Detail Syllabus

M.Tech in Computer Science and Engineering

With specialization in

Artificial Intelligence

Under Computer Science and Engineering Department, NIT Agartala

Major Area / Department: Computer Science and Engineering

Specialization: Artificial Intelligence

Updated on: **6th September 2021**

Institute

National Institute of
Technology Agartala

P.O: NIT Agartala,Tripura(West), India,799046
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Department

Computer Science and Engineering Department

APJ Abdul kalam Block
NIT Agartala, Agartala,Tripura(West), India,799046

Title of Curriculum **M.Tech in Artificial Intelligence as specialization** **Under Computer Science and Engineering Department, NIT Agartala**	
Objectives of the AI Specialization In the recent decades, artificial intelligence, popularly known as AI, has received much attention for its wide-spread applications in real-world problems of diverse domains. AI is a very broad field of study falling under the rubric of Computer Science that aims at solving computationally hard problems by mimicking human-like and biologically inspired approaches. Theoretical aspects of AI include logic and reasoning, machine learning (ML), intelligent search, intelligent planning, coordination and perception. In recent times, ML is receiving much popularity for its scope of handshaking with emerging areas like Data Science, Cognitive Science and Robotics. This program would provide students an opportModuley to learn both foundation and experimental components of AI and Machine Learning. A student, on completion of this program, will be able to undertake industry careers involving innovation and problem-solving using Artificial Intelligence (AI) and Machine Learning (ML) technologies and research careers in AI, ML, and Data Science, in general. Along with courses that provide specialization in AI, students will also have option to explore some applied domains such as computer vision, natural language processing, robotics, and software analysis. **Major aspects of the programme,** **1) Theoretical foundations: This will include the mathematical background required for the subjects.** **2) Application of Theory: This will include courses where the fundamentals and advanced concepts (subjects) could be implemented.** **3) Thesis/Project Work: Covering the application of the concepts learned or research, oriented work.** **The programme is able to:** **1. Build mathematical foundations for studying AI. (Core subjects)** **2. Once the foundations are built, give options to the students to choose their domain of interest (Computer Vision, Speech, Text, Robotics etc.) so that they can apply the concepts learned. (Elective subjects).**	
Detail Syllabus	• **Annexure ,I**
Class room available Labs available	**YES** **YES**
Number of existing Faculty in the areas of Artificial Intelligence and allied fields in NITA CSE Department	**8**
Duration of Program	2 year (4 Semester)
Total Number of Intake	10
Academic eligibility	Existing institute rules for MTech Program

Vision

To be an academic leader in the areas of Computer Science and Engineering, Information Technology and other potential of Computer Science with worldwide recognition.

Mission

1) Provide high quality graduate educational programs in Computer Science and Engineering.
2) Contribute significantly to the research and the discovery of new knowledge and methods in computing.
3) Offer expertise, resource and service to the community.
4) To retain the present faculty members by providing opportunities for professional development.

Program Educational Objectives (PEO's)

PEO-1: To impart advance theoretical and practical Knowledge, enhance skills to design, test and adapt new computing technologies for attaining professional excellence and leading successful career in industries and academia.

PEO-2: To develop the ability to critically think, analyze and offer techno-commercially feasible and socially acceptable solutions to computational problems, attaining professional excellence and carrying research. & Development (R&D) effectively.

PEO-3: To work collaboratively on development of innovative systems and optimized solutions on multidisciplinary domains, and exhibit high levels of professional and ethical values within organization and society globally.

PEO-4: To develop design thinking capabilities for innovation and entrepreneurship development.

Program Specific Objectives (PSO's)

PSO-1: To understand the evolutionary changes in computing, apply standard practices and strategies to promote research and development for innovative career paths and meet future challenges.

PSO-2: The ability to incorporate contemporary and evolving computational problem-solving techniques for lifelong learning support leading to higher studies and entrepreneurship development.

PSO-3: To inculcate knowledge with moral values and professional ethics, to act as a responsible citizen.

Program Outcomes (PO’s)

PO1: To develop the ability to apply knowledge of mathematics, engineering sciences for conducting independent research/investigation for solving practical problems.

PO2: To develop the ability to identify, formulate, conduct experiments, interpret data, synthesize information, and analyse engineering problems by writing and presenting an effective technical report/document.

PO3: To develop the ability to demonstrate mastery over the area as per the program's specialisation. The knowledge should be at a level higher than the requirements in the appropriate bachelor's program.

PO4: To develop problem-solving ability to design solutions for complex engineering problems in the context of societal and environmental commitments.

PO5: To demonstrate the capability of functioning effectively as a member or team leader in software projects considering multidisciplinary environments, thus solving real-world multifaceted problems.

PO6: To develop design thinking capabilities for innovation and contribute to technological knowledge and intellectual property development.

Detail Syllabus

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Under Computer Science and Engineering Department, NIT Agartala

Major Area / Department: Computer Science and Engineering

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Course structure for M.Tech in
Artificial Intelligence
Department of CSE, NIT Agartala

Semester	Subject	L	T	P	Cr.	Class Hours per week	Marks
1	1. Advanced Data Structures and Algorithms	3	1	0	4	4	100
	2. Artificial Intelligence	3	1	0	4	4	100
	3. Computational Methods of Optimization	3	1	0	4	4	100
	4. Elective, I i) Stochastic Models and Applications ii) Natural Language Processing iii) Soft computing iv) Data Mining v) Pattern Recognition	4	0	0	4	4	100
	5. Elective, II i) Expert Systems ii) Computer Vision iii) Wireless Communication Network iv) Information Retrieval v) AI for Cyber Security	4	0	0	4	4	100
	6. Laboratory I (Advanced Data Structures and Algorithms)	0	0	2	2	3	100
	7. Laboratory II (Artificial Intelligence)	0	0	2	2	3	100
	8. Seminar	0	0	1	1	2	100
	Total	**17**	**3**	**5**	**25**	**28**	**800**
2	1. Robotics and automation	3	1	0	4	4	100
	2. Machine Learning	3	1	0	4	4	100
	3. Computational Linear Algebra	3	1	0	4	4	100
	4. Elective, III **i)** Agent based intelligent system **ii)** Deep learning **iii)** Data Visualization **iv)** Human Computer Interaction **v)** Embedded and Realtime System	4	0	0	4	4	100
	5. Laboratory- I (Robotics and Automation Lab)	0	0	2	2	3	100
	6. Laboratory-II(Machine Learning)	0	0	2	2	3	100
	7. Project Preliminaries	0	0	3	3	6	100
	8. Comprehensive Viva	0	0	2	2	0	100
	Total	**13**	**3**	**9**	**25**	**28**	**800**

Semester	Subject	L	T	P	Cr.	Class Hours per week	Marks
3	Project and Thesis Work- I ***Students may go for industrial or inter institute collaboration, based Project work for 6 months to 1 year. The DPPC and concerned local guide may be empowered to recommend such provision. All existing academic rules of institute will prevail. The exact modalities may be recommended by DPPC.**	0	0	10	10	FULL	100
	Total	**0**	**0**	**10**	**10**		**100**

Semester	Subject	L	T	P	Cr.	Class Hours per week	Marks
4	Project and Thesis Work- II ***Students may go for industrial or inter institute collaboration, based Project work for 6 months to 1 year. The DPPC and concerned local guide may be empowered to recommend such provision. All existing academic rules of institute will prevail. The exact modalities may be recommended by DPPC.**	0	0	20	20	FULL	300
	Total	**0**	**0**	**20**	**20**		
Cumulative credit of the course							
Semester-I		**17**	**3**	**5**	**25**	**28**	**800**
Semester -II		**13**	**3**	**9**	**25**	**28**	**800**
Semester -III		**0**	**0**	**10**	**10**	**Full**	**100**
Semester -IV		**0**	**0**	**20**	**20**	**Full**	**300**
Total		**30**	**6**	**44**	**80**		**2000**

Program Outcome for the M Tech. AI

PO1: To develop the ability to apply knowledge of mathematics, engineering sciences for conducting independent research/investigation for solving practical problems.

PO2: To develop the ability to identify, formulate, conduct experiments, interpret data, synthesise information, and analyse engineering problems by writing and presenting an effective technical report/document.

PO3: To develop the ability to demonstrate mastery over the area as per the program's specialisation. The knowledge should be at a level higher than the requirements in the appropriate bachelor's program.

PO4: To develop problem-solving ability to design solutions for complex engineering problems in the context of societal and environmental commitments.

PO5: To demonstrate the capability of functioning effectively as a member or team leader in software projects considering multidisciplinary environments, thus solving real-world multifaceted problems.

PO6: To develop design thinking capabilities for innovation and contribute to technological knowledge and intellectual property development.

Annexure, I

Detail Syllabus

Course structure for M.Tech in Artificial Intelligence
Department of CSE, NIT Agartala

Semester I

1.1 Advanced Data Structures and Algorithms	
L T P 3 ,1, 0 : **4 Credits**	Prerequisites: *None*

Course Objective:

1. The course is intended to provide the foundations of the practical implementation and usage of Algorithms and Data Structures.
2. One objective is to ensure that the student evolves into a competent programmer capable of designing and analyzing implementations of algorithms and data structures for different kinds of problems.
3. Another objective is to expose the student to the algorithm analysis techniques, to the theory of reductions, and to the classification of problems into complexity classes.

Detailed syllabus:

MODULE I
Introduction to advanced data structures, Fundamentals of the analysis of algorithms, Algorithms, Performance analysis- time complexity and space complexity, Asymptotic Notation-Big Oh, Omega and Theta notations, Complexity Analysis Examples. Data structures-Linear and non linear data structures, ADT concept, Linear List ADT, Recurrences: The substitution method, Recursive tree method, Masters Method, Probabilistic analysis, Amortized analysis, Randomized algorithms, Mathematical aspects and analysis of algorithms.

MODULE II
Divide and Conquertechnique, Binary search tree ,AVL-trees, red-black trees, B and B+-trees, Finding the minimum and maximum, Merge sort, Quick sort, Strassen’s matrix multiplication.Splay Trees,Binomial Heaps,Fibonacci Heaps, Application of k-d tree (k-dimensional tree) in range searches and nearest neighbor searches.

MODULE III
Greedy algorithms: Introduction, Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees, Kruskal’s algorithm, Prim’s algorithm, Optimal storage on tapes, Optimal merge pattern, Subset cover problem, Container loading or Bin packing problem.

MODULE IV
Dynamic algorithms: Introduction Dynamic algorithms, All pair shortest path, 0/1 knapsack, Travelling salesman problem, Coin Changing Problem, Matrix Chain Multiplication, Flow shop scheduling, Optimal binary search tree (OBST), Analysis of All problems, Introduction to NP-Hard And NP-Complete Problems
More algorithms: Dynamic programming, graph algorithms: DFS, BFS, topological sorting, shortest path algorithms, network flow problems.
MODULE IV
String Matching: The naïve string matching algorithm, Rabin Karp algorithm, KnuthMorrisPratt algorithm (KMP), longest common subsequence (LCS), Fractional cascading, suffix trees, geometric algorithms.

References:
1. Introduction to algorithms: Cormen, Leiserson, Rivest and Stein (Main textbook)
2. Algorithm Design: Kleinberg and Tardos
5. Data structures and algorithm analysis in C++(Java): Mark Weiss
6. Data structures and algorithms: Aho, Hopcroft and Ullman
7. S. Sahni, Data Structures, Algorithms, and Applications in C++, Silicon Press

To establish the correlation between COs & POs and Cos & PSOs

Table 1(Cos)

No. of Cours Outcome (CO)	Course Outcome
CO1	Basic ability to analyze algorithms and to determine algorithm correctness and time Efficiency class.
CO2	Master a variety of advanced abstract data type (ADT) and data structures and their implementations.
CO3	Master different algorithm design techniques (brute-force, divide and conquer, greedy, etc
CO4	Ability to apply and implement learned algorithm design techniques and data structures to solve problem.
CO5	Ability to crawl information and explain different types of search algorithms.

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	3	1	3
CO2	2	3	3	1	2	3
CO3	2	2	2	2	3	2
CO4	3	3	1	3	3	2
Total	8	9	7	9	9	10
Average	2	2.25	1.75	2.25	2.25	2.5
EqAvg **Attainment**	2	2	1	2	2	2

1.2 Artificial Intelligence	
L T P 3 , 1 , 0 : **4 Credits**	Prerequisites: *None*

Course Objectives

1. To impart knowledge about Artificial Intelligence.
2. To give understanding of the main abstractions and reasoning for intelligent systems.
3. To enable the students to understand the basic principles of Artificial Intelligence in various applications.

Detailed syllabus:

MODULE I

Introduction to AI and intelligent agents, Problem Solving: Solving Problems by Searching, heuristic search techniques, constraint satisfaction problems, stochastic search methods, Game playing: min max, alpha beta pruning, Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus, Theorem Proving in First Order Logic.

MODULE II

Uncertain Knowledge and Reasoning, Overview of Probability Theory, Bayes Networks, Undirected Graphical Models, Template Based Representations, Exact Inference: Variable Elimination, Clique Trees, Belief Propagation, Tree Construction, Baye’s Theorem, Dempster-Shafer theory of evidence.

MODULE III

Introduction to Optimization, Approximate Inference: Sampling, Markov Chains, Maximum A posteriori Probability (MAP) Inference, Inference in Temporal Models, Introduction to learning graphical models, Parameter Estimation, Bayesian Networks and Shared Parameters.

MODULE IV

Learning: Overview of different forms of learning, Learning Decision Trees, Statistical learning methods, k-nearest neighbor algorithm, Naïve Bayes classifier, Decision Problems

MODULE V

Neural Networks, ANN, McCulloch Pitts Model, Perceptron Network. Foundations of Convolutional Neural Networks. Implement the foundational layers of CNNs (pooling, convolutions). Introduction to Deep Reinforcement Learning, Generative Adversarial Nets, Conditional GAN, Super-Resolution GAN, CycleGAN.

MODULE VI

Fuzzy Logic: operations of Fuzzy sets, Variables inference techniques, defuzzification techniques, basic Fuzzy interference algorithm, application of fuzzy logic , Fuzzy system design implementation.

Text book:

Artificial Intelligence and Soft Computing by Amit Konar, CRC Press, Taylor and Francis

Artificial Intelligence: A Modern Approach by S.Russell and P. Norvig.

Reference Books

Nils J. Nilsson, Artificial Intelligence: A New Sythesis, Morgan,Kaufmann.

Probabilistic Graphical Models, by Daphne Koller and Nir Friedman, MIT Press.

References:

Neural Network Design, Hagan, Demuth and Beale, Vikas PublishingHouse

Fundamentals of Artificial Neural Networks, Mohamad H Hassoum.PHI
Fuzzy Set Theory & its Applica tion, H.J. Zimmerman Allied PublishedLtd.

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	Solve basic AI based problems and construct logical building blocks for problem formulation.	**I,II**
2	Acquaint with Knowledge Representation and decision under uncordiality.	**II, III**
3	Apply Optimization and inferencing with available knowledge.	**III**
4	Pragmatic approach of Machine learning and fuzzy knowledge representation.	**III,IV,VI**
5	Apply AI techniques to real-world problems to develop intelligent systems.	**IV,V**
6	Select appropriately from a range of techniques when implementing intelligent system	**V**

<u>CO-PO Mapping</u> (Rate: scale of 1 to 3)

Course Outcome	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	**1**	**1**	**1**	**2**	**1**	**2**
CO-2	**2**	**2**	**1**	**2**	**2**	**2**
CO-3	**2**	**2**	**2**	**1**	**2**	**3**
CO-4	**2**	**3**	**2**	**3**	**2**	**3**
CO-5	**3**	**3**	**3**	**3**	**3**	**3**
CO-6	**3**	**3**	**3**	**3**	**3**	**3**
Total	**13**	**14**	**12**	**14**	**13**	**16**
Average	**2.16**	**2.33**	**2**	**2.33**	**2.16**	**2.66**
Attainment	**2**	**2**	**2**	**2**	**2**	**2**

Where Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION “--”

1.3 Computational Methods of Optimization	
L T P 3 , 1 , 0 : **4 Credits**	Prerequisites: *None*

Course Objectives

During the course, students will:

1. learn how to pose optimization problems.
2. learn how to transform those problems into hopefully simpler-to-solve problems.
3. learn how to solve problems by using different algorithms.
4. learn how much time such algorithms would need.
5. we will also cover some recent techniques in optimization with broad applicability.

Detailed syllabus:

MODULE I
Classification and general theory of optimization. Linear Programming (LP): Introduction to LP and formulation of Linear Programming problems, geometric ideas, simplex and revised simplex methods, duality and sensitivity, interior-point methods for LP problems.

MODULE II
Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization , Simplex Algorithm, Minimization , Two phase method, Duality in linear programming, Integer linear programming.

MODULE III
Transportation & Assignment Problems: Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.

MODULE IV
Nonlinear optimization, method of Lagrange multipliers, Karush-Kuhn-Tucker theory, numerical methods for nonlinear optimization, convex optimization, quadratic optimization; Dynamic programming.

MODULE V
Queuing Models: Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process.
Replacement & Maintenance Models: Replacement of items, subject to deterioration of items subject to random failure group vs. individual replacement policies.
Simulation: Introduction & steps of simulation method, distribution functions and random number generation.

Text Books:
1. Jasbir. Arora , Introduction to optimum Design, Elsevier
2. Singeresu S. Rao, "Engineering Optimization , Theory and Practice" New Age Intl. Ltd., Publishers.

References:
Handy A Taha, Operations Research , An Introduction, Prentice Hall of India, New Delhi.

Hillier F S and Lieberman G J, Operations Research, Holden Day Inc., San Francisco.
Payne T A, Quantitative Techniques for Management: A Practical Approach, Reston Publishing Co. Inc., Virginia.

Course Outcomes

CO-No.	Course Outcome
1	Solve basic Linear programming problems and construct simplex method solutions.
2	Acquaint with Knowledge Representation and decision under uncordiality.
3	Apply Optimization and inferencing with available knowledge.
4	Pragmatic approach of Machine learning and fuzzy knowledge representation.
5	Apply AI techniques to real-world problems to develop intelligent systems.
6	Select appropriately from a range of techniques when implementing intelligent system

<u>CO-PO Mapping</u> (Rate: scale of 1 to 3)

Course Outcome	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	**1**	**1**	**1**	**2**	**1**	**2**
CO-2	**2**	**2**	**1**	**2**	**2**	**2**
CO-3	**2**	**2**	**2**	**1**	**2**	**3**
CO-4	**2**	**3**	**2**	**3**	**2**	**3**
CO-5	**3**	**3**	**3**	**3**	**3**	**3**
CO-6	**3**	**3**	**3**	**3**	**3**	**3**
Total	**13**	**14**	**12**	**14**	**13**	**16**
Average	**2.16**	**2.33**	**2**	**2.33**	**2.16**	**2.66**
Attainment	**2**	**2**	**2**	**2**	**2**	**2**

Where Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION “--”

Semester I- Elective

1.4.i) Stochastic Models and Applications	
L T P 4 , 0 , 0 : **4 Credits**	Prerequisites: *None*

Course Objectives

1. Understand the need for system models that capture random behavior to assess the risk of undesirable outcomes.
2. Be able to model a number of important industrial and service systems and analyze those models to improve system performance.
3. Be able to construct algorithmic solution strategies to explore system models that have been developed.

MODULE I

Introductory Probability: Defining Random Variables (RVs) Events, Measurability, Independence Sample Spaces, Events, Measures, Probability, Independence, Conditional probability, Bayes' theorem Random Variables. RVs: Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Normal, Lognormal, Expectations, Moments and Moment generating functions Random Vectors. Random Vectors: Joint and Marginal distributions, Dependence, Covariance, Copulas, Transformations of random vectors, Order statistics.

MODULE II

Intermediate Probability: Manipulating RVs Conditioning RVs. Conditional Distribution of a RV, Computing probabilities and expectations by conditioning, RVs Distributions.
Inequalities: Markov, Chebyshev, Jensen, Holder, Convergence of RVs: Weak and Strong laws, Central limit theorem, Distributions of extreme.

MODULE III

Stochastic Processes: Indexing RVs Markov Chains, Markovian property and Transition probabilities, Irreducibility and Steady, State probabilities.
Generic Applications: Hidden Markov Chains Exponential Distribution and Poisson Process, Construction of Poisson Process from Exponential Distribution, Thinning and Conditional Arrival Times, Service Applications: Waiting Times Normal Distribution and Brownian Process, Construction of Brownian Process from Normal Distribution, Hitting Times and Maximum Values, Finance Applications: Option Pricing and Arbitrage Theorem

References:

Introduction to Stochastic Processes. S.M. Ross.
Adventures in Stochastic Processes. S. Resnick. Birkhauser
Comparison Methods for Stochastic Models and Risks. A. Muller and D. Stoyan. John Wiley & Sons
Mathematical Theoy of Reliability. R.E. Barlow and F. Proschan.

To establish the correlation between COs & POs and Cos & PSOs

Table 1(Cos)

No. of Course Outcome (CO)	Course Outcome
CO1	Students would acquire a rigorous understanding of basic concepts in probability theory.
CO2	Learn some important concepts concerning multiple random variables such as Bayes rule for random variables, conditional expectation and its uses etc.
CO3	Explain and work on stochastic processes, including Markov Chains and Poisson Processes.

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	1	3	1
CO2	2	3	3	2	3	2
CO3	3	3	2	2	2	2
Total	6	7	8	5	8	5
Average	2	2.33	2.67	1.67	2.67	1.67
EqAvg Attainment	2	2	2	1	2	1

1.4.ii) Natural Language Processing	
L T P 4 , 0 , 0 : **4 Credits**	Prerequisites: *None*

Course Objective:

1. Teach students the leading trends and systems in natural language processing.
2. Make them understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the mentioned concepts in the syllabus.
3. Teach them to recognize the significance of pragmatics for natural language understanding.
4. Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Detailed syllabus:

MODULE I
Sound: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

MODULE II
Words and Word Forms : Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

MODULE III
Structures : Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

MODULE IV
Meaning and pragmatics: Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Coreferences. Discourse, Dialogue and Conversational agents, Natural Language Generation, Machine Translation.

MODULE V
Web 2.0 Applications: Sentiment Analysis; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

References:

1. Speech and Language Processing by Daniel Jurafsky, James H. Martin, Second Edition, Prentice Hall
2. James Allen, "Natural Language Understanding", 2/E, Addison-Wesley, 1994
3. Foundations of Statistical Natural Language Processing by Christopher D. Manning, Hinrich Schutze, MIT Press.
4. Statistical Language Learning by Charniack, Eugene, MIT Press, 1993.
5. The Handbook of Computational Linguistics and Natural Language Processing, Alexander Clark, Chris Fox, Shalom Lappin.
6. Steven Bird, Natural Language Processing with Python, 1st Edition, O'Reilly, 2009.

Table-1

Course Outcome No	Course Outcome
CO1	Understand the fundamental concept of NLP, Regular Expression, Finite State Automata along with the concept and application of word tokenization, normalization, sentence segmentation, word extraction, spell checking in the context of NLP.
CO2	Understand the concept of Morphology such as Inflectional and Derivational Morphology and different morphological parsing techniques and scope of ambiguity and it's resolution.
CO3	Understand the concepts of pragmatics, lexical semantics, lexical dictionary such as WordNet, lexical computational semantics, distributional word similarity and concepts related to the field of Information Retrieval in the context of NLP.
CO4	Understand the concepts of Semantic Roles; Word Sense Disambiguation; Multilinguality; Metaphors; Coreferences. Discourse, Dialogue and Conversational agents, Natural Language Generation, Machine Translation.
CO5	Understand the concepts related to language modeling with introduction to N-grams, chain rule, smoothing, spelling and word prediction and their evaluation along with the concept of Markov chain, HMM, Forward and Viterbi algorithm, POS tagging.
CO6	Describe and apply concepts of discourse machine translation, summarization and question answering to solve problems in NLP.

Table2

CO-PO Matrices; CO-PSO Mapping of course

1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	2	2	2	2	1	2
CO3	2	2	3	2	1	3
CO4	2	3	3	3	3	3
CO5	3	3	3	3	3	3
CO6	3	3	3	3	3	3
Total	13	14	15	14	12	15
Average	2.16	2.3	2.5	2.3	2	2.5
Eq. Average Attainment	2	2	3	2	2	3

1.4.iii) Soft Computing	
L T P 4 , 0 , 0 : **4 Credits**	Prerequisites: *None*

Course Outcomes:

CO1: Develops students' skill in neuro-fuzzy engines to handle machine learning in presence of uncertainty.
CO2: Provides solution to real world problems with approximate reasoning using fuzzy logic.
CO3: Instills the scope of optimization in engineering design using evolutionary computation.
CO4: Demonstrates the scope of the subject in all aspects of science, humanities and engineering.
CO5: Emphasizes the necessity of soft techniques in engineering industry, where mathematically hard techniques are difficult to realize in absence of sufficient data.

MODULE I

Introduction to Fuzzy sets, Fuzzy t- and s- norms, projection, cylindrical extension, Fuzzy relations, Implication relations, Fuzzy relational equations, Possibilistic reasoning, Fuzzy pattern recognition, Introduction to Fuzzy control and Fuzzy databases.

MODULE II

Boltzmann machine and Mean field learning-Combinational optimization problems using recurrent Neural network. Competitive Learning, Self organizing maps, Growing cell structure Principal component analysis.

MODULE III

Biological vs. artificial neurons, McCulloch and Pitts Model, Perceptron as linear classifier, Supervised learning: Perceptron learning algorithm, Steepest descent learning and backpropagation algorithm, Radial basis function neural net. Unsupervised learning: Hopfield neural net, Self-organizing feature map neural net, Competitive neural learning, Reinforcement learning: Q-learning and temporal difference Q-learning, Support vector machine (SVM), Kernelized SVM, Learning vector quantization.

MODULE IV

Genetic Algorithm: Binary and real codes, Genetic programming, Particle swarm optimization, Differential Evolution, Bacterial Foraging

MODULE V

Hybridization of neuro-fuzzy, neuro-GA, neuro-swarm, neuro-evolution algorithms. Applications in Pattern Recognition, Robotics, and Image Processing.

MODULE VI
Reinforcement Learning: Q-Learning and Learning Automata, Deterministic Q-Learning, Stochastic Q-Learning, Multi-agent Reinforcement Learning and Planning, Nash and Other equilibrium based multi-agent Learning and Planning.

MODULE VII
Belief Networks: Pearl's Model for Distributed Approach of Belief Propagation and Revision in a causal network, Concepts of D-separation, Bayesian Belief Networks, Dempster-Shafer theory for Orthogonal summation of Beliefs, Data Fusion techniques, Uncertainty management using Belief Networks.

MODULE VIII
Visual Perception: Marr's 2 and 1/2 Dimensional Vision, 3-D Vision, Camera Model, Perspective Projection Geometry, Inverse Perspective Projection Geometry, 3D Reconstruction from 2D Images by Kalman Filter and other Prediction Algorithms.

MODULE IX
Linguistic Perception: Parse Tree and Automata Based syntactic prediction of Natural Languages, Syntax and Semantics based Language understanding Models, Language Learning Models.

MODULE X
Deep Learning: Convolution Neural Networks, Long-Short Term Memory (LSTM) Models, Deep Recurrent Neural Networks. Applications in automated feature extraction in images and high dimensional data.

MODULE XI
Advanced Models of Reasoning: Soundness and Completeness issues of Resolution based Proof procedures in propositional and predicate logic, Herbrand's theorem and Lifting Lemma, Herbrand interpretation, Temporal Logic, Reasoning with Space and Time, Distributed Models of Reasoning using Petri Nets, and other graph theoretic approaches.

Text Books:
1. Computational Intelligence: Principles, Techniques, and Applications by A. Konar, Springer 2005
2. Computational Intelligence by A. P. Engelbrecht

References:

1. Artificial Intelligence and Soft Computing: Behavioral and Cognitive Modeling of the Human Brain by A. Konar, CRC Press, 2018.
2. Multi-Agent Coordination: A Reinforcement Learning Approach by A. K. Sadhu and A. Konar, Wiley-IEEE Press, 2021.
3. D. E. Goldberg, Genetic Algorithms in Search Optimization and Machine Learning, Addison Wesley, 3rd edition.
4. S. Haykin, Neural Networks: A comprehensive foundation, Pearson, 1999.

Course Outcomes

CO 1: Develops students' skill in neuro-fuzzy engines to handle machine learning in presence of uncertainty.
CO 2: Provides solution to real world problems with approximate reasoning using fuzzy logic.
CO 3: Instills the scope of optimization in engineering design using evolutionary computation.
CO 4: Demonstrates the scope of the subject in all aspects of science, humanities and engineering.
CO 5: Emphasizes the necessity of soft techniques in engineering industry, where mathematically hard techniques are difficult to realize in absence of sufficient data.

TABLE 2: CO-PO Mapping

1: Slight(LOW) 2: Moderate(MEDIUM) 3: Substantial (HIGH) and for NO CORELATION-“-“

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	2	2	3	2	1	2
CO3	3	3	2	2	2	2
CO4	2	2	2	2	2	3
CO5	3	3	3	3	3	3
Total	13	13	12	12	10	12
Average	2.6	2.6	2.4	2.4	2	2.4
Equivalent Average Attainment	3	3	2	2	2	2

1.4.iv) Data Mining	
L T P 3 , 0 , 0 : **4 Credits**	Prerequisites: *None*

Course Objectives:

1. To understand Data Mining in Knowledge discovery process, and its applications.
2. To understand different data attribute types and apply different data preprocessing techniques.
3. To understand how to identify association among data objects by learning various association mining algorithms.
4. To understand the various classification techniques, their applications in different domains.
5. To understand the various clustering techniques, their applications in different domains.
6. To learn various data visualization techniques for data analysis.

Detailed syllabus:

MODULE I
Introduction: Data Mining, Motivation, Application, Data Mining—On What Kind of Data?, Data Mining Functionalities, Data Mining Task Primitives, Major Issues in Data Mining.
Data pre-processing: Attribute types, Similarity & Dissimilarity measures.

MODULE II
Data Preprocessing: Data Cleaning, Data Integration, Data Reduction, Data Transformation & Discretization.

MODULE III
Mining Frequent Patterns: Basic Algorithms, Association Rule Mining, Apriori Algorithm, FP tree growth Algorithm, Advanced Pattern Mining Techniques.

MODULE IV
Classification Techniques: Decision Tree, Bayes Classification, Bayesian Belief Networks, Support Vector Machines, Classification Evaluation Techniques, Classification Accuracy improvement Techniques.

MODULE V
Clustering Techniques: Partitioning algorithms, Hierarchical algorithms, Density-Based algorithms, Grid-Based algorithms, Evaluation of Clustering. Outlier Detection Techniques.

MODULE VI
Applications and Trends in Data Mining: Applications, Advanced Techniques, Web Mining, Web Content Mining, Structure Mining.

Text Books:
J. Han and M. Kamber. Data Mining: Concepts and Techniques. 3rd Edition, Morgan Kaufman.
Pang Ning Tan, Introduction to Data Mining, 2nd Edition, Pearson.
M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education.
Roiger & Geatz, Data Mining, Pearson Education
A.K.Pujari, Data Mining, University Press

References Books:

1) Charu C. Aggarwal, Data Mining: The Text Book, Springer.
2) I. H. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann.
2) D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. Prentice, Hall.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to interpret the contribution of data mining in Knowledge discovery process.
CO2	Students will be able to identify different data attribute types and apply different data preprocessing techniques.
CO3	Students will be able to apply the link analysis and frequent item-set algorithms to identify the entities on the real-world data.
CO4	Students will be able to apply the various classification and clustering algorithms for supervised and unsupervised learning problems.
CO5	Students will be able to apply various data visualization techniques for in-depth data analysis.
CO6	Students will be able to apply the advanced data mining techniques and use the popular data mining tools.

CO-PO Mapping:

Table2

Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	--
CO2	2	2	2	--	--	--
CO3	3	2	3	1	--	--
CO4	3	3	3	1	2	1
CO5	3	3	3	1	2	1
CO6	3	3	3	1	3	2
Total	16	15	16	5	8	4
Average Attainment	2.7	2.5	2.7	0.8	1.3	0.7
Equivalent Average Attainment	3	3	3	1	1	1

1.4.v) PATTERN RECOGNITION	
L T P 3 - 1 - 0 : 4 Credits	Prerequisites: *None*

Course Objectives:

This course covers the techniques and gain proficiency of pattern recognition that are fundamental to a wide variety of application areas such as medical research, biometrics, computer vision, etc.

Detailed Syllabus:

MODULE I: **Introduction**

Pattern recognition basis, Pattern Recognition problems and System Design, and learning (supervised, unsupervised), training and test sets, feature selection, Dimensionality Reduction.

MODULE II**: Supervised learning and classification**

Discriminant functions and decision boundaries Linear discriminant functions, relaxation procedure, non-separable behaviour Minimum distance classifier. Bayesian decision theory. Maximum likelihood classification. Parameter estimation, sufficient statistics, component analysis and discriminants (PCA, Fisher's) Nonparametric techniques. Density estimation, Parzen window, K-NN estimation, Supervised neural learning: Back-propagation algorithm, Radial basis-function neural net; Linear Classifier-Support vector machine classifier, Learning vector quantization

MODULE III: **Unsupervised learning and clustering**

Data description and clustering –, similarity measures, criterion for clustering, Methods of clustering - Sequential and hierarchical Clustering, graph theoretic, density based, k-means, k-mediod, fuzzy c-means clustering, Vector Quantization, Cluster validity

MODULE IV: **Feature extraction and feature selection**

Problems of dimensionality- Feature extraction --PCA-Feature selection –Karhunen Loeve, stochastic approximation, kernel approximation, divergence measures, Independent component analysis

Text Books:

1. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification and Scene Analysis, 2nd ed., Wiley, New York, 2000.

2. J. T. Tou and R. C. Gonzalez, Pattern Recognition Principles, Addison-Wesley, London, 1974.

Reference Books :

3. C.M Bishop "Pattern Recognition and Machine Learning " Springer, 2006.
4. A. Konar, Computational Intelligence: Principles, Techniques, and Applications, Springer 2005.

Course Outcomes (CO):

Table1

Course Outcome No	Course Outcome
CO1	Determine Classifiers for Pattern recognition.
CO2	Analyze Feature Selection and Dimensionality Reduction.
CO3	Ability to select an appropriate Pattern Analysis tools and different models for Analyzing data in a given feature Space.
CO4	Classify the data objects and develop template matching module to recognize the pattern.
CO5	Apply Unsupervised learning algorithm to data objects.
CO6	Analyze Clustering Algorithm.

CO-PO Mapping:

Table2

Levels: 1: Slight(LOW) 2: Moderate(MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	3	1
CO2	1	2	2	1	3	2
CO3	2	2	1	1	3	2
CO4	2	1	-	2	3	1
CO5	2	2	2	1	3	1
CO6	2	1	2	2	3	2
Total	11	10	8	8	18	9
Average	1.8	1.6	1.6	1.6	3	1.5
Eq. Average Attainment	2	2	2	2	3	2

Semester I Elective II

1.5.i) EXPERT SYSTEMS	
L T P 4,0,0:4Credits	Prerequisites: None

Course Objectives:

1. Students will be able to explain and describe the concepts central to the creation of knowledge bases and expert systems.
2. Students will be knowledgeable about the tools and the processes used for the creation of an expert system.
3. Student will know methods used to evaluate the performance of an expert system.
4. Students will be able to conduct an in-depth examination of an existing expert system with an emphasis on basic methods of creating a knowledge base.
5. Students will be able to examine properties of existing systems in a case-study manner, comparing differing approaches.

MODULE I
Introduction to AI: Intelligent agents, Perception, Natural language processing, Problem, Solving agents, Searching for solutions: Uniformed search strategies, Informed search strategies.

MODULE II
Adversarial search, Optimal and imperfect decisions, Alpha, Beta pruning, Logical agents: Propositional logic, First order logic, Syntax and semantics, Using first order logic, Inference in first order logic.

MODULE III
Uncertainty, acting under uncertainty, Basic probability notation, Axioms of probability, Baye's rule, Probabilistic reasoning, making simple decisions.

MODULE IV
Planning: Planning problem, Partial order planning, Planning and acting in non, deterministic domains, Learning: Learning decision trees, Knowledge in learning, Neural networks , Reinforcement learning , Passive and active.

MODULE V
Definition, Features of an expert system, Organization, Characteristics, Prospector, Knowledge Representation in expert systems, Expert system tools, MYCIN, EMYCIN.

Text Books:

Stuart Russel and Peter Norvig, 'Artificial Intelligence A Modern Approach', Second Edition, Pearson Education, PHI.
Donald A.Waterman, 'A Guide to Expert Systems', Pearson Education.

References:

1. George F.Luger, 'Artificial Intelligence, Structures and Strategies for Complex Problem Solving', Fourth Edition, Pearson Education.

2. Elain Rich and Kevin Knight, 'Artificial Intelligence', Second Edition Tata McGraw Hill.

<u>To establish the correlation between COs & POs and Cos & PSOs</u>

<u>Table 1(Cos)</u>

No. of Course Outcome (CO)	Course Outcome
CO1	Implements an expert system.
CO2	Determines inference mechanism for a given problem.
CO3	Determines knowledge representation method for a given problem.
CO4	Knows the commonsense databases and their construction phases.
CO5	To compare the design patterns and explain which design pattern should be used.

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

Rating: 1→Slight (LOW), 2→Moderate (MEDIUM), 3→Substantial (HIGH) and "-" → NO CORELATION

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	1	2	2	2	1	2
CO3	2	2	2	3	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Total	10	11	11	12	10	11
Average	2	2.2	2.2	2.4	2	2.2
EqAvg **Attainment**	2	2	2	2	2	2

1.5.ii) COMPUTER VISION	
L T P 4, 0, 0: **4Credits**	Prerequisites: None

Course Objectives:

1. To introduce students the fundamentals of image formation.
2. To introduce students the major ideas, methods and techniques of computer vision and pattern recognition.
3. To develop an appreciation for various issues in the design of computer vision and object recognition systems.
4. To provide the student with programming experience from implementing computer vision and object recognition applications.

Course Outcomes:

1. Describe different image representation, their mathematical representation and different data structures used.
2. Classify different segmentation algorithm for given input.
3. Create a 3D object from given set of images.
4. Detect a moving object in video using the concept of motion analysis.
5. Recognize the object using the concept of computer vision

Detailed Syllabus::

MODULE I

Digital Image Formation and low, level processing: Overview and State of the art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Depth estimation and Multi camera views:

Perspective, Binocular Stereopsis: Camera and Epipolar Geometry, Homography, Rectification, DLT, RANSAC, 3D reconstruction framework, Auto calibration.

MODULE II

Feature Extraction: Edges , Canny, LOG, DOG, Line detectors (Hough Transform), Corners , Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale, Space Analysis, Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph, Cut, Mean, Shift, MRFs, Texture Segmentation, Object detection.

MODULE III

Pattern Analysis:

Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised, Classifiers: Bayes, KNN, ANN models, Dimensionality Reduction: PCA, LDA, ICA, Nonparametric methods.

MODULE IV

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio, Temporal Analysis, Dynamic Stereo, Motion parameter estimation.

Shape from X: Light at Surfaces, Phong Model, Reflectance Map, Albedo estimation, Photometric Stereo, Use of Surface Smoothness Constraint, and Shape from Texture, color, motion and edges.

MODULE V

Miscellaneous: Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing, Modern trends, super-resolution, GPU, Augmented Reality, cognitive models, fusion and SR&CS.

Text Books:

1. Szeliski, R., Computer Vision: Algorithms and Applications, Springer, Verlag London .
2. Forsyth, A., D. and Ponce, J., Computer Vision: A Modern Approach, Pearson Education.

References:

1. Hartley, R. and Zisserman, A., Multiple View Geometry in Computer Vision Cambridge University Press.
2. Fukunaga, K., Introduction to Statistical Pattern Recognition, Academic Press, Morgan Kaufmann.

To establish the correlation between COs & POs and Cos & PSOs

Table 1(Cos)

No. of Course Outcome (CO)	Course Outcome
CO1	Describe different image representation, their mathematical representation and different data structures used.
CO2	Classify different segmentation algorithm for given input.
CO3	Create a 3D object from given set of images.
CO4	Detect a moving object in video using the concept of motion analysis.
CO5	Recognize the object using the concept of computer vision

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

Rating: 1→Slight (LOW), 2→Moderate (MEDIUM), 3→Substantial (HIGH) and "-" → NO CORELATION

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	1	2	2	2	1	2
CO3	2	2	2	3	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Total	10	11	11	12	10	11
Average	2	2.2	2.2	2.4	2	2.2
EqAvg Attainment	2	2	2	2	2	2

1.5.(iii) Wireless Communication Network	
L T P 4 , 0 , 0 : 4 Credits	Prerequisites: *None*

Course Objectives:

1. To understand the functions of wireless communication system.
2. To gather knowledge about the evolution of different wireless communication systems and standards.
3. To understand the architectures of various access technologies such as 3G, 4G, WiFi etc and to gather knowledge about multiple access techniques for Wireless Communication.
4. To understand the principles of mobile radio communication and to study the recent trends adopted in cellular systems and wireless standards.
5. To understand various protocols and services provided by the next generation networks .

Detailed syllabus:

MODULE I

Introduction and Generations of Wireless Networks, Characteristics of the Wireless Medium: Radio Propagation Mechanisms, Path Loss Modelling and Signal Coverage, Effect of Multipath and Doppler, Channel Measurement and Modelling Technique, Diversity in wireless communications - Non-coherent and coherent reception; error probability for uncoded transmission, Realization of diversity: time diversity; frequency diversity: DSSS and OFDM; receiver diversity: SC, EGC and MRC; transmit diversity: space-time codes; Multiple-Input Multiple-Output (MIMO) wireless systems: Capacity of MIMO wireless systems; spatial multiplexing; space-time coding.

MODULE II

Multiple Access Techniques: FDMA, TDMA, CDMA, OFDM, SDMA and their comparisons, Modulation Techniques – AM, FM, FSK, PSK, QPSK, QAM, 16QAM, interference management, power control, Mobile Data Networks: Introduction, Data Oriented CDPD Network, GPRS, EDGE and High Data Rates, SMS in GSM, Mobile Application Protocols

MODULE III

Network Planning: Introduction, Wireless Network Topologies, Cellular Topology, Cell Fundamentals, Signal to Interferences Ratio Calculations, Channel reuse, Dynamic resource allocation: Cognitive Radio, Network Planning for CDMA Systems. Wireless Network Operations: Mobility Management, Radio Resources and Power Management.

MODULE IV

Introduction to Wireless LAN, Overview of IEEE 802.11, Reference Architecture, PHY and MAC Layer, Wireless Home Networking, Technologies for Home Area Network (HAN), HIPERLAN. IEEE 802.15 WPAN, HomeRF, Bluetooth, Adhoc Networks, Mesh networks: capacity, routing, and scheduling., Introduction to 2.5 G and 3 G Networks.

Text Books

1. A. Goldsmith, Wireless Communications, Cambridge Univ. Press, 2005.
2. Kaveh Pahlavan, Prashant Krishnamurthy “Principles of Wireless Networks”, PHI.

Reference Books

1. D. Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge Univ. Press, 2005
2. Dharma Prakash Agrawal, Qing- An Zeng, “Introduction to Wireless and Mobile Systems” CENGAGE Learning.
3. Kamilo Feher “Wireless Digital Communications”, PHI
4. Jochen Schiller “Mobile Communications”, PEARSON

To establish the correlation between COs & POs and Cos & PSOs

Table 1

Course Outcome No.	Course Outcome
CO1	Discuss the basic principles, concepts of wireless networks and analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.
CO2	Analyze the design parameters, link design, smart antenna, and MIMO systems.
CO3	Analyze Multiuser Systems, CDMA, WCDMA network planning and OFDM Concepts.
CO4	Identify the importance of Wireless LAN, Adhoc Networks and Wireless Mesh Network and analyze different technologies for HAN.
CO5	Summarize the principles and applications of wireless systems and design a cellular system based on resource availability and traffic demands.

CO-PO Mapping:

TABLE 2

1: Slight(LOW) 2: Moderate(MEDIUM) 3: Substantial (HIGH) and for NO CORELATION-“-“

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	2	2	1
CO2	1	1	1	2	1	1
CO3	2	2	3	2	1	2
CO4	3	3	3	3	2	3
CO5	3	3	3	3	3	3
Total	10	10	12	12	9	11
Average	2	2	2.4	2.4	1.8	2.2
EqAvg Attainment	2	2	2	2	2	2

1.5.iv) Information Retrieval	
L T P 4 , 0 , 0 : **4 Credits**	Prerequisites: *None*

Courses objective:

1. To understand fundamental concepts of Information retrieval systems.
2. To understand the knowledge of data structures and indexing methods in information retrieval Systems.
3. To learn the evaluation of different indexing techniques.
4. To learn and develop indexing systems for audio and visual documents.
5. To learn the concept of searching of webs.

Detailed Syllabus::

MODULE I
Basic Concepts of IR, Data Retrieval & Information Retrieval, IR system block diagram. Automatic Text Analysis, Luhn's ideas, Conflation Algorithm, Indexing and Index Term Weighing, Probabilistic Indexing, Automatic Classification, Measures of Association, Different Matching Coefficient, Classification Methods, Cluster Hypothesis. Clustering Algorithms, Single Pass Algorithm, Single Link Algorithm, Rochhio's Algorithm and Dendograms.

MODULE II
File Structures, Inverted file, Suffix trees & suffix arrays, Signature files, Ring Structure, IR Models, Basic concepts, Boolean Model, Vector Model, and Fuzzy Set Model. Search Strategies, Boolean search, serial search, and cluster based retrieval, Matching Function.

MODULE III
Performance Evaluation, Precision and recall, alternative measures reference collection (TREC Collection), Libraries & Bibliographical system, Online IR system, OPACs, Digital libraries , Architecture issues, document models, representation & access, Prototypes, projects & interfaces, standards.

MODULE IV
Taxonomy and Ontology: Creating domain specific ontology, Ontology life cycle Distributed and Parallel IR: Relationships between documents, Identify appropriate networked collections, multiple distributed collections, parallel IR, MIMD Architectures, Distributed IR, Collection Partitioning, Source Selection, and Query Processing.

MODULE V
Multimedia IR models & languages, data modelling, Techniques to represent audio and visual document, query languages Indexing & searching, generic multimedia indexing approach, Query databases of multimedia documents, Display the results of multimedia searches, one dimensional time series, two dimensional color images, automatic feature extraction.

MODULE VI
Searching the Web, Challenges, Characterizing the Web, Search Engines, Browsing, Mata searchers, Web crawlers, robot exclusion, Web data mining, Metacrawler, Collaborative filtering, Web agents (web shopping, bargain finder,..), Economic, ethical, legal and political
Issues.

Text Books/References:

1. Introduction to Information Retrieval. C.D. Manning, P. Raghavan, H. Schütze. Cambridge UP, 2008.
2. Modern Information Retrieval. R. Baeza-Yates, B. Ribeiro-Neto. Addison-Wesley, 1999.
3. Information Retrieval: Algorithms and Heuristics. D.A. Grossman, O. Frieder. Springer, 2004.
4. Managing Gigabytes. I.H. Witten, A. Moffat, T.C. Bell. Morgan Kaufmann, 1999.
5. The Geometry of Information Retrieval. C.J. van Risjbergen. Cambridge UP, 2004.

To establish the correlation between COs & POs and Cos & PSOs

Table 1(Cos)

No. of Course Outcome (CO)	Course Outcome
CO1	Ability to understand the nature of information and retrieval requirements.
CO2	Ability to use knowledge of data structures and indexing methods in information retrieval systems.
CO3	Ability to evaluate performance of retrieval systems.
CO4	Ability to choose clustering and searching techniques.
CO5	Ability to crawl information and explain different types of search algorithms.

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

Rating: 1→Slight(LOW), 2→Moderate(MEDIUM), 3→Substantial (HIGH)

and '-' → NO CORELATION-"-"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Total	11	11	11	11	11	11
Average	2.2	2.2	2.2	2.2	2.2	2.2
EqAvg Attainment	2	2	2	2	2	2

1.5.(v) AI for Cyber Security	
L T P 4 , 0 , 0 : 4 Credits	Prerequisites: *None*

Course Objective

The objective of this course is to introduce Artificial Intelligence and Cyber security and their inherent relationship, using Artificial Intelligence Tools to enhance Security, learn machine learning aspects to identify security treats, decipher attacks, vulnerabilities, the Future of AI in Advancing Security and Promoting create architectural, algorithmic and technological foundations for ensuring cyber security, maintenance of the privacy of individuals/organizations.

Detailed Syllabus:

Module 1:

Introduction: Understanding Cyber security, Looking at the Various Aspects of Cyber security, Social engineering and phishing , Introducing ransom ware, Malware intrusion, Non-malware intrusion, Detect, Respond, and Mitigate, Responding to and Recovering From Cyber attacks and Security Events, Meeting the Challenges of Cyber security,

Module 2:

Understanding Artificial Intelligence: Teaching Machines to be Smarter , Learning Algorithms , Supervised learning, Unsupervised learning , Being Smarter , Interacting with Humans , Natural Language Processing.

Module 3:

Discovering Machine Learning and Deep Learning: Deep Learning and Deeply Layered Neural Networks , Introducing cognitive computing , Structured and Unstructured Data.

Module 4:

Applying Machine Learning and Deep Learning to Cyber security: Predictive Analytics, Taught Not Programmed, Uncovering the needle in the haystack, Introducing cognitive computing, Identifying root cause, A Smarter Adversary.

Module 5:

Using the Cognitive Capabilities to Investigate Security Incidents, Taking Intelligent Action, Understand, Reason and Learn, Detecting spam with Perceptron, Malware threat detection.

Module 6:

Responding to Ransomware, Network anomaly detection with AI, Fraud prevention with cloud AI solutions, GANs - Attacks and Defenses.

Reference Book:

1. Artificial Intelligence & Cybersecurity For Dummies, IBM Limited Edition.
2. Machine Learning for Computer and Cyber Security Principle, Algorithms, and Practices, 1st Ed. By Brij B. Gupta, Quan Z. Sheng, CRC Press.
3. Artificial Intelligence for Security by Archie Addo, Srini Centhala, Muthu Shanmugam, Publisher(s): Business Expert Press ISBN: 9781951527273.
4. Machine Learning and Security: Protecting Systems with Data and Algorithms 1st Edition, by Clarence Chio, David Freeman, O'Reilly Media.
5. Hands-On Artificial Intelligence for Cybersecurity by Alessandro Parisi, 2019, Publisher(s): Packt, ISBN: 9781789804027

Course Outcomes

CO1	Students will be able to have insight into the methods used in artificial intelligence (AI) and machine learning (ML) related to cyber security.
CO2	Students will be able to demonstrate why are AI important for cybersecurity and how is AI used in Cyber Security Today.
CO3	Students will be able to measure the Implications of AI in privacy and the applications of machine learning in security.
CO4	Students will be able to detect intrusion in networks and systems by applying tools and techniques revealing abnormal patterns in datasets.
CO5	Students will be able to analyze the trends of applications of Artificial Intelligence in cyber security.

Table: CO-PO Matrices

1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	--	1	1	1	--	--
CO2	1	2	2	2	--	--
CO3	1	3	3	3	2	2
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	2
Total	8	12	12	12	6	7
Average	1.6	2.4	2.4	2.4	1.2	1.4
Eq. Average Attainment	2	2	2	2	1	1

1.6. Laboratory I(Advanced Data Structures and Algorithms)	
L T P 0 , 0 , 2 : **2 Credits**	Prerequisites: *None*

Course Outcomes:

1 Describe how arrays, records, linked structures, stacks, queues, trees, and graphs are represented in memory and used by algorithms [ABET (a, b, c, i)].

2 . Describe common applications for arrays, records, linked structures, stacks, queues, trees, and graphs [ABET (a, b, c) .

3. Write programs that use arrays, records, linked structures, stacks, queues, trees, and graphs[ABET (a, c)]

4. Demonstrate different methods for traversing trees [ABET (a)].

Programme Outcomes:

1. Identify, formulate, and analyze complex engineering problems reaching substantiated conclusions using first principles engineering sciences.

Experiment 1 (Arrays, Linked List, Stacks, Queues, Binary Trees)

I. WAP to implement a 3,stacks of size 'm' in an array of size 'n' with all the basic operations such as IsEmpty(i), Push(i), Pop(i), IsFull(i) where 'i' denotes the stack number (1,2,3), m ≅ n/3. Stacks are not overlapping each other. Leftmost stack facing the left direction and other two stacks are facing in the right direction.

II. WAP to implement 2 overlapping queues in an array of size 'N'. There are facing in opposite direction to eachother. Give IsEmpty(i), Insert(i), Delete(i) and IsFull(i) routines for ith queue

III. WAP to implement Stack ADT using Linked list with the basic operations as Create(), Is Empty(), Push(), Pop(), IsFull() with appropriate prototype to a functions.

IV. WAP to implement Queue ADT using Linked list with the basic functions of Create(), IsEmpty(), Insert(), Delete() and IsFull() with suitable prototype to a functions

Experiment 2 (Sorting & Searching Techniques)

Experiment 3 (Hashing)

I. WAP to store k keys into an array of size n at the location computed using a hash function, loc = key % n, where k<=n and k takes values from [1 to m], m>n. To handle the collisions use the following collision resolution techniques,
a. Linear, Quadratic, Random probing, Double hashing/rehashing, Chaining.

Experiment 4 (BST and Threaded Trees)
Experiment 5 (AVL Trees and Red,Black Trees)
Experiment 6 (B,Trees)
Experiment 7 (Min,Max Heaps, Binomial Heaps and Fibonacci Heaps)
Experiment 8 (Disjoint Sets)
Experiment 9 (Graphs Algorithms)
Experiment 10 (String Matching)

<u>To establish the correlation between COs & POs and Cos & PSOs</u>

<u>Table 1(Cos)</u>

No. of Course Outcome (CO)	Course Outcome
CO1	Describe how arrays, records, linked structures, stacks, queues, trees, and graphs are represented in memory and used by algorithms [ABET (a, b, c, i)].
CO2	Describe common applications for arrays, records, linked structures, stacks, queues, trees, and graphs [ABET (a, b, c) .
CO3	Write programs that use arrays, records, linked structures, stacks, queues, trees, and graphs[ABET (a, c)]
CO4	Demonstrate different methods for traversing trees [ABET (a)].

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	3	1	3
CO2	2	1	3	1	2	3
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	1
Total	9	7	9	9	8	9
Average	2.25	1.75	2.25	2.25	2	2.25
EqAvg Attainment	2	1	2	2	2	2

1.7. Laboratory II (Artificial Intelligence)	
L T P 0 , 0 , 2 : **2 Credits**	Prerequisites: *None*

Course Objective:

1. Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
2. Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
3. Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool.
4. Explore the current scope, potential, limitations, and implications of intelligent systems

List of Experiments

MODULE I

1 Study of PROLOG. Write the following programs using PROLOG / CLIPS
2 Write a program to solve 8 queens problem
3 Solve any problem using depth first search.
4 Solve any problem using best first search.
5 Solve 8-puzzle problem using best first search
6 Solve Robot (traversal) problem using means End Analysis
7 Solve traveling salesman problem.

MODULE II

Experiments on Planning, Situation Calculus Planning using STRIPS

MODULE III

Experiments on Markov Chains, Maximum A posteriori Probability (MAP) Inference, Inference in Temporal Models, Introduction to learning graphical models, Parameter Estimation, Bayesian Networks and Shared Parameters.

MODULE IV

Experiments on Neural Networks, ANN, McCulloch Pitts Model, Perceptron Network.

MODULE V

Experiments on Fuzzy Logic: operations of Fuzzy sets, Variables inference techniques, defuzzification techniques.

To establish the correlation between COs & POs and Cos & PSOs

Table 1(Cos)

No. of Course Outcome (CO)	Course Outcome
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
CO2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
CO3	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
CO4	Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	3	1	3
CO2	2	1	3	1	2	3
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	1
Total	9	7	9	9	8	9
Average	2.25	1.75	2.25	2.25	2	2.25
EqAvg Attainment	2	1	2	2	2	2

Semester II

2.1 Robotics and Automation	
L T P 3 , 1 , 0 : 4 Credits	Prerequisites: *None*

Course Objective:
1. Explain the fundamentals of robotics and its components.
2. Illustrate the Kinematics and Dynamics of robotics.
3. Elucidate the need and implementation of related Instrumentation & control in robotics
4. Illustrate the movement of robotic joints with computers/microcontrollers.
5. Explain sensors and instrumentation in robotics.

MODULE I
Robotics Foundations: Kinematics , Dynamics , Mechanisms and Actuation , Sensing and Estimation , Motion Planning , Motion Control , Force Control , Robotic Systems Architectures and Programming , AI Reasoning Methods for Robotics.

MODULE II
Robot Structures: Performance Evaluation and Design Criteria , Redundant Manipulators Parallel Mechanisms and Robots , Robots with Flexible Elements , Model Identification , Robot Hands , Legged Robots , Wheeled Robots , Micro/Nano Robots.

MODULE III
Sensing and Perception: Force and Tactile Sensors , Inertial Sensors, GPS and Odometry, Sonar Sensing , Range Sensors , 3D Vision and Recognition , Visual Servoing and Visual Tracking , Sensor Fusion.

MODULE IV
Manipulation and Interfaces: Motion for Manipulation Tasks , Modelling and Manipulation , Grasping , Cooperative Manipulators, Haptics, Telerobotics, Networked Teleoperation, Exoskeletons for Human Performance Augmentation.

MODULE V
Mobile and Distributed Robotics: Motion Control of Wheeled Mobile Robots , Motion Planning and Obstacle Avoidance , World Modeling , Simultaneous Localization and Mapping , Behavior Based Systems , Distributed and Cellular Robots , Multiple Mobile Robot Systems , Networked Robots.

MODULE VI
Field and Service Robotics: Industrial Robotics, Underwater Robotics, Aerial Robotics, Space Robots and Systems, Chap. 46. Robotics in Agriculture and Forestry, Robotics in Construction, Robotics in Hazardous Applications, Mining Robotics , Search and Rescue Robotics, Intelligent Vehicles, Medical Robots and Systems, Rehabilitation and Health Care Robotics , Domestic Robots, Robots for Education.

MODULE VII
Human-Centered and Life Like Robotics: Humanoids , Safety for Physical Human Robot Interaction , Social Robots that Interact with People , Robot Programming by Demonstration , Biologically, Inspired Robots , Evolutionary Robotics, Neurorobotics: From Vision to Action Perceptual Robotics, Roboethics: Social and Ethical Implications.

Text Books:

1. Introduction to Robotics: Mechanics & Control, 3ed, J. Craig, Prentice Hall, 2004.
2. Robot Modeling and Control, M. Spong, S. Hutchinson, M. Vidyasagar, Wiley, 2005.
3. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, Prentice Hall, 1990.
4. Theory of Applied Robotics 2nd Ed., R. Jazar, Springer, 2010.

CO-No.	Course Outcome	Module Covered
1	Introduction to kinematics and basic construction of Robotics concept.	**I**
2	Learners will know about structural and design criteria of robot construction with ethical application.	**II**
3	An introduction to Perception - actuator sequence with environmental variation and haptic manipulation.	**III**
4	Introduction to mobile robot with AGV and UGV.	**IV,V**
5	Field application of robotics including agricultural and service sector.	**V**
6	Human robot interaction and visual perception for surround localization and mapping.	**V,VI, VIII**

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	3	1	3
CO2	2	3	3	1	2	3
CO3	2	2	2	2	3	2
CO4	3	3	1	3	3	2
Total	8	9	7	9	9	10
Average	2	2.25	1.75	2.25	2.25	2.5
EqAvg Attainment	2	2	1	2	2	2

2.2. Machine Learning	
L T P 3 , 1 , 0 : **4 Credits**	Prerequisites: *None*

Course Objectives:

1. To recognize the characteristics of machine learning that makes it useful to solve real-world problems.
2. To understand the appropriate implementation of supervised, semi supervised and unsupervised learning techniques in real-world applications.
3. To choose a suitable machine learning model, implement, and examine the performance of the chosen model for a given real world problem.
4. To understand cutting edge technologies related to machine learning applications.

Detailed syllabus:

MODULE I

Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias.

MODULE II

Supervised Learning: Classification vs. Regression, Linear and Logistic Regression, Gradient Descent, Support Vector Machines, Kernels, Decision Trees, ML and MAP Estimates, K-Nearest Neighbor, Naive Bayes, Introduction to Bayesian Networks, Artificial Neural Networks.

MODULE III

Unsupervised Learning: Partitioning based methods, Hierarchical methods, Density based methods, Gaussian Mixture Models, Learning with Partially Observable Data (EM). Dimensionality Reduction and Principal Component Analysis.

MODULE IV

Optimization Techniques: Bias-Variance tradeoff, Regularization, Evaluation techniques for supervised and unsupervised learning.

MODULE V

Other Learning techniques: A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Recommender Systems.

MODULE VI

Applications of Machine Learning: Texts, Image, Time-series data.

Textbooks:

1) T. Mitchell, Machine Learning, McGrawHill.

2) Ethem Alpaydın, Introduction to Machine Learning 3rd Edition, MIT Press
3) Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012

References:

1) Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2) Shwartz and David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.
3) C.M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
4) Andrew Ng, Machine Learning Yearning.
5) Other online material.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to understand the mathematics and engineering sciences behind functioning of machine learning.
CO2	Students will be able to analyze the given dataset and data attributes for designing a machine learning-based solution.
CO3	Students will be able to identify different machine learning approaches, optimization techniques, and apply them on different problem domains.
CO4	Students will be able to design and deploy machine learning solutions for real-world applications with popular machine learning tools.

CO-PO Mapping:

Table2

Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	--
CO2	2	2	1	2	2	--
CO3	3	3	3	3	2	1
CO4	3	3	2	1	2	2
Total	10	10	8	8	8	3
Average Attainment	2.5	2.5	2	2	2	0.75
Eq. Average Attainment	3	3	2	2	2	1

2.3 Computational Linear Algebra	
L T P 3 , 1 , 0 : 4 Credits	Prerequisites: *None*

Course Objective:

The goals of this course are for students to:

1. Understand basic models of computation and how to use them to analyze the efficiency of algorithms.
2. Understand the fundamentals of how a computer's architecture affects the performance of an algorithms.
3. Understand basic programming paradigms and the tools for implementations using these paradigms.

MODULE I

Fundamental operation with vectors in Euclidean space Rn , Linear combination of Schwarz inequality, Triangle–vectors, Dot product and their properties, Cauchy inequality, Projection vectors, Some elementary results on vector in Rn , Matrices, Gauss, Jordan row reduction, Reduced row echelon form, Row equivalence, Rank, Linear combination of vectors, Row space, Eigenvalues, Eigenvectors, Eigenspace, Characteristic polynomials, Diagonalization of matrices, Definition and examples of vector space, Some elementary properties of vector spaces, Subspace.

MODULE II

Span of a set, A spanning set for an eigenspace, Linear independence and linear dependence of vectors, Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets, Application of rank, Homogenous and non homogenous systems of equations, Coordinates of a vector in ordered basis, Transition matrix, Linear transformations: Definition and examples, Elementary properties, The matrix of a linear transformation, Linear operator and Similarity.

MODULE III

Application: Computer graphics, Fundamental movements in a plane, Homogenous coordinates, Composition of movements, Kernel and range of a linear transformation, Dimension theorem, One to one and onto linear transformations, Invertible linear transformations, Isomorphism: Isomorphic vector spaces (to Rn), Orthogonal and orthonormal vectors, Orthogonal and orthonormal bases, Orthogonal complement, Projection theorem (Statement only), Orthogonal projection onto a subspace, Application: Least square solutions for inconsistent systems.

Textbooks

Introduction to Linear Algebra, Fifth Edition, Gilbert Strang.
Linear Algebra Done Right, Third Edition.
No Bullshit Guide To Linear Algebra, Ivan Savov.
Matrix Computations, Gene Golub and Charles Van Loan.
Numerical Linear Algebra, Lloyd Trefethen and David Bau.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to understand the mathematics and engineering sciences behind functioning of hardware.
CO2	Students will be able to analyze the given problem, its computations requirements and solution domain in general terms .
CO3	Students will be able to identify different transformation functions.
CO4	Students will be able to design and deploy graph theoretic approach to different real-life problem.

CO-PO Mapping:

Table2

Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	--
CO2	2	2	1	2	2	--
CO3	3	3	3	3	2	1
CO4	3	3	2	1	2	2
Total	10	10	8	8	8	3
Average Attainment	2.5	2.5	2	2	2	0.75
Eq. Average Attainment	3	3	2	2	2	1

Semester II Elective III

2.4.(i) Agent based intelligent system	
L T P 4 , 0 , 0 : 4 Credits	Prerequisites: *None*

Course Objectives:

1. To understand Agent development
2. To gain Knowledge in Multi agent and Intelligent agents
3. To understand Agents and security
4. To gain Knowledge in Agent Applications

MODULE I
Definitions , Foundations , History , Intelligent Agents, Problem Solving, Searching, Heuristics, Constraint Satisfaction Problems , Game playing.

MODULE II
Logical Agents, First order logic, First Order Inference, Unification, Chaining, Resolution Strategies, Knowledge Representation, Objects, Actions, and Events

MODULE III
Planning Problem, State Space Search, Partial Order Planning, Graphs, Nondeterministic Domains, Conditional Planning, Continuous Planning, MultiAgent Planning.

MODULE IV
Acting under uncertainty , Probability Notation, Bayes Rule and use , Bayesian Networks, Other Approaches, Time and Uncertainty, Temporal Models, Utility Theory , Decision Network , Complex Decisions.

MODULE V
Knowledge in Learning, Relevance of Information, Statistical Learning Methods, Reinforcement Learning, Communication, Formal Grammar, Augmented Grammars, Future of AI.

Text Book:
Stuart Russell and Peter Norvig, "Artificial Intelligence , A Modern Approach",2nd Edition, Prentice Hall, 2002

References
Michael Wooldridge, "An Introduction to Multi Agent System", John Wiley.
Patrick Henry Winston, Artificial Intelligence, 3rd Edition, AW.
Nils.J.Nilsson, Principles of Artificial Intelligence, Narosa Publishing House.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to understand development of software agents.
CO2	Students will be able to analyze the given dataset and data attributes for designing a neural network-based solution Gain Knowledge in Multi agent and Intelligent agents.
CO3	Students will be able to understand Agents and security.
CO4	Students will be able to gain knowledge on applications of agents.

CO-PO Mapping:

Table2

Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	--
CO2	2	2	1	2	2	--
CO3	3	3	3	3	2	1
CO4	3	3	2	1	2	2
Total	10	10	8	8	8	3
Average Attainment	2.5	2.5	2	2	2	0.75
Eq. Average Attainment	3	3	2	2	2	1

2.4.(ii) Deep Learning	
L T P 4 , 0 , 0 :4 Credits	Prerequisites: *None*

Course Objectives:

1. To introduce the idea of Artificial Neural Networks and their applications.
2. To study and implement different architectures of Artificial Neural Networks.
3. To study and implement various optimization techniques on Artificial Neural Networks.
4. To enable design and deployment of deep learning models for machine learning problems.

Detailed syllabus:

MODULE I
Introduction: Artificial Intelligence and Deep Learning-a historical perspective, Artificial neural networks, Shallow neural networks, Deep neural networks, gradient descent, forward and backpropagation, computational graphs, linear and non-linear activation functions.

MODULE II
Optimization techniques: Regularization, Dropout, Batch Normalization, Vanishing/Exploding gradients, Mini-batch gradient, Gradient descent with momentum, RMSprop, Adam optimization, Learning rate decay, Local optima, Global optima. Hyperparameter tuning,

MODULE III
Convolutional Neural Networks: Basic operations: padding, stride, pooling; Classic convolutional models: LeNet-5, AlexNet, VGG, Modern Deep Convolutional models: ResNet, GoogleNet; Inception Network, 1-D convolutions, Object detection and Face Recognition with CNN.

MODULE IV
Recurrent Neural Networks: Sequence modelling, Types of Recurrent Neural Networks, Backpropagation through time, Language modelling and sequence generation, Word Embeddings, vanishing gradients with RNNs, Long-Short Term Memory (LSTM), Gated Recurrent MODULEs (GRU), Bidirectional LSTMs, Sequence-to-Sequence model, Attention Mechanism, Transformer Network.

MODULE V
Advanced topics: Deep Reinforcement Learning, Generative Adversarial Networks, Autoencoders.

References:

1) Charu C. Aggarwal, Neural Networks and Deep Learning- A textbook, 2018, Springer.
2) Ian Goodfellow, Yoshua Bengio, Aaron Courville, ”Deep Learning (Adaptive Computation and Machine Learning series”, MIT Press.
3) Nikhil Buduma, Nicholas Locascio, “Fundamentals of Deep Learning: Designing Next Generation Machine Intelligence Algorithms”, O'Reilly Media.
4) Other online resources and research publications.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to understand the mathematics and engineering sciences behind functioning of artificial neural networks.
CO2	Students will be able to analyze the given dataset and data attributes for designing a neural network-based solution.
CO3	Students will be able to identify different neural network architectures, neural network optimization techniques, and apply them on different problem domains.
CO4	Students will be able to design and deploy deep learning solutions for real-world applications with popular deep learning tools.

CO-PO Mapping:

Table2

Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	--
CO2	2	2	1	2	2	--
CO3	3	3	3	3	2	1
CO4	3	3	2	1	2	2
Total	10	10	8	8	8	3
Average Attainment	2.5	2.5	2	2	2	0.75
Eq. Average Attainment	3	3	2	2	2	1

2.4.(iii) Data Visualization	
L T P 4 , 0 , 0 : 4 Credits	Prerequisites: *None*

Course Objectives

1. This course is all about data visualization, the art and science of turning data into readable graphics.
2. How to design and create data visualizations based on data available and tasks to be achieved.
3. This process includes data modeling, data processing (such as aggregation and filtering), mapping data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception as well as the task(s) at hand.
4. Students will also learn to evaluate the effectiveness of visualization designs, and think critically about each design decision, such as choice of color and choice of visual encoding.

MODULE I

Importance of analytics and visualization in the era of data abundance, Review of probability, statistics and random processes, Brief introduction to estimation theory.

MODULE II

Introduction to machine learning, supervised and unsupervised learning, gradient descent, overfitting, regularization etc. , Clustering techniques: K-means, Gaussian mixture models and expectation-maximization, agglomerative clustering, evaluation of clustering , Rand index, mutual information based scores, Fowlkes-Mallows index etc. , Regression: Linear models, ordinary least squares, ridge regression, LASSO, Gaussian Processes regression. , Supervised classification methods: K-nearest neighbor, naive Bayes, logistic regression, decision tree, support vector machine. , Sparse coding and dictionary learning, orthogonal matching pursuit. , Introduction to artificial neural networks (ANNs), deep NNs, convolutional neural network (CNN), and other recent topics.

MODULE III

Data visualization: Basic principles, categorical and continuous variables. , Exploratory graphical analysis. , Creating static graphs, animated visualizations, loops, GIFs and Videos. , Data visualization in Python and R, examples from Bokeh, Altair, ggPlot, ggplot2, gganimate, Image Magick etc. , Introduction to Visualization Toolkit (VTK) for 3D computer graphics, image processing and visualization. , Visualization for deep learning

REFERENCE BOOKS

1. Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie, The Elements of Statistical Learning, Springer.
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.
3. David G. Stork, Peter E. Hart, and Richard O. Duda, Pattern Classification (2nd edition), Wiley.
4. Edward Tufte, The Visual Display of Quantitative Information (2nd edition), Graphics Press.
5. Colin Ware, Information Visualization: Perception for Design (2nd edition), Morgan Kaufmann.
6. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, Pearson Education.
7. Nathan Yau, Data Points: Visualization That Means Something, Wiley.
8. Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Academic Press.
9. Will Schroeder, Ken Martin, and Bill Lorensen, The Visualization Toolkit: An Object,Oriented Approach to 3D Graphics, Kitware Inc. Publishers.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to explain design and create data visualizations.
CO2	Students will be able to conduct exploratory data analysis using visualization.
CO3	Students will be able to use knowledge of perception and cognition to evaluate visualization design alternatives.
CO4	Students will be able to apply data transformations such as aggregation and filtering for visualization.
CO5	Students will be able to explain and identify opportunities for application of data visualization in various domains.

CO-PO Mapping:

Table: CO-PO Matrices

1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	--	1	1	1	--	--
CO2	1	2	2	2	--	--
CO3	1	3	3	3	2	2
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	2
Total	8	12	12	12	6	7
Average	1.6	2.4	2.4	2.4	1.2	1.4
Eq. Average Attainment	2	2	2	2	1	1

2.4.(iv) Human Computer Interaction	
L T P 4 , 0 , 0 : 4 Credits	Prerequisites: *None*

Course Objectives

Upon successful completion of this course, students should be able to:
• Design, implement and evaluate effective and usable graphical computer interfaces.
• Describe and apply core theories, models and methodologies from the field of HCI.
• Describe and discuss current research in the field of HCI.
• Implement simple graphical user interfaces.
• Describe special considerations in designing user interfaces for older adults.

Detailed syllabus

HCI foundations- Input–output channels, Human memory, Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning

Designing- Programming Interactive systems- Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, The context of the interaction, Experience, engagement and fun, Paradigms for interaction,

Cantered design and testing- Interaction design basics-The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping, Design for non-Mouse interfaces, HCI in the software process, Iterative design and prototyping, Design rules, Principles to support usability, Standards and Guidelines, Golden rules and heuristics, HCI patterns

Implementation support - Elements of windowing systems, Programming the application, Using toolkits, User interface management systems, Evaluation techniques, Evaluation through expert analysis, Evaluation through user participation, Universal design, User support

Models and Theories - Cognitive models, Goal and task hierarchies, Linguistic models, The challenge of display-based systems, Physical and device models, Cognitive architectures

Collaboration and communication - Face-to-face communication, Conversation, Text-based communication, Group working, Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design

Human factors and security - Groupware, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware Implementing synchronous groupware, Mixed, Augmented and Virtual Reality

Text Books

1. A Dix, Janet Finlay, G D Abowd, R Beale., Human-Computer Interaction, 3rd Edition, Pearson Publishers,2008.

2. Shneiderman, Plaisant, Cohen and Jacobs, Designing the User Interface: Strategies for Effective Human Computer Interaction, 5th Edition, Pearson Publishers, 2010.

To establish the correlation between COs & POs and Cos & PSOs

Table 1(Cos)

No. of Course Outcome (CO)	Course Outcome
CO1	Design and Development processes and life cycle of Human Computer Interaction
CO2	Analyze product usability evaluations and testing methods.
CO3	Apply the interface design standards/guidelines for cross cultural and disabled users.
CO4	Categorize Design and Develop Human Computer Interaction in proper architectural structures.

TABLE 2

CO-PO Matrices & CO-PSO mapping of course

1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION-"-"

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
CO1	2	3		2	2		1		1	1
CO2	1		3					1	2	2
CO3	2	2	1	3		2	2	1	3	3
CO4	1	1	1	2	2			2	3	3
Total	6	6	5	7	4	2	3	4	9	9
Average	1.50	2.00	1.67	1.75	2.00	2.00	1.5	1.00	2.25	2.25
Eq Avg Attainment	2	2	2	2	2	2	2	2	2	2

2.4.(v) Embedded and Real Time System	
L T P 4 , 0 , 0 : **4 Credits**	Prerequisites: *None*

Course Objectives:

1.This course emphasizes on comprehensive treatment of embedded hardware and real time operating systems along with case studies, in tune with the requirements of Industry.
2. The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

Programme Outcomes:

1. To learn the concept of designing computer organization and architecture
2. To gain an understanding of applications of embedded systems involving real-time programming of microcontrollers.

MODULE I

Introduction to Embedded Systems, CPUs vs. MCUs vs. Embedded Systems, Examples of, Embedded Systems, Options for Building Embedded Systems, Features of Embedded Systems, Introduction to Internet of Things (IoT), Challenges of IoT, Building Embedded Systems , Building Embedded System using MCUs, Introduction to the mbedTM Platform, Introduction to mbed, mbed Software Development Kit (SDK), , Hardware Development Kit (HDK), mbed Development Tools, mbed Worldwide Developer CommModuley, Freedom KL25Z, NXP LPC1768 Hardware Platform, Nordic nRF51822 Hardware Platform, mbed and Internet of Things.

MODULE II

ARM Architectures and Processors, ARM Processor Families, ARM Cortex-M Series, Cortex-M0+ Processor, ARM Processor vs. ARM Architectures, ARM Cortex-M0+ Processor, Cortex-M0+ Block Diagram, Cortex-M0+ Memory Map, Bit-band Operations, ARM Cortex-M0+ Processor Instruction Set, ARM and Thumb Instruction Set, Cortex-M0+ Interrupts, NVIC (Nested Vectored Interrupt Controller), Port Module and External Interrupts, Cortex Microcontroller Software Interface Standard (CMSIS), Benefits of CMSIS, CMSIS Functions, mbed Software Development Kit (SDK), Features of mbed SDK, mbed SDK Library Structure, Program Code, C Language vs. Assembly Language, Program-Generation Flow, Program Image, Program Data, Data Types, Accessing Data using C and Assembly, Mixed Assembly and C Programming, Embedded Assembly.

MODULE III

Digital Input and Output, Voltages and Logic Values, GPIO Controller, Using Pointer to Access, GPIO, Define Data Structure for Peripherals, Digital IO Examples, Using LED, Using 7-Segment Display, Using Infrared Emitter/ Detector, Analog Input, Digital-to-Analog Converter, Analog Output, Analog-to-Digital Converter, ADC range, Resolution and Quantization, Sampling Frequency, Input/ Output Analog Signals using mbed, mbed Analog Input, mbed Analog Output.

MODULE IV

Timer and Pulse-Width Modulation, Timer Overview, Components of a Standard Timer, Compare Mode, Capture Mode, Pulse-Width Modulation Mode, mbed Timer and PWM, mbed Timer, mbed time ticker, mbed PWM, Serial Communication Overview, UART Communication, Operating System Overview, Types and Services of Operating Systems, Real-Time Operating System, RTOS Overview, RTOS Task Scheduling, Keil RTX RTOS, RTOS on mbed platform, mbed RTOS API, Using mbed RTOS API for your Project, Thread, Mutex and Semaphore.

MODULE V

Practical Implementation; Introduction to the Keil Mdk-Arm Tool, C And Assembly Coding - Processing Text In Assembly Language, Square Root Approximation, Digital Input/ Output and GPIO, Interrupt and Low Power Features, Programming using mbed API, Analog Input and Output Timer and PWM, Serial Communication

Text Books and References:

1. The Definitive Guide to the ARM Cortex-M0 by Joseph Yiu
2. Marilyn Wolf, Computers as Components – Principles of Embedded Computing System Design, Third Edition Morgan Kaufmann Publisher (An imprint from Elsevier), 2012. (Module I, II, III, V)
3. Jane W.S.Liu, Real Time Systems, Pearson Education, Third Indian Reprint, 2003.(Module IV)
4. Lyla B.Das, Embedded Systems : An Integrated Approach Pearson Education, 2013.

To establish the correlation between COs & POs and Cos & PSOs

Table 1(Cos)

No. of Course Outcome (CO)	Course Outcome
CO1	Apply the concepts of embedded system.
CO2	Design and program for Embedded Systems.
CO3	Explain and work on Real time operating systems.

TABLE 2

CO-PO Matrices & CO-PSO Mapping of course

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	1	3	1
CO2	2	3	3	2	3	2
CO3	3	3	2	2	2	2
Total	6	7	8	5	8	5
Average	2	2.33	2.67	1.67	2.67	1.67
EqAvg Attainment	2	2	2	1	2	1

2.5 Laboratory, I (Robotics and Automation Lab)	
L T P 0,0,3:2Credits	Prerequisites: None

Course Objective:

1. To recognize data attribute types and data preprocessing techniques.
2. To understand and apply supervised, unsupervised, and other learning techniques.
3. To understand and apply machine learning optimization techniques.
4. To understand and apply various machine learning algorithm performance evaluation techniques.
5. To choose a suitable machine learning model, implement, and examine the performance of the chosen model for a given real world problem.
6. To understand cutting edge technologies related to machine learning applications.

Detailed Syllabus:

MODULE I
Robotics Foundations: Kinematics , Dynamics , Mechanisms and Actuation , Sensing and Estimation , Motion Planning , Motion Control , Force Control , Robotic Systems Architectures and Programming , AI Reasoning Methods for Robotics.

MODULE II
Robot Structures: Robots with Flexible Elements , Model Identification .

MODULE III
Sensing and Perception: Force and Tactile Sensors , Inertial Sensors, GPS and Odometry, Sonar Sensing , Range Sensors , 3D Vision and Recognition , Visual Servoing and Visual Tracking , Sensor Fusion.

MODULE IV
Manipulation and Interfaces: Motion for Manipulation Tasks , Modelling and Manipulation.

MODULE VII
Human-Centered and Life Like Robotics: Humanoids , Experiments with humanoid Robot kinematics and control.

Text Books:

1. Introduction to Robotics: Mechanics & Control, 3ed, J. Craig, Prentice Hall, 2004.
2. Robot Modeling and Control, M. Spong, S. Hutchinson, M. Vidyasagar, Wiley, 2005.
3. Fundamentals of Robotics: Analysis and Control, Robert J. Schilling, Prentice Hall, 1990.
4. Theory of Applied Robotics 2nd Ed., R. Jazar, Springer, 2010.

LIST OF EXPERIMENTS

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3. Estimation of accuracy, repeatability and resolution.

4. Robot programming and simulation for pick and place.
5. Robot programming and simulation for Color identification.
6. Robot programming and simulation for Shape identification.
7. Robot programming and simulation for Kinematics.
8. Robot programming and simulation for remote operation.
9. Speech Processing for Robots.
10. Home and device automation.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to explain the fundamentals of robotics and its components.
CO2	Students will be able to . illustrate the Kinematics and Dynamics of robotics.
CO3	Students will be able to elucidate the need and implementation of related Instrumentation & control in robotics.
CO4	Students will be able to design and deploy the movement of robotic joints with computers/microcontrollers.
CO5	Students will be able to explain sensors and instrumentation in robotics

CO-PO Mapping:

Table: CO-PO Matrices

1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	--	1	1	1	--	--
CO2	1	2	2	2	--	--
CO3	1	3	3	3	2	2
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	2
Total	8	12	12	12	6	7
Average	1.6	2.4	2.4	2.4	1.2	1.4
Eq. Average Attainment	2	2	2	2	1	1

2.6 Laboratory, II (Machine Learning Lab)	
L T P 0,0,3:2Credits	Prerequisites: None

Course Objective:

7. To recognize data attribute types and data preprocessing techniques.
8. To understand and apply supervised, unsupervised, and other learning techniques.
9. To understand and apply machine learning optimization techniques.
10. To understand and apply various machine learning algorithm performance evaluation techniques.
11. To choose a suitable machine learning model, implement, and examine the performance of the chosen model for a given real world problem.
12. To understand cutting edge technologies related to machine learning applications.

Detailed Syllabus:

MODULE I
Data preprocessing: Introduction to NumPy, Pandas, matplotlib, Scikit-learn.

MODULE II
Supervised Learning: Implementation of Linear and logistic regression, Naïve bayes, Decision Tree, Support Vector Machines, Neural Networks.

MODULE III
Unsupervised Learning: Implementation of k-means, Agglomerative, DBSCAN, Dimensionality Reduction and Principal Component Analysis.

MODULE IV
Optimization Techniques: Bias-Variance tradeoff, Cross-validation, Regularization, Precision, Recall and F-measure.

MODULE V
Other Learning techniques: Implementation of Reinforcement Learning, Recommender Systems, Anomaly Detection.

MODULE VI
Applications of Machine Learning: Texts, Image, Time-series data.

Textbooks:

1) Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists, O’Reilly.
2) Other online material.

Course Outcomes (CO):

Table1

Course Outcome No.	Course Outcome
CO1	Students will be able to understand the mathematics and engineering sciences behind functioning of machine learning.
CO2	Students will be able to analyze the given dataset and data attributes for designing a machine learning-based solution.
CO3	Students will be able to identify different machine learning approaches, optimization techniques, and apply them on different problem domains.
CO4	Students will be able to design and deploy machine learning solutions for real-world applications with popular machine learning tools.

CO-PO Mapping:

Table2

Levels: 1: Slight (LOW) 2: Moderate (MEDIUM) 3: Substantial (HIGH) and for NO CORELATION "--"

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	--
CO2	2	2	1	2	2	--
CO3	3	3	3	3	2	1
CO4	3	3	2	1	2	2
Total	10	10	8	8	8	3
Average Attainment	2.5	2.5	2	2	2	0.75
Eq. Average Attainment	3	3	2	2	2	1

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