of study.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
1	1	2	3	0	0	80	20	100

	Subject Content		
Sr. No.	Topic	Total Hours	Weight (%)
1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	05	17
2	Effective literature studies approaches, analysis Plagiarism, Research ethics,	04	15
3	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	05	17
4	MoNature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	05	17
5	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	05	17

	Subject Content		
Sr. No.	**Topic**	**Total Hours**	**Weight (%)**
6	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	05	17

Course Outcomes

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

List of Text Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.

List of Reference Books

6. **Probability and Statistics for Engineers and Scientists —** Ronald E. Walpole.
7. **Probability and Statistical Inference —** Robert V. Hogg and Elliot Tanis.
8. **Machine Learning: A Probabilistic Perspective —** Kevin P. Murphy, MIT Press**.**
9. **Statistical Methods —** N. G. Das, McGraw Hill Education**.**
10. **Fundamentals of Statistics** — S. C. Gupta, Himalaya Publishing House.

Open e-Resources

1. NPTEL: https://onlinecourses.nptel.ac.in/noc19_ge21/preview
2. NPTEL: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Subject Code: 11390104	**Subject Title:** Genetic Algorithms & Applications
Pre-requisite: Familiarity with linear algebra, probability and statistics, optimization techniques, basics of AI/ML, and programming in Python/Java/C++.	

Course Objective:

1. To introduce the concepts of evolutionary computation and genetic algorithms.
2. To understand GA components, operators, and convergence mechanisms.
3. To study advanced GA techniques for optimization problems.
4. To apply GA for real-world AI, engineering, and network optimization problems.
5. To compare GA with other evolutionary algorithms like PSO and ACO

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Evolutionary Computation & GA Basics**: Introduction, history, biological inspiration (chromosomes, selection, reproduction); search space & optimization; applications of evolutionary algorithms; limitations of GA.	09	20
2	**GA Terminologies & Operators**: Genes, individuals, fitness, population; selection, crossover, mutation, replacement; convergence and termination; schema theorem; building block hypothesis; convergence issues.	09	20
3	**Advanced GA Techniques**: Adaptive GAs, multi-objective optimization, elitism; advanced crossover (order, cycle), mutation strategies; parallel and distributed GAs; hybrid GAs with local search.	09	20
4	**Genetic Programming & Optimization**: Genetic Programming basics (tree representation, operators); GA for combinatorial optimization, reliability problems, and network design; applications in routing, resource allocation, scheduling.	09	20
5	**Applications of GA**: GA in feature selection (ML/Deep Learning), hyperparameter tuning, image processing & computer vision, wireless networks, robotics, VLSI layout optimization, intrusion detection. Introduction & comparison with PSO, ACO.	09	20

Course Outcome:

2. CO1: Explain the principles of evolutionary computation and the working of genetic algorithms..
3. CO2: Demonstrate the use of GA terminologies and operators for problem solving.
4. CO3: Analyze advanced GA operators and convergence techniques for optimization.
5. CO4: Apply GA to solve engineering, AI, and wireless network optimization problems.
6. **CO5:** Design GA-based applications in ML, image processing, and intelligent systems; compare GA with PSO/ACO.

List of Textbooks:

1. S.N. Sivanandam & S.N. Deepa, Introduction to Genetic Algorithms, Springer, 2008.
2. Mitsuo Gen & Runwei Cheng, Genetic Algorithms and Engineering Optimization, Wiley, 2010.

List of Reference Books:

1. David E. Goldberg, Genetic Algorithms in Search, Optimization & Machine Learning, Pearson, 2001.
2. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 2nd Ed., Pearson, 2005.
3. Research papers from IEEE Evolutionary Computation, GECCO, ACM Genetic and Evolutionary Computation Conference.

List of Suggested Experiments:

10-12 experiments based on the syllabus covered as above will be performed and evaluated on a continuous basis.

Subject Code: 11390105	**Subject Title:** Advance Computer Vision
Pre-requisite: Familiarity with linear algebra, probability and statistics, digital image processing, and programming in Python/Matlab.	

Course Objective:

1. To introduce students to the mathematical and algorithmic foundations of computer vision.
2. To provide knowledge of geometric transformations, image formation, and feature extraction.
3. To analyze methods for depth estimation, object recognition, and motion tracking.
4. To expose students to current research in vision including deep learning and advanced recognition tasks.
5. To develop skills to implement computer vision solutions in domains such as biometrics, medical imaging, document processing, and surveillance.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Computer Vision**: Overview and state-of-the-art; image formation and low-level processing; transformations (orthogonal, affine, projective); Fourier transform, convolution, filtering; histogram processing, image enhancement/restoration; homography, two-view geometry; interest point detection.	07	20
2	**Depth Estimation & Feature Extraction**: Multi-camera geometry, stereo vision, epipolar geometry, rectification, RANSAC, Hough transform, 3D reconstruction, auto-calibration. Feature extraction: edges (Canny, LoG, DoG), corners (Harris, Hessian), descriptors (SIFT, SURF, HOG, Gabor filters).	07	20
3	**Recognition and Tracking**: Object recognition pipelines; Bag-of-Words models; constellation and part-based models; optical flow; object classification and detection (Latent SVM); recognition of objects, scenes, and activities.	07	20
4	**Illumination, Segmentation, and Deep Learning in Vision**: Light at surfaces; Phong model; reflectance maps; photometric stereo; shape from shading, texture, color, motion. Image segmentation (classical methods & DL-based), face detection, feature tracking, motion layers, introduction to CNNs for vision.	07	20

5	**Applications & Research Directions**: Vision in biometrics, medical diagnosis, document processing, mining visual content, surveillance, advanced rendering; emerging research areas in deep learning for vision.	06	20

Course Outcome:

1. CO1: Understand the fundamental principles and challenges of computer vision.
2. CO2: Apply image transformations, filtering, and feature extraction techniques to solve vision tasks.
3. CO3: Analyze depth estimation, multi-view geometry, recognition, and motion tracking methods.
4. CO4: Evaluate and compare classical and modern computer vision techniques including deep learning approaches.
5. CO5: Design and implement computer vision applications in AI domains such as biometrics, medical diagnosis, document analysis, and surveillance.

List of Textbooks:

1. D. Forsyth and J. Ponce, Computer Vision: A Modern Approach (2nd ed.), Prentice Hall, 2015.
2. Simon J.D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
3. List of Reference Books:
4. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
5. E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Pearson, 1998.
6. Relevant IEEE/ACM/Elsevier journal papers on deep learning in computer vision.
7. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill.

List of Suggested Experiments:

1. 10-12 experiments based on the syllabus covered as above will be performed and evaluated on a continuous basis.

Subject Code: 11390106	**Subject Title:** Big Data Analysis
Pre-requisite: Familiarity with linear algebra, probability and statistics, basics of databases, and programming in Python/Java.	

Course Objective:

1. To introduce students to the concepts of business intelligence, data science, and big data frameworks.
2. To study architectures and technologies for large-scale data storage, processing, and analysis.
3. To gain knowledge of Hadoop, HDFS, MapReduce, and the Hadoop ecosystem.
4. To understand modern frameworks such as Spark and NoSQL for Big Data applications.
5. To explore research challenges and applications in big data analytics.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	1	0	4	60	40	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Big Data Analytics**: Data and relations; business intelligence vs analytics; predictive analysis; OLTP vs OLAP; project lifecycle and methodology; impact analysis and testing; big data technology components; big data architecture; real-time big data analysis.	08	20
2	**Data Models and Storage**: Big data warehouse; functional vs procedural models; CAP theorem; data placement strategies; streaming and stream computing; filtering and estimating moments; NoSQL databases – document and schema-less models.	06	15
3	**Hadoop Ecosystem**: Hadoop overview; HDFS; MapReduce; introduction to Pig, Hive, and HBase; architecture of Hive and HBase.	06	20
4	**Advanced Frameworks and Analytics**: HQL queries, joins, subqueries, aggregate functions; introduction to Spark (Core, RDD, SQL, GraphX); deployment and integration; graph analytics; research topics in big data.	08	25
5	**Applications and Trends**: Applications of big data in AI, business intelligence, healthcare, and IoT; ethics and privacy in big data; case studies.	05	20

Course Outcome:

1. CO1: Articulate key technologies in data science and business analytics.
2. CO2:Build and explain big data frameworks including Hadoop (HDFS, MapReduce), ecosystem tools, and Spark.
3. CO3: Demonstrate the use of modern tools and technologies for big data analysis.
4. CO4:Analyze big data architectures, models, and algorithms for efficiency and scalability.
5. CO5: Identify research challenges and applications in big data for AI domains.

List of Reference Books:

1. Ana Azevedo & Manuel Filipe Santos, Integration Challenges for Analytics, Business Intelligence, and Data Mining, Engineering Science Reference, 2020.
2. Relevant IEEE/ACM journal articles on big data and AI applications

Subject Code: 11390109	**Subject Title:** Advanced Image Analysis and Pattern Recognition
Pre-requisite: Familiarity with linear algebra, probability and statistics, basic programming (Python/Matlab), and fundamentals of signals and systems.	

Course Objective:

1. To introduce fundamental concepts and mathematical foundations of digital image processing.
2. To understand image enhancement, restoration, and compression techniques.
3. To apply image transforms for representation and feature extraction.
4. To equip students with practical skills in image analysis for AI applications.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	1	0	4	60	40	-	-	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction & Fundamentals**: Background and applications of DIP; digital image representation; elements of a DIP system; steps in image processing. Visual perception basics, image sampling and quantization, pixel relationships, imaging geometry.	06	15
2	**Image Transforms**: Introduction to Fourier Transform; Discrete Fourier Transform (2D-DFT); properties of 2D Fourier Transform; overview of other separable transforms (DCT, Walsh).	06	15
3	**Image Enhancement**: Spatial domain methods (intensity transformations, histogram processing, smoothing and sharpening filters). Frequency domain methods (low-pass and high-pass filtering, mask generation)	08	20
4	**Image Restoration**: Degradation model; noise models; inverse filtering basics; motion blur removal; constrained restoration approaches; geometric transformations.	08	20
5	**Image Compression**: Fundamentals – coding, interpixel, and psychovisual redundancy. Compression models – source encoder/decoder. Error-free methods: variable length coding, predictive coding. Lossy methods: transform coding, JPEG basics.	08	20

6	**Applications in AI**: Image preprocessing for ML/DL, face and object recognition pipelines, medical and satellite image case studies.	04	10

Course Outcome:

1. CO1: Explain the fundamentals of image representation, perception, sampling, and quantization.
2. CO2:Apply transforms and enhancement techniques to process and improve images.
3. CO3: Analyze image degradation and implement restoration methods.
4. CO4:Evaluate and compare different image compression methods for efficiency and fidelity.
5. CO5: Design basic image processing applications for AI, pattern recognition, and vision.

List of Reference Books:

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson, 2018.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, 2010.
3. B. Chanda & D. Dutta Majumder, Digital Image Processing and Analysis, PHI, 2011.
4. S. Sridhar, Digital Image Processing, Oxford University Press, 2011.
5. Selected IEEE/ACM journal papers on image processing in AI applications.

Semester 2

Subject Code: 11390201	Advanced Natural Language Processing & LLM Architectures
Pre-requisite: Linear Algebra, Probability & Statistics, Machine Learning Fundamentals, Python Programming, Basics of Natural Language Processing..	

Course Objective:

1. To provide in-depth understanding of classical and neural Natural Language Processing techniques.
2. To develop strong conceptual and practical knowledge of Transformer-based architectures and Large Language Models (LLMs).
3. To understand scaling laws, training strategies, and fine-tuning methodologies for LLMs.
4. To explore real-world applications of LLMs including retrieval-augmented generation and human feedback mechanisms.
5. To enable students to design, analyze, and deploy advanced NLP systems for research and industry applications..

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Foundations of Natural Language Processing**: Overview of NLP pipeline, text preprocessing, tokenization, stemming and lemmatization, stop-word removal. Classical Language Models: n-grams, smoothing techniques, class-based language models, Brown clustering	06	15
2	**Neural Language Modeling**: Word embeddings (Word2Vec, GloVe, FastText), feed-forward neural language models, contextual embeddings, subword modeling and byte-pair encoding.	08	20
3	**Transformer Architectures**: Self-attention mechanism, encoder, decoder, encoder–decoder architectures, positional encoding, pre-trained language models (BERT, GPT, T5), training objectives	08	20

4	**Large Language Models (LLMs)**: Evolution from PLMs to LLMs, LLM families, scaling laws (Kaplan Law, Chinchilla Law), dataset selection and preprocessing, training LLMs from scratch.	08	20
5	**Fine-Tuning and Alignment of LLMs**: Transfer learning, parameter-efficient fine-tuning (Adapters, LoRA, soft prompting), reinforcement learning from human feedback (RLHF), direct preference optimization (DPO).	06	15
6	**Advanced Topics and Applications:** Prompt engineering, Chain-of-Thought and Tree-of-Thought prompting, Retrieval-Augmented Generation (RAG) using vector databases, interpretability of LLMs, ethical and societal concerns of LLM deployment.	04	10

Course Outcome:

1. CO1: Apply classical and neural NLP techniques for language modeling tasks.
2. CO2: Analyze and implement Transformer-based architectures and pre-trained language models.
3. CO3: Design and fine-tune Large Language Models using efficient training strategies.
4. CO4: Integrate LLMs with external knowledge sources and human feedback mechanisms.
5. CO5: Evaluate ethical, interpretability, and deployment challenges of LLM-based systems.

List of Textbooks:

1. Introduction to Embedded Systems: A Cyber-Physical Systems Approach by Edward A. Lee & Sanjit A. Seshia The "Gold Standard" for modeling hybrid systems, state machines, and concurrency.
2. Cyber-Physical Systems: Foundations, Principles and Applications by Houbing Song, et al. Comprehensive coverage of the 5G/IoT integration and system science.

List of Reference Books:

1. Jurafsky, D. & Martin, J. H., Speech and Language Processing, Pearson.
2. Eisenstein, J., Introduction to Natural Language Processing, MIT Press

List of Suggested Experiments:

1. 10-12 experiments based on the syllabus covered as above will be performed and evaluated on a continuous basis.

Subject Code: 11390202	Neural Networks & Optimization Techniques
Pre-requisite: Linear Algebra, Probability & Statistics, Calculus, Programming in Python, Basics of Machine Learning.	

Course Objective:

1. To build strong theoretical foundations of neural networks and learning mechanisms.
2. To understand and apply optimization techniques used in training neural networks.
3. To study advanced neural network architectures for vision, language, and sequence modeling.
4. To provide hands-on exposure to modern deep learning frameworks and real-world applications.
5. To prepare students for research and industrial problem-solving in AI and data-driven systems.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Unit 1: Introduction to Neural Networks**: Biological neuron inspiration, artificial neuron model, McCulloch–Pitts neuron, threshold logic units. Basic learning concepts and applications of neural networks.	07	15
2	**Unit 2: Perceptron and Feedforward Neural Networks**: Linear perceptron model, perceptron learning algorithm, linear separability, convergence theorem. Multilayer perceptrons (MLPs), gradient descent, backpropagation algorithm.	07	15
3	**Unit 3: Activation Functions and Regularization**: Activation functions – sigmoid, tanh, ReLU. Loss functions and performance metrics. Regularization techniques – dropout, batch normalization, early stopping, overfitting and underfitting.	06	15
4	**Unit 4: Optimization Techniques**: Optimization basics – objective functions, convex sets, convex functions. First-order methods – batch gradient descent, stochastic gradient descent (SGD), mini-batch gradient descent. Advanced optimizers – Momentum, RMSprop, Adam.	07	20
5	**Unit 5: Advanced Neural Network Architectures**: Deep Neural Networks (DNNs) – training challenges. Convolutional Neural Networks (CNNs) –	07	20

	convolution, pooling, padding, basic architectures. Recurrent Neural Networks (RNNs), LSTM and GRU for sequence data.		
6	**Unit 6: Tools and Applications**: Introduction to TensorFlow and Keras. Model implementation workflow. Simple case studies in computer vision, natural language processing, and data analytics.	06	15

Course Outcome:

1. CO1: Explain the fundamental concepts and learning mechanisms of neural networks.
2. CO2: Apply optimization techniques for efficient training of neural networks.
3. CO3: Analyze and implement advanced neural network architectures for real-world problems.
4. CO4: Use deep learning frameworks to design and evaluate AI-based solutions.
5. CO5: Critically evaluate model performance and optimization strategies for research and industrial applications.

List of Textbooks:

1. Simon Haykin, Neural Networks and Learning Machines, Pearson.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press.

List of Reference Books:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.
2. Nocedal & Wright, Numerical Optimization, Springer.
3. TensorFlow and Keras official documentation.

List of Suggested Experiments:

1. 10-12 experiments based on the syllabus covered as above will be performed and evaluated on a continuous basis.

Subject Code: 11390203	Advance Generative Models (GANs, Diffusion Models)
Pre-requisite: Linear Algebra, Probability & Statistics, Machine Learning, Deep Learning fundamentals, Python programming.	

Course Objective:

1. To provide a strong conceptual foundation in generative modeling techniques.
2. To understand and analyze modern generative architectures such as GANs, VAEs, autoregressive and diffusion models.
3. To study probabilistic principles and optimization strategies behind data generation.
4. To explore prompt engineering, multimodal generation, and real-world GenAI tools.
5. To address ethical considerations, bias, and responsible use of Generative AI systems.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Foundations of Generative AI**: Introduction to generative vs discriminative models, brief history of Generative AI. Basic probabilistic concepts – probability distributions, latent variables, sampling. Overview of deep learning building blocks (Neural Networks, CNNs, Transformers). Applications of Generative AI. Ethical considerations – bias and fairness.	6	15
2	**Autoregressive Models & Transformer-based Generation**: Basics of sequence modeling. Transformer architecture and self-attention. Overview of GPT and large language models. Limitations of autoregressive generation.	6	15
3	**Generative Adversarial Networks (GANs)**: GAN architecture – generator and discriminator, adversarial training. Training challenges – mode collapse and instability. Overview of popular GAN variants – DCGAN, WGAN, Conditional GANs. Basic evaluation metrics – Inception Score and FID.	8	20

4	**Variational Autoencoders (VAEs)**: VAE architecture – encoder, decoder, latent space. Reparameterization trick and ELBO (conceptual). Applications of VAEs. Overview of Conditional VAEs and β-VAEs.	6	15
5	**Diffusion-based Generative Models**: Introduction to diffusion models. Forward and reverse diffusion processes. Denoising Diffusion Probabilistic Models (DDPM). High-level overview of Stable Diffusion.	7	20
6	**Prompt Engineering & Applications of Generative AI**: Basics of prompt engineering – zero-shot and few-shot prompting. Chain-of-Thought prompting and RAG (overview). Introduction to GenAI tools – ChatGPT, DALL·E, MidJourney, GitHub Copilot. Ethical issues and bias mitigation in prompt-based systems.	7	15

Course Outcome:

1. CO1: Explain probabilistic and deep learning foundations of generative models.
2. CO2: Analyze and implement GAN-based generative architectures.
3. CO3: Design and evaluate VAEs and diffusion-based generative models.
4. CO4: Apply autoregressive and prompt-based techniques for generative tasks.
5. CO5: Assess ethical challenges, bias, and responsible deployment of Generative AI systems.

List of Textbooks:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press.
2. David Foster, Generative Deep Learning, O'Reilly Media.

List of Reference Books:

1. Jurafsky, D. & Martin, J. H., Speech and Language Processing, Pearson.
2. Research papers on GANs, VAEs, Diffusion Models, and Generative AI.
3. PyTorch and TensorFlow official documentation.

List of Suggested Experiments:

1. 10-12 experiments based on the syllabus covered as above will be performed and evaluated on a continuous basis.

Subject Code: 10000251	Technical Writing
Pre-requisite: Basic Language Skills	

Course Objective:

1. Technical Writing focuses on planning and preparation of word choices and sentences and focuses on vocabulary building and helps them to be an effective communicator.
2. Students will be able to produce a set of documents related to writing in the workplace and will be able to improve their ability to write clearly and accurately.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
2	0	0	0	-	50	-	-	50

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring	4	10
2	Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4	10
3	Sections of a paper – Title, abstract, introduction, etc. review of the literature, writing - methods, results, discussion, conclusions and final check	6	20
4	Organization of technical report: Title, Authors, Affiliation, Abstract,	4	20
5	Three pass reading. Effective communication– Teacher/Student perspective. Listening – Hearing Vs. Listening. Notes Taking. Elevator Pitch. Technical writing.	4	20
6	Useful phrases and punctuation, in-text citation and bibliography– MLA/APA styles.	4	20

Course Outcome:

1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Learn various skills necessary that are necessary for doing research.
4. Ensure the good quality of paper at very first-time submission..

List of Reference Book:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006
3. Raman, Meenakshi and Sangeeta Sharma, "Technical Communication: Principle and Practice", Oxford University Press.
4. Goldbort R. Writing for Science, Yale University Press, 2006

Open e-Resource:

- https://onlinecourses.nptel.ac.in/
- https://nptel.ac.in/courses

Subject Code: 11390204	Advanced Signal Processing for AI
Pre-requisite: Linear Algebra, Probability & Statistics, Signals and Systems, Digital Signal Processing, Python/Matlab programming, Basics of Machine Learning.	

Course Objective:

1. To develop strong foundations in advanced digital and statistical signal processing techniques.
2. To integrate signal processing concepts with machine learning and deep learning methods.
3. To understand adaptive, time-frequency, and multirate signal processing approaches.
4. To enable students to design and implement AI-driven signal processing solutions.
5. To prepare students for advanced research and industry roles in AI-enabled signal processing domains.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Mathematical Foundations for Signal Processing & AI**: Review of linear algebra – vector spaces, eigenvalues, eigenvectors, Singular Value Decomposition (SVD). Probability and stochastic processes – random variables, probability distributions, expectation, correlation, Central Limit Theorem (CLT), introduction to Markov chains.	6	15
2	**Advanced Digital Signal Processing**: Multirate DSP – decimation and interpolation, polyphase structures. Digital filter banks and applications. Spectral analysis – non-parametric and parametric spectral estimation methods. Fast Fourier Transform (FFT) review and applications.	8	20
3	**Statistical Signal Processing**: Random signal modeling. Detection theory – hypothesis testing, Neyman–Pearson criterion. Estimation theory – Maximum Likelihood (ML) and Minimum Mean Square Error (MMSE) estimators. Applications in communication and sensor systems.	7	15
4	**Adaptive Signal Processing**: Adaptive filtering concepts. Wiener and LMS algorithms. Recursive Least Squares (RLS) overview. Applications of adaptive filters in noise cancellation, echo suppression, and prediction.	6	15

5	**Time-Frequency Analysis & Optimization**: Time-frequency representations – Short-Time Fourier Transform (STFT), wavelet transform. Introduction to convex optimization concepts for signal processing. Optimization techniques used in adaptive and learning-based signal models.	6	15
6	**Signal Processing with AI & Applications**: Introduction to machine learning for signal processing. Neural networks and deep learning models for signal data. Case studies – speech processing, biomedical signal analysis, power systems, and multimedia signals. Integration of DSP with AI frameworks.	7	20

Course Outcome:

1. CO1: Apply mathematical and probabilistic foundations to advanced signal processing problems.
2. CO2: Analyze and implement advanced DSP techniques including multirate processing and spectral analysis.
3. CO3: Design adaptive and statistical signal processing algorithms.
4. CO4: Integrate machine learning and deep learning methods with signal processing applications.
5. CO5: Evaluate and solve real-world AI-based signal processing problems in research and industry.

List of Textbooks:

1. Alan V. Oppenheim & Ronald W. Schafer, Discrete-Time Signal Processing, Pearson.
2. Simon Haykin, Adaptive Filter Theory, Pearson.

List of Reference Books:

1. Steven M. Kay, Fundamentals of Statistical Signal Processing, Prentice Hall.
2. Boyd & Vandenberghe, Convex Optimization, Cambridge University Press.
3. Deep Learning and Signal Processing research papers and online resources.

List of Suggested Experiments:

1. Implementation of FFT and spectral estimation techniques
2. Design of multirate filter banks
3. Adaptive filtering using LMS/RLS algorithms
4. Time-frequency analysis using STFT and wavelets
5. Application of neural networks to signal classification

Subject Code: 11390205	Time Series Analysis & Forecasting
Pre-requisite: Linear Algebra, Probability & Statistics, Signals and Systems, Digital Signal Processing, Python/Matlab programming, Basics of Machine Learning.	

Course Objective:

1. To understand the fundamentals of time series data and forecasting.
2. To apply statistical and AI-based forecasting techniques.
3. To analyze real-world time-dependent data using modern tools.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Foundations & Statistical Basics:** Definition and examples of time series (finance, IoT, healthcare). Components: Trend, Seasonality, Cyclicity, Noise. Descriptive statistics, forecasting errors. Correlation, Covariance. Autocorrelation (ACF) and Partial Autocorrelation (PACF). Stationarity, White Noise, Augmented Dickey-Fuller (ADF) test. Handling non-stationary data: differencing, transformations.	8	20
2	**Regression & Classical Forecasting Models:** Linear regression analysis, dependent and independent variables, least squares, Durbin–Watson statistic. Univariate forecasting methods. AR, MA, ARIMA models. Model identification and prediction intervals.	8	20
3	**Seasonal & Advanced Statistical Models:** Smoothing methods – Simple, Double, Holt–Winters. Decomposition methods. Seasonal ARIMA (SARIMA). Model quality evaluation using AIC and BIC. Introduction to ARCH and GARCH models for volatility analysis.	8	20
4	**Machine Learning & Deep Learning for Time Series:** Feature engineering – lag features, rolling statistics. ML models: Random Forest, SVM, Gradient Boosting. DL models: RNN, LSTM, GRU. Overview of attention mechanisms and Transformer-based forecasting.	8	20

5	**Advanced Topics, Applications & Tools:** Multivariate time series – VAR. State-space models: Markov and Hidden Markov Models (HMM). Anomaly detection. Generative AI: GANs, diffusion models. Practical implementation using Python libraries – statsmodels, Prophet, PyTorch Forecasting, sktime.	8	20

Course Outcome:

1. CO1: Understand and model time series data using statistical and AI techniques.
2. CO2: Apply classical forecasting methods including ARIMA and SARIMA.
3. CO3: Implement smoothing and volatility models for seasonal and financial time series.
4. CO4: Develop machine learning and deep learning models for forecasting tasks.
5. CO5: Analyze multivariate time series and implement advanced AI tools for real-world applications.

List of Textbooks:

1. Box, G. E. P., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M., Time Series Analysis: Forecasting and Control.
2. Hyndman, R. J., & Athanasopoulos, G., Forecasting: Principles and Practice.
3. Shumway, R. H., & Stoffer, D. S., Time Series Analysis and Its Applications.
4. Brockwell, P. J., & Davis, R. A., Introduction to Time Series and Forecasting.

List of Suggested Experiments:

1. Time series visualization and decomposition.
2. ARIMA and SARIMA modeling.
3. Holt–Winters forecasting.
4. Machine learning-based forecasting using Python.
5. Deep learning (RNN/LSTM/GRU) forecasting on real datasets.
6. Mini-project on real-world time series datasets.

Subject Code: 11390206	AI-Driven Remote Sensing & GIS
Pre-requisite: Fundamentals of Remote Sensing, GIS, Python/Matlab programming, Basics of Machine Learning.	

Course Objective:

1. To understand the fundamentals of remote sensing, GIS, and geospatial data.
2. To apply AI and machine learning techniques to geospatial analysis.
3. To enable students to design AI-driven solutions for spatial and environmental problems.
4. To prepare students for real-world applications in smart cities, disaster management, and environmental monitoring.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	0	2	5	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Foundations of Remote Sensing:** Principles of remote sensing, EMR interaction with atmosphere and earth surface, spectral signatures, sensors, and platforms.	6	15
2	**Geographic Information Systems (GIS):** GIS components, data models (raster & vector), spatial analysis, overlaying, buffering, and map projections.	6	15
3	**Digital Image Processing & Photogrammetry:** Image enhancement, filtering, classification, segmentation. Principles of photogrammetry, aerial photography, stereoscopy, and basic mapping.	6	15
4	**Geospatial Data Management & GNSS:** Spatial databases, query and retrieval, RDBMS for GIS. GNSS principles, positioning, and integration with GIS.	6	15
5	**AI & Machine Learning for Geospatial Analysis:** Introduction to AI, problem-solving agents, ML & DL models for spatial data (Random Forest, CNNs, GANs). Feature extraction, preprocessing, and geospatial pattern recognition.	8	20

6	**Advanced GeoAI Applications & Tools:** AI in geoinformatics, geocomputation, spatial analytics. Web GIS & cloud GIS services. AI-enabled drones/UAS applications. Real-world projects: disaster management, urban planning, climate monitoring. Practical implementation using Python, R, QGIS, and ArcGIS.	8	20

Course Outcome:

1. CO1: Understand core concepts of remote sensing, GIS, and geospatial data management.
2. CO2: Apply AI and machine learning techniques to analyze spatial datasets.
3. CO3: Implement digital image processing and geospatial analytics workflows.
4. CO4: Integrate AI with geospatial tools and sensors for real-world applications.
5. CO5: Solve complex environmental, urban, and disaster management problems using AI-driven geospatial solutions.

List of Textbooks:

1. Lillesand, T. M., Kiefer, R. W., & Chipman, J., Remote Sensing and Image Interpretation, Wiley.
2. Jensen, J. R., Introductory Digital Image Processing, Pearson.
3. Kang-tsung Chang, Introduction to Geographic Information Systems, McGraw-Hill.
4. Goodfellow, I., Bengio, Y., & Courville, A., Deep Learning, MIT Press.

List of Reference Books:

1. Burrough, P., McDonnell, R., Principles of Geographical Information Systems, Oxford University Press.
2. Anji Reddy, M., Remote Sensing and GIS, B.S. Publications.
3. Research papers on GeoAI, GANs for remote sensing, and AI-driven GIS applications.

List of Suggested Experiments:

1. Image classification, segmentation, and feature extraction using satellite/aerial data.
2. Spatial analysis and overlay operations in GIS.
3. Integration of GNSS data with GIS mapping.
4. ML/DL-based prediction on geospatial datasets (Random Forest, CNNs, GANs).
5. AI-driven urban or environmental monitoring mini-project using Python, R, QGIS/ArcGIS.

Subject Code: 11390207	AI for Smart Healthcare & Medical Imaging
Pre-requisite: Probability & Statistics, Python Programming, Basics of Machine Learning	

Course Objective:

1. To understand the role of Artificial Intelligence in modern healthcare systems.
2. To apply machine learning and deep learning techniques for medical data and imaging analysis.
3. To explore advanced tools such as EDA, PCA, augmentation, ECA attention and RAG in healthcare AI.
4. To design diagnostic and predictive AI-based clinical support systems.
5. To prepare students for research and industry roles in AI-enabled smart healthcare

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	1	0	4	60	40	0	0	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Artificial Intelligence in Medicine:** Definition of AI and its applications in clinical settings, scope of AI in healthcare. Overview of machine learning, natural language processing in healthcare. Smart healthcare ecosystem and medical data types (EHR, imaging, signals) and its Applications.	6	15
2	**Fundamentals of Machine Learning and Data Analysis Tools:** Supervised, unsupervised, and reinforcement learning. Feature engineering in healthcare datasets. Model evaluation metrics (accuracy, precision, recall, ROC). Bias–variance tradeoff . Exploratory Data Analysis (EDA). Principal Component Analysis (PCA) for dimensionality reduction. Handling missing and imbalanced medical datasets.	7	15
3	**Deep Learning Architectures for Medical Imaging:** Basics of deep learning and neural networks. Convolutional Neural Networks (CNNs). Recurrent Neural Networks (RNNs). Transfer learning and pre-trained models in medical imaging. Medical image segmentation (U-Net overview).	8	20

4	**AI in Diagnostics and Disease Prediction:** Predictive modeling for disease risk assessment. Early disease detection using AI algorithms. Medical image preprocessing techniques. Data augmentation methods (rotation, flip, MixUp, CutMix). GAN-based medical augmentation. Efficient Channel Attention (ECA) mechanism	6	15
5	**Retrieval-Augmented Generation (RAG) in Healthcare:** Introduction to large language models in healthcare. RAG architecture: retriever and generator. Integration with EHR databases.	4	15
6	**Natural Language Processing (NLP) in Healthcare:** Text mining and information extraction from clinical notes. Clinical language understanding and medical coding. Named Entity Recognition (NER) in healthcare. Applications of NLP in EHR analysis and clinical documentation. Multimodal AI (imaging + clinical text).	6	20

Course Outcome:

1. CO1: Understand AI concepts and applications in smart healthcare.
2. CO2: Apply machine learning, EDA, and PCA to medical datasets.
3. CO3: Design deep learning and CNN-based medical imaging systems.
4. CO4: Implement augmentation, ECA, and RAG in healthcare AI solutions.
5. CO5: Develop NLP-enabled intelligent clinical support systems.

List of Textbooks:

1. Kevin Zhou et al., Deep Learning for Medical Image Analysis, Academic Press.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.

List of Reference Books:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow.
2. Biomedical AI and Medical Imaging research papers and online resources.
3. Recent literature on RAG, ECA-Net, and Healthcare NLP.

Subject Code: 11390208	Data Engineering & Data Pipeline Systems
Pre-requisite: Database Management Systems, Python Programming, Basics of Machine Learning, Distributed Computing Fundamentals.	

Course Objective:

1. To provide advanced understanding of data engineering principles and large-scale data management systems.
2. To study data ingestion, transformation, and pipeline orchestration techniques.
3. To design scalable data pipelines for AI and machine learning applications.
4. To explore distributed data processing frameworks and cloud-based data platforms.
5. To develop expertise in building reliable, fault-tolerant, and efficient data pipelines.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	1	0	4	60	40	0	0	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	Introduction to Data Engineering: Role of data engineering in AI systems, data lifecycle management, data architecture concepts, structured vs unstructured data, batch and stream processing, data warehouses and data lakes, overview of modern data engineering tools and ecosystems.	8	15
2	**Data Ingestion and Data Integration**: Data ingestion techniques, ETL and ELT processes, data extraction from APIs, databases and streaming sources, data integration frameworks, data quality management, schema evolution, data validation and preprocessing for AI pipelines.	10	20
3	**Distributed Data Processing Systems**: Big data processing frameworks, Hadoop ecosystem, distributed storage systems, Apache Spark architecture, data parallelism, cluster resource management, scalable data transformation techniques.	8	20
4	**Data Pipeline Design and Orchestration**: Pipeline architecture and workflow design, data pipeline scheduling and monitoring, orchestration tools (Apache	8	20

	Airflow, Luigi), workflow automation, fault tolerance and recovery mechanisms, data lineage and metadata management.		
5	**Real-Time Data Processing and AI Pipelines**: Stream processing frameworks (Kafka, Spark Streaming, Flink), event-driven architectures, feature engineering pipelines for machine learning, model data pipelines, cloud-based data platforms, scalable AI data infrastructure and case studies.	8	25

Course Outcome:

1. CO1: Understand data engineering concepts and architectures used in AI systems.
2. CO2: Design and implement ETL/ELT pipelines for large-scale data processing.
3. CO3: Use distributed frameworks for scalable data transformation and storage.
4. CO4: Develop automated data pipelines with orchestration and monitoring tools.
5. CO5: Build real-time data processing pipelines for AI and machine learning applications.

List of Textbooks:

1. Joe Reis & Matt Housley, Fundamentals of Data Engineering, O'Reilly Media.
2. Tyler Akidau et al., Streaming Systems: The What, Where, When, and How of Large-Scale Data Processing, O'Reilly**.**

List of Reference Books:

1. Bill Chambers & Matei Zaharia, Spark: The Definitive Guide, O'Reilly.
2. Holden Karau et al., Learning Spark, O'Reilly Media.
3. Martin Kleppmann, Designing Data-Intensive Applications, O'Reilly Media.

Subject Code: 11390209	Advanced Data Mining & Knowledge Discovery
Pre-requisite: Machine Learning, Probability & Statistics, Database Management Systems, Python Programming.	

Course Objective:

1. To provide advanced knowledge of data mining techniques and knowledge discovery processes.
2. To understand methods for extracting useful patterns and insights from large datasets.
3. To explore advanced algorithms for classification, clustering, and association analysis.
4. To study text mining, web mining, and big data mining techniques.
5. To develop skills for applying data mining methods in real-world AI applications.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
3	1	0	4	60	40	0	0	100

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
1	**Introduction to Data Mining and Knowledge Discovery**: Data mining concepts and tasks, knowledge discovery in databases (KDD) process, data preprocessing and cleaning, data integration and transformation, data warehousing concepts, overview of data mining applications in AI.	8	15
2	**Classification and Prediction Techniques**: Decision trees, Bayesian classification, support vector machines, neural networks for classification, ensemble learning methods, evaluation metrics and model validation techniques.	10	20
3	**Clustering and Pattern Discovery**: Clustering methods (k-means, hierarchical clustering, density-based clustering), cluster validation techniques, anomaly detection, pattern discovery techniques in large datasets.	8	20
4	**Association Rule Mining and Sequential Pattern Mining**: Frequent pattern mining, Apriori algorithm, FP-growth algorithm, sequential pattern discovery, market basket analysis, applications of association rule mining.	8	20

5	**Advanced Topics in Data Mining**: Text mining, web mining, social network mining, graph mining, big data mining frameworks, deep learning approaches for knowledge discovery, real-world data mining case studies.	8	25

Course Outcome:

1. CO1: Understand the concepts and processes of data mining and knowledge discovery.
2. CO2: Apply classification and prediction techniques to analyze complex datasets.
3. CO3: Use clustering and pattern discovery techniques to extract hidden structures.
4. CO4: Perform association rule mining and sequential pattern analysis.
5. CO5: Apply advanced data mining techniques to solve real-world AI problems.

List of Textbooks:

1. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, Morgan Kaufmann.
2. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann.

List of Reference Books:

1. Bill Chambers & Matei Zaharia, Spark: The Definitive Guide, O'Reilly.
2. Holden Karau et al., Learning Spark, O'Reilly Media.
3. Martin Kleppmann, Designing Data-Intensive Applications, O'Reilly Media.

Semester 3

Subject Code: 11390301	Internal Review I

Course Objective:

1. To guide students in finalizing the research problem and scope.
2. To assess the quality of literature review and research gap identification.
3. To ensure the research methodology is clearly defined.
4. To provide constructive feedback before proceeding to Dissertation Phase–I implementation.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	4	2	0	0	0	100	100

Internal Review – I ,is conducted before the formal submission of Dissertation Phase–I. The review is carried out by the faculty guide/supervisor to monitor the early-stage research progress.

Students are required to present:

- Proposed research topic in AI
- Problem statement
- Literature review
- Research gap identification
- Objectives of the research
- Proposed methodology or framework
- Expected outcomes

The guide evaluates the research feasibility, technical depth, and relevance of the selected topic.

Review Components

Students must submit and present:

- Topic approval document
- Literature survey summary
- Research problem formulation
- Proposed methodology
- Preliminary research plan
- Timeline for Dissertation Phase–I

Subject Code: 11390302	Dissertation Phase I
Pre-requisite: Research Methodology, Machine Learning, Deep Learning, Data Analytics, or relevant core AI courses.	

Course Objective:

1. To enable students to identify a research problem in Artificial Intelligence or related domains.
2. To develop skills in literature survey, problem formulation, and research methodology.
3. To encourage students to analyze existing AI techniques and identify research gaps.
4. To design a novel approach, model, or framework for solving an AI problem.
5. To prepare students for independent research, experimentation, and scientific reporting.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	28	14	0	0	100	0	100

Course Description

In this phase of dissertation work, students are expected to select a research topic in Artificial Intelligence or related interdisciplinary areas such as:

- Machine Learning
- Deep Learning
- Natural Language Processing
- Computer Vision
- AI for Healthcare
- Intelligent Systems
- Data Science
- Reinforcement Learning
- AI for Cybersecurity
- AI for IoT / Smart Systems

Students will work under the supervision of a faculty guide and perform an extensive literature review to identify the research gap and define the problem statement.

The work in Phase-I should include:

- Identification of research problem
- Literature survey
- Definition of objectives and scope
- Selection of methodology
- Initial design of system/model
- Preliminary experimentation (if possible)

Students are required to present their research proposal and progress in seminars and reviews conducted by the department.

Progress Report (Submission Requirements)

Students must submit a progress report containing:

- Research problem statement
- Literature survey and related work
- Research gap identification
- Objectives of the research
- Proposed methodology
- Expected outcomes

Students must present their work before the department review committee.

Assessment Components

Evaluation may be based on:

- Problem definition and novelty
- Literature survey quality
- Research methodology
- Presentation and seminar
- Progress report documentation

Semester 4

Subject Code: 11390401	Internal Review II

Course Objective:

1. To evaluate the implementation progress of the dissertation work.
2. To assess experimental setup, security analysis, and preliminary results.
3. To guide improvements in methodology and experimentation.
4. To ensure readiness for final Dissertation Phase–II submission.
5. To improve research documentation and presentation quality.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	4	2	0	0	0	100	100

Course Description

Internal Review – II is conducted after completion of Dissertation Phase–I and before Dissertation Phase–II submission.

This review evaluates the progress of implementation, experiments, and initial results.

The review is conducted by the research guide/supervisor to ensure that the student is progressing toward the successful completion of the dissertation.

Students must present:

- Implementation progress
- System architecture or model design
- Experimental setup
- Preliminary results
- Security evaluation or performance analysis
- Planned improvements and future work

Review Components

Students must submit and present:

- Implementation status report
- Experimental setup and methodology
- Preliminary results and analysis
- Challenges faced and solutions
- Plan for final dissertation completion

Subject Code: 11390402	Dissertation Phase II
Pre-requisite: Successful completion of Dissertation Phase-I	

Course Objective:

1. To implement the proposed AI model or system developed in Phase-I.
2. To perform experiments, validation, and performance evaluation.
3. To analyze results and compare with existing state-of-the-art approaches.
4. To prepare a research thesis and technical documentation.
5. To develop skills for research presentation, defense, and publication.

Teaching Scheme (Hours per week)				**Evaluation Scheme (Marks)**				
				Theory		**Practical**		
Lecture	**Tutorial**	**Practical**	**Credit**	**University Assessment**	**Continuous Assessment**	**University Assessment**	**Continuous Assessment**	**Total**
0	0	28	14	0	0	100	0	100

Course Description

This phase represents the final stage of the M.Tech dissertation work. Students will implement the proposed solution developed in Phase-I and conduct extensive experiments and analysis.

The dissertation work may involve:

- Algorithm development
- AI model training and evaluation
- Simulation or system implementation
- Dataset analysis and performance validation
- Comparative study with existing approaches

Students must prepare a complete dissertation report and present their research findings in an open seminar and viva-voce examination.

Dissertation Report Structure

The final thesis should include:

- Introduction
- Literature Review
- Problem Statement and Research Gap
- Proposed Methodology / Model
- Implementation and Experimental Setup
- Results and Analysis

- Comparison with Existing Methods
- Conclusion and Future Work
- References

Assessment Components

Evaluation will be based on:

- Implementation and technical quality
- Experimental validation and analysis
- Dissertation report
- Research contribution
- Seminar presentation and viva-voce

ANNEXURE III
Industry & Employer Survey Analysis

Sample Size	Survey Period	Region	Framework
25 Organizations	**February – April 2026**	**Gujarat / Pan-India**	**NEP 2020 / UGC 2024**

1. Executive Summary

A structured industry validation survey was conducted among 25 senior technology leaders, HR professionals, and engineering managers across IT, BFSI, manufacturing, healthcare, and public-sector organizations in Gujarat and pan-India to assess the demand for formally trained M.Tech. graduates in Artificial Intelligence and Machine Learning (AI & ML) Engineering and to validate the need for the proposed programme at the University.[1]

The findings are unambiguous and strongly positive. India currently faces a structural AI talent deficit that no existing academic pipeline is resolving at the required pace. *NASSCOM's 2025 Technology Workforce Report estimates that India will need approximately 2 lakh additional AI/ML professionals by 2027 — a gap that current education pipelines cannot fill at the required pace or quality level.*[2] Simultaneously, the World Economic Forum's Future of Jobs Report 2025 ranks AI and Machine Learning Specialist as the single fastest-growing occupation globally, with projected employment growth of 40% over 2025–2030.[3]

Every survey respondent confirmed a significant talent gap in the current market. Twenty-two out of twenty-five organizations expressed willingness to recruit graduates from a formally structured university M.Tech. programme aligned with UGC's Curriculum and Credit Framework for PG Programmes (June 2024) and NEP 2020. Twenty organizations expressed interest in participating as industry partners. The survey validates the University's decision to launch this programme and provides strong industry backing for an immediate start.[4]

Confirm critical AI/ML talent gap in current market	**100%**
Would actively recruit M.Tech. graduates	**88%**
Open to formal industry partnership with the University	**80%**
Average rating — recommend programme launch	**4.5 / 5**
Overall recommendation score (launch now / with adjustments)	**96%**

2. Regulatory and Policy Framework

The proposed M.Tech. in AI & ML Engineering is designed in full conformity with applicable national regulatory instruments. The University Grants Commission (UGC), as the statutory body set up by the Ministry of Education, Government of India, *is responsible for maintaining the standards of Higher Education in India, and UGC approval is mandatory for degree validity.*[5] AICTE approval is additionally mandatory for all technical engineering programmes and is responsible for the planning and development of technical as well as management education in India.[6]

In June 2024, the UGC released its ***Curriculum and Credit Framework for Post-graduate Programmes*** under NEP 2020, which provides for flexible one-year and two-year PG programme structures, exit provisions at the end of Year 1, multi-disciplinary elective baskets, and creditization of work experience under the National Credit Framework (NCrF).[7]

Specifically, NEP 2020 explicitly proposes that universities should focus on providing postgraduate programmes in fundamental subjects like machine learning, alongside interdisciplinary fields such as 'AI + X,' and professional domains such as healthcare, agriculture, and law.[8] The University's proposed M.Tech. programme directly fulfils this mandate. For M.Tech. eligibility, candidates who have completed a 4-year undergraduate programme or a 3-year undergraduate programme and a 2-year PG programme in STEM subjects are eligible for admission in M.E./M.Tech. in allied areas.[9]

IIT Roorkee's revised 2024 PG curriculum — aligned with NEP 2020 — exemplifies best practice and offers flexible basket-based courses including programme core courses (PCC), programme elective courses (PEC), social sciences courses (SSC), and a mandatory industrial internship/social activity (ISA) basket.[10] The University's M.Tech. AI & ML curriculum mirrors this structure to ensure national comparability and industry relevance.

3. Respondent Profile

The 25 respondents were drawn from technology-intensive organizations across five sectors — Information Technology & Software, Banking, Financial Services & Insurance (BFSI), Manufacturing & Industry 4.0, Healthcare & Life Sciences, and Public Sector & Smart City initiatives — spanning Ahmedabad, Gandhinagar, Surat, and national tech hubs (Bengaluru, Pune, Hyderabad). Respondent designations included Chief Technology Officers, Heads of AI/ML, Senior Engineering Managers, HR & Talent Acquisition Heads, and R&D Directors, ensuring responses reflect both technical requirements and strategic hiring decisions.

Sector	**No. of Respondents**	**% of Sample**
Information Technology & Software	10	40%
Banking, Financial Services & Insurance (BFSI)	5	20%
Manufacturing & Industry 4.0	4	16%
Healthcare & Life Sciences	3	12%
Public Sector / Smart City / Research	3	12%

4. Findings — Q1: AI/ML Talent Gap in Fresh Graduates

Respondents were asked to identify the biggest knowledge gaps they observe when hiring fresh engineering graduates for AI/ML roles. Multiple selections were permitted. The responses reveal a consistent and severe pattern. India currently boasts 1.3 million AI learners — the highest globally — yet ranks 89th out of 109 nations in measured AI proficiency, creating a massive 50–55% talent gap with a projected demand for nearly one million AI professionals by 2026 and only about half that number currently qualified to fill them.[11]

Furthermore, the AI Engineer role grew 99% in a single year — nearly doubling — with the highest demand-to-supply pressure point in the entire technology talent dataset. Demand for AI engineers is rising 40% year-on-year while the supply of production-ready engineers grows far more slowly.[12][13]

Knowledge Gap Identified	**Respondents**	**Percentage**
No hands-on MLOps / model deployment experience	**25/25**	100%
No Large Language Model (LLM) / GenAI knowledge	**24/25**	96%

Knowledge Gap Identified	Respondents	Percentage
No applied deep learning / neural network skills	**23/25**	92%
Cannot work with real-world unstructured data	**22/25**	88%
No AI ethics, bias detection or governance literacy	**21/25**	84%
No cloud / GPU computing skills (AWS / GCP / Azure)	**20/25**	80%
Weak statistical / mathematical foundations	**19/25**	76%
No NLP / computer vision applied skills	**18/25**	72%
Poor research / thesis documentation ability	**14/25**	56%
No industry domain knowledge (BFSI / Healthcare etc.)	**12/25**	48%

Selected Employer Comments — Talent Gap

> *"We have had to build internal bootcamps running 12–16 weeks for every fresh hire just to make them production-ready. An M.Tech. that delivers MLOps-capable graduates from Day 1 would eliminate this cost entirely."*
> *— Industry Survey Respondent, Ahmedabad IT Sector*

> *"Our BFSI clients expect AI models to be explainable and compliant. We cannot find graduates who understand both the ML pipeline and the regulatory environment simultaneously. That dual literacy is what the market needs."*
> *— Industry Survey Respondent, BFSI Sector*

> *"GenAI is now a production workload, not a research experiment. We need people who can fine-tune LLMs, build RAG pipelines, and manage inference costs. None of the graduates we interview in 2025–26 can do this without months of additional training."*
> *— Industry Survey Respondent, Technology Sector*

5. Findings — Q2: MLOps & Production AI Readiness

Respondents were asked how their need for production-ready AI/MLOps-skilled professionals has changed since 2022 and whether they are finding enough qualified professionals in the Gujarat and

national market. The responses confirm a structural shortage that has worsened as enterprise AI deployment has scaled.[14]

How has demand for MLOps-literate staff changed since 2022?	Count	%
Significantly increased	18	72%
Moderately increased	5	20%
No change	2	8%
Decreased	0	0%

Are you finding enough qualified AI/ML professionals?	Count	%
No — serious shortage at production-ready level	20	80%
Partially — some available but require extensive upskilling	4	16%
Yes — enough supply	1	4%

6. Findings — Q3: Most Valued Curriculum Subject Areas

Respondents were asked which subject areas they feel would most benefit their AI/ML engineering teams and which they would most value in M.Tech. graduates. This question was structured to directly inform curriculum design under the UGC PG Credit Framework 2024. The results directly support the University's proposed four-semester curriculum structure distributing core and elective credits across foundational AI/ML, applied domains, research methodology, and thesis work.[15]

Subject Area / Curriculum Module	Respondents	Percentage
MLOps, CI/CD pipelines & model deployment	**25/25**	100%
Large Language Models (LLMs) & Generative AI	**24/25**	96%
Deep Learning (CNN, RNN, Transformers)	**23/25**	92%

Subject Area / Curriculum Module	Respondents	Percentage
Data Engineering & Big Data Pipelines (Spark / Kafka)	**22/25**	88%
AI Ethics, Bias Auditing & Responsible AI Governance	**21/25**	84%
Cloud Computing & GPU Infrastructure (AWS / GCP / Azure)	**20/25**	80%
Natural Language Processing & Speech Recognition	**19/25**	76%
Computer Vision & Image Processing	**18/25**	72%
Statistical Learning & Bayesian Methods	**16/25**	64%
AI for Domain Applications (FinTech / Healthcare / Industry 4.0)	**15/25**	60%
Research Methods & Academic Paper Writing	**12/25**	48%

7. Findings — Q4: Recruitment Intent

This is the most strategically important finding of the survey. Respondents were asked to rate their likelihood of actively recruiting from a University M.Tech. programme producing graduates trained in production AI/ML engineering, LLM development, MLOps, responsible AI, and applied domain AI. This reflects the market reality described by industry data: average salaries for AI engineers have nearly doubled due to strong demand and a persistent talent shortage, with demand rising 40% year-on-year while supply lags significantly.[16][17]

Rating	Developers	Percentage	Interpretation
5 — Definitely would recruit	14	56%	High intent
4 — Likely to recruit	8	32%	Positive intent
3 — Possibly would recruit	3	12%	Neutral
2 — Unlikely	0	0%	—
1 — Definitely would not	0	0%	—
Average Rating	4.4 / 5.0		Strong positive

Specific roles for which organizations would most actively hire M.Tech. AI & ML graduates:

Target Role	Respondents	Percentage
MLOps Engineer / AI Platform Engineer	**24/25**	96%
Machine Learning Engineer (Production)	**23/25**	92%
AI Research & Development Engineer	**22/25**	88%

Target Role	Respondents	Percentage
Data Scientist (Applied / Industry)	**20/25**	80%
LLM / GenAI Application Developer	**19/25**	76%
AI Solutions Architect	**16/25**	64%
Computer Vision / NLP Specialist	**14/25**	56%
AI Ethics & Governance Analyst	**12/25**	48%

8. Findings — Q5: Industry Partnership Interest

Respondents were asked whether they would engage formally with the University as industry partners covering guest faculty, lab sessions, internships, capstone project panels, recruitment letters of intent, and curriculum advisory input. The enthusiasm for partnership reflects the sector's recognition that academia-industry collaboration is essential to closing the AI talent gap identified by NASSCOM and the World Economic Forum.[18]

Partnership Engagement Mode	Respondents	Percentage
Guest faculty / expert lecture sessions	**23/25**	92%
Industry project / capstone problem host	**22/25**	88%
Internship provider (6-month structured internship)	**21/25**	84%
Capstone pitch panelist & industry evaluator	**20/25**	80%
Letter of Intent for recruitment	**18/25**	72%
Curriculum advisory board membership	**16/25**	64%
GPU / cloud computing resource sharing (lab access)	**12/25**	48%
Co-branding / sponsorship of student competitions	**10/25**	40%

Selected Partner Quotes — Industry Partnership

> *"We are happy to provide our enterprise AI use cases as capstone problem statements. Real-world data and real deployment constraints are exactly what thesis projects should be built on."*
> *— Industry Survey Respondent, BFSI Sector*

> *"If M.Tech. students work on live production-grade ML pipelines during internship, they understand what model drift, latency SLAs, and cost optimization actually mean. We can absorb 3–4 interns per year from a structured programme."*
> *— Industry Survey Respondent, Ahmedabad IT Sector*

> *"A formal Letter of Intent from our organization is the minimum we can commit. If the programme is as described — research-intensive with real MLOps exposure — we want to be associated from Batch 1."*
> *— Industry Survey Respondent, Technology Sector*

9. Overall Programme Recommendation Rating

Respondents were asked to rate overall whether they would recommend that the University proceed with launching the M.Tech. in AI & ML Engineering programme.

Overall Rating	**Count**	**%**	**Meaning**
5 — Strongly recommend launching now	15	60%	Launch immediately
4 — Recommend with minor conditions	9	36%	Launch with adjustments
3 — Neutral / more information needed	1	4%	Cautious
2 — Do not recommend	0	0%	—
1 — Strongly against	0	0%	—
Average Rating	**4.6 / 5.0**		

10. Conclusions & Recommendations

The industry validation survey of 25 organizations produces five clear and actionable conclusions:

01	**The talent gap is real, acute, and universally confirmed.** Every organization surveyed identified one or more critical knowledge gaps in fresh graduates. MLOps deployment readiness, LLM/GenAI competency, and

	production-grade AI engineering are the top three deficiencies. The University's proposed curriculum directly addresses all three.[2][11][12]

02	**The market is ready to recruit from the programme immediately.** An average recruitment intent score of 4.4 out of 5.0 with 88% of organizations rating 4 or 5 means the placement pipeline for the first batch is already being built before the programme launches. AI engineer demand is growing at 40% year-on-year and average salaries have nearly doubled — creating an exceptional graduate outcome environment.[13][16]

03	**MLOps and LLM/GenAI are the two most valued subject areas.** 100% and 96% of respondents respectively identified MLOps and LLM/GenAI as the most critical curriculum areas. This validates the University's decision to embed production AI deployment, model lifecycle management, and generative AI applications across Semesters I through III rather than treating them as standalone electives.[11][15]

04	**The industry partnership interest is exceptional.** 84% of organizations are open to internship provision, 72% are ready to issue Letters of Intent for recruitment, and 64% are willing to serve on the curriculum advisory board. This is the credibility infrastructure the programme needs to launch with authority and to ensure the 6-month industry internship embedded in Semester III is operationalized from Day 1.[18]

05	**The overall recommendation is to proceed without delay.** 96% of respondents gave a rating of 4 or 5, recommending that the University launch the programme. A 4.6 out of 5.0 average recommendation score represents one of the strongest industry validation signals a new academic programme can receive. NEP 2020 and the UGC PG Framework 2024 provide complete regulatory authorization. The market conditions, talent deficit data, and employer commitment all point to an immediate launch.[3][7][8]

11. References & Citations

All citations embedded in the body of this Annexure correspond to the following authoritative sources. These references were verified as of April 2026 and are provided to substantiate the market demand analysis, regulatory compliance positioning, and curriculum validation findings presented herein.

[1] Structured Industry Validation Survey — M.Tech. AI & ML Engineering, University (Internal Document), February–April 2026. Survey administered to 25 senior technology leaders across Gujarat and pan-India.

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[6] AICTE (All India Council for Technical Education). Approval requirements for technical and management education programmes in India. Available at: https://www.aicte-india.org/

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