RAJIV GANDHI NATIONAL INSTITUTE OF YOUTH DEVELOPMENT
(Institute of National Importance by the Act of Parliament No. 35/2012)
Ministry of Youth Affairs & Sports, Government of India Pennalur,
Sriperumbudur – 602 105, Tamil Nadu.

Regulations, Curriculum, and Syllabus

for

Master of Science in Computer Science -Artificial Intelligence and Machine Learning

(Regulations 2023)

Department of Computer Science – Artificial Intelligence and Machine Learning

Rajiv Gandhi National Institute of Youth Development,
Sriperumbudur, Tamilnadu.

RAJIV GANDHI NATIONAL INSTITUTE OF YOUTH DEVELOPMENT
(Institute of National Importance by the Act of Parliament No. 35/2012)
Ministry of Youth Affairs & Sports, Government of India Pennalur,
Sriperumbudur – 602 105, Tamil Nadu.

Vision of Rajiv Gandhi National Institute of Youth Development

As the apex national agency for youth development, the Institute strives to develop into a globally recognized and acclaimed center of excellence in the field of youth development, fully responsive to the national agenda for inclusive growth, and the needs and aspirations of young people of the country to realize their potentials to create a just society.

Mission of Rajiv Gandhi National Institute of Youth Development

The Institute seeks to realize its Vision by:

- Introducing socially relevant and job oriented academic programs for producing human resources.
- Initiating outreach activities through partnership with other academic institutions and skill-based organizations.
- Providing substantive inputs in the formulation of youth-related policies and in developing innovative program initiatives that respond effectively to the needs and concerns of the young people of the country.
- Developing professional capacity of all youth development agencies in the country - state-sponsored or voluntary organizations - through training and specialized services, such as: consultancies, and providing expertise and training materials for in-house training programs.
- Setting up a world-class and modern Resource Centre that will provide library and other related services and facilities to those involved in youth-related activities - youth organizations, educational and training institutions, researchers, scholars, and young people.
- Generating authentic and comprehensive primary and secondary data on all issues and matters that impact the life of the young people in the country through a systematic and extensive program of action research and study.

RAJIV GANDHI NATIONAL INSTITUTE OF YOUTH DEVELOPMENT
(Institute of National Importance by the Act of Parliament No. 35/2012)
Ministry of Youth Affairs & Sports, Government of India Pennalur,
Sriperumbudur – 602 105, Tamil Nadu.

Vision of Computer Science-Artificial Intelligence and Machine Learning

To be a globally recognized center of excellence in computer science education and research, specifically in the fields of Artificial Intelligence and Machine Learning. We strive to empower students with cutting-edge knowledge and skills, fostering innovation and ethical AI practices that positively impact society.

Mission of Computer Science-Artificial Intelligence and Machine Learning

Our mission is to provide a comprehensive and dynamic learning environment for students to excel in computer science, with a specialized focus on Artificial Intelligence and Machine Learning. Through rigorous academic programs, practical exposure, capstone projects, and collaborative research opportunities, we aim to:

- Equip students with a strong foundation in AI and ML concepts, methodologies, and applications.
- Cultivate critical thinking and problem-solving skills through practical experiences and real-world projects.
- Foster a culture of research, innovation, and lifelong learning among students and faculty.
- Promote ethical and responsible AI practices, addressing societal challenges and concerns.
- Engage in partnerships and collaborations with industries, research organizations, and academia to contribute to the advancement of AI and ML technologies.
- Create a supportive and inclusive community that encourages diversity, creativity, and intellectual exploration.

Master of Science [M.Sc.] Computer Science in Artificial Intelligence and Machine Learning

Rajiv Gandhi National Institute of Youth Development, Sriperumpudur, Govt. of India.
Department of Computer Science - Artificial Intelligence and Machine Learning

---

Table of Contents

1. OVERVIEW OF THE PROGRAM

The M.Sc. in Computer Science - Artificial Intelligence and Machine Learning program is dedicated to empowering individuals in the expansive field of AI and ML. With a focus on nurturing expertise, the program offers foundational courses in AI principles, intricate machine learning & deep learning models, and practical laboratory experiences. The curriculum cultivates adept programming skills, reinforces essential mathematical foundations, and provides opportunities for research-driven learning.

Specialized electives, spanning from reinforcement learning to explainable AI, robotics process automation, and data engineering, enrich the academic journey, catering to diverse interests. Culminating in a capstone project, the program is supported by supplementary online courses, ensuring graduates are equipped with the knowledge and skills to excel in impactful careers within the ever-evolving AI and ML landscape. This meticulously designed program serves as a pathway for individuals aspiring to make a significant mark in this dynamic domain.

Eligibility for Admission

- Any Bachelor's degree in Computer Science.
- Any Bachelor's degree in Information Technology.
- Any Bachelor's degree with at least four mathematics courses.
- Any other equivalent Bachelor's degree in Computer Science.

Duration of the Course

- The course duration shall be two years, spread over four semesters. The maximum duration to complete the course shall be three years.

Medium

- The medium of instruction shall be English.

Passing and Classification

- Passing eligibility and classification for the award of the degree are as per the norms of Rajiv Gandhi National Institute of Youth Development.

a) Program Educational Objectives (PEOs):

1. **Technical Proficiency:** Graduates will possess a deep understanding of the foundational concepts, theories, and advanced techniques in artificial intelligence and machine learning, enabling them to design and implement innovative solutions for real-world challenges.

2. **Problem Solving and Application**: Graduates will apply artificial intelligence and machine learning methodologies to solve complex problems across diverse domains, such as computer vision, natural language processing, robotics, and data analytics, thereby contributing to the advancement of technology-driven solutions.

3. **Research and Innovation**: Graduates will engage in research-based learning and innovation, leading to the development of novel AI and ML technologies. They will contribute to the expansion of knowledge in the field and stay updated with the latest developments.

4. **Adaptation to Technological Evolution**: Graduates will adapt to the dynamic and evolving landscape of AI and ML by continuously learning and staying informed about emerging technologies, trends, and best practices. They will be well-prepared to embrace new challenges and advancements in the field.

b) **Program Outcomes (Pos):**

Upon successful completion of this program, students will be able to;

- PO1 : Demonstrate a comprehensive understanding of advanced concepts and theories

- PO2: Apply mathematical and algorithmic principles to solve complex computational problems.

- PO3: Design, develop, and implement software systems that meet specified requirements and adhere to industry best practices.

- PO4: Analyze and evaluate the performance of algorithms, data structures, and software systems using relevant metrics.

- PO5: Utilize advanced programming languages, tools, and frameworks to develop efficient and robust solutions.

- PO6: Communicate technical concepts and findings clearly and effectively to both technical and non-technical audiences.

- PO7: Adapt to emerging technologies and stay updated with the latest advancements in the field.

- PO8: Engage in continuous learning and professional development to enhance their expertise and contribute to the advancement of the field.

c) **Program Specific Outcomes (PSOs)**

The specialized skills and competencies that graduates will develop in the Artificial Intelligence and Machine Learning specialization. The Graduates will

- PSO-1: Demonstrate the ability to apply a variety of AI techniques, including machine learning algorithms, neural networks, and natural language processing, to solve complex problems in diverse domains.

- PSO-2: Analyze intricate datasets, extract meaningful insights, and interpret patterns using advanced AI and ML methods, contributing to data-driven decision-making.

- PSO-3: Design and implement AI applications for specialized areas such as computer vision, robotics, speech processing, and data analytics.

- PSO-4: Effectively translate AI theories into real-world implementations, aligning AI solutions with practical requirements.

2. CREDIT STRUCTURE

Category-wise Credit distribution

Programme Credit Structure	Credits
AI & ML Core	21
AI & ML Electives	12
Computer Science Core	14
Computer Science - Electives	3
Discipline Linked Core	7
Soft Core	2
Online Learning	3
Research Based Learning	3
Capstone Project / Master Thesis	12
Total Credit	77

RAJIV GANDHI NATIONAL INSTITUTE OF YOUTH DEVELOPMENT
(Institute of National Importance by the Act of Parliament No. 35/2012)
Ministry of Youth Affairs & Sports, Government of India Pennalur,
Sriperumbudur – 602 105, Tamil Nadu.

M.Sc. in Computer Science -Artificial Intelligence and Machine Learning

COURSES

AI & ML Core (AIMLC)					**21**
		L	**T**	**P**	**C**
CSAI1001	Artificial Intelligence	3	0	0	3
CSAI2001	Machine Learning	3	0	0	3
CSAI2002	Image Analysis and Computer Vision	3	0	0	3
CSAI3001	Neural Networks and Deep Learning	3	0	0	3
CSAI3002	Speech and Natural Language Processing	3	0	0	3
CSAI2003	Machine Learning lab	0	0	4	2
CSAI3003	Neural Networks and Deep Learning lab	0	0	4	2
CSAI3004	Speech and Natural Language Processing Lab	0	0	4	2

AI & ML Electives (AIMLE) Credit Requirements					**12**
		L	**T**	**P**	**C**
CSAIE001	Reinforcement Learning	3	0	0	3
CSAIE002	Principles of Explainable AI	3	0	0	3
CSAIE003	Responsible AI	3	0	0	3
CSAIE004	Knowledge Representation and Reasoning in AI	3	0	0	3
CSAIE005	Deep Learning for Language And Speech Technologies	3	0	0	3
CSAIE006	Deep Learning for Computer Vision	3	0	0	3
CSAIE007	Robotics Process Automation	2	0	2	3
CSAIE008	3D Graphics and Animation	3	0	0	3
CSAIE009	Soft Computing	2	0	2	3
CSAIE010	Data Engineering and Management	3	0	0	3
CSAIE011	Big Data Frameworks	2	0	2	3
CSAIE012	Cloud Computing ecosystem	2	0	2	3
CSAIE013	Image Processing and Video Analytics	3	0	0	3

Computer Science Core(CSC)					**14**
		L	**T**	**P**	**C**
MSCS101	Data structures & Algorithm	2	0	0	2
MSCS102	Python Programming	3	0	0	3
MSCS203	Object Oriented Programming using Java	3	0	0	3
MSCS105	Data Structures & Algorithm Lab	0	0	4	2
MSCS107	Python Programming Lab	0	0	4	2
MSCS205	Object Oriented Programming using Java Lab	0	0	4	2

Discipline linked Core (DLC)					**7**
		L	**T**	**P**	**C**
MSMA104	Probability and statistics	4	0	0	4
MSMA2001	Mathematics for Machine Learning	3	0	0	3

Soft Core (SC)					**2**
		L	**T**	**P**	**C**
Softcore (English for Communication / Ethics & IPR / Leadership Communication / Understanding human behaviour)		2	0	0	2

Online Learning(OL)					**3**
		L	**T**	**P**	**C**
MOOC Course		0	0	0	3

Research Based Learning(RBL)					3
		L	**T**	**P**	**C**
Research based Learning		0	1	4	3

Computer Science Electives(CS-E)					**3**

Capstone Project / Master Thesis					**12**

M.Sc. Computer Science-Artificial Intelligence and Machine Learning

3. CURRICULUM AND SYLLABUS – SEMESTER-WISE

SEMESTER I

Course code	Course Title	Category	Contact Sessions			
			L	T	P	C
THEORY						
MSCS101	Data Structures and Algorithms	CSC	3	0	0	3
MSCS102	Python Programming	CSC	2	0	0	2
MSMA104	Probability and Statistics	DLC	4	0	0	4
CSAI1001	Artificial Intelligence	AIMLC	3	0	0	3
	Computer Science - Elective I*	CS-E				3
PRACTICALS						
MSCS105	Data Structures and Algorithms Lab	CSC	0	0	4	2
MSCS107	Python Programming Lab	CSC	0	0	4	2
		TOTAL				**19**

SEMESTER II

Course code	Course Title	Category	Contact Sessions			
			L	T	P	C
THEORY						
MSCS203	Object oriented programming using Java	CSC	3	0	0	3
MSMA2001	Mathematics for AI & ML	DLC	3	0	0	3
CSAI2001	Machine Learning	AIMLC	3	0	0	3
CSAI2002	Image Analysis and Computer Vision	AIMLC	3	0	0	3
	AI & ML Elective - I	AIMLE	0	0	0	3
	AI & ML Elective - II	AIMLE	0	0	0	3

PRACTICALS						
MSCS205	Object oriented programming using Java Lab	CSC	0	0	4	2
CSAI2003	Machine Learning Lab	AIMLC	0	0	4	2
		TOTAL				**22**

	MOOC Course ***	**OL**	**0**	**0**	**0**	**3**

SEMESTER III

Course code	**Course Title**	**Category**	**Contact Sessions**			
			L	**T**	**P**	**C**
THEORY						
CSAI3001	Neural Networks and Deep Learning	AIMLC	3	0	0	3
CSAI3002	Speech and Natural Language Processing	AIMLE	3	0	0	3
	AI & ML Elective - III	AIMLE	0	0	0	3
	AI & ML Elective - IV	AIMLE	0	0	0	3
	Research based learning** / Computer Science - Elective II	RBL	0	1	4	3
	Soft core	SC	2	0	0	2
PRACTICALS						
CSAI3003	Neural Networks and Deep Learning Lab	AIMLC	0	0	4	2
CSAI3004	Speech and Natural Language Processing Lab	AIMLC	0	0	4	2
		TOTAL				**21**

SEMESTER IV

Course code	**Course Title**	**Category**	**Contact Sessions**			
			L	**T**	**P**	**C**
PRACTICALS						
	Capstone Project Work/ Master Thesis****	CPT	0	0	0	12
		TOTAL				**12**

TOTAL NO. OF CREDITS (19+22+3+21+12):**77**

A) *Computer Science - Elective (CS-E)

A Computer Science elective (CS-E) refers to a course that a student can choose as part of their academic curriculum. The student is allowed to choose from other Computer Science departments with different specializations or select an additional elective from the AI & ML electives basket. Before registering for CS-E course, the student should obtain prior approval from the department head. Institute elective in Computer Science provide students with the opportunity to explore specialized topics or areas of interest beyond their core Computer Science and CS- Artificial Intelligence and Machine learning curriculum.

B)*Online Learning (OL-MOOC Course):**

Students will be permitted to do Massive Open Online courses (MOOC) of maximum three credits during the second year, with the prior approval from the Head of the Department or from the list of courses approved by Head of the Department. On successful completion of the course, the candidate has to submit the copy of the certificate to the Head of the Department. The Head of the Department can form a team of faculty members to recommend the grade to be awarded to the candidate by mapping the score earned by the students and the results can be sent to the Controller of Examinations after the approval of the Head of the Department.

C) **Research Based Learning (BL):

Overview:
This course is designed to equip students with the skills, strategies, and mindset needed for effective research-based learning. Through hands-on exploration, critical thinking, and collaboration, students will learn to engage in the research process, analyze information, and contribute to knowledge in their chosen field.

Objectives:
By the end of this course, students should be able to:

1) Understand the fundamental principles of research-based learning and its significance in academic and real-world contexts.
2) Formulate clear research questions and hypotheses that guide their inquiry.
3) Demonstrate proficiency in conducting comprehensive literature reviews and identifying credible sources.
4) Collect and analyze data using appropriate methods and tools.
5) Develop critical thinking skills to evaluate information, draw conclusions, and make informed decisions.
6) Communicate research findings through well-structured written reports and engaging presentations.

7) Reflect on their learning journey, recognizing personal growth in research skills and mindset.

Outcomes:
To empower students with the ability to conduct meaningful research, think critically, and communicate effectively. They learn to formulate research questions, gather and analyze data, and present findings.

Evaluation Criteria for RBL
The evaluation of the research-based learning course will be divided into two components: the student's research findings and the published/communicated research article. The distribution of weightage is as follows:

1. Research Findings (75% Weightage):
The research findings produced by the student will carry the majority of the evaluation, with 75% weightage. This component is divided into two segments:

- Course faculty assessment (50%): Half of the total weightage will be assigned by the course faculty. They will assess the quality, depth, and significance of the research conducted by the student. This evaluation encompasses research methodology, data analysis, critical insights, and overall contributions.

- Committee Evaluation (25%): The 25% within the research findings category will be evaluated by a committee. The committee consists of members including the internal faculty, the Head of Department (HoD), or an external evaluator. They will collectively assess the research outcomes, methodological rigor, and implications of the work.

2. Published/Communicated Research Article (25% Weightage):
The publication or communication of the research article adds another dimension to the evaluation. This component is further subdivided based on the status of the article:

- Communicated Article (15%): If the research article has been communicated but not yet accepted or published, it contributes 20% to the overall evaluation. This recognizes the effort in sharing research with the academic community, even if the peer-review process is ongoing.
- Accepted/Published Article (25%): When the research article has been accepted for publication or is already published, it carries the full 25% weightage. This acknowledges the significance of peer-reviewed dissemination in the scholarly world.

Minimum mark required to pass Research-Based Learning Course:

To successfully pass the Research-Based Learning course, students must achieve a minimum overall mark of 50% out of maximum possible mark. This overall mark encompasses the evaluation of research findings and the assessment of the published/communicated research article, each weighted according to the course's marking scheme.

D)****Capstone Project/Master Thesis:

Students in the M.Sc. CS AI & ML program have the option to choose either a Capstone Project or a Thesis. Both options require a thorough understanding of AI and ML concepts, research methodologies, and practical implementation.

- Capstone Project:
  A Capstone Project involves the development and implementation of an AI/ML solution to address a specific real-world problem or challenge. The project emphasizes practical application, collaboration with external partners (if applicable), and the creation of an innovative solution.

- Thesis:
  A Thesis involves conducting in-depth research on a specific AI/ML topic. Students are expected to identify research gaps, formulate research questions, conduct a thorough literature review, propose methodologies, collect and analyze data, and contribute new insights to the field. Students can collaborate with external partners (if applicable) to enrich the research.

a) Learning Objective

The primary objective of a Capstone Project or Thesis in the field of AI/ML is to provide students with an opportunity to apply their theoretical knowledge, technical skills, and research abilities to a real-world problem or a research question within the AI/ML domain. The project aims to bridge the gap between academic learning and practical application, fostering critical thinking, innovation, and the integration of cutting-edge techniques.

b) Learning Outcomes

- Ability to apply AI/ML theories to real-world problems, showcasing your practical skills.
- To strengthen problem-solving capabilities in tackling intricate challenges using AI/ML techniques.
- Proficiency in utilizing AI/ML tools, algorithms, and frameworks for building and training models.
- Ability to address ethical concerns within AI/ML, including fairness and privacy considerations.
- Effective presentation of project outcomes through concise reports, presentations, and discussions.

c) Timeline:

- The Capstone Project or Thesis is typically conducted over one semester

d) Process:

- Each student must submit a detailed project proposal outlining the problem, objectives, methodology, timeline, and potential outcomes. The proposal will be reviewed and approved by the faculty advisor.

- Students will be assigned a faculty advisor with expertise in AI and ML. The advisor will guide the student throughout the project, providing feedback and support.

- A comprehensive written report must be submitted, detailing the project's background, objectives, methodology, results, analysis, conclusions, and references. This report should adhere to academic writing standards

- Each student will present their project or thesis findings to a panel of faculty members, peers, and potentially external experts. The presentation will be followed by a defense where the student will respond to questions from the panel.

- The deployment of the project using MLOps (Machine Learning Operation).

e) Evaluation Procedure for Capstone Projects and Theses:

- Project Proposal Review: Students submit a detailed proposal outlining their project or research topic, including objectives, methodologies, and expected outcomes. The proposal is reviewed by faculty advisors and possibly a committee to ensure clarity and alignment with program goals.

- Project Development/Research: Students execute their chosen option - either working on the Capstone Project's practical implementation or conducting in-depth research for the Thesis.

- Progress Reports: Throughout the project duration, students may be required to submit progress reports to their guide/advisors. This allows advisors to provide guidance and ensure students are on track.

- Final Document Submission: Students submit a comprehensive written report detailing their project's or research's background, methodology, findings, analysis, and conclusions.

- Presentation and Defense: Students present their work to a panel of faculty members, peers, and possibly external experts. They defend their choices, methodology, findings, and insights during a Q&A session. The panel evaluates the project or thesis based on these metrics and their overall alignment with program objectives. Students are typically graded on a scale that considers the quality of their work, the depth of analysis, their ability to communicate their findings, and the level of innovation or contribution to the AI/ML field.

f) Evaluation Metrics for Capstone Projects:

- Problem Statement and Scope: Clarity and significance of the chosen problem or challenge.
- Solution Implementation: Quality of the developed AI/ML solution and its alignment with the problem.
- Innovation: Creativity and uniqueness of the solution, showcasing practical innovation.
- Practical Application: Demonstration of how the solution addresses a real-world problem.
- Code Quality: Quality, efficiency, and organization of the implementation code.
- Metrics and Performance: Measurable impact and performance of the developed solution.

g) Evaluation Metrics for Theses:

- Research Question: Clarity and relevance of the chosen research question.
- Literature Review: Depth and thoroughness of the literature review.
- Research Design and Methodology: Appropriateness and rigor of the research design and methodology.
- Data Collection and Analysis (if applicable): Quality of data collection methods and depth of analysis.
- Contribution to the Field: Novelty, significance, and potential impact of research findings.
- Insights and Interpretation: Depth and clarity of interpreting research outcomes.
- Ethical Considerations (If applicable): Adherence to ethical guidelines and considerations.
- Writing Quality: Clarity, organization, grammar, and adherence to academic writing standards.

E) Embedded Theory and Lab

The Embedded Theory and Lab course combines theoretical knowledge with practical hands-on experience in a single package. For calculation of total score in a 3-credit course, where 2 credits are allocated to the theory component and 1 credit is designated for the lab component, the total marks are computed by taking the individual's marks from the theory portion, multiplying them by 2, dividing the result by 3, and then adding to that the individual's marks from the lab portion, divided by 3.
The calculation can be expressed as follows:
Total Marks = (Marks in Theory * 2) / 3 + (Marks in Lab * 1) / 3

4. ASSSESSMENT PATTERN

A) Internal Assessment - Added Learning Score (ALS) to encourses academic achievement

To make a student's learning capabilities more meaningful and activity-oriented, programs such as Hack-a-thons, Make-a-thons, Coding Competitions, Open Source Contributions, Machine Learning Challenges, Start-up Competitions, Tech Workshops, National / International level seminar and similar activities are encouraged for participation both inside and outside the institution. For the purpose of integration into academics, additional marks can be awarded to the student by the Head of Department (HoD) and the course faculty following necessary assessment. The student benefits from these additional marks, with a maximum limit of 10 marks, which can then be added to the internal score for a single course per semester. Similarly, the students who enroll in online courses relevant to their pursing courses with added learning content apart from the curriculum can also receive additional marks.

However, it should be noted that additional learning is not confined solely to the activities mentioned above. In any scenario, obtaining prior approval from the faculty responsible for the course and the HoD is imperative for incorporating extra marks within such categories.

This supplementary learning is specific to each course. Ensuring that additional marks are assigned to only one course for a designated activity. Moreover, the overall internal marks, including the extra marks, are subject to an upper limit of the total internal marks.

B) Final Assessment - Question pattern based on higher order thinking skills

In order to evaluate the proficiency of computer science learners and effectively assess their developed analytical, evaluative, and synthetic skills, the design of assessment questions incorporates the application of Higher Order Thinking Skills (HOTS) within both Internal and Final Assessment Tests. Aligned meticulously with Bloom's Taxonomy, the assessment is systematically divided into two distinctive sections: Part A and Part B.

Part A encompasses precisely formulated questions that target Bloom's Taxonomy levels 1 and 2, thereby contributing to 20% of the overall marks. Importantly, this section does not present any choices. The primary objective of these questions is to rigorously test the students' abilities in remembering and comprehension.

On the other hand, Part B is composed of questions that center around Bloom's Taxonomy level 3 or 4, accounting for a substantial 80% of the total marks. This section deliberately emphasizes Analyzing or Evaluating skills. Importantly, this section does not include any alternative choices for every question. Its primary purpose is to encourage learners to showcase their critical thinking prowess and their advanced application of foundational concepts.

Furthermore, the question paper for the final assessment is anticipated to encompass a selection of questions drawn not only from the external but also from the internal, enhancing the

comprehensiveness and robustness of the evaluation process. Sample question paper for final assessment is enclosed in Appendix – A.

5. SYLLABUS

Course Code	Course Title	L	T	P	C
CSAI1001	ARTIFICIAL INTELLIGENCE	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To understand the role of logic in artificial intelligence.
- To understand knowledge and reasoning under certainty and uncertainty
- To enable design and implement AI principles for problem solving, inference and perception.
- To implement algorithms on simple and complex decision making.

Expected Course Outcome:

- Identify the role of propositional and first order logic in Artificial Intelligence
- Demonstrate an understanding of knowledge and reasoning under certainty and Uncertainty.
- Apply principles of AI in solutions that require problem solving, inference, perception
- Implement algorithms on simple and complex decision making.

Unit:1	AI & SEARCHING TECHNIQUES	9 hours

Introduction to Artificial Intelligence, types of AI, Problem-Solving Agent - problem formulation, searching solution and executing actions. Measuring Problem-Solving Performance -Completeness, Optimality, Time complexity, Space complexity. Types of searching, Uninformed search - Depth-first Search, Breadth-first Search, Uniform-cost search, Bidirectional Search.

Unit:2	CONSTRAINT SATISFACTION PROBLEMS	9 hours

Constraint Satisfaction Problems (CSP) in Artificial Intelligence - basic components, CSP representation, CSP Algorithms, Constraint Types, Constraint Propagation, Forward checking- Reducing the domains of variables based on assigned values. Arc consistency- Ensuring that binary constraints are satisfied, Local Search for CSPs, Constraint Satisfaction Algorithms and reasoning systems for categories – reasoning with default information – Case study: The internet shopping world.

Unit:3	UNCERTAIN KNOWLEDGE	7 hours

Uncertainty - Quantifying uncertainty - Acting under uncertainty – basic probability notation – inference using full joint distributions – independence - Bayes' rule and its use

Unit:4	PROBABILISTIC REASONING	10 hours

Representing knowledge in an uncertain domain – semantics of Bayesian networks – efficient representation of conditional distributions – exact and approximate inference in Bayesian networks - relational and first order probability models – Time and uncertainty – inference in temporal models Bayesian Learning: Learning with complete and hidden data – Expectation Maximization Algorithm; – Hidden Markov Models – Kalman filters – dynamic Bayesian networks – multiple object tracking.

Unit:5	DECISION MAKING AND LEARNING	10 hours

Reinforcement Learning : Basics of Reinforcement learning – Active and Passive reinforcement learning – Generalization – Applications ;Making simple decisions: combining beliefs and desires – The basis of utility theory – Utility functions – multi attribute utility functions – decision networks – The value of information – Decision theoretic expert systems; Sequential Decision problems – value iteration – policy iteration – Partially Observable MDPs ; Decisions with Multiple Agents : Game Theory – Mechanism Design.

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Artificial Intelligence: A modern approach, by Stuart Russell and Peter Norvig, Third Edition, Pearson Series in Artificial Intelligence. 2022.	
Reference Books		
1.	Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning by James V Stone, Sebtel Press, 2019.	
2.	Artificial Intelligence by Example: Acquire advanced AI, machine learning, and deep learning design skills by Denis Rothman, 2nd Edition, 2020.	
3.	Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.	
4.	Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, 2021.	
Recommended by Board of Studies	31-08-2023	

Course Code	Course Title	L	T	P	C
CSAI2001	MACHINE LEARNING	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To introduce the basic concepts and techniques of Machine Learning.
- To enable design and implementation of machine learning solutions to classification, regression, and clustering problems
- To study the concepts of deep learning
- To gain experience of doing independent study and research

Expected Course Outcome:

By the end of the course, students should

- Explain Machine Learning algorithms and their limitations.
- Apply common Machine Learning algorithms in practice and implement them.

Unit:1	INTRODUCTION TO MACHINE LEARNING	8 hours

Overview of machine learning: Definition, history, and applications. Types of machine learning: Supervised, unsupervised, reinforcement learning. Machine learning process: Data collection, preprocessing, model training, evaluation, deployment. Terminology and concepts: Features, labels, instances. Ethical considerations in machine learning. Data Preprocessing and Exploration Data cleaning and preprocessing techniques. Handling missing data and outliers. Feature selection and feature engineering. Exploratory Data Analysis (EDA).

Unit:2	SUPERVISED LEARNING	13 hours

Linear Regression: single & multiple variables, Gradient descent, Bias variance trade-off, Overfitting & Under fitting, Regularization & Generalization. Classification: Logistic regression - Decision Trees, Naive Bayes, Support Vector Machines - linear and non-linear kernel functions. Model evaluation metrics-Accuracy, precision, recall, F1-score, ROC, AUC

Unit:3	UNSUPERVISED LEARNING	7 hours

Clustering basics - Partitioned, Hierarchical and Density based - K-Means clustering – K-Mode clustering – Expectation maximization, Dimensionality reduction- t-SNE. Anomaly detection techniques.

Unit:4	ENSEMBLE LEARNING & ETICAL CONSIDERATION	9 hours

Random forests, Bagging and Boosting (Random forests, Adaboost, XG boost inclusive) – Metrics & Error Correction. Optimization of hyper parameters. Ethical considerations: Bias, fairness, transparency, and accountability.

Unit:5	REINFORCEMENT LEARNING (RL)	7 hours

Basics of reinforcement learning: Agents, environments, rewards. Markov Decision Processes (MDPs). Q-learning and Deep Q Networks (DQNs). Policy gradients and actor-critic methods.

Total Lecture hours: 45 hours

Text Book(s)

1. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, 2021.
2. Machine Learning -The Art and Science of Algorithms that Make Sense of Data, Peter Flach
3. Foundations of Machine Learning, Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar

4.	An Introduction to Statistical Learning with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani
5.	Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, Richard S. Sutton and Andrew G. Barto, A Bradford Book; 2018, ISBN 978-0262039246.
Reference Books	
1.	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar Foundations of Machine Learning, MIT Press, 2019.
2.	Tom Mitchell, Machine Learning, McGraw Hill, First Edition,2017.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI2002	IMAGE ANALYSIS AND COMPUTER VISION	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To provide students with a comprehensive understanding of computer vision principles and image analysis techniques.
- To enabling them to develop and apply algorithms for image processing, object detection, and visual recognition.

Expected Course Outcome:

- Students will acquire the ability to analyze visual data, implement computer vision algorithms, solve practical image analysis problems, and apply ethical considerations.
- Preparing them to develop applications for object detection, image recognition, and related fields.

Unit:1	IMAGE PROCESSING BASICS	8 hours

Image representation and pixel operations, Image enhancement techniques (histogram equalization, contrast adjustment), Noise reduction and image denoising, Filtering and Convolution - Convolution operation and its applications. Gaussian and median filtering, Edge detection (Sobel, Canny).

Unit:2	IMAGE SEGMENTATION & FEATURE EXTRACTION	9 hours

Thresholding and Pixel-Based Segmentation - Global and local thresholding methods. Region-Based Segmentation - Region growing and splitting-merging methods. Watershed transformation for image segmentation. Significance of feature extraction in computer vision. Histogram of Oriented Gradients (HOG) - Extraction of HOG features from images. Extracting texture features using Local Binary Patterns.

Unit:3	OBJECT DETECTION AND RECOGNITION	10 hours

Traditional Approaches to Object Detection - Sliding window technique for object detectionm, Image pyramid and multi-scale detection, Haar-like features and Viola-Jones algorithm for rapid object detection. Feature-Based Object Detection using Scale-Invariant Feature Transform. Speeded-Up Robust Features (SURF), Applications in image stitching and object recognition. Evaluation Metrics for Object Detection: Intersection over Union (IoU) and mAP (mean Average Precision).

Unit:4	3D COMPUTER VISION	9 hours

Stereo Vision Basics - Stereo disparity and depth perception, Epipolar geometry and stereo camera calibration.Stereo Correspondence Matching - Local and global stereo correspondence methods, Block matching and semi-global matching algorithms.Depth Map Estimation - Depth map generation from stereo disparity.

Unit:5	MOTION ANALYSIS	9 hours

Optical Flow Estimation - Understanding optical flow as apparent motion in images.Lucas-Kanade and Horn-Schunck methods for flow estimation. Kalman Filter for Object Tracking and its use in tracking, Tracking object trajectories and handling occlusions. Particle Filter (Monte Carlo) Tracking - Importance sampling and resampling in particle filters, Applications in tracking non-linear and non-Gaussian systems.

Total Lecture hours:	45 hours

Text Book(s)

1.	Reinhard Klette, Concise Computer Vision: An Introduction into Theory and Algorithms, Springer, 2014
Reference Books	
1.	Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
2.	D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003.
3.	Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.
4.	R. Szeliski, Computer Vision: Algorithms and Applications, Springer 2011.
5.	E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI3001	NEURAL NETWORKS AND DEEP LEARNING	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To provide the mathematical and computational demands of building neural networks
- To study the concepts of deep learning
- To introduce dimensionality reduction techniques
- To apply deep learning techniques for real time applications

Expected Course Outcome:

After completing this course, students should be able to

- Analyze the deep learning algorithms which are more appropriate for various types of Learning tasks in various domains.
- Solve real-world problems by implementing deep learning algorithms

Unit:1	INTRODUCTION OF ARTIFICIAL NEURAL NETWORKS (ANN)	6 hours

Introduction of Artificial Neural Networks (ANN) - Functions in ANN – Activation function, Loss function - L1, L2 - Function approximation, classification / clustering problems – Applications.

Unit:2	FOUNDATIONS OF DEEP NETWORKS	10 hours

Neural networks: Biological neuron - Perceptron - Multilayered Feedforward Networks - Backpropagation learning, Activation functions: Linear - sigmoid - rectified linear and softmax, Loss functions, regularization, Deep networks: Unsupervised Pretrained Networks - Deep Belief Networks - Generative Adversarial Networks

Unit:3	CONVOLUTIONAL NEURAL NETWORKS (CNNs)	10 hours

Convolutional Operation, Motivation, Pooling layers, Fully connected layers, A complete CNN architecture: AlexNet - VGG - Inception - ResNet, Training a Convnet: weights initialization - batch normalization - hyperparameter optimization.

Unit:4	SEQUENCE MODELING USING RECURRENT NETS	10 hours

Recurrent Neural Networks (RNN), Bidirectional RNNs, Encoder-Decoder sequence-to-sequence architectures, Deep RNNs, Recursive NN, Challenge of long term dependencies, Long Short-term Memory (LSTM) and other Gated RN

Unit:5	GENERATIVE ADVERSARIAL NETWORKS AND TRANSFORMER	9 hours

Generative Adversarial Networks (GANs) -GAN Architecture, Training GANs, GAN Variants, valuation and Metrics, Applications of GANs. Transformer Networks - Introduction to Transformers, Self-Attention Mechanism, Positional Encoding, Transformer Architecture, Training Transformers

Total Lecture hours:	**45 hours**

Text Book(s)

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2023
2. Josh Patterson, Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017.
3. Tom Mitchell, Machine Learning, McGraw Hill, First Edition, 2017.
4. Charu C. Aggarwal, Data Classification Algorithms and Applications, CRC Press, 2014.

Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI3002	SPEECH AND NATURAL LANGUAGE PROCESSING	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

The primary objective of this course is to make the student

- Learn the language models
- Understand the levels of knowledge in language processing
- Learn the roles of language models building a large vocabulary speech recognition system
- Understand the phonological rules to build a TTS system

Expected Course Outcome:

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

- Explain the language models.
- Explain levels of knowledge in language processing.
- Build a speech recognition with language models
- Explain the intricacies in developing a voice using HMM

Unit:1	OVERVIEW AND LANGUAGE MODELING	9 hours

Origins and challenges of NLP, Knowledge in Language Processing, NLP Applications. Language Modeling: Language and Grammar, Grammar-based Language Models: Lexical Functional Grammar - Government and Binding, Statistical Language Model: N-gram Model - Smoothing Techniques.

Unit:2	WORD LEVEL AND SYNTACTIC ANALYSIS	9 hours

Word Level Analysis: Regular Expressions - Survey of Morphology - Word and Sentence Tokenization - Stemmer - Spelling Error Detection and correction - Word classes - Part-ofSpeech Tagging - HMM POS Tagging - Tree bank, Syntactic Analysis: Constituency – Context free Grammar - Dependency Grammar - Top-down parsing - Bottom-up parsing - Ambiguity - Early algorithm - CYK - Probabilistic CYK Parsing.

Unit:3	SEMANTIC ANALYSIS AND DISCOURSE PROCESSING	9 hours

Semantic Analysis: Meaning Structure of Language - Lexical Semantics - Word senses, relations - WordNet - Word Sense Disambiguation - Word Similarity, Discourse Processing: Reference Resolution - Anaphora Resolution Algorithms - Co-reference Resolution.

Unit:4	SPEECH RECOGNTION	9 hours

Large Vocabulary Continuous Speech Recognition: Introduction – Subword units – Subword Unit Models – Training of Subword Unit Models – Language Models – Statistical Language Modeling – Perplexity – Overall Recognition System – Semantic Postprocessor.

Unit:5	TEXT TO SPEECH SYNTHESIS	9 hours

Computational Phonology: Speech Sounds and Phonetic Transcription - Phoneme and Phonological Rules - Machine learning of Phonological Rules - Mapping Text to Phones, HMM-based Approach: HMM-based Speech Synthesis System – F0 Modeling – Speech parameter Generation from an HMM.

Total Lecture hours: 45 hours

Text Book(s)

1. Daniel Jurafsky and James H Martin, “Speech and Language Processing: An introduction

2.	to Natural Language Processing, Computational Linguistics and Speech Recognition", 2nd Edition, Prentice Hall, 2009. Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, "Fundamentals of Speech Recogntion" 1st Edition, Pearson, 2009.
Reference Books	
1.	Tanveer Siddiqui, Tiwary U S, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
2.	Shrikanth Narayanan, Abeer Alwan, "Text To Speech Synthesis – New Paradigms and Advances", Prentice Hall, 2005.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI2003	MACHINE LEARNING LAB	0	0	4	2

Pre-requisite	**NIL**

Course Objectives:

- To teach the theoretical foundations of various learning algorithms.
- To train the students better understand the context of supervised and unsupervised
- learning through real-life examples.
- To understand the need for Reinforcement learning in real – time problems.
- Apply all learning algorithms over appropriate real-time dataset.
- 5. Evaluate the algorithms based on corresponding metrics identified.

Expected Course Outcome:

At the end of this course, student will be able to:

- Understand, visualize, analyze and preprocess the data from a real-time source.
- Apply appropriate algorithm to the data.
- Analyze the results of algorithm and convert to appropriate information required for the real – time application.
- Evaluate the performance of various algorithms that could be applied to the data and to suggest most relevant algorithm according to the environment.

List of Indicative Experiments

1.	Linear & Multiple Linear Regression
2.	Naïve Bayes classifier
3.	Decision trees – ID3 & CART
4.	Logistic regression
5.	Support Vector Machines – Linear & Non-linear
6.	Single & Multi-layer Perceptron
7.	K-NN, K-Means & K-mode clustering
8.	Random – forest
9.	Adaboost, XGboost
10.	Principal component analysis
11.	Self – Organizing maps
12.	Q-Learning

Text Book(s)

1.	Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, 2021.
2.	Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, Richard S. Sutton and Andrew G. Barto, A Bradford Book; 2018, ISBN 978-0262039246

Reference Books

1.	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2019
2.	Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 2017.
3.	Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.

Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI3003	NEURAL NETWORKS AND DEEP LEARNING LAB	0	0	4	2
Pre-requisite	NIL				

Course Objectives:

1. Introduce major deep neural network frameworks and issues in basic neural networks
2. To solve real world applications using Deep learning

Expected Course Outcome:

At the end of this course, student will be able to:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications
4. Design of test procedures to assess the efficiency of the developed model.

To understand the need for Reinforcement learning in real – time problems

List of Indicative Experiments

1.	Demonstration and implementation of Shallow architecture, using Python, Tensorflow and Keras • Google Colaboratory - Cloning GitHub repository, Upload Data, Importing Kaggle's dataset, Basic File operations • Implementing Perceptron, • Digit Classification : Neural network to classify MNIST dataset
2.	Hyper parameter tuning and regularization practice - • Multilayer Perceptron (BPN) • Mini-batch gradient descent,
3.	Convolution Neural Network application using Tensorflow and Keras, • Classification of MNIST Dataset using CNN • Face recognition using CNN
4.	Object detection using Transfer Learning of CNN architectures
5.	Image denoising (Fashion dataset) using Auto Encoders • Handling Color Image in Neural Network aka Stacked Auto Encoders (Denoising)
6.	Text processing, Language Modeling using RNN
7.	Transfer Learning models for classification problems
8.	Sentiment Analysis using LSTM
9.	Image generation using GAN

Text Book(s)

1.	Deep Learning, Ian Goodfellow Yoshua Bengio Aaron Courville, MIT Press, 2023

2.	Neural Networks and Deep Learning, Michael Nielsen,, Determination Press
Reference Books	
1.	Deep Learning Step by Step with Python, N D Lewis, 2016
2.	Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Media, 2017
3.	Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Umberto Michelucci, Apress, 2018
4.	Deep Learning with TensorFlow: Explore neural networks with Python, Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, Packt Publisher, 2017.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI3004	SPEECH AND LANGUAGE PROCESSING LAB	0	0	4	2
Pre-requisite	NIL				

Course Objectives:

1. Be competent with fundamental concepts for natural language processing and automatic speech recognition
2. To understand technologies involved in developing speech and language Applications.
3. To demonstrate the use of deep learning for building applications in speech and natural language processing

Expected Course Outcome:

At the end of this course, student will be able to:

1. Describe the importance of different NLP modules in text processioning and fundamentals of speech production
2. Describe ways to represent speech and text
3. Demonstrate the working of sequence models for text
4. Use signal processing techniques to analyze/represent the speech signal
5. Execute trials of speech/language systems

List of Indicative Experiments

1.	Installing various packages for text and Speech Processing: NLTK, Spacy, Speech Recognition etc.
2.	POS Tagging and Parsing using various python packages
3.	Implementation of BOW, topic models for text representation and classification
4.	Implementing N-gram language models for next word prediction
5.	Implementing Word embedding based text classification
6.	Implementing CNN for sentiment analysis
7.	Implementing RNN for Named Entity recognition
8.	Implementing text summarization using deep learning
9.	Implementing chatbot using deep learning
10.	Implementing machine translation using encoder-decoder models
11.	Developing speech recognition system to recognize voice commands
12.	Developing speech recognition system to recognize continuous speech
13.	Implementing CNN based speech recognition using mel spectal images

Text Book(s)

1.	Delip Rao, Brian McMahan, “Natural Language Processing with PyTorch: Build Intelligent language Applications Using Deep Learning”, 2019, 1st Edition, O'Reilly Media

Reference Books

1.	Mark Liu, “Make Python Talk: Build Apps with Voice Control and Speech Recognition”, 2021, 1st Edition, No Starch Press.

Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE001	REINFORCEMENT LEARNING	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- Introduce the different basic elements of Reinforcement Learning (RL).
- Study about Tabular methods and Q-networks.
- Study about policy optimization.
- Learn current advancements and applications in RL.

Expected Course Outcome:

At the end of the course, the students should be able to

- CO 1: Explain the elements of reinforcement learning.
- CO 2: Apply tabular methods and Q-networks to solve classical problems.
- CO 3: Interpret policy gradient methods from vanilla to more complex cases.
- CO 4: Implement real-world problems applying code standards.

Unit:1	BASICS OF REINFORCEMENT LEARNING(RL)	9 hours

Elements of RL, RL framework, Markov property, Partially Observable Markov Decision Process, policies, value functions and Bellman equations.

Unit:2	TABULAR METHODS	9 hours

Planning with dynamic Programming, Monte Carlo control, and Temporal-Difference learning methods - TD (0), SARSA, and Q-Learning.

Unit:3	Q-NETWORKS	9 hours

Deep Q-networks - DQN, DDQN, Dueling DQN, Prioritized Experience Replay

Unit:4	POLICY OPTIMIZATIONS	9 hours

Optimal policies and optimal value functions, Bellman optimality equations, Vanilla Policy Gradient, REINFORCE algorithm and stochastic policy search, Actor-critic methods - A2C and A3C, Advanced policy gradient - PPO, TRPO, DDPG.

Unit:5	RECENT ADVANCEMENTS AND APPLICATIONS	9 hours

Meta-learning, Multi-Agent RL, Model-based RL approach, Code Standards and Python Libraries used in RL: SuperSuit, Stable Baselines3, Pistonball and MAgent. RL for real-world problems: Autonomous Driving- Train an RL agent to navigate a self-driving car through complex urban environments, obeying traffic rules, and making safe decisions.

Total Lecture hours:	**45 hours**

Text Book(s)

1. Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction”, MIT Press, 2nd edition, 2018.

Reference Books

1. Russell, Stuart J., and Peter Norvig. "Artificial intelligence: a modern approach. “Pearson Education Limited, 2022.
2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective",2012.
3. Csaba Szepesvari, “Algorithms for Reinforcement learning”,2009.
4. Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning." Adaptation, learning, and optimization 12 (2012).
5. Li, Yuxi. "Deep reinforcement learning." arXiv preprint arXiv:1810.06339 (2018).

	Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. "Deep learning." MIT press, 2016
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI002	PRINCIPLES OF EXPLAINABLE AI	3	0	0	3
Pre-requisite	Basic Knowledge in Artificial Intelligence CSAI1001				

Course Objectives:

- To understand the importance of interpretability and explainability in AI.
- To explore a wide range of XAI methods and their underlying principles.
- To equip students with the skills to apply XAI techniques to real-world machine learning problems.
- To critically evaluate and compare different XAI approaches.
- To discuss ethical implications and societal impact of XAI.

Expected Course Outcome:

- Understand the importance of making AI models interpretable and explainable.
- Categorize different XAI methods and their roles.
- Apply techniques to explain model predictions and behavior.
- Implement model-agnostic and deep explanation techniques.
- Develop interactive interfaces for explaining AI models.
- Evaluate ethical considerations in XAI and AI fairness.

Unit:1	INTRODUCTION TO XAI	6 hours

Understanding the need for explainability in AI, Importance of interpretability and explainability in AI, The trade-off between complexity and transparency. Ethical considerations in XAI, Categories of XAI methods -ante-hoc and post-hoc, Taxonomy of XAI techniques for Machine Learning.

Unit:2	INTERPRETABILITY METHODS & MODEL-AGNOSTIC XAI	12 hours

Common interpretability techniques, Local Interpretability Techniques - Generating SHAP (SHapley Additive exPlanations) values for model features, Visualizing feature importance using heatmaps and bar charts. Global interpretability methods (e.g., partial dependence plots, feature interaction analysis). Model-specific interpretability techniques, Model-Agnostic - Implementing LIME (Local Interpretable Model-Agnostic Explanations), SHAP (SHapley Additive exPlanations), Contrastive explanations, Explaining ensemble models.

Unit:3	INTERACTIVE MACHINE LEARNING TECHNIQUES & DEEP EXPLANATION TECHNIQUES	12 hours

Interactive Machine Learning (IML) techniques -Building user-friendly explanation interfaces, Human-in-the-loop XAI.Neural Network Interpretability - Visualizing saliency maps using gradient-based methods, Interpreting CNNs using Class Activation Mapping (CAM) Feature visualization techniques for neural networks. Deep Explanation techniques - Attention mechanisms for interpreting neural networks, Activation maps and gradient-based approaches, Saliency maps and occlusion analysis.

Unit:4	POST HOC EXPLANATION APPROACHES & ETHICAL CONSIDERATIONS IN XAI	9 hours

Implementing model distillation to transfer knowledge, Using SHAP to explain ensemble models, Generating counterfactual explanations for individual predictions- Exploring bias and fairness issues in XAI. Fairness and bias in explainable AI.

Unit:5	USER-CENTRIC XAI AND EVALUATION	6 hours

Designing user-centric explanations for different stakeholders, Conducting user studies to evaluate explanation effectiveness Metrics for evaluating the quality of explanations. Real-World Applications and Case Studies	
Total Lecture hours:	**45 hours**
Text Book(s)	
1.	Molnar, Christoph.” Interpretable machine learning”. Lulu. com, 2020.
2.	Biecek, Przemyslaw, and Tomasz Burzykowski. "Local interpretable model-agnostic explanations (LIME)." Explanatory Model Analysis Explore, Explain and Examine
3.	Predictive Models 1 (2021): 107-124. Kleppmann, Martin. Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. " O'Reilly Media, Inc.", 2017.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAI003	RESPONSIBLE ARTIFICIAL INTELLIGENCE	3	0	0	3
Pre-requisite	Basic Knowledge in Artificial Intelligence CSAI1001				

Course Objectives:

The students should be able to:

- a) Demonstrate a comprehensive understanding of ethical challenges in AI and ML.
- b) Apply ethical theories and frameworks to analyze AI and ML-related ethical dilemmas.
- c) Develop strategies to mitigate bias, ensure fairness, and enhance transparency in AI and ML systems.
- d) Communicate ethical considerations effectively to stakeholders.

Expected Course Outcome:

Upon successful completion of this course, students will be able to:

- Recognize and critically analyze ethical issues arising in AI and ML contexts.
- a) Apply ethical theories to evaluate complex AI and ML decisions.
- b) Design AI and ML systems with considerations for fairness, transparency, and accountability.
- c) Formulate ethical guidelines and recommendations for AI and ML projects.

Unit:1	INTRODUCTION TO ETHICAL CONSIDERATIONS IN AI & ML	9 hours

Introduction to AI & ML Ethics - Importance of ethical considerations in AI and ML. Historical context of AI ethics and real-world cases. Ethical theories - utilitarianism, deontology, virtue ethics. Applying ethical frameworks to AI and ML decision-making.

Unit:2	BIAS AND FAIRNESS	9 hours

Recognizing Bias in Data and Algorithms - Understanding different forms of bias in AI systems, Identifying sources of bias in data collection and labeling. Bias Detection and Mitigation Techniques - Techniques for identifying and quantifying bias in AI models, Fairness and Addressing Fairness Concerns - Defining fairness in AI systems: statistical, individual, and group fairness. Techniques for measuring and assessing fairness in machine learning models.

Unit:3	TRANSPARENCY, EXPLAINABILITY, AND PRIVACY	9 hours

Transparency and Explainability - Importance of transparency in AI and ML models, Techniques for creating interpretable and explainable AI systems. Balancing model accuracy with interpretability, Ethical implications of black-box vs. explainable models. Privacy and Security Considerations - Ethical considerations related to data privacy and security, GDPR and other regulations for protecting user data. Privacy-preserving AI techniques- Differential privacy, federated learning, etc. Ensuring ethical handling of sensitive and private information.

Unit:4	RESPONSIBLE AI PRACTICES	9 hours

Accountability and Responsibility - Responsibilities of AI practitioners, developers, and organizations, Ethical considerations in autonomous systems and decision-making. Ethical AI Design and Development - Developing AI systems that align with human values, Ensuring fairness, transparency, and accountability in design.

Unit:5	GLOBAL ETHICAL PERSPECTIVES AND REGULATIONS	9 hours

Global Perspectives and AI Regulations - Analyzing international perspectives on AI ethics and regulations, Addressing cultural and ethical variations in AI technologies, Preparing for cross-

border ethical challenges and compliance.	
Total Lecture hours:	**45 hours**
Text Book(s)	
1.	Müller, Vincent C. "Ethics of artificial intelligence and robotics." (2020).
2.	Responsible AI: A Global Policy Framework" by Oxford Internet Institute.
3.	Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy" by Cathy O'Neil.
4.	Fairness and Abstraction in Sociotechnical Systems" by Daniel Susser, et al.
5.	Explainable AI: Interpreting, Explaining and Visualizing Deep Learning" by Kevin D. Ashley.
6.	Machine Ethics" by Michael Anderson and Susan Leigh Anderson.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE004	KNOWLEDGE REPRESENTATION AND REASONING IN AI	3	0	0	3

Pre-requisite NIL

Course Objectives:

- Learn different knowledge representation languages and their applications.
- Understand the role of knowledge representation and reasoning in AI systems.
- Explore reasoning mechanisms to make inferences and deductions from knowledge.
- Gain insights into advanced topics like ontological engineering, non-monotonic reasoning, and uncertainty handling.
- Apply knowledge representation and reasoning techniques in practical problem-solving scenarios.

Expected Course Outcome:

At the end of the course, the students will be able to

- Represent knowledge in suitable language format
- Solve a problem using resolution method
- Apply various representation formats to store the knowledge
- Build probabilistic reasoning models to solve uncertainty problems
- Represent planning problems and find the sequence of actions to achieve goals

Unit:1	INTRODUCTION	6 hours

Importance of Knowledge Representation in AI, Key Challenges and Requirements, Types of Knowledge, Approaches to Knowledge Representation, Role of Logic in AI

Unit:2	PROPOSITIONAL LOGIC AND PREDICATE LOGIC	9 hours

Propositional case-Handling variables and quantifiers, Syntax, Semantics, and Inference. Predicate Logic - Syntax, Semantics, and Quantification, Knowledge Encoding using Logic, Resolution and Theorem Proving

Unit:3	REPRESENTATION, DESCRIPTION LOGICS AND ONTOLOGIES	12 hours

Concept of Frames and Slots, Semantic Networks: Nodes, Arcs, and Inheritance. Representation and Navigation in Frames. Limitations and Advantages of Frame-Based Approach. Introduction to Description Logics, Axioms and Knowledge Representation using DL, Ontological Engineering and OWL, Utilizing Ontologies for Knowledge Sharing and Interoperability

Unit:4	REASONING	9 hours

Default Reasoning – Closed - World reasoning – Circumscription - Default logic - Autoepistemic logic -Noncategorical reasoning - Objective probability - Subjective probability - Vagueness

Unit:5	ACTIONS AND PLANNING	9 hours

Representing Actions and Events, Situation Calculus and the Frame Problem, STRIPS Representation for Planning, Hierarchical and Conditional Planning. Complex actions - Planning in the Situation calculus

Total Lecture hours: 45 hours

Text Book(s)

1. Ronald J Brachman, Hector J Levesque, “Knowledge representation and reasoning”, Morgan Kaufmann Publishers,2004.

2.	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson education, 2022.
Reference Books	
1.	Michael Gelfond,Yulia Kahl, "Knowledge Representation, Reasoning, and the Design of Intelligent Agents: The Answer-set Programming approach", Cambridge University Press,2014.
2.	"Handbook of Knowledge Representation", Editors: Frank van Harmelen Vladimir Lifschitz Bruce Porter, Volume 1, First Edition, Elsevier, 2007.
3.	R.J.Brachman,H.J.Levesque,"Readings in Knowledge Representation",Morgan Kaufmann, San Mateo, CA, 1985.
	https://archive.nptel.ac.in/content/syllabus_pdf/106106140.pdf https://onlinecourses.nptel.ac.in/noc22_cs02/preview
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE005	DEEP LEARNING FOR LANGUAGE AND SPEECH TECHNOLOGIES	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

The objective of this course is to enable the students to

- Apply encoder-decoder and transformer models
- Understand conference and coherence
- Build question answering systems
- Build chatbots and dialogue systems
- Develop a speech recognition system
- Develop a speech synthesizer

Expected Course Outcome:

On successful completion of this course, the students should be able to

- CO1: Explain existing and emerging deep learning architectures for text and speech processing
- CO2: Apply deep learning techniques for NLP tasks, language modeling and machine translation
- CO3: Explain coreference and coherence for text processing
- CO4: Build question answering systems, chatbots and dialogue systems
- CO5: Apply deep learning models for building speech recognition and text-to-speech systems

Unit:1	DEEP LEARNING ARCHITECTURES FOR LANGUAGE PROCESSING	11 hours

Foundations of natural language processing – Recurrent neural networks, RNN for language modelling, semantic embeddings – GRU, LSTM, BLSTM – Attention models and Transformers – machine translation – the encoder-decoder model, bidirectional transformer encoders - transfer learning

Unit:2	SEMANTIC, PRAGMATIC AND DISCOURSE ANALYSIS	9 hours

Word Sense and WordNet - Word Sense Disambiguation - FrameNet - Semantic Role Labeling - Implicatures - presuppositions - Speech acts theory - Linguistics pragmatics analysis -Coreference phenomena – coreference tasks and datasets – mention detection – coreference algorithms – neural mention-ranking algorithm – evaluation of coreference – gender bias in coreference – coherence relations – discourse structure parsing – centering and entity-based coherence – local coherence – global coherence

Unit:3	QUESTION ANSWERING AND DIALOGUE SYSTEMS	9 hours

Information retrieval – relation extraction – extraction of time – extracting events – template filling – review of SRL – lexicons – IR-based factoid question answering – entity linking – knowledge based question answering – language models for QA – classic QA models – evaluation of factoid answers Properties of human conversation – chatbots – GUS a frame-based dialogue system – dialogue-state architecture – evaluating dialogue systems – design of dialogue systems

Unit:4	AUTOMATIC SPEECH RECOGNITION	8 hours

Speech recognition: Acoustic modeling. Deep neural network (DNN) acoustic modeling; HMM, HMM-DNN systems. Feature extraction; Connectionist Temporal Classification (CTC) - Listen,

Attend & Spell (LAS). Multi-task objectives for end-to-end ASR – ASR Evaluation: ord Error rate.		
Unit:5	**TEXT TO SPEECH SYNTHESIS**	**8 hours**
Text to Speech (TTS): Overview. Text normalization. Letter-to-sound. Prosody, Getting TTS; Working well: Data collection. Evaluation. Signal processing. Concatenative and parametric; approaches, WaveNet and other deep learning based TTS systems		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Daniel Jurafsky and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Third Edition, 2022.

Reference Books

1.	Tanveer Siddiqui, Tiwary U S, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
2.	Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, "Fundamentals of Speech Recognition" 1st Edition, Pearson, 2009.
3.	Shrikanth Narayanan, Abeer Alwan, "Text To Speech Synthesis – New Paradigms and Advances", Prentice Hall, 2005.
4.	Steven Bird, Ewan Klein, and Edward Loper, "Natural language processing with Python", O'RREILLY.
5.	Dipanjan Sarkar, "Text Analytics with Python: A Practical Real-World approach to Gaining Actionable insights from your data", APress.

Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE006	DEEP LEARNING FOR COMPUTER VISION	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To study the fundamentals of computer vision and deep learning
- To introduce the concepts of Convolutional neural networks
- To learn various deep learning models for real time applications.

Expected Course Outcome:

At the end of the course, the students should be able to

- CO 1: Explain the fundamentals of computer vision techniques.
- CO 2: Describe deep learning architecture models.
- CO 3: Apply the deep learning algorithms and solve real-world problems

Unit:1	INTRODUCTION TO VISUAL FEATURES AND REPRESENTATIONS	9 hours

Image Formation, Image Representation: Linear Filtering, Correlation, Convolution; Visual Features: Edge, Blobs, Scale Space and Scale Selection, SIFT, SURF, HoG, LBP, Optical Flow.

Unit:2	CONVOLUTIONAL NEURAL NETWORKS	9 hours

Image Segmentation - Semantic segmentation and instance segmentation, U-Net architecture and fully convolutional networks, Mask R-CNN. Generative adversarial networks (GANs) for image synthesis, Style transfer and image-to-image translation.

Unit:3	VISUALIZATION AND UNDERSTANDING DNNs	9 hours

Visualization of Kernels; Backprop-to-image/Deconvolution Methods; Deep Dream, Hallucination, Neural Style Transfer; CAM, Grad-CAM, Grad-CAM++; Recent Methods (IG, Segment-IG, SmoothGrad).

Unit:4	DNNs FOR RECOGNITION, VERIFICATION, SEGMENTATION	9 hours

CNNs for Recognition and Verification: Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss; CNNs for Detection: Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD;CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN

Unit:5	RECURRENT NEURAL NETWORK, ATTENTION AND RECENT MODELS	9 hours

Review of RNNs; CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition; Attention Models in Vision; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers: Transformer Networks; Deep Generative Models: GANs, VAEs; Recent Trends: Zero-shot, One-shot, Few-shot Learning.

Total Lecture hours: 45 hours

Text Book(s)

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2023.
2. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.

Reference Books

1. Michael Nielsen, Neural Networks and Deep Learning, 23,2020.
2. Yoshua Bengio, Learning Deep Architectures for AI, 2009
3. Richard Szeliski, Computer Vision: Algorithms and Applications, 2010.

4.	David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 2002.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE007	ROBOTIC PROCESS AUTOMATION	2	0	2	3
Pre-requisite	NIL				

Course Objectives:

- To provide insights on robotic process automation (RPA) technology and its value proposition
- To introduce different platforms for RPA
- To illustrate basic programming concepts and the underlying logic/structure related to RPA
- To describe the different types of variables, Control Flow and data manipulation techniques in a RPA platform
- To describe automation to Email and various types of Exceptions and strategies to
- handle

Expected Course Outcome:

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

- Gain insights into Robotic Process Automation Technology
- Demonstrate the underlying logic/structure related to RPA using UiPath platform
- Classify several types of data inside a workflow and, gain skills in building workflows in UiPath
- Comprehend different types of variables, Control Flow and data manipulation techniques
- Identify and understand Image, Text and Data Tables Automation
- Design automation to Email and various types of Exceptions and strategies to handle
- Realize the trends in RPA technology and industrial process automation using RPA

Unit:1	INTRODUCTION TO ROBOTIC PROCESS AUTOMATION	6 hours

Emergence of Robotic Process Automation (RPA), Defining Robotic Process Automation & its benefits, Types of Bots, Application areas of RPA, RPA development methodology and key considerations, List of Robotic Process Automation Tools.

Unit:2	BOT DEVELOPMENT	8 hours

Activities, Flowcharts and Sequences, Sequencing the workflow, Activities, Log Message, Variables, Control flow, various types of loops, and decision making, Best Practices for Bot Development, Step-by-step example using Sequence and Flowchart, Step-by-step example using Sequence and Control flow.

Unit:3	DATA MANIPULATION AND TAKING CONTROL OF THE CONTROLS	6 hours

Data table usage, Clipboard management, File operation, Data transfer between CSV/Excel and data table. Finding the control, Techniques for waiting for a control, Act on controls – mouse and keyboard activities, Handling events, Recording and scraping

Unit:4	HANDLING USER EVENTS AND ASSISTANT BOTS	4 hours

Assistant bots, Monitoring system event triggers, Monitoring image and element triggers, Launching an assistant bot on a keyboard event

Unit:5	EXCEPTION HANDLING AND LOGGING, MANAGING AND MAINTAINING THE CODE	6 hours

Exception Handling: Common exceptions and ways to handle them, Logging and taking Screenshots: Client logging, Server logging. Project organization, When to use Flowcharts, State Machines, or Sequences	
Total Lecture hours:	**30 hours**

Text Book(s)

1.	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, Mumbai, 2018.
2.	Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.

Reference Books

1.	Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant" (1st Edition), Independently published, 2018. ISBN 978-1983036835.
2.	Gerardus Blokdyk, "Robotic Process Automation Rpa A Complete Guide ", 2020.
3.	Frank Casale, Rebecca Dilla, Heidi Jaynes and Lauren Livingston, "Introduction to Robotic Process Automation: A Primer (Kindle Edition)", Institute of Robotic Process Automation.

List of Indicative Experiments

1.	Setup and Configure UiPath Studio and understand the user interface of UiPath Studio; • Create a Sequence to obtain user inputs display them using a message box; • Create a Flowchart to navigate to a desired page based on a condition; • Create a State Machine workflow to compare user input with a random number
2.	Build a process in UiPath using UI Automation Activities. • Create an automation process using key System Activities, Variables and Arguments • Also implement Automation using System Trigger
3.	Automate login to Email account
4.	Recording mouse and keyboard actions to perform an operation, scraping data from website and writing to CSV
5.	Different ways of Error Handling in UiPath • Browse through the log files related to UiPath Project
6.	Using various components of Orchestrator • Create an automated Gmail Login Application • Create an automated Remote Data Entry Application
7.	Data manipulation in the workbook PDF Data Extraction

Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE008	3D GRAPHICS AND ANIMATION	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- Goal is to describe and analyze how modeling and viewing transformations can be used to compose 3D scenes
- To recognize the basic terminologies and mathematical functions being applied for 3D Modelling, Rendering and Animation

Expected Course Outcome:

Student will be able to

- Describe and apply the mathematical basics of 3D graphics such as coordinate systems, homogeneous coordinates, matrix operations, transformation matrices object translation, projection and rendering methods.
- Describe and apply data structures for 3D graphics applications from the computer graphics theories they learn.
- To recognize the meaning of computer graphics terminologies, differentiate methods.
- To analyses and design interactive functions to simulate scenes using animation methods.

Unit:1	INTRODUCTION TO COMPUTER GRAPHICS	6 hours

Computer Graphics Pipeline, Raster Images, Coordinate-Reference Frames, Coordinate systems, Graphics Output Primitives and algorithms.

Unit:2	INTERACTIVE 3D GRAPHICS FUNCTIONS	9 hours

3D coordinate systems, Homogeneous Co-ordinate systems, 3D Linear transformations – Affine - Rotation, Translation, Scale, Reflection and Shear; General Composite Transformations, Transformations Between Coordinate Systems, 3D Viewing pipeline.

Unit:3	3D MODELING	12 hours

The Camera Transformations - Orthographic, isometric, Perspective, and stereo-graphic views. 3D representation - Polygon, Plane Equations, Wire-frame, Curves - Splines and Bezier curves, Boundary representation. Triangle Meshes, Constructing a torus, Procedural models, Fractal models, Grammar-based models, Octrees, Sweep, Boundary representations.

Unit:4	3D RENDERING	9 hours

Back face detection, Z-buffer method, Painter's algorithm, scan-line algorithm, BSP-trees, Area Sub-division method, Basic illumination Models. Color models, Polygon- Rendering Methods, Shading, Flat, Phong and Gouraud, Virtual reality rendering.

Unit:5	3D ANIMATION	9 hours

Principles of Animation, Design of Animation Sequences, Keyframing, Deformations, Character Animation, Physics-Based Animation, Procedural Techniques, Motion Specifications, Direct Motion Specification, Morphing

Total Lecture hours:	45 hours

Text Book(s)

1. John F. Hughes, Andries Van Dam, Morgan Macguire, David F. Sklar, James D. Foley,Steven K. Feiner, Kurt Akeley, Computer Graphics; Principles and practice, Pearson – Third edition, 2019.
2. Donald D. Hearn, Pauline Baker, Warren Carithers, Computer Graphics with Open GL: Pearson New International 4 th Edition, 2015

Reference Books	
1.	Fundamentals of Computer Graphics, Steve Marschner, Peter Shirley, 4th edition A K Peters/CRC Press, ISBN 9781482229394
2.	Computer Graphics: From Pixels to Programmable Graphics Hardware By Alexey Boreskov,Evgeniy Shikin, Chapman and Hall/CRC, ISBN 9781439867303
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE009	SOFT COMPUTING	2	0	2	3
Pre-requisite	NIL				

Course Objectives:

- The objective of this course is to introduce methods for handling imprecise and uncertain data using Rough sets, Neuro Fuzzy Systems and foster their abilities in designing and implementing optimal solutions for real-world and engineering problems using derivative free optimization techniques.

Expected Course Outcome:

After successfully completing the course the student should be able to

- Have a general understanding of soft computing methodologies, to deal with imprecise and uncertain data
- Develop computational neural network models for some simple biological systems
- Develop fuzzy models for engineering systems, particularly for control systems
- Apply derivative free optimization methods to solve real world problems
- Demonstrate some applications of computational intelligence

Unit:1	INTRODUCTION TO SOFT COMPUTING AND NEURAL NETWORKS	6 hours

Soft Computing Overview – Uncertainty in data, Hard vs Soft Computing. Introduction, RBF Networks, Self-Organizing Map, Boltzmann Machines, Unsupervised learning Networks - Adaptive Resonance Theory (ART), Classical ART Networks, Simplifies ART Architecture, Features, algorithms and Illustration of ART1 and ART2 model, Related Applications

Unit:2	FUZZY SYSTEMS	6 hours

Fuzzy Sets, Fuzzy Relations, and Membership functions, Properties of Membership functions, Fuzzification and Defuzzification. Fuzzy Rule based systems, Fuzzy Decision making, Fuzzy Classification, FuzzyC-Means Clustering.

Unit:3	ROUGH SETS	6 hours

Rough Sets – Definition, Upper and Lower Approximations, Boundary Region, Decision Tables and Decision Algorithms. Properties of Rough Sets. Rough K-means clustering, Rough support vector clustering.

Unit:4	OPTIMIZATION TECHNIQUES	6 hours

Genetic Algorithm - Basic concepts, Creation of offspring, working principles, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, crossover, inversion & deletion, mutation operator, Bitwise operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Hybrid systems, evolutionary computing, Genetic Algorithm based on Backpropagation networks. Memetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization, Frog-Leaping.

Unit:5	HYBRID SYSTEMS	6 hours

GA Based Back Propagation Networks, Fuzzy Back Propagation Networks, Evolutionary Ensembles.

Total Lecture hours:	30 hours

Text Book(s)

1. S.N. Sivanandham and S.N.Deepa, “Principles of Soft Computing”, 2nd Edition, Wiley

	Publications.
2.	Andries P. Engelbrecht, "Computational Intelligence: An Introduction", John Wiley & Sons,2007
3.	Laurene V. Fausett “Fundamentals of Neural Networks: Architectures, Algorithms And Applications”, Pearson,1994
4.	Simon Haykin "Neural Networks and Learning Machines" Prentice Hall, 2016.
5.	Timothy Ross, “Fuzzy Logic with Engineering Applications”, Third Edition, Wiley, 2010.
Reference Books	
1.	Simon Haykin, Neural Networks: A Comprehensive Foundation, Macmillan College Publishing Company, 1999.
2.	E. Cox, The Fuzzy Systems Handbook, Boston: AP Professional, 1998
3.	F.F. Soulie and P. Gallinari (Editors), Industrial Applications of Neural Networks, Singapore; River Edge, NJ: World Scientific, 2000
List of Indicative Experiments	
1.	Develop Fuzzy Decision-Making for Job Assignment Problem
2.	Implement TSP using Optimization Techniques
3.	Develop a suitable method for Health Care Application using Neuro- Fuzzy systems
4.	Develop a suitable method for Face Recognition System
5.	Layout Optimization using Genetic Algorithms
6.	Fault Diagnosis using rough set theory
7.	Software safety analysis using rough sets
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE010	DATA ENGINEERING AND MANAGEMENT	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To learn relational ,SQL and NoSQL databases
- To learn relational models and transaction processing.
- To learn distributed databases
- To understand the concepts of big data
- To learn the big data governance and security

Expected Course Outcome:

On successful completion of this course, the student should be able to

- CO1: Develop database designs using Relational models.
- CO2: Use advanced SQL features for managing relational databases.
- CO3: Apply concurrency control and recovery mechanisms for practical problems.
- CO4: Store and process big data in a distributed environment.
- CO5: Use various concepts of NoSQL databases.
- CO6: Design and develop applications on Hadoop/Spark

Unit:1	INTRODUCTION TO DATA ENGINEERING AND MANAGEMENT	5 hours

Role of data engineering in modern computing. Data lifecycle: collection, storage, processing, analysis, visualization Data engineering challenges and opportunities

Unit:2	RELATIONAL , SQL AND NOSQL DATABASES	10 hours

Relational database concepts -Data models - Types of data models - Relational DBMS – Normalization: Functional dependencies - Normal Forms- SQL Overview of query processing and evaluation. Indexing and optimization techniques Transaction management and ACID properties. Types of NoSQL databases: document, key-value, column-family, graph Data modeling for NoSQL databases Querying NoSQL databases.

Unit:3	DISTRIBUTED DATABASES	12 hours

Distributed DBMS-architecture -design, query processing - Distributed Transactions; Data Warehouses - ETL, ELT, Data Cube, Data Lakes, Scalable Data Processing - Hadoop - Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system, Stream Concepts-Data Analysis with Spark, Real-time stream processing with Spark Streaming, Distributed ML training with Spark MLlib.

Unit:4	DATA WAREHOUSING AND OLAP FOR AI/ML	9 hours

Firebase: Cloud Firestore Databases – Application development using MongoDB and Firebase-HBase and ZooKeeper. Applications on Big Data Using Pig and Hive- Data processing operators in Pig – Hive services HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphere .

Unit:5	DATA GOVERNANCE AND SECURITY	9 hours

Data quality and data governance best practices, Data privacy and security considerations, Auditing, access controls, and encryption .Compliance with data regulations (e.g., GDPR, HIPAA)

Total Lecture hours:	45 hours

Text Book(s)	
1.	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts, Seventh Edition, Tata McGraw Hill, 2019.
2.	Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, Seventh Edition, Pearson Education, 2016.
3.	Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGrawHill Publishing, 2012.
4.	Tom White, Hadoop: The Definitive Guide, Third Edition, O'Reilley, 2012.
5.	Bill Chambers, Matei Zaharia, Spark: The Definitive Guide, First Edition, O'Reilley, 2018.
6.	Guy Harrison, Next Generfation Databases - No SQL, New SQL and Bigdata, Apres, 2015.
Reference Books	
1.	Programming Hive, Jason Rutherglen, Dean Wampler & Edward Capriolo, O'REILLY, 2012, First edition.
2.	Programming Pig, Alan Gates,O'REILLY , 2012,First edition.
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE011	BIG DATA FRAMEWORK	2	0	2	3
Pre-requisite	NIL				

Course Objectives:

- The course objective is to impart an understanding of the challenges in storing and processing big data and how to use different big data frameworks effectively to store and process big data.

Expected Course Outcome:

After successfully completing the course the student should be able to

- Discuss the challenges in Big Data.
- Describe the need of different big data frameworks.
- Write MapReduce programming in both Hadoop and Spark Framework.
- Write programs in Spark Streaming, SPARK SQL and GraphX

Unit:1	INTRODUCTION TO BIG DATA	6 hours

Data Storage and Analysis - Characteristics of Big Data – Big Data Analytics - Typical Analytical Architecture – Requirement for new analytical architecture – Challenges in Big Data Analytics – Need of big data frameworks

Unit:2	HADOOP FRAMEWORK	6 hours

Hadoop – Requirement of Hadoop Framework - Design principle of Hadoop –Comparison with other system - Hadoop Components –Hadoop 1 vs Hadoop 2 – Hadoop Daemon's – HDFS Commands –Map Reduce Programming: I/O formats, Map side join, Reduce Side Join, Secondary sorting, Pipelining MapReduce jobs

Unit:3	HADOOP ECOSYSTEM	6 hours

Introduction to Hadoop ecosystem technologies: Serialization: AVRO, Co-ordination: Zookeeper, Databases: HBase, Hive,Scripting language: Pig, Streaming: Flink, Storm

Unit:4	SPARK FRAMEWORK	6 hours

Overview of Spark – Hadoop vs Spark – Cluster Design – Cluster Management – performance,Application Programming interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD,RDD Operations, Saving RDD - Lazy Operation – Spark Jobs.

Unit:5	SPARK SQL , GRAPHX AND SPARK STREAMING	6 hours

SQL Context – Importing and Saving data – Data frames – using SQL – GraphX overview – Creating Graph – Graph Algorithms. Overview – Errors and Recovery – Streaming Source – Streaming live data with spark.

Total Lecture hours: 30 hours

Text Books

1. Hadoop: The Definitive Guide" by Tom White "Spark: The Definitive Guide" by Bill Chambers and Matei Zaharia
2. "Big Data: A Revolution That Will Transform How We Live, Work, and Think" by Viktor Mayer-Schönberger and Kenneth Cukie.
3. Big Data: Principles and Best Practices of Scalable Real-Time Data Systems" by Nathan Marz and James Warren.

Reference Books

1. Mike Frampton, "Mastering Apache Spark", Packt Publishing, 2015.

2.	Tom White, “Hadoop: The Definitive Guide”, O’Reilly, 4th Edition, 2015.
3.	Nick Pentreath, Machine Learning with Spark, Packt Publishing, 2015.
4.	Mohammed Guller, Big Data Analytics with Spark, Apress, 2015
5.	Donald Miner, Adam Shook, “MapReduce Design Pattern”, O’Reilly, 2012
List of Indicative Experiments	
1.	HDFS Commends
2.	MapReduce Program to show the need of Combiner
3.	MapReduce I/O Formats –Text, key- value
4.	MapReduce I/O Formats - NLine, Multiline
5.	Sequence file Input / Output Formats
6.	Secondary sorting
7.	Distributed Cache & Map Side Join, Reduce side Join
8.	Building and Running a Spark Application
9.	Wordcount in Hadoop and Spark
10.	Manipulating RDD
11.	Inverted Indexing in Spark
12.	Sequence alignment problem in Spark
13.	Implementation of Matrix algorithms in Spark
14.	Spark Sql programming
15.	Building Spark Streaming application
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE012	CLOUD COMPUTING ECOSYSTEM	2	0	2	3
Pre-requisite	NIL				

Course Objectives:

- The fundamentals and essentials of Cloud Computing
- The ability to adopt Cloud Computing tools and services for real life scenarios
- An exposure to use commercial systems such as Google Apps, Microsoft Azure and Amazon Web Services etc.
- To impart knowledge in applications of cloud computing

Expected Course Outcome:

After successfully completing the course the student should be able to

- Deploy real-world applications onto the cloud
- Differentiate between Public, Private and hybrid clouds
- Formulate devOps based design and development of cloud applications
- Appreciate the requirements of various service paradigms in cloud computing
- Describe Datacenter requirements for the cloud

Unit:1	INTRODUCTION TO CLOUD COMPUTING	4 hours

Cloud Computing Overview: Characteristics – challenges, benefits, limitations, Evolution of Cloud Computing, Cloud computing architecture, Cloud Reference Model (NIST Architecutre), open group cloud ecosystem reference model

Unit:2	CLOUD SERVICE MODELS ,DEPLOYMENT MODELS AND RESOURCE MANAGEMENT	6 hours

Service Models, Characteristics, Benefits, Enabling Technologies (IaaS/PaaS/SaaS). Public/Private/Multi-cloud deployments, Shared Resources – Resource Pool – Usage and Administration Portal – Resource Management – Elastic Environment – Resilient Environment – Security – Workload Distribution – Dynamic provisioning.

Unit:3	CLOUD ECO SYSTEMS	6 hours

The concept of a cloud ecosystem, Actors and Roles in the Cloud Eco System, Cloud adoption vision, Identifying your use cases, Developing your plan, Understanding the implications of Cloud Service Layers, Utilizing cloud to gain strategic advantage

Unit:4	INTRODUCTION TO DEVOPS	8 hours

Understanding the Business Needs for Devops, DevOps Culture, Process and Technology in DevOps,DevOps Myths, Path to DevOps Adoption, Plan and Measure, Develop and Test (collaborative and continuous), Release and Deploy Monitor and Optimize (Continuous and Customer Feedback)

Unit:5	DEVOPS CAPABILITIES AND CLOUD DATA CENTERS	6 hours

Open stack Architecture, Open stack Compute, Network, Object storage in detail, Automation, Open stack installations. Historical Perspective, Datacenter Components, Design Considerations, Power Calculations, Evolution of Data Centers.

	Total Lecture hours:	30 hours

Text Books

1. "Cloud Computing: Principles and Paradigms" by Rajkumar Buyya, James Broberg, and

	Andrzej Goscinski
2.	"Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
3.	"Cloud Computing: From Beginning to End" by Ray J. Rafaels
4.	"Cloud Computing: A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti
Reference Books	
1.	Kai Hwang , Geoffrey Fox, Jack J. Dongarra, Morgan Kaufmann, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, 1st Edition, 2011.
2.	Gautham Shroff, "Enterprise Cloud Computing: Technology, Architecture, Applications", Cambridge press, 2010.
3.	Rajkumar Buyya, James Broberg, Andrzej Goscinski," Cloud Computing Principles and Paradigms", John Wiley & Sons, 2011.
4.	John Rhoton and Risto Haukiojal, "Cloud Computing Architectured : Solution Design Handbook", Recursive Press, 2013.
5.	Dinkar Sitaram, Geetha Manjunathan, " Moving to the Cloud: Developing Apps in the new world of Cloud Computing", Syngress, 2012.
6.	Introduction to Cloud Eco Systems
7.	"DevOps for Dummies" by Sanjeev Sharma
8.	Mandis Walls, "Building a DevOps Culture", O'relly
9.	"Handbook on Data Centers" Samee. U. Khan, Albert. Y. Zomaya, Springer

List of Indicative Experiments	
1.	Virtual box based Webserver creation, Images/Snapshots access webpage from 2nd VM on another subnet work
2.	EC2 AWS – S3 bucket based static webpages. Use this page as a start page vis EC2 webserver
3.	AWS – Local balancing and auto scaling
4.	DaaS – Deployment of a basic web app and add additional functionality(Java scripts based)
5.	PaaS – IOT – Mobile sensor based IOT application hosted via PaaS environment
6.	SaaS – Deployment of any SaaS application for a online collaborative tool
7.	Deployment of Open stack or Virtual box from the scratch (2 Lab sessions)
8.	DevOps deployment of library automation etc. on the cloud platform with one complete upgrade of the application (2 Lab sessions)
9.	Automating Open stack deployment using Chef/Puppet configuration for 4 node/ 5 node/ HA clusters
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
CSAIE013	IMAGE PROCESSING AND VIDEO ANALYTICS	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To impart knowledge on the basic principles and concepts in digital image and video processing.
- To explore and demonstrate real time image and video analytics in solving practical problems of commercial and scientific interests.

Expected Course Outcome:

- Understand the requirements of image processing
- Illustrate the principles and techniques of digital image in applications related to digital imaging system
- Demonstrate the image recognition and motion recognition
- Understand the fundamentals of digital video processing
- Illustrate the motion estimation, segmentation and modeling
- Design and Analysis of video processing in application

Unit:1	INTRODUCTION	6 hours

Basic steps of Image processing system – Pixel relationship- Image Transforms-. Image Enhancement- Histogram Processing, Spatial filtering, Frequency Domain filtering

Unit:2	IMAGE SEGMENTATION, COMPRESSION AND COLOUR IMAGE PROCESSING	9 hours

Image Segmentation –Detection of Discontinuities. - Edge Linking and Boundary Detection. - Thresholding. - Region-Based Segmentation. Image Compression – Encoder-Decoder model, Lossy and Lossless compression, Huffman Coding, Arithmetic Coding, JPEG, and JPEG 2000. Colour Image Processing – Colour Models, Color Transformations Color Image Smoothing and Sharpening, Color Noise Reduction, Color-Based Image Segmentation.

Unit:3	FEATURE EXTRACTION AND TEXTURE ANALYSIS	9 hours

Feature Extraction - Binary object feature, Histogram-based (Statistical) Features, Intensity features, Shape feature extraction, PCA - SIFT – SURF. Texture Analysis - Concepts and classification, statistical, structural and spectral analysis. Object Recognition -Patterns and pattern class, Bayes' Parametric classification, Feature Selection and Boosting, Template- Matching. Content Based Image Retrieval - Feature based image retrieval, Object Based Retrieval

Unit:4	DIGITAL VIDEO PROCESSING	9 hours

Digital Video, Sampling of video signal, Video Enhancement and Noise Reduction- Rate control and buffering, MPEG, H.264, Inter frame Filtering Techniques, Fundamentals of Motion Estimation and Motion Compensation.

Unit:5	VIDEO SEGMENTATION AND TRACKING	12 hours

Change Detection, Background modelling, Motion Segmentation, Simultaneous Motion Estimation and Segmentation, Motion Tracking, Multi-target/Multi-camera tracking. Video Analysis Action Recognition, Video based rendering, Context and scene understanding.

Total Lecture hours:	45 hours

Text Book(s)

1.	Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Ed., Prentice-Hall, 2008
2.	A. Murat Tekalp, "Digital Video Processing", Second Edition, Prentice Hall, 2015.
Reference Books	
1.	Oge Marques, "Practical Image and Video Processing Using MATLAB", Wiley-IEEE Press,2011
2.	Yu Jin Zhang, "Image Engineering: Processing, Analysis and Understanding", Tsinghua University Press, 2017.
3.	Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2013
4.	Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011
5.	Boguslaw Cyganek,"Object Detection and Recognition in Digital Images: Theory and Practice", Wiley 2013
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
MSCS 101	**DATA STRUCTURES AND ALGORITHMS**	**3**	**0**	**0**	**3**
Pre-requisite	**NIL**				

Course Objectives:

- It encompass a range of algorithmic concepts and problem-solving skills, with a comprehensive understanding of algorithm analysis, data structures, searching and sorting algorithms, advanced problem-solving techniques, and the importance of computational complexity in algorithm design.

Expected Course Outcome:

- Understand the concepts of algorithm analysis and solving recurrence relations
- Learn linear and non-linear data structures and their usage in applications
- Understand and Analyze various searching and sorting algorithms
- Applying greedy and dynamic approaches to solve challenging problems
- Understand computational complexity classes and their importance in designing algorithms

Unit:1	**INTRODUCTION TO ALGORITHMS AND ANALYSIS**	**9 hours**

Overview and importance of algorithms and data structures – Fundamentals of algorithm analysis – Space and time complexity of an algorithm – Asymptotic Notations – Order of growth – Algorithm Efficiency – Best case, Worst Case, Average Case – Recurrence Relations –Solving recurrence relations using substitution method, recurrence tree method and Master Method.

Unit:2	**LINEAR AND NON-LINEAR DATA STRUCTURES**	**9 hours**

Linear Data Structures: Stacks – Queues – Lists – Applications. Non-linear Data Structures: Graphs – Trees – Binary Trees – Traversal Techniques – Binary Search Tree and its operations – AVL Trees

Unit:3	**SEARCHING AND SORTING ALGORITHMS, DIVIDE AND CONQUER APPROACH**	**9 hours**

Search Problem – Linear Search – Binary Search – Sorting Problem – Bubble Sort – Insertion Sort – Heap Sort – Divide and Conquer Paradigm – Merge Sort – Quick Sort – Complexity analysis of searching and sorting algorithms.

Unit:4	**GREEDY METHOD AND DYNAMIC PROGRAMMING APPROACH**	**9 hours**

Greedy Method: Activity Selection Problem – Graph Traversal Algorithms. Dynamic Programming Paradigm: Knapsack problem – Matrix Chain Multiplication – All Pair Shortest Path – Single Source Shortest Path – Travelling Salesman Problem.

Unit:5	**OTHER ALGORITHM PARADIGMS AND COMPUTATIONAL COMPLEXITY CLASSES**	**9 hours**

Backtracking: 8-Queens problem – Graph coloring. Brach and Bound: Least Cost 0/1 Knapsack Problem. Tractable and Intractable problems – Decidable and Undecidable problems – P, NP and NP-Complete classes – Cook's Theorem (without proof) – NP-Hard problems.

Total Lecture hours:	**45 hours**

Text Book(s)

1. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press February 2010

Reference Books	
1.	Sanjoy Dasgupta, C.Papadimitriou and U.Vazirani , Algorithms , Tata McGraw-Hill, 2008
2.	A. V. Aho, J.E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms, Pearson, 1st edition, 2006.
3.	Fundamentals of Data Structures in C -- by Horowitz, Sahni and Anderson-Freed (Silicon Press 2007).
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
MSCS 102	**PYTHON PROGRAMMING**	**2**	**0**	**0**	**2**
Pre-requisite	**NIL**				

Course Objectives:

- Python programming empower individuals to develop versatile software, streamline processes, solve intricate problems, and gain valuable insights from data, contributing to a wide range of industries and applications.

Expected Course Outcome:

- Understand the fundamental concepts of python and its main components.
- Develop (Read and Write) python programs using variables, assignments, and conditional statements using functions.
- Illustrate and implement different data structures.
- Demonstrate Object-oriented concepts and file handling.
- Analyze and plot data using python visualization libraries.

Unit:1	**Introduction to Python**	**6 hours**

Introduction to a programming language – History of Python- Python environment setup – Python 2 vs. Python 3 - Comments and documentation in Python- Keywords and Identifiers - Programming Errors - Writing and Running python programs.

Unit:2	**Variables and Conditionals in Python**	**6 hours**

Variables – Constants- Strings - Assignment statements – Expressions-Operators – Type Conversions-Control Flow statements and Loops- Functions.

Unit:3	**Data Structures in Python**	**6 hours**

List Basics- List Indexing and Slicing-Appending-Sorting and Ranging-Tuples-Creation,Deletion-Converting tuple to list- Assignment- Dictionaries-Adding-Modifying and Retrieving Values-Traversing all keys in the dictionary-Operations and methods-Sets- manipulating and accessing sets

Unit:4	**Exception handling and File I/O**	**6 hours**

Exception handling - Catching and Handling Exceptions-Object Orientated Concepts (Basics) – Creating python class and Objects - Object properties and methods- Inheritance- Operator overloading- Polymorphism- File handling - Opening, Reading, Writing and Deleting files

Unit:5	**Graph Plotting**	**6 hours**

Introduction to plotting python libraries -Plots and Graphs- Applied Visualizations – Seaborn – Matplotlib.

Total Lecture hours: 30 hours

Text Book(s)

1. Python: The Complete Reference , 2018
2. Python in easy steps, McGraw Hill, 2nd Reprint , 2014

Reference Books

1. Python 3 Documentation, https://docs.python.org/
2. https://www.coursera.org/learn/python

Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
MSCS 203	**OBJECT ORIENTED PROGRAMMING USING JAVA**	**3**	**0**	**0**	**3**
Pre-requisite	**NIL**				

Course Objectives:

- To equip with the skills needed to design, develop, and deploy Java applications for real world application.

Expected Course Outcome:

- CO1: Understanding Object-Oriented programming concepts using basic syntaxes of control Structures, strings for developing skills of logic building activity using Java
- CO2: Identification of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem
- CO3: Illustration to achieve reusability using inheritance, interfaces, and packages and describes faster application development can be achieved with exception handling mechanisms
- CO4: Understanding concept of multithreading for robust faster and efficient application development and applications of collection interfaces in Java
- CO5: Learning of various I/O operations, connecting Java with databases using JDBC and implementation of networking with Java.

Unit:1	**OVERVIEW OF OOP AND INTRODUCTION TO JAVA**	**9 hours**

Structured Programming and its limitation – Object-Oriented Paradigm: Basic concepts of ObjectOriented Programming (OOP) – Structured Programming vs OOP – Benefits of OOP – Object Modeling – Association – Aggregation and Generalization. Introduction to Java – Evolution of Java – Features of Java – Java Environment – JVM – Data types – variables – operators – Decision statements – Control Structures – Loops – Arrays in Java – Strings in Java – String Buffer Class – Wrapper Classes.

Unit:2	**OBJECTS AND CLASSES**	**9 hours**

Introducing Classes - Class Fundamentals - Declaring Objects - Object Reference Variables - Introducing Methods - Constructors - this Keyword - Garbage Collection - A Closer Look at Methods and Classes - Overloading Methods - Objects as Parameters - Returning Objects - Access control - static - final - nested and inner class - Command line arguments

Unit:3	**INHERITANCE, PACKAGES, INTERFACES AND EXCEPTION HANDLING**	**9 hours**

Inheritance in Java – Constructors in Inheritance – super – Multilevel Inheritance – Overriding – Dynamic Method Dispatch – final Keyword – Interfaces – Packages – JAR files – Exception Handling

Unit:4	**MULTI THREADING AND JAVA COLLECTIONS**	**9 hours**

Threads – Multithreading in Java – Thread Priorities – Creating Multiple Threads – Inter Thread Communication – Synchronization – Suspending, Resuming and Stopping Threads – Collections Overview – Collection Interfaces – Collection Classes – Accessing collection via Iterator.

Unit:5	**JAVA I/O, JDBC AND JAVA NETWORKING**	**9 hours**

I/O Basics - Reading Console Input - Java I/O Classes and Interfaces - Serialization. Networking Classes and Interfaces - InetAddress - TCP/IP Client Sockets - URL - URL Connection - JDBC Driver, Database Connection Steps, DriverManager Class, Statement Interface, ResultSet Interface.

Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Herbert Schildt, Java: The Complete Reference, Eleventh Edition, 11th Edition December 2018, McGraw-Hill, ISBN: 9781260440249
Reference Books	
1.	Javin Paul, Grokking the Java Interview: Prepare for Java interviews by learning essential Core Java concepts and APIs, 2020
2.	Kishori Sharan, Adam L. Davis, Beginning Java 17 Fundamentals, Springer Link, 2022
3.	Herbert Schildt and Dale Skrien, Java Programming: A Comprehensive Introduction, 2013, National Edition
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
MSCS 105	**DATA STRUCTURES AND ALGORITHMS LAB**	**0**	**0**	**4**	**2**
Pre-requisite	**NIL**				

Course Objectives:

- Designed to hands-on learning experiences that align with the theoretical course outcomes, to apply the concepts in practical programming tasks and data analysis scenarios.

Expected Course Outcome:

- CO1: Understand the fundamental concepts of python and its main components.
- CO2: Develop (Read and Write) python programs using variables, assignments, and conditional
  Statements using functions.
- CO3: Illustrate and implement different data structures.
- CO4: Demonstrate Object-oriented concepts and file handling.
- CO5: Analyze and plot data using python visualization libraries.

List of Indicative Experiments

1.	Stacks and Queues
2.	Lists
3.	Linear Search and Binary Search
4.	Sorting Algorithms
5.	Graph Traversal Algorithms
6.	Tree Traversal Algorithms
7.	Shortest Path Algorithms
8.	Knapsack Problem
9.	Travelling Salesman Problem
10	N-Queens's Problem

Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
MSCS 107	**PYTHON PROGRAMMING LAB**	**0**	**0**	**4**	**2**
Pre-requisite	**NIL**				

Course Objectives:

- To find practical application across various domains, from software engineering and data analysis to game development and business analytics, showcasing the versatility and importance of Python programming skills.

Expected Course Outcome:

- CO1: Understand the fundamental concepts of python and its main components.
- CO2: Develop (Read and Write) python programs using variables, assignments, and conditional statements using functions.
- CO3: Illustrate and implement different data structures.
- CO4: Demonstrate Object-oriented concepts and file handling.
- CO5: Analyze and plot data using python visualization libraries.

List of Indicative Experiments

1.	Test and Debug simple Python programs
2.	Different datatypes in python (variables constants and strings)
3.	Programs on different operators
4.	Control statements and Loops
5.	Working on Functions
6.	Data structures in python (List, Tuple, Dictionary and Set)
7.	Objects and Classes manipulation using python
8.	Open, Read and write data from/to files in Python
9.	Different plots using Matplotlib
10	Visualization of data using seaborn
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
MSCS 205	**OBJECT ORIENTED PROGRAMMING USING JAVA LAB**	**0**	**0**	**4**	**2**
Pre-requisite	**NIL**				

Course Objectives:

- To provide hands-on experiences that align with the theoretical concepts outlined in the user description. Through practical exercises, students will develop skills in Java programming, object-oriented analysis, application development, multithreading, collection interfaces, I/O operations, database connectivity, and networking.

Expected Course Outcome:

- CO1: Understanding Object-Oriented programming concepts using basic syntaxes of control Structures, strings for developing skills of logic building activity using Java
- CO2: Identification of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem
- CO3: Illustration to achieve reusability using inheritance, interfaces, and packages and describes faster application development can be achieved with exception handling mechanisms
- CO4: Understanding concept of multithreading for robust faster and efficient application development and applications of collection interfaces in Java
- CO5: Learning of various I/O operations, connecting Java with databases using JDBC and Implementation of networking with Java.

List of Indicative Experiments

1.	Basic Problems
2.	Arrays
3.	Panagrams
4.	Duplicate Elements
5.	Class – Objects – Constructors
6.	Access Specifiers
7.	Static and Non-static variables
8.	Packages and Interfaces
9.	Exception Handling
10	Multithreading and JDBC and Networking
Recommended by Board of Studies	31-08-2023

Course Code	Course Title	L	T	P	C
MSMA104	PROBABILITY AND STATISTICS	4	0	0	4
Pre-requisite	Basic Knowledge in definition and preliminaries of mathematical statistics				

Course Objectives:

The main objectives of this course are to

- To provide a thorough treatment of probability ideas and techniques necessary for a frim understanding of the subjects
- Understanding of the ideas in their proofs, and ability to make direct application of those results to related problems.
- As evidence of that understanding, students should be able to demonstrate mastery of all relevant vocabulary, familiarity with common examples and counter examples, knowledge of the content of the major theorems.

Expected Course Outcome:

- The ability to use and simulate random variables, distribution functions, probability mass function and probability density functions
- Through calculus and functional transformations, to answer quantitative questions about the outcomes of probabilistic systems.
- The ability to use and simulate multivariate distributions, independence, conditioning and functions of random variables.
- The ability to compute expectations, moments, and correlation functions, to describe relationships between different experimental conditions.
- The ability to use probabilistic reasoning and the foundations of probability theory to describe probabilistic engineering experiments in terms of sample spaces, event algebras, classical probability, and Kolmogorov's axioms.
- Do statistical data analysis like test of hypothesis.

Unit:1 **12 hours**

Random variables-Conditional probability-Probability density function-Distribution function-Marginal and conditional distributions. Two Dimensional Random variables: Jint distributions-Marginal and conditional distributions-Transformations of random variables of the continuous type.

Unit:2 **12 hours**

Mathematical expectation I & II: Expectations of functions of random variables. Moment generating function. Regression curve & lines-Correlation

Unit:3 **12 hours**

Some Special distributions: The Normal distribution – The Gamma and Chi-Square Distributions and related problem. Tchebyshev's Inequality and related problem.

Unit:4 **12 hours**

Sampling Theory- Introduction to statistical inference: point Estimation – Unbiased & Consistence estimator – Confidence interval for mean – Confidence intervaLS FOR Difference of means – Confidence intervals for variance. – Curve Fitting by principle of least squares – Regression lines – Goodness fit.

Unit:5 **12 hours**

Testing of hypothesis: Sampling distributions – Type I and Type II errors – Small and Large samples – Tests based on Normal, t, chi square and F distributions for testing of mean, variance.

	Total Lecture hours:	**60 hours**
Text Book(s)		
1.	Fundamentals of Mathematical Statistics, Gupta & Kapoor. Sultan Chand & sons, 2002.	
2.	S.Ross, A first course in Probability, 6th edition, Pearson Education, 2006.	
3.	R.V.Hogg, J.McKean and A.T. Craig, Introduction to mathematical Statistics, Pearson Education, sixth edition, 2005.	
Reference Books		
1.	Oliver C Ibe, Fundamentals of applied probability & Random Process.	
2.	"Probability theory and Mathematical Statistics" by Marek Fisz, John Wiley and Sons, Third Edition, New York, 1963.	
Recommended by Board of Studies	31-08-2023	

Course Code	Course Title	L	T	P	C
MSMA2001	MATHEMATICS FOR MACHINE LEARNING	3	0	0	3
Pre-requisite	NIL				

Course Objectives:

- To study the basics of linear space and linear transformation.
- To learn various methods in matrix theory and decomposition methods.
- To apply the concepts of differentiation and integration for solving maxima and minima problems.
- To represent networks using graph models.
- To apply and evaluate the optimization problems.

Expected Course Outcome:

- CO1: Identify the standard distributions and apply them in solving problems.
- CO2: Acquire knowledge of linear spaces and solve problems.
- CO3. Apply various methods in matrix theory to solve decomposition problems.
- CO4: Understand the concepts of differential and integral calculus and solve problems.
- CO5: Acquire knowledge of graphs and cut-sets and apply in network flow problems.

Unit:1	VECTOR SPACES	6 hours

Vector spaces –Subspaces –Linear combinations and system of Linear equations –Linear Independence and Linear dependence – Basis and Dimensions.

Unit:2	LINEAR TRANSFORMATION AND MATRIX DECOMPOSITION	9 hours

Linear transformations –Null spaces Range –Matrix representation of linear transformation – Eigenvalues –Eigenvectors –Diagonalization - Inner and outer products – Inner product space – orthogonality and orthonormality - Singular value decomposition -LU decomposition, Principal Component Analysis (PCA), Singular Value Decomposition (SVD).

Unit:3	DIFFERENTIAL AND INTEGRAL CALCULUS	9 hours

Functions of a single variable, limit, continuity, differentiability - Mean value theorems, indeterminate forms, L'Hospital's rule - Maxima and minima - Taylor's series, infinite series summation/integration concepts - Fundamental and mean value-theorems of integral calculus, Evaluation of definite and improper integrals - Beta and gamma functions.

Unit:4	GRAPHS THEORY	9 hours

Graphs: Directed and Undirected – Subgraphs – Matrix Representation of graphs– Cut-Sets and Cut vertices: Properties of a Cut-Set – Fundamental Circuits and Cut-Sets – Connectivity and Separability – Case Studies: Applications of Bayesian networks.

Unit:5	COMPLEX ANALYSIS & PARTIAL DIFFERENTIAL EQUATIONS (PDES)	12 hours

Analytic functions and Cauchy's theorem-Residue theorem and contour integration, Classification of PDEs (elliptic, parabolic, hyperbolic).Boundary value problems and initial value problems-Numerical methods for solving PDEs.

	Total Lecture hours:	45 hours

Text Book(s)

1. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Prentice Hall of India, New Delhi,

	2004.
2.	Strang G, Linear Algebra and its applications, Thomson (Brooks/Cole), New Delhi, 2005.
3.	O'Neil, P.V., Advanced Engineering Mathematics, Thomson Asia Pvt. Ltd., Singapore, 2003.
4.	NarsinghDeo, Graph Theory with Applications to Engineering & Computer Science, Dover Publications, Inc. Mineola, New York, 2016.
5.	Elias M. Stein and Rami Shakarchi, Complex Analysis, Princeton University Press, 2010.
6.	Stanley J. Farlow, "Partial Differential Equations for Scientists and Engineers", Dover Publications, India, 2003.
Reference Books	
1.	B. S. Grewal, Higher Engineering Mathematics, Krishna Publications, 2017.
2.	Linear Programming and Network Flows. by Mokhtar S. Bazaraa, Wiley; 4th edition (15 January 2010).
3.	Johnson, R.A. and Gupta, C.B., Miller and Freund's Probability and Statistics for Engineers, Pearson Education, Asia, 8th Edition, 2011.
Recommended by Board of Studies	31-08-2023

Member of Board of Studies

Department of Computer Science -Artitifical Intelligence and Machine Learning
Rajiv Gandhi National Institute of Youth Development
Ministry of Youth Affairs & Sports, Government of India
Sriperumbudur, Tamil Nadu.

Dr. B. Rajesh Kanna, Associate Professor & Head, Computer Science -Artitifical Intelligence and Machine Learning, RGNIYD	*Chairman & Convener*
Prof. Dr. Chandrabose Aravindan, Professor & Head, Department of Information Technology. Sri Sivasubramaniya Nadar College of Engineering, Chennai	*Subject Expert - External Member*
Dr. Noor Mahammad SK, Associate Professor, Department of Computer Science and Engineering, Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram	*Subject Expert - External Member*
Dr. C. Jaya Kumar, Associate Professor & Head, Computer Science – Data Science, RGNIYD	*Internal Expert*
Shri. Aurobind. G Assistant Professor, Computer Science – Data Science, RGNIYD	*Internal Expert*
Dr. Parthasakha Das, Assistant Professor, Head in-charge, Department of Mathematics, RGNIYD	*Institute Expert - Allied disciplines*
Dr. S. Lalitha, Assistant Professor, CoE(i/c) Department of Social Work, RGNIYD	*Institute Expert - Cognate discipline*

RAJIV GANDHI NATIONAL INSTITUTE OF YOUTH DEVELOPMENT
(Institute of National Importance by the Act of Parliament No. 35/2012)
Ministry of Youth Affairs & Sports, Government of India Pennalur,
Sriperumbudur – 602 105, Tamil Nadu.

Appendix A

Final Assessment Question Paper –Template

Total Marks: 75

Part –A

(Under Bloom's Taxonomy levels 1 and 2, contributing to 20% of the overall marks)

Answer all the questions (5*3=15 Marks)

1.	
2.	
3.	
4.	
5.	

Part-B

(Under Bloom's Taxonomy level 3 or 4, accounting for a substantial 80% of the total marks)

Answer any five questions (5*12=60)

1.	
2.	
3.	
4.	
5.	
6.	

RAJIV GANDHI NATIONAL INSTITUTE OF YOUTH DEVELOPMENT
(Institute of National Importance by the Act of Parliament No. 35/2012)
Ministry of Youth Affairs & Sports, Government of India Pennalur,
Sriperumbudur – 602 105, Tamil Nadu.

Internal Marks - Template

Internal Assessment Component	Maximum Marks
Assignment	*5 Marks*
Seminar	*10 Marks*
Internal assessment	*10 Marks*
Added Learning Score(ALS)	*(Maximum of 10 Marks)**
Total	***25 Marks***

*Applicable only for the deserved students as per item no.4.A.