Department of Computer Science & Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

M.Tech in AIML

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

To educate students at Undergraduate, Postgraduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

The department strives to be recognized globally for outstanding education and research, leading to excellent professionals and innovators in the field of Computer Science and Engineering, who can positively contribute to the society.

Department Mission

To impart quality education and equip the students with strong foundation that could make them capable of handling challenges of the new century.

To maintain state of the art research facilities and facilitate interaction with world's leading universities, industries and research organization for constant improvement in the quality of education and research.

Programme Educational Objectives (PEOs) – M.Tech in AIML

The program aims:

PEO1: To train the students in such a way that makes them capable of exploiting and enhancing theoretical and practical knowledge in the domain of machine learning and artificial intelligence.

PEO2: To impart students with a strong base of knowledge that makes them suitable for both industry teaching and research.

PEO3: To train the students to develop practical and efficient solutions to the research challenges in the growing field of artificial intelligence to gain leadership positions in the organization and/or teams.

PEO4: To inculcate students with the sensitivity towards ethics, public policies and their responsibilities towards the society to gain trust and respect of others as ethical team members.

PROGRAM OUTCOMES (POs) for MTech (AIML)

The program will enable students to possess:

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: An ability to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: In depth understanding of fundamental principles and concepts of various domains of machine learning and artificial intelligence.

PO5: Ability for analytical and critical thinking to analyse, design and improve existing tools and techniques.

PO6: Knowledge of contemporary issues in the field of machine learning and artificial intelligence and ability to engage in lifelong learning.

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEW COURSE STRUCTURE - To be effective from academic session 2024-25 Based on CBCS & OBE model
Recommended scheme of study for M.Tech. (AI ML)

SEMESTER / Session of Study (Recommended)	Course Level	Categoryof Course	Course Code	Courses	Mode of delivery & credits *L- Lecture; T-Tutorial; P- Practicals*			Total Credits *C-Credits*
					L (*Periods/ week*)	T *(Periods /week)*	P *(Periods /week)*	C
	THEORY							
FIRST / Monsoon	Fifth	Programme Core (PC)	AI501	Artificial Intelligence Concepts	3	0	0	3
			AI502	Advanced Concepts of Supervised Learning	3	0	0	3
			AI503	Advanced Concepts of Unsupervised Learning	3	0	0	3
			CS530	Linear Algebra	3	0	0	3
			CS531	Data Structures and Algorithm	3	0	0	3
								15
		LABORATORIES						
	Fifth	Programme Core (PC) Lab	CS550	Data Structures and Algorithm Lab	4	0	0	2
			CS551	Machine Learning Lab	4	0	0	2
			MT132	Communication Skill-I	0	0	3	1.5
								5.5
		TOTAL						15+5.5=20.5
SECOND/ Spring	Fifth	Programme Elective (PE)		PE I	3	0	0	3
				PE II	3	0	0	3

				PE III	3	0	0	3
				PE IV	3	0	0	3
				PE V	3	0	0	3
								15
		LABORATORIES						
	Fifth	Programme Elective (PE) Lab		PE I Lab	0	0	4	2
				PE II LAB	0	0	4	2
			MT133	Communication Skill-II	0	0	3	1.5
		TOTAL						15+5.5=20.5
TOTAL FOR FIFTH LEVEL								20.5+20.5 =41
THIRD /Monsoon	Sixth	Programme Core (PC)	AI600	Thesis Part I				8
		Open Elective (OE)	*	OE 1/MOOC-I	3	0	0	3
		Open Elective (OE)	*	OE 2/MOOC-II	3	0	0	3
		TOTAL						8+6=14
FOURTH/ Spring	Sixth	Programme Core (PC)	AI650	Thesis Part II				16
		TOTAL						16
TOTAL FOR SIXTH LEVEL								14+16= 30
GRAND TOTAL FOR M.TECH. PROGRAMME (46 + 24)								71

List of Electives

Course Code	**Courses**	**Mode of delivery & credits** ***L-Lecture; T-Tutorial; P- Practical***			**Total Credits** ***C-Credits***
AI601	Concepts of Deep Learning	3	0	0	3
AI602	Modern Artificial Intelligence	3	0	0	3
AI626	Concepts of Reinforcement Learning	3	0	0	3
CS632	Data Analysis and Interpretation	3	0	0	3
CS636	Evolutionary Computing	3	0	0	3

Program Elective Labs

PE Lab					
Course Code	**Courses**	**Mode of delivery & credits** ***L-Lecture; T-Tutorial; P- Practical***			**Total Credits** ***C-Credits***
AI622	Advanced Concepts of Deep Learning Lab	0	0	4	2
CS689	Data Analytics Lab	0	0	4	2

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: CS530
Course title: LINEAR ALGEBRA
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/V
Branch: AI & ML

Course Objectives
This course enables the students to:

1.	Present basic concepts and techniques of linear algebra
2.	Use the concept of linear algebra to formulate problems and solve those
3.	Develop mathematical thinking and problem-solving skill
4.	Provide the foundations of probabilistic and statistical analysis
5.	Apply the concept of number theory in Cryptography

Course Outcomes
After the completion of this course, students will be able to:

1.	Demonstrate skills in solving mathematical problems
2.	Analyze problems and identify the computing requirements appropriate to its solution
3.	Understand basic concepts in probability theory and statistical analysis
4.	Attain sufficient knowledge for studying the courses of Computer science such as Machine learning, Data Science, Computational problems (like solving set of linear equations), Networking (graph representation using matrix), etc.
5.	Apply linear algebra concepts to model, solve and analyse real-world situations

Syllabus

Module-I [6L]
Set, Relation, Function, Sequences, Counting techniques, Group, Ring, Field, Field polynomial

Module-II [8L]

Matrices, Various types of matrices, Sparse and dense matrix, Row reduction and echelon forms, Determinants and their properties, Operations on matrices including inverse, Linear transformation on matrices, Block matrices, Rank of matrix, Systems of linear equations (homogenous and non-homogenous), Solving linear equations, Cramer's Rule

Module -III [8L]

Vectors, Vector operations (sum and product), Linear dependence and independence, Vector space and dimension and subspace, Basis vectors and dimension, Orthogonality, Norms, Metric spaces, Gram-Schmidt Process

Module – IV [8L]

Eigenvalues and eigenvectors, Diagonalization of a matrix, characterizations of eigenvalues, Eigen Value Decomposition, Singular Value Decomposition. Elementary number theory: Prime numbers, Divisibility, Congruences

Module-V: [10L]

Probability and Statistics

Basic Probability:

Experiment, definition of probability, conditional probability, independent events, Bayes' rule, Bernoulli trials, Random variables, discrete random variable, entropy calculation, probability mass function, continuous random variable, probability density function, cumulative distribution function, properties of cumulative distribution function, Two dimensional random variables and their distribution functions, Independent random variables

Some special Probability Distributions:

Binomial distribution, Poisson distribution, Normal distributions

Basic Statistics:

Measure of central tendency: Moments, Expectation, dispersion, skewness, expected value of two dimensional random variable, Linear Correlation, correlation coefficient, rank correlation coefficient, Regression

Applied Statistics: Formation of Hypothesis, Test of significance: Sampling, parameter and statistic, data transformation, Confidence interval, Critical region, Testing of hypothesis, Likelihood ratio, testing, examples. Chi-square test of goodness of fit, Large sample test for single proportion, Test of significance for Small samples: t- Test for single mean, difference of means, t-test for correlation coefficients, F- test for ratio of variances, Chi-square test for goodness of fit and independence of attribute

Recommended Books:

1. Introduction to Linear Algebra, Gilbert Strang, Wellesley-Cambridge Press, Fifth Edition (2016)

2. Schaum's Outline of Linear Algebra, Seymour Lipschutz and Marc Lars Lipson, McGraw-Hill Education, Sixth Edition (2018)

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment:

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment:

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	low	medium	medium	medium	medium
CO2	high	medium	high	medium	high	medium
CO3	high	medium	high	high	high	high
CO4	medium	low	medium	high	high	high
CO5	high	medium	high	high	high	high

Mapping Between Course Outcomes and Course Delivery Methods

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD7

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: CS531
Course title: DATA STRUCTURES AND ALGORITHIMS
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/V
Branch: AI & ML

Course Objectives

This course enables the students to:

1.	Choose appropriate data structures and ADT/libraries.
2.	Design algorithms for a specific problem using the data structures and libraries.
3.	Understand the necessary mathematical abstraction to solve problems.
4.	Familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
5.	Come up with analysis of efficiency and proofs of correctness.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Develop an understanding of asymptotic notation and basic data structures.
CO2	Develop an understanding of the implementation of linear data structures.
CO3	Develop and analyze algorithms for non-linear structures.
CO4	Interpret the basic working of sorting techniques.
CO5	Develop an ability to understand the working of graphs and traversal methods.

SYLLABUS

Module-I [8L]

Fundamental Data Structures: Definition, Structure and Properties of Algorithms, Asymptotic Analysis, Solving recurrences, Arrays, Singly Linked Lists, Circularly Linked Lists, Doubly Linked Lists.

Module-II [8L]

Stacks, Queues, Dequeues: Simple Array Based Stack, Queue, Dequeue Implementation, Implementing Stack, Queue with Singly Linked List, Reversing an Array using Stack, Matching Parenthesis, A Circular Queue.

Module -III [8L]

Trees: General Trees, Binary Trees, Implementing Trees, Tree Traversal Algorithms, Binary Search Trees, M-way search trees, AVL Trees, B Trees, B+ Trees.

Module – IV [8L]

Sorting: Merge sort, Quick sort, Comparing Sorting Algorithms. Heap: Priority Queues, Array Implementation of Heaps, Construction of Heaps, Heap Sort.

Module-V [8L]

Graphs: Data Structures for graphs, Graph Traversals, Transitive Closure, Directed Acyclic Graphs, Shortest Paths, Minimum Spanning Trees

Text Books:

1. Klein Shmuel Tomi, Basic Concepts in Data Structures, Cambridge University Press, 1st Edition, 2016.

2. Goodrich Michael T., Tamassia Roberto, Goldwasser Michael H. “Data Structures and Algorithms in Java”, Wiley, 6th Edition, 2014.

Reference Books:

1. G A V Pai – Data Structures and Algorithms: Concepts, Techniques and Applications, 2nd Edn, Tata McGraw-Hill, 2008.

2. Horowitz E.Sahni, S., Susan A., Fundamentals of Data Structures in C, 2nd Edition, University Press, 2010.

3. J. P. Tremblay , P. G. Sorenson – An Introduction to Data Structures With Applications, 2nd Edn, McGraw-Hill, Inc. New York, NY, USA.

4. Seymour Lipschutz – Data Structures, 6th Edn, 9th Reprint 2008, Tata McGraw-Hill

Gaps in the syllabus (to meet Industry/Profession requirements):N/A
POs met through Gaps in the Syllabus:N/A
Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	low	medium	high	medium	medium
CO2	medium	medium	medium	high	high	medium
CO3	medium	medium	high	high	high	high
CO4	high	medium	high	high	high	high
CO5	high	medium	high	high	high	high

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHODS

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD5, CD7

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Industrial/guest lecture
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: AI502
Course title: CONCEPTS OF SUPERVISED LEARNING
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I /V
Branch: AI & ML

Course Outcomes

After the completion of this course, students will be:

1	Able to demonstrate with examples the advanced concepts of supervised learning
2	Able to build tree-based classifiers and demonstrate the splitting criteria, as well as perform classification using SVMs and decide the proper kernel.
3	Able to articulate the working of a simple neural network with backpropagation
4	Able to apply Semi-supervised learning with EM using labelled and unlabeled data.
5	Able to demonstrate how Ensemble learning helps improve classifier performance.

SYLLABUS

Module-I [6L]
Preliminaries
Machine Learning – what and why? Regression, Confusion Matrix, Gradient Descent, Naïve Bayes Classifier, KNN Classifier.

Module-II [10L]
Learning with Decision Trees and Support Vector machines
Basics of Feature Selection and Evaluation, Decision Tree, Overfitting and Pruning, Logistic Regression. Support Vector Machine and Kernel; Noise, bias-variance trade-off, under-fitting and over-fitting concepts

Module -III [10L]
Neural Networks
Perceptron: representational limitation and gradient descent training. The concept of Bias, Backpropagation and its working, Practical aspects of learning – Amount of

training data, number of hidden layers. Deriving the back propagation algorithm. Overfitting, learning network structure, recurrent networks.

Module – IV [8L]
Semi Supervised Learning
Learning from unclassified data. Semi-supervised learning with EM using labelled and unlabeled data.

Module-V [6L]
Ensemble
Bagging, Boosting, Random Forest, Different ways to combine classifiers

Textbook:

1. Marsland S., "Machine Learning: An Algorithmic Perspective", CRC Press, 2nd Edition, 2015

Reference Book

1) Han J., Kamber M., Pei J., "Data Mining: Concepts and Techniques", Morgan Kaufman, 3rd Edition, 2012

Gaps in the syllabus (to meet Industry/Profession requirements):N/A
POs met through Gaps in the Syllabus:N/A
Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	high	high	medium	medium	medium
CO2	high	high	medium	medium	high	low
CO3	high	high	medium	high	medium	medium
CO4	high	high	high	high	medium	low
CO5	high	high	high	high	low	low

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHODS

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: AI503
Course title: ADVANCED CONCEPTS OF UNSUPERVISED LEARNING
Pre-requisite(s): CS530 Linear Algebra
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I /V
Branch: AI & ML

Course Outcomes

After the completion of this course, students will be:

1	Able to create dissimilarity matrices for datasets using different techniques
2	Able to use partitional and hierarchical techniques to cluster datasets and identify suitable use cases for their usage.
3	Able to perform density-based clusters on datasets unsuitable for clustering using traditional methods.
4	Measure the goodness of a cluster using formal methods.
5	Detect outliers in large datasets.

Syllabus

Module-I [8L]
Preliminaries
Introduction to Clustering, Dissimilarity Matrices, Overview of Basic Clustering Methods

Module-II [8L]
Foundational Methods of Clustering
Partitioning Methods: K-means and K-Medoids, Hierarchical Clustering Algorithms

Module -III [8L]
Advanced Clustering Techniques
Density -Based Methods: DBSCAN, OPTICS, Grid-Based Methods: STING, CLIQUE
.

Module – IV [8L]
Cluster Validation
Clustering Validation Techniques, Measuring Clustering Quality, Clustering Applications

Module-V [8L]
Outlier Analysis

Outliers and Outlier Analysis, Outlier Detection Methods, Clustering-Based Approaches

Textbook:

1. Mohammed J. Zaki, and Wagner Meira Jr., "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2016.

Reference Books

1) Jiawei Han, and Micheline Kamber, "Data Mining Concepts & Techniques", 3rd Edition, Publisher Elsevier India Private Limited, 2015.
2) Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, "Introduction to Data Mining", Pearson, 201

Gaps in the syllabus (to meet Industry/Profession requirements):N/A
POs met through Gaps in the Syllabus:N/A
Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course outcomes onto Program Outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	high	high	high	medium	medium	medium
CO2	high	high	medium	medium	high	low
CO3	high	high	medium	high	medium	medium
CO4	high	high	high	high	medium	low
CO5	high	high	high	high	low	low

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHODS

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: AI501
Course title: ARTIFICIAL INTELLIGENCE CONCEPTS
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I /V
Branch: AI & ML

Course Outcomes

After the completion of this course, students will be:

1	Understanding the principles and approaches of artificial intelligence, history of AI, its foundations, and different aspects of Intelligent agents.
2	Understanding various applications of AI in real-world problem solving that require perception, environment, learning and search techniques
3	Understand and apply different types of heuristic and adversarial search techniques for solving real world problems and select the most appropriate solution by comparative evaluation.
4	Understanding the various concepts of knowledge representations and demonstrate working knowledge of reasoning in the presence of incomplete and/or uncertain information.
5	To develop a basic understanding of some of the more advanced topics of AI such as learning, Supervised Learning, Unsupervised Learning, Natural Language Processing, its current scope and limitations, and its impact on society.

Syllabus

Module-I [8L]

Introduction: Overview of Artificial Intelligence, AI vs. Human Intelligence, Subfields of AI, History and Evolution of AI, Applications and limitations of current AI systems, Ethical and societal challenges of AI, AI Technique, Tic - Tac - Toe Problem.

Problem Solving: Problems, Problem Space & Search: Defining The Problem as State Space Search, Production System, Problem Characteristics, Issues in The Design of Search Programs.

Module-II [8L]

Intelligent Agents: Agents & Environment, Nature of Environment, concept of rationality, Multi-agent systems, Structure of Agents, Goal Based Agents, Utility Based Agents, Learning Agents.

Search Techniques: Solving Problems by Searching, Problem Solving Agents, Searching for Solutions; Uniform Search Strategies: Breadth First Search, Depth First Search, Depth Limited Search, Bi-directional Search, Comparing Uniform Search Strategies.

Module -III [8L]

Heuristic Search Strategies: Greedy Best-First Search, A* Search, Memory Bounded Heuristic Search: Local Search Algorithms & Optimization Problems: Hill Climbing Search, Simulated Annealing Search, Local Beam Search, Genetic Algorithms; Constraint Satisfaction Problems

Adversarial Search: Games, Optimal Decisions & Strategies in Games, The Minimax Search Procedure, Alpha-Beta Pruning, Additional Refinements, Iterative Deepening.

Module – IV [8L]

Knowledge Representation & Reasoning: Knowledge Representation Issues, Representation & Mapping, Approaches to Knowledge Representation, Propositional logic, First order predicate logic, Inference, Forward changing, Backward changing, Resolution, Procedural Versus Declarative Knowledge

Module-V [8L]

AI Applications: Machine learning basics - Learning from examples - forms of learning (supervised, unsupervised, reinforcement learning),

Natural Language Processing - Language Models – Machine Translation; Speech Recognition

Gaps in the syllabus (to meet Industry/Profession requirements):N/A
POs met through Gaps in the Syllabus:N/A
Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment:

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment:

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes:

Course Outcome	Program Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	high	high	medium	medium	medium
CO2	high	high	medium	high	medium	low
CO3	high	high	medium	high	high	medium
CO4	high	high	medium	high	high	low
CO5	high	medium	medium	medium	high	low

Mapping Between Course Outcomes and Course Delivery Methods

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD7

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: CS632
Course title: Data Analytics and Interpretation
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/V
Branch: AI & ML

Course Objectives

This course enables the students to:

1.	**Develop a strong foundation in statistical analysis**, probability distributions, and hypothesis testing methods.
2.	**Explore and apply machine learning algorithms** for regression and classification problems.
3.	**Analyze and optimize machine learning models** for performance enhancement.
4.	**Understand and implement unsupervised learning techniques** addressing challenges in big data analytics.
5.	**Applying prescriptive analytics techniques for** data-driven decision-making.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Develop a strong foundation in descriptive and inferential statistics.
CO2	Learn and implement regression models.
CO3	Learn and implement supervised learning models.
CO4	Learn the different methods of combining classifiers.
CO5	Learn and implement unsupervised learning models.

Syllabus

Module-I [10L]
Descriptive Statistics- Introduction to the course Descriptive Statistics Probability Distributions Inferential Statistics-Inferential Statistics through hypothesis tests Permutation & Randomization Test.

Module-II [8L]
Machine Learning: Introduction and Concepts Differentiating algorithmic and model based frameworks Regression: Regression & ANOVA Regression ANOVA (Analysis of Variance) Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification.

Module -III [8L]
Supervised Learning with Regression and Classification techniques - Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Regression and Classification Trees, Support Vector Machines.

Module – IV [6L]
Ensemble Methods- Random Forest, Neural Networks, Deep learning

Module-V [8L]
Unsupervised Learning and Challenges for Big Data Analytics- K-Means and Hierarchical Clustering, Associative Rule Mining, Challenges for big data analytics. Prescriptive analytics- Creating data for analytics through designed experiments, Creating data for analytics through Active learning, Creating data for analytics through Reinforcement learning

Text books:

1. Hastie, Trevor, Tibshirani, Robert, Friedman, Jerome, "The Elements of Statistical Learning". Vol. 2. No. 1. Springer, New York, 2009.
2. Montgomery, Douglas C., and Runger George C., "Applied statistics and probability for Engineers". John Wiley & Sons, 2010.

Gaps in the syllabus (to meet Industry/Profession requirements):N/A
POs met through Gaps in the Syllabus:N/A
Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment

Assessment Tools	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	medium	medium	medium	high	low	medium
CO2	high	medium	high	high	high	medium
CO3	high	medium	high	high	high	high
CO4	medium	medium	medium	high	high	high
CO5	high	medium	high	medium	high	high

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: AI601
Course title: Concepts of Deep Learning
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II /V
Branch: AI & ML

Course Objectives

This course enables the students to:

1.	Understand the concept and architecture of deep learning, gradient descent and its variants
2.	Understand to concept of different types of attributes and their pre-processing.
3.	Understand the concept and architecture of Convolution Neural Networks.
4.	Understand the idea of Recurrent Neural Networks and backpropagation through time.
5.	Understand the architecture of LSTM, and GRU, RNN model

Course Outcomes

After the completion of this course, students are expected to:

CO1	Build deep learning model and apply optimization techniques
CO2	Implement numerical representation of data and its transformation.
CO3	Apply CNN with hyper parameters tuning.
CO4	Build RNN based Deep learning models.
CO5	Apply RNN to sequential data tasks.

Syllabus

Module-I [8L]

Introduction:

Defining Deep Learning, Common Architectural Principles, Building blocks of Deep Learning, Understanding Bias and Variance, Hyperparameters, Gradient Descent and its Variants including Minibatch, Momentum, RMSProp, ADAM and Nesterov factor

Module-II [8L]

Design Techniques for DL

Vectorization, Types of attributes – Nominal, Ordinal, Interval and Ratio, Feature Engineering and Normalization techniques, Dimensionality Reduction, One Hot Encoding, Data Augmentation

Module -III [8L]

Convolutional Neural Networks

Understanding images and CNNs, Basic architecture, Filters, Pooling and Stride. Configuring CNN Layers, Applying CNNs to common datasets. Challenges in working with CNNs.

Module – IV [8L]

Recurrent Neural Networks - I

Input Data and input layers, RNNs – basic architecture and backpropogation through time, Issues with RNNs – the vanishing and exploding gradient problem

Module-V [8L]

Recurrent Neural Networks – II

LSTM – architecture and improvements over RNNs, GRUs. Applying Recurrent Neural Networks on common datasets, RNNs for NLP.

Text Books:

1) 1. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O’Reilly Media, 2017
2) Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." MIT Press book, 2015.

Gaps in the syllabus (to meet Industry/Profession requirements):N/A
POs met through Gaps in the Syllabus:N/A
Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	medium	high	medium	medium	medium
CO2	medium	medium	medium	medium	medium	medium
CO3	high	high	high	high	high	high
CO4	high	high	high	high	high	high
CO5	high	high	high	high	high	high

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHODS

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: AI626
Course title: Concepts of Reinforcement Learning
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: I/V
Branch: AI & ML

Course Outcomes

After the completion of this course, students are expected to:

CO1	Explain with examples the basic concepts of reinforcement learning
CO2	Solve problems of MDP and DP
CO3	Explain the implementation of different MC and TD Algorithms
CO4	Demonstrate bootstrapping, planning and learning models.
CO5	Elaborate the functions of on and off policy prediction with approximation.

Syllabus

Module-I [8L]

Introduction:

Reinforcement Learning, Examples, Elements of Reinforcement Learning, Limitations and Scope ,An Extended Example: Tic-Tac-Toe, Multi Arm Bandits :A k-armed Bandit Problem, Action Value Methods, The 10-armed Testbed, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial values, UCB, Gradient Bandit Algorithms, Associative Search

Module-II [8L]

Finite Markov Decision Process:

Agent -Environment Interface, Goals and Rewards, Returns and Episodes, Unified Notation for Episodic and Continuing Tasks, Policies and value Functions, Optimal Policies and Optimal Value Functions, Optimality and Value Functions

Dynamic Programming:

Policy Evaluation and Improvement, Policy and Value Iteration ,Asynchronous Dynamic Programming, GPI ,Efficiency of Dynamic Programming

Module -III [8L]

Monte Carlo Methods:

MC Prediction**,** MC Estimation of Action values, MC Control, MC Control without Exploring Starts,Off-Policy Prediction via Importance Sampling,Off-Policy MC Control.

Temporal-Difference Learning:

TD Prediction, Advantages of TD, Optimality of TD(0),Sarsa-On-Policy TD Control, Q-Learning Off-Policy TD Control, Expected Sarsa Maximization Bias and Double Learning

Module – IV [8L]

n-step Bootstraping:

n-step TD Prediction, n-step Sarsa, n-step Off-Policy Learning, Pré-decision Methods with Control Variates
Planning and Learning with Tabular Methods: Models and Planning, Dyna, When the model is wrong? Prioritized sweeping, Expected Vs Sample Updates, Trajectory sampling

Module-V [8L]

On Policy prediction with Approximation:
Value function Approximation, The prediction Objective, Stochastic-Gradient and Semi gradient Methods , Linear Methods, On-Policy Control with Approximation
Off-Policy methods with Approximation: Semi-gradient Methods, Examples of Off-Policy Divergence, The Deadly Triad, Linear value Function Geometry. Gradient descent in the Bellman Error. Eligibility Traces: The λ-Return, TD(λ).

Textbook:

1. Richard S .Sutton and Andrew G Barto, ”Reinforcement Learning: An Introduction, Second Edition, MIT press,2020

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment:

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment:
1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes:

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	high	high	medium	medium	medium
CO2	high	high	medium	medium	high	low
CO3	high	high	medium	high	medium	medium
CO4	high	high	high	high	medium	low
CO5	high	high	high	high	low	low

Mapping Between Course Outcomes and Course Delivery Methods

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD7

COURSE INFORMATION SHEET

L	T	P	C
3	0	0	3

Course code: CS636
Course title: Evolutionary Computing
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 3
Class: M. Tech
Semester / Level: II/V
Branch: AI & ML

Course Objectives

This course enables the students to:

1.	Understand the principles of evolutionary computing.
2.	Familiarize with the mathematical aspect of evolutionary computing.
3.	Analyze how evolutionary computing is used to solve problems.
4.	Develop an understanding of multi-objective evolutionary optimization models.
5.	Apply the use of evolutionary computing for machine learning and the implementation aspects.

Course Outcomes

After the completion of this course, students are expected to:

CO1	Differentiate and understand various evolutionary computation techniques.
CO2	Grasp the fundamental of genetic algorithms.
CO3	Apply advance techniques for multi-objective optimization.
CO4	Explore different methods for multi-objective evolutionary optimization.
CO5	Design of Genetic Algorithm based applications in Machine Learning.

Syllabus:

Module-I [8L]

Introduction to Evolutionary Computation :

Generic Evolutionary Algorithm, Representation – The Chromosome, Initial Population, Fitness Function, Selection, Reproduction Operators, Stopping Conditions, Evolutionary Computation versus Classical Optimization

Module-II [8L]

Genetic Algorithms :

Canonical Genetic Algorithm, Crossover, Mutation, Control Parameters, Genetic Algorithm Variants: Generation Gap Methods, Messy Genetic Algorithms, Interactive Evolution, Island Genetic Algorithms

Module -III [8L]

Advanced Topics :

Niching Genetic Algorithms, Constraint Handling, Multi-Objective Optimization, Dynamic Environments, Applications, Coevolution: Competitive Fitness, Generic Competitive Coevolutionary Algorithm

Module – IV [8L]

Multi-objective Evolutionary Optimization :

Multi-objective Problems: Linear, Nonlinear, Convex, Nonconvex; Pareto optimality, Multi-objective Optimization, Methods: Weighted Sum Method, e-Constraint Method, Weighted Matrix Method, Benson's Method, Value Function Method, Goal Programming Method

Module-V [8L]

Application of Genetic Based Machine Learning (GBML):

Rise of GBML, Development of CS-1, Smith's Poker Player, Other efforts of GBML, Current Applications of GBML: BOOLE, CL-ONE, Simple sequential Programs: JB and TB

Text- Books

1. A. P. Engelbrecht, Computational Intelligence, Wiley, USA, 2007
2. Genetic Algorithms in Search, Optimuization and machine Learning, D. E. Goldberg, Addition -Wisley Companay Inc, 1989
3. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley, USA,2001

Reference Book

1. S.N.Sivanandam & S.N.Deepa, Introduction to Genetic Algorithms, Springer Berlin Heidelberg New York,2008

Gaps in the syllabus (to meet Industry/Profession requirements):N/A

POs met through Gaps in the Syllabus:N/A

Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
Three quizzes	30 %(3X10%)
Assignment(s)	10
Seminar before a committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment
1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	high	medium	high	medium	low	high
CO2	medium	high	medium	medium	medium	medium
CO3	medium	high	medium	high	high	high
CO4	high	medium	medium	medium	medium	medium
CO5	medium	medium	low	medium	high	medium

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHODS

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

COURSE INFORMATION SHEET

L	T	P	C
0	0	4	2

Course code: AI622
Course title: Advanced Concepts of Deep Learning Lab
Pre-requisite(s):
Co- requisite(s):
Class schedule per week: 4
Class: M. Tech
Semester / Level: II/V
Branch: AI & ML

Course Objectives

This course enables the students:

1	To understand concept of deep learning, MLP, Activation function, gradient descent and its variants
2	To understand Design techniques for deep learning, feature engineering, Normalization techniques, PCA, Data augmentation
3	To understand the concept of CNN and its application.
4	To understand the idea of Recurrent Neural Networks
5	To understand the architecture of LSTM, and GRU, RNN model

Course Outcomes

After the completion of this course, students will be able:

1	Build deep learning model, tune hyper parameter, apply optimization techniques
2	Implement numerical representation of data, improve to efficiency of model by feature engineering and normalization, uniform features, application of PCA, transform variable use for machine learning, create dataset with more samples
3	Apply CNN to solve different image datasets.
4	Apply RNN to solve problem such as NLP, time series forecasting etc.
5	Apply LSTM and GRU to solve sequential data task, natural language processing

Gaps in the syllabus (to meet Industry/Profession requirements):N/A
POs met through Gaps in the Syllabus:N/A
Topics beyond syllabus/Advanced topics/Design:N/A
POs met through Topics beyond syllabus/Advanced topics/Design:N/A

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment

Assessment Tools	**% Contribution during CO Assessment**
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	**% Distribution**
Day to day performance & Lab files	30
Quiz	10
Viva	20
Semester End Examination	**% Distribution**

Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)					
	1	2	3	4	5	6
CO1	high	high	high	medium	medium	low
CO2	high	high	medium	low	medium	medium
CO3	medium	medium	high	high	low	medium
CO4	medium	medium	medium	medium	medium	medium
CO5	medium	high	low	low	medium	medium

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHODS

Course Outcomes	Course Delivery Method
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7