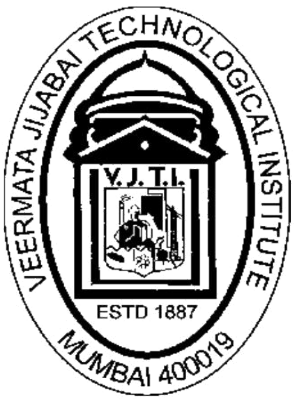
VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)



Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Post Graduate Programme Leading to
Masters of Engineering Degree
in
Computer Engineering
(Specialization in Artificial Intelligence and Data Science)

2024

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(Autonomous Institute affiliated to University of Mumbai)

Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

Post Graduate Programme Leading to
Masters of Engineering Degree

In

Computer Engineering
(Specialization in Artificial Intelligence and Data Science)

M. Tech. Computer Engineering
(Specialization in Artificial Intelligence and Data Science)

Programme Outcomes

LIST OF PROGRAM OUTCOMES	
PO1	Carry out research /investigation and development work to solve computational problems.
PO2	Write and present a substantial technical report/document.
PO3	Demonstrate a degree of mastery over the field of data science for intelligent reasoning and analysis.
PO4	Apply mathematical modeling, algorithms and techniques in broad areas of application domain.
PO5	Design and develop tools and techniques for knowledge-based systems to enhance lifelong learning.

M. Tech. Computer Engineering
(Specialization in Artificial Intelligence and Data Science)

Scheme of Instruction and Evaluation
SEMESTER I

Scheme of Instruction					Scheme of Evaluation			
S.No	Course Code	Course Title	L-T-P	Credits	TA	IST	ESE	ESE hours
1	AD5001S	Computational Methods (Program Specific Maths)	3-0-0	3	20	20	60	3
2	AD5011T	Artificial Intelligence (Core-1)	3-1-0	3	20	20	60	3
3	AD5012S	Analysis of Algorithms (Core-2)	3-0-0	3	20	20	60	3
4	AD5021T	Program Elective 1	3-1-0	4	20	20	60	3
5	AD5031S	Program Elective 2	3-0-0	3	20	20	60	3
6	AD5061S	Open Elective-1	3-0-0	4	20	20	60	3
7	AD5071L	Analysis of Algorithms (Laboratory -1)	0-0-2	1	60%CIE		40	-
8	AD5072L	Data Analytics (Laboratory-2)	0-0-2	1	60%CIE		40	-
9	AD5073L	Data Visualization (Laboratory-3)	0-0-2	1	60%CIE		40	-
10	MTEC081L	Liberal Learning	0-0-2	1	60%CIE		40	-
			28	24				

Program Elective 1	
AD5021T	Data Mining and Analysis
AD5022T	AI and Social Responsibility
AD5023T	Dependable AI

Program Elective 2	
AD5031S	Machine Learning
AD5032S	Time Series Analysis
AD5033S	Probabistic Graphical Models

Open Elective 1	
AD5061S	Analysis of Algorithm
AD5062S	Machine Learning

M. Tech. Computer Engineering
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Scheme of Instruction and Evaluation
SEMESTER II

Scheme of Instruction					Scheme of Evaluation			
S.No	Course Code	Course Title	L-T-P	Credits	TA	IST	ESE	ESE hours
1	AD5002S	Research Methodology and IPR (Mandatory Learning)	3-0-0	3	20	20	60	3
2	AD5013T	Optimization Method (Core-1)	3-1-0	3	20	20	60	3
3	AD5014S	Deep Learning (Core-2)	3-0-0	3	20	20	60	3
4	AD5041T	Program Elective 3	3-1-0	4	20	20	60	3
5	AD5051S	Program Elective 4	3-0-0	3	20	20	60	3
6	AD5062S	Open Elective -2	3-1-0	4	20	20	60	3
7	AD5074L	Vision Analytics (Laboratory - 4)	0-0-2	1	60%CIE		40	-
8	AD5075L	Big Data Analytics (Laboratory -5)	0-0-2	1	60%CIE		40	-
9	AD5076L	Text Analytics (Laboratory - 6)	0-0-2	1	60%CIE		40	-
10	MTEC082L	Liberal Learning	0-0-2	1	60%CIE		40	-
			28	24				

Program Elective 3	
AD5041T	Soft Computing
AD5042T	Reinforcement Learning
AD5043T	Graph Mining

Program Elective 4	
AD5051S	Natural Language Processing
AD5052S	Social Network Analysis
AD5053S	Information Retrieval

Open Elective 2	
AD5063S	Soft Computing
AD5064S	Deep Learning

M. Tech. Computer Engineering
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Scheme of Instruction and Evaluation
SEMESTER III

Scheme of Instruction					Scheme of Evaluation
S.No	Course Code	Course Title	L-T-P	Credits	
1	AD091D	Skill Based Course (Project Stage -I)	---	5	100%CIE
2	AD092D	Skill Based Course (Project Stage -II)	---	5	100%CIE
3	AD101S	Self Learning Course -1	1-0-0	1	100% ESE of 3 hours or credit transfer
4	AD201S	Self Learning Course -2	1-0-0	1	100% ESE of 3 hours or credit transfer
5	AD201MNC	Mandatory Non Credit Course	2-0-0	0	100% ESE of 3 hours or credit transfer
				12	

Scheme of Instruction and Evaluation
SEMESTER IV

Scheme of Instruction					Scheme of Evaluation
S.No	Course Code	Course Title	L-T-P	Credits	
1	AD093D	Skill Based Course (Project Stage -III)	---	5	100%CIE
2	AD094D	Skill Based Course (Project Stage -IV)	---	7	100%CIE
				12	

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5001S
Course Title	Foundation of Computational Mathematics
Course Type	Program Specific Maths
Prerequisites: Fundamental of computer science, discrete mathematics and probability theory and statistics.	
Course Outcomes: At the end of the course students will be able to: CO1. Express machine learning concepts using the language of mathematics. CO2. Analyze the vector and matrices to represent the data. CO3. Demonstrate analytic geometry usage in computer applications. CO4. Illustrate probability principles for addressing randomness in the applications. CO5. Interpretation of data for learning.	

Course Content	
1	Linear Algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector spaces, Linear independence, Basis and Rank, Linear Mapping, Affine Spaces
2	Analytic Geometry: Norms, Inner Products, Lengths and Distance, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations
3	Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation, Matrix Phylogeny
4	Vector calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series
5	Probability: Events and Probability Spaces, Conditional Probability and Independence, Random Variables (Discrete and Continous), Distributions, Properties of Expectation

Text Books	
1	Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
Reference Books	
1	Lehman, Eric, Tom Leighton, and Albert R. Meyer. Mathematics for computer science. Technical report, 2006. Lecture notes, 2010.
2	Shelton Ross, First Course on Probability, Pearson, 2010.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5011T
Course Title	Artificial Intelligence
Course Type	Core Subject
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Demonstrate the key aspects of Artificial Intelligence. CO2. Apply artificial intelligence techniques, including search heuristics, knowledge representation, planning and reasoning for problem solving. CO3. Analyze algorithms in game playing and search. CO4. Demonstrate the key aspects of propositional logic and AI applications.	

Course Content	
1	Search: Uninformed strategies (BFS, DFS, Dijkstra), Informed strategies (A* search, heuristic functions, hill-climbing), Adversarial search (Minimax algorithm, Alpha-beta pruning)
2	Propositional and Predicate Logic: Knowledge representation, Resolution
3	Rule-based systems: Natural language parsing, Context free grammar, Constraint satisfaction problems
4	Planning: State space search, Planning Graphs, Partial order planning
5	Uncertain Reasoning: Probabilistic reasoning, Bayesian Networks, Dempster-Shafer theory
6	Markov process and chain and Hidden Markov Model

Text Books	
1	Deepak Khemani,"A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013.
2	Stuart Russell, Peter Norvig,"Artificial Intelligence A Modern Approach", Prentice Hall, 3rd Edition, 2009.
Reference Books	
1	Stefan EdelKamp and Stefan Schroedl, "Heuristic Search: Theory and Application", Morgan Kaufmann, 2011.
2	Zbigniew Michalewicz and David B. Fogel, " How to Solve it: Modern Heuristics", Springer, 2nd Edition, 2004.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5012S
Course Title	Analysis of Algorithm
Course Type	Core Subject
Prerequisites: Programming and probability theory and statistics	
Course Outcomes: At the end of the course student will be able to: CO1. Analyze algorithms and determine efficiency of algorithm. CO2. Design analysis algorithms using the greedy, dynamic programming, and divide and conquer techniques. CO3. Design and build solutions for a real world problem using graphs. CO4. Prove problems of P, NP, or NP-Complete. CO5. Demonstrate geometric algorithms usage in real life problems.	

Course Content	
1	Introduction: Asymptotic notation, recurrences, amortized analysis
2	Algorithm design techniques: Greedy algorithms, divide-and-conquer algorithms, dynamic programming
3	Graph algorithms: Traversal, topological sort, minimum spanning trees, shortest path,biconnected components, strongly connected components in directed graphs, network flow
4	NP-completeness: Classes P, NP and space complexity, reduction, NP-completeness, examples of NP-complete problems
5	Geometric algorithms: Convex hulls, sweep paradigm, Voronoi diagrams, closest pair, nearest neighbour search.
6	Approximation Algorithms: Approximation algorithms for known NP complete problems

Text Books	
1	Kleinberg, Jon, and Eva Tardos. Algorithm design. Pearson Education India, 2006.
2	Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022.
Reference Books	
1	Aho, A., J. Hopcroft, and J. Ullman. ”The Design and Analysis of Algorithms. Addison and Wesley.” Reading, MA, 1974.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5021T
Course Title	Data Mining and Analysis
Course Type	Elective Subject
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Compare and contrast different uses of data mining as evidenced in both research and application. CO2. Characterize the kinds of patterns that can be discovered by mining methods. CO3. Identify and characterize sources of noise, redundancy, and outliers in presented data. CO4. Evaluate different methodologies for effective application of data mining.	

Course Content	
1	Data Analysis Foundations: Data, Matrix, Attributes, Numeric Attributes, Categorical Attributes, Graph Data, Kernel Methods, High-dimensional Data
2	Data Preprocessing: Cleaning, Integration, Reduction, Transformation, Discretization
3	Frequent Pattern Mining: Itemset Mining, Summarizing Itemsets, Sequence Mining, Graph Pattern Mining, Pattern and Rule Assessment
4	Clustering: Representative-based Clustering, Hierarchical Clustering, Density-based Clustering, Spectral and Graph Clustering, Clustering Validation.
5	Advancement in the domain / Domain specific case-studies

Text Books	
1	Mohammed J. Zaki and Wagner Meira Jr.. Data Mining and Analytics: Fundamentals Concepts and Algorithms. Cambridge University Press, 2014.
2	Jiawei Han and Micheline Kamber. Data Mining: Concepts and Techniques. Morgan Kaufmann, 2006.
Reference Books	
1	Pang-Ning Tan, Michael Steinbach, Vipin Kumar. Data Mining. Pearson Education Limited, 2014.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5022T
Course Title	AI and Social Responsibility
Course Type	Elective Subject
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Understand the complex interplay of AI development and regulatory practices, comprehending how emerging technologies influence and are influenced by public norms and values. CO2. Apply interdisciplinary approaches integrating knowledge from the humanities, social sciences, and public policy to evaluate the social impact of emerging AI applications in realworld scenarios. CO3. Analyze emerging AI governance strategies, critically assessing their origins, applications, and effectiveness for responsible AI management and regulation. CO4. Identify and remember core principles, challenges, and developments in AI governance, including essential policy milestones and landmark case studies.	

Course Content	
1	Social and Moral Questioning Around AI and Its Ecosystem
2	Ethics: Ethical approach to AI, Ethical Framework Associated with AI, Issues
3	Goverance of AI: Integrity, Transparency, Accountability, Fairness, Control, Sustainability, Democracy, Interoperability
4	AI Ecosystem for Human Flourishing
5	Advancement in the domain/domain specific case-studies

Text Books	
1	Jerome Beranger, Societal Responsibility of Artificial Inetlligence, Wiley, 2021.
Reference Books	
1	Julian Kinderlerer, Artificial Intelligence for a Better Future, Springer, 2020.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5023T
Course Title	Dependable AI
Course Type	Elective Subject
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Assess the dependability of AI systems. CO2. Develop explainable, robust, and safe AI models. CO3. Discover the various dimension of AI ethics and trust.	

Course Content	
1	Introduction: Overview, Motivation, Challenges – medical and surveillance
2	Explainable AI: Accuracy-explainability Tradeoff, Interpretability Problem, Predictability, Transparency, Traceability, Causality, Reasoning, Attention and Saliency
3	Interpretable AI: Prediction Consistency, Application Level Evaluation, Human Level Evaluation, Function Level Evaluation
4	Adversarial Robustness: Adversarial Attacks and Defences
5	Trustworthy AI: Integrity, Reproducibility, Accountability, Reliable, Safe, Secure and Responsible
6	Bias-free AI: Accessibility, Fair, Data Agnostics Design, Disentanglement
7	Privacy Preserving AI:Federated Learning, Differential Privacy and Encrypted Computation
8	AI: Environment and Specification Modeling, Design with Formal Inductive Synthesis, Evaluation Platforms for AI Safety

Text Books	
1	Beena Ammanath, Trustworthy AI: A Business Guide for Navigating Trust and AI, Wiley, 2022.
Reference Books	
1	Josef Baker-Brunnbauer, Trustworthy Artificial Intelligence Implementation, Springer, 2023.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5031S
Course Title	Machine Learning
Course Type	Elective Subject
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Compare and contrast various techniques. CO2. Evaluate the performance of a learning system. CO3. Demonstrate the usages of learning methods. CO4. Demonstrate the usages of standard practives used in machine learning.	

Course Content	
1	Introduction: Motivation, Different types of learning, Linear regression, Logistic regression Gradient Descent: Introduction, Stochastic Gradient Descent, Subgradients, Stochastic Gradient Descent for risk minimization Model selection and validation: Validation for model selection, k-fold cross-validation, Training Validation-Testing split, Regularized loss minimization
2	Support Vector Machines: Hard SVM, Soft SVM, Optimality conditions, Duality, Kernel trick, Implementing Soft SVM with Kernels
3	Classification Techniques: Decision Tree, Random forest, Ensemble Techniques, Linear Discriminant Analysis, Probabilistic Classification
4	Neural Networks: Feedforward neural networks, Expressive power of neural networks, SGD and Backpropagation
5	Classification Assessment: Classification Performance Measures, Classifier Evaluation

Text Books	
1	Mohammed J. Zaki and Wagner Meira Jr.. Data Mining and Analytics: Fundamentals Concepts and Algorithms. Cambridge University Press, 2014.
2	Shalev-Shwartz,S., Ben-David,S., Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.
Reference Books	
1	Christopher M. Bishop. Pattern Recognition and Machine Learning, Springer, 2006.
2	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning, Springer, 2013.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5032S
Course Title	Time Series Analysis
Course Type	Elective Subject
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Perform the trend analysis of data. CO2. Find the relation between the data. CO3. Apply parameter estimation concepts and methods.	

Course Content	
1	Introduction: Probability, Statistics, Random Processes, Stationarity & Ergodicity, Auto- and cross-correlation functions, Partial correlation functions
2	Models: Linear Stationary and Non-Stationary Processes
3	Fourier analysis of signals, Spectral densities and representations; Wiener-Khinchin theorem; Harmonic processes; SARIMA models
4	Estimation Theory: Introduction, Goodness of estimators, Fishers information, Properties of estimators, bias, variance, efficiency; C-R bound, consistency
5	Estimators: Least squares, WLS and non-linear LS estimators, Maximum likelihood and Bayesian estimators, Estimation of signal properties, time-series models

Text Books	
1	Terence C. Mills. Applied Time Series Analysis. Academic Press, 2019.
Reference Books	
1	Chris Chatfield. The Analysis of Time Series. CRC Press, 2003.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5033S
Course Title	Probabilistic Graphical Models
Course Type	Elective Subject
Prerequisites: Probability theory and statistics.	
Course Outcomes: At the end of the course student will be able to: CO1. Demonstrate deep knowledge of the fundamentals of probabilistic models. CO2. Design and analyze the probabilistic models. CO3. Apply models to real-life analytic problems.	

Course Content	
1	Fundamentals: Introduction, Probability Theory, Graph Theroy
2	Probabilistic Models: Bayesian Classifiers, Hidden Markov Models, Markov Random Field, Bayesian Network
3	Decision Models: Decision Graph, Markov Decision Process
4	Rational and Causal Models: Relational Probabilistic Model, Graphical Causal Model, Cuasal Discovery
5	Advancement in the domain/ Specific case studies

Text Books	
1	Diane J. Cook , Lawrence B. Holder, Mining Graph Data, Wiley Publication, 2010.
Reference Books	
1	Charu C. Agrawal, Haixun Wang, Managing and Mining Graph Data, Springer, 2012.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5071L
Course Title	Algorithm Laboratory
Course Type	Laboratory
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Formulate practical solution to a problem, making effective use of time and resource available. CO2. Analyze runtime asymptotic complexity of algorithms including formulating recurrence relations. CO3. Design technique of standard algorithms, and use it to develop new computational solution to problems. CO4. Reason about complexity and algorithmic efficiency.	

Course Content	
1	Dynamic programming
2	Divide-and-conquer algorithms
3	Graph algorithms
4	Geometric algorithms
5	Approximation algorithms

Text Books	
1	Kleinberg, Jon, and Eva Tardos. Algorithm design. Pearson Education India, 2006.
2	Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022.
Reference Books	
1	Aho, A., J. Hopcroft, and J. Ullman. ”The Design and Analysis of Algorithms. Addison and Wesley.” Reading, MA, 1974.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5072L
Course Title	Data Analytics Laboratory
Course Type	Laboratory
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Develop a sense of data analytics techniques in the modern context, and independently work on problems relating to data science. CO2. Design and program efficient algorithms related to data analtytics, train models, conduct experiments, and deliver data science-related applications. CO3. Evaluate the performance of a learning system.	

Course Content	
1	Binary classifier
2	Support vector machine
3	Tree classifier
4	Probabilistic classifier
5	Ensemble method
6	Neural network

Text Books	
1	Mohammed J. Zaki and Wagner Meira Jr.. Data Mining and Analytics: Fundamentals Concepts and Algorithms. Cambridge University Press, 2014.
2	Shalev-Shwartz,S., Ben-David,S., Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.
Reference Books	
1	Christopher M. Bishop. Pattern Recognition and Machine Learning, Springer, 2006.
2	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning, Springer, 2013.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5074L
Course Title	Data Visualization Laboratory
Course Type	Laboratory
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Understand the design considerations for the components of the good visualization. CO2. Know the methods and algorithms used to map data to graphical depictions. CO3. Understand graphical primitive used in the rendering and techniques that visualize data to convey relational information.	

Course Content	
1	Data visualization task
2	Filtering and transformation technique.
3	Data connection and analysis
4	Interactive dashboard (Data Storytelling)
5	Interactive data animation
6	Mini project

Text Books	
1	Tamara Munzner. Visualization Analysis and Design. CRC Press, 2015.
Reference Books	
1	Scott Murray. Interactive Data Visualization for the Web, O’Reilly, 2015.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5002S
Course Title	Research Methodology and IPR
Course Type	Mandatory Learning
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Design and formulation of research problem. CO2. Analyze research related information and statistical methods in research. CO3. Carry out research problem individually in a perfect scientific method. CO4. Understand the filing patent applications processes, Patent search, and various tools of IPR, Copyright, and Trademarks.	

Course Content	
1	Introduction to research, Definitions and characteristics of research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Quantitative vs. Qualitative Approach, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs. Theoretical Research, Importance of reasoning in research
2	Problem Formulation, Understanding Modeling & Simulation, Literature Review, Referencing, Information Sources, Information Retrieval, Indexing and abstracting services, Citation indexes, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Interpretation of Results
3	Statistics: Probability & Sampling distribution, Estimation, Measures of central Tendency, Arithmetic mean, Median, Mode, Standard deviation, Co efficient of variation (Discrete serious and continuous serious), Hypothesis testing & application, Correlation & regression analysis, Orthogonal array, ANOVA, Standard error, Concept of point and interval estimation, Level of significance, Degree of freedom, Analysis of variance, One way and two way classified data, 'F' test
4	Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents
5	Intellectual property rights (IPR) patents copyrights Trademarks Industrial design geographical indication. Ethics of Research Scientific Misconduct Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science

Text Books	
1	K. S. Bordens, and B. B.Abbott, , Research Design and Methods – A Process Approach, 8th Edition, McGraw Hill, 2011.
2	Douglas C. Montgomary and George C. Runger, Applied Statistics & probability for Engineers, Wiley, 2007.
Reference Books	
1	Michael P. Marder, Research Methods for Science, Cambridge University Press, 2011.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5013T
Course Title	Optimization Method
Course Type	Core Subject
Prerequisites: Linear Algebra	
Course Outcomes: At the end of the course student will be able to: CO1. Apply various techniques to solve linear programming type optimization problems. CO2. Investigate the multivariable optimization problem and solution. CO3. Perform a theoretical investigation of a given optimization problem in order to access its complexity. CO4. Analyse the obtained solutions.	

Course Content	
1	Linear Programming: Introduction, Simplex Method, Duality, Non-simplex Method, Integer Linear Programming
2	Unconstrained Optimization: Condition for Local Minimizer, One-Dimensional Search Methods, Gradient Methods, Newton's Method, Conjugate Direction Methods, Quasi-Netwon Methods, Solving Linear Equation, Neural Network, Global Search Algorithms
3	Non-linear Constrained Optimization: Problems with Equality Constraints, Problems with inequality Constraints, Convex Optimization Problems, Algorithms for Constrainted Optimization
4	Multiobjective Optimization

Text Books	
1	Edwin K P Chong and Stanislaw H. Zak. Introduction to Optimization, Wiley, 2013.
2	Jorge Nocedal and Stephen J. Wright. Numerical Optimization, Springer, 2000.
Reference Books	
1	Sukanta Nayak, Fundamentals of Optimization Techniques with Algorithms, Academic Press, 2020.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5014S
Course Title	Deep Learning
Course Type	Core Subject
Prerequisites: Machine Learning	
Course Outcomes: At the end of the course student will be able to: CO1. Apply various deep learning architectures to solve real-world problems in different domains. CO2. Interpret the results to make informed decisions about model improvements. CO3. Demonstrate a comprehensive understanding of deep learning concepts.	

Course Content	
1	Deep Networks: CNN, RNN, LSTM, Attention layers, Applications Techniques to improve deep networks: DNN Optimization, Regularization, AutoML
2	Representation Learning: Unsupervised pre-training, transfer learning, and domain adaptation, distributed representation, discovering underlying causes Auto-DL: Neural architecture search, network compression, graph neural networks
3	Probabilistic Generative Models: DBN, RBM Deep Generative Models: Encoder-Decoder, Variational Autoencoder, Generative Adversarial Network (GAN), Deep Convolutional GAN, Variants and Applications of GANs

Text Books	
1	Goodfellow,I., Bengio.,Y., and Courville,A., Deep Learning, The MIT Press, 2016.
Reference Books	
1	Charniak, E., Introduction to deep learning, The MIT Press, 2019.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5041T
Course Title	Soft Computing
Course Type	Elective Subject
Prerequisites: None	
Course Outcomes: At the end of the course student will be able to: CO1. Identify and describe soft computing techniques. CO2. Understand soft computing approaches in problem solving. CO3. Formulate real-world methodologies to data mining using soft computing tools.	

Course Content	
1	Introduction to Soft Computing: Difference between soft and hard computing, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Applications
2	Fuzzy Sets and Fuzzy Systems: Membership functions, Fuzzy operations, Fuzzy relations, Fuzzy proposition, Fuzzy implication, Fuzzification, Fuzzy inference, Fuzzy rule based systems, Defuzzification
3	Genetic Algorithm: Representation, Fitness function, Population, Operators – Selection, Mutation, Crossover, Others, Multi-objective optimization problems
4	Metaheuristic and Swarm Intelligence: Ant colony optimization, Bee colony optimization, Particle swarm optimization, Cuckoo search algorithm and others
5	Rough Sets, Knowledge representations, Rough decision making and data mining techniques, Granular Computing
6	Hybrid Systems: Neuro-fuzzy systems, Rough-neural computing, Fuzzy logic and Genetic Algorithm, GA based back propagation networks, Fuzzy associative memories, Hybrid systems using fuzzy and rough sets
7	Big Data Challenges and Soft Computing Opportunity: Uncertainties in Big Data Inputs, Uncertainties in Big Data Decisions

Text Books	
1	S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, Wiley India, 2018.
2	Z. Pawlak, Rough Sets: Theoretical Aspects of Reasoning about Data, Springer, 1991.
Reference Books	
1	F.O. Karray, C. De Silva, Soft Computing and Intelligent Systems Design: Theory, Tools and Applications, Pearson Education, 2004.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5042T
Course Title	Reinforcement Learning
Course Type	Elective Subject
Prerequisites: Probability Theory	
Course Outcomes: At the end of the course student will be able to: CO1. Model a control task in the framework of MDPs. CO2. Identify the model based from the model free methods. CO3. Identify stability/convergence and approximation properties of RL algorithms. CO4. Use deep learning methods to RL problems in practice.	

Course Content	
1	Introduction: State of the art applications in Atari, Alpha Go, relation to other problems in artificial intelligence
2	Markov Decision Processes (model based): Formulation, Value Iteration (VI), Policy Iteration (PI), Linear Programming (LP)
3	Approximate Dynamic Programming (approximate model based): curse-of-dimensionality, representations, Approximate value iteration, approximate policy iteration, approximate linear program, approximation and convergence guarantees
4	Stochastic Approximation: Single and multi-timescale stochastic approximation, introduction to ordinary differential equation based convergence results.
5	Value function learning (approximate model-free): Temporal difference (TD learning, TD(0), TD(lambda), Q-learning, State-Action-Reward-State Algorithm (SARSA) , TD with function approximation, on/off-policy learning, gradient temporal difference learning
6	Actor-Critic: Policy gradient, Natural Actor-Critic
7	Deep RL, Exploration vs Exploitation: Upper Confidence Bound (UCB), Upper Confidence Reinforcement Learning (UCRL)

Text Books	
1	Richard S. Sutton and Andrew G. Barto, Introduction to Reinforcement Learning, 2nd Edition, MIT Press. 2017.
2	Dimitri Bertsekas and John G. Tsitsiklis, Neuro Dynamic Programming, Athena Scientific. 1996.
Reference Books	
1	Deep Learning. Ian Goodfellow and Yoshua Bengio and Aaron Courville. MIT Press. 2016.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5043T
Course Title	Graph Mining
Course Type	Elective Subject
Prerequisites: Fundamental of Graphs and Probability theory	
Course Outcomes: At the end of the course student will be able to: CO1. Demonstrate deep knowledge of the fundamentals of graph matching, visualization and data mining. CO2. Design and analyze the graph patterns for graph based application. CO3. Develop efficient and salable implementations of graph mining algorithms. CO4. Applying graph mining knowledge to design effective solution to real-life graph analytic problems.	

Course Content	
1	Introduction: Terminology, Graph Databases
2	Graphs: Graph Matching, Graph Visualization and Mining, Graph Pattern and R-MAT generator
3	Mining Techniques: Discovery of Frequent Substructure, Topological Frequent Patterns, Supervised and Un-supervised Learning, Grammer Learning, Graph-based Decision Tree, Formal Concept Analysis, Kernel Method and Analysis, Entity Resolution
4	Application and advancement in the domain/ Specific case studies

Text Books	
1	Diane J. Cook , Lawrence B. Holder, Mining Graph Data, Wiley Publication, 2010.
Reference Books	
1	Charu C. Agrawal, Haixun Wang, Managing and Mining Graph Data, Springer, 2012.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5051S
Course Title	Natural Language Processing
Course Type	Elective Subject
Prerequisites: Machine Learning	
Course Outcomes: At the end of the course student will be able to: CO1. Perform and understand stages of NLP and their application using NLTK toolkit. CO2. Use and processing of corpora, word embeddings in NLP experiments. CO3. Access and analyse data from social platforms and perform text classification. CO4. Implement Different approaches such as Supervised, Unsupervised and Knowledge-based approaches to NLP applications.	

Course Content	
1	Introduction to NLP. Stages in classical model of NLP and challenges in every stage. Brief ideas on Recent trends in NLP. Basic Steps in Text processing
2	Words: structure, semantics, distributional semantics, WordNet and similarity measures. WSD tasks
3	Language Modeling. N-gram Models. Advanced smoothing for language modelling
4	Sequence labeling tasks – Part of Speech Tagging, Named Entity Recognition
5	Syntax Parsing – Classical Parsing, Dependency Parsing
6	Vector Space Model - word vectors, embeddings, GloVe/Word2Vec model and advanced embeddings.
7	Text Classification, Clustering, topic modeling techniques. : Basics and Applications such as Sentiment Analysis, News filtering
8	NLP Advanced Topics and Applications – Deep NN for NLP, Information Retrieval, Coreference Resolution, Question-Answering System

Text Books	
1	Dan Jurafsky, James H. Martin, Speech and Language Processing, Stanford University, 2023.
2	Christopher D.Manning and Hinrich Schuetze, Foundations of Statistical Natural Language Processing, MIT press, 1999.
Reference Books	
1	Joseph D. Booth, Natural Language Processing, Syncfusion, Inc., 2018.
2	Shuly Wintner, Formal Language Theory for Natural Language Processing, ESSLLI, 2001.
3	Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly, 2014.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5052S
Course Title	Social Network Analysis
Course Type	Elective Subject
Prerequisites: Machine Learning	
Course Outcomes: At the end of the course student will be able to: CO1. Demonstrate statistical properties for real world problems in Social Network Analysis. CO2. Distinguish different edge classification techniques and use in the application. CO3. Examine shared data operations and replication in the distributed applications. CO4. Inspect data mining in Social Network Analysis with case studies.	

Course Content	
1	Introduction: Sociometry, small groups, and communities; Cliques, roles, and matrices; Space and distance; Dynamics and social change, Graph concepts and properties, Measures
2	Community Discovery in Social Networks: Defining communities; Core Methods: Quality Functions, Kernighan-Lin(KL) algorithm, Agglomerative/Divisive Algorithms, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering; Community Discovery in Dynamic Networks, Heterogeneous Networks, Directed Networks
3	Node Classification in Social Networks: The Node Classification Problem; Problem Formulation; Local Classifiers, Random Walk based classifier, Node Classification to Large Social Networks, Basic Methods, Second-order Methods, Map-Reduce, Dissimilarity in Labels, Edge Labeling, Label Summarization
4	Data Mining in Social Media: Data Representation, Event Maps, Social Networking Sites: Illustrative Examples, Blogosphere: Illustrative Examples
5	Visualizing Social Network: Visual Images, MDS and SVD to explore data, Exploratory Research, Validating a Model, Structural Visualization, Semantic and Temporal Visualization, Statistical Visualization
6	Social Media: Conundrum of social Media, Friend, Fans and Followers, Influence

Text Books	
1	Charu C. Aggarwal, ”Social Network Data Analytics” Springer New York, NY, 2011.
2	Carrington, P., Scott, J., Wasserman, S. (Eds.). Models and Methods in Social Network Analysis (Structural Analysis in the Social Sciences). Cambridge: Cambridge University Press, 2005.
Reference Books	
1	Xiaoming Fu, Jar-Der Luo, Margarete Boos. Social Network Analysis Interdisciplinary Approaches and Case Studies.CRC Press, 2020.
2	Marshall Sponder, Social Media Analytics, Tata McGraw Hill, 2012.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5053S
Course Title	Information Retrieval
Course Type	Elective Subject
Prerequisites: Fundamental of computer science, discrete mathematics and probability theory and statistics.	
Course Outcomes: At the end of the course student will be able to: CO1. Understand underlying technologies of modern information retrieval system. CO2. Developing new search engines with high search accuracy. CO3. Analyse theoretical aspects as well as implementation issues of classical and modern retrieval problems.	

Course Content	
1	Introduction to Information Retrieval: The nature of unstructured and semi-structured text, Inverted index and Boolean queries
2	Search Engine Architecture: Basic building blocks of a modern search engine system: web crawler, basic text analysis techniques, Inverted index, Query processing, Search result interface, Semantic search using Ontology
3	Retrieval Models: Boolean vector space, TFIDF, Okapi, Probabilistic language modeling, Latent semantic indexing, Vector space scoring, The cosine measure, Efficiency considerations, Document length normalization, Relevance feedback and query expansion, Rocchio, Ontological models
4	Performance Evaluation: Evaluating search engines, User happiness, Precision, Recall, F-measure, Creating Test collections: kappa measure, Inter-judge agreement
5	Text Categorization and Filtering: Introduction to text classification, Spam filtering, Vector space classification using hyperplanes, Centroids and advancement in domain
6	Text Clustering: Summarization, Topic detection and tracking, Personalization, Question answering, Cross language information retrieval
7	Web Information Retrieval: Hypertext, web crawling, Search engines, Ranking, Link analysis, PageRank, HITS
8	Retrieving Structured Documents: XML retrieval, Semantic web

Text Books	
1	C.D. Manning, P. Raghavan, H. Schuetze, Introduction to Information Retrieval, Cambridge University Press, 2008.
2	B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, Pearson Education, 2010.
Reference Books	
1	B. Ricardo, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 2011.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5074L
Course Title	Vision Analytics Laboratory
Course Type	Laboratory
Prerequisites: Machine Learning	
Course Outcomes: At the end of the course student will be able to: CO1. Build and train the deep learning model for various application. CO2. Identify the key deep learning architecture parameters. CO3. Use best practices to train and develop test sets and analyze bias/variance for building DL applications.	

Course Content	
1	Deep neural network
2	Convolutional neural network
3	Transfer learning
4	Neural Style transfer
5	GAN

Text Books	
1	Jeremy Howard and Sylvain Gugger, Deep learning for coders with fastai and PyTorch, O'Reilly, 2020.
Reference Books	
1	Valliappa Lakshmanan, Martin Gorner and Ryan Gillard. Practical Machine Learning for Computer Vision, O'Reilly, 2021.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5075L
Course Title	Text Analytics Laboratory
Course Type	Laboratory
Prerequisites: Machine Learning	
Course Outcomes: At the end of the course student will be able to: CO1. Build and train the sequential deep learning model for text and speech application. CO2. Identify the key sequential deep learning architecture parameters. CO3. Model the character-level language, natural language processing, etc. Architectures.	

Course Content	
1	Sequential deep learning
2	Word vector representation
3	Neural machine translation
4	Name entity recognition
5	Speech data processing

Text Books	
1	Jeremy Howard and Sylvain Gugger, Deep learning for coders with fastai and PyTorch, O'Reilly, 2020.
Reference Books	
1	Valliappa Lakshmanan, Martin Gorner and Ryan Gillard. Practical Machine Learning for Computer Vision, O'Reilly, 2021.

Programme Name	M. Tech. Computer Engineering (Specialization in Artificial Intelligence and Data Science)
Course Code	AD5076L
Course Title	Big Data Analytics Laboratory
Course Type	Laboratory
Prerequisites: Machine Learning	
Course Outcomes: At the end of the course student will be able to: CO1. Build and train the deep learning model for various application. CO2. Identify the key deep learning architecture parameters. CO3. Use best practices to train and develop test sets and analyze bias/variance for building DL applications.	

Course Content	
1	Hadoop creation
2	Map Reduce for ML/DL
3	Knowledge build-up (Mahout)
4	Graph analytics
5	Apache spark

Text Books	
1	Seema Acharya and Subhashini Chellappan, Big Data and Analytics, Wiley, 2016.
Reference Books	
1	Alex Holmes, Big Data Black Book, Dreamtech, 2015.