SHADAN COLLEGE OF ENGINEERING & TECHNOLOGY
M. Tech. ARTIFICIAL INTELLIGENCE & DATA SCIENCE
EFFECTIVE FROM ACADEMIC YEAR 2023-24 ADMITTED BATCH

R23 COURSE STRUCTURE AND SYLLABUS

I YEAR I SEMESTER

Course Code	Course Title	L	T	P	Credits
Professional Core – I	Artificial Intelligence and Intelligent Systems	3	0	0	3
Professional Core – II	Statistical Foundations for Data Science	3	0	0	3
Professional Elective – I	1. Advanced Data Structures using Python 2. Machine Learning 3. Database Programming with PL/SQL	3	0	0	3
Professional Elective – II	1. Functional Programming 2. Game Theory and Applications 3. Computational Neuroscience	3	0	0	3
Lab – I	Artificial Intelligence and Intelligent Systems Lab	0	0	4	2
Lab – II	Professional Elective – I Lab	0	0	4	2
	Research Methodology & IPR	2	0	0	2
Audit – I	Audit Course – I	2	0	0	0
	Total	**16**	**0**	**8**	**18**

Professional Elective- I and Professional Elective- I Lab must be of same course.

I YEAR II SEMESTER

Course Code	Course Title	L	T	P	Credits
Professional Core – III	Deep Learning	3	0	0	3
Professional Core – IV	Data Analytics	3	0	0	3
Professional Elective – III	1. Social Media Mining 2. Visual Analytics 3. Enterprise Cloud Concepts	3	0	0	3
Professional Elective – IV	1. Reinforcement Learning 2. Machine Translation 3. Nature Inspired Computing	3	0	0	3
Lab – III	Deep Learning Lab	0	0	4	2
Lab – IV	Professional Elective – III Lab	0	0	4	2
	Mini Project with Seminar	0	0	4	2
Audit – II	Audit Course – II	2	0	0	0
	Total	**14**	**0**	**12**	**18**

Professional Elective- III and Professional Elective- III Lab must be of same course.

II YEAR I SEMESTER

Course Code	Course Title	L	T	P	Credits
Professional Elective – V	1. Predictive Analytics 2. Conversational AI 3. Computer Vision and Robotics	3	0	0	3
Open Elective	Open Elective	3	0	0	3
Dissertation	Dissertation Work Review – II	0	0	12	6
	Total	**6**	**0**	**12**	**12**

II YEAR II SEMESTER

Course Code	Course Title	L	T	P	Credits
Dissertation	Dissertation Work Review – III	0	0	12	6
Dissertation	Dissertation Viva-Voce	0	0	28	14
	Total	**0**	**0**	**40**	**20**

Note: For Dissertation Work Review - I, Please refer 7.10 in R23 Academic Regulations.

Audit Course I & II:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by yoga
8. Personality Development Through Life Enlightenment Skills

Open Electives for other Departments:

1. IPR
2. Fault Tolerance Systems
3. Intrusion Detection Systems
4. Digital Forensics
5. Optimization Techniques
6. Cyber Physical Systems
7. Graph Analytics

ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS (PC - I)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: UG level course in Mathematics, Data Structures

Course Objectives:

1. To impart knowledge about Artificial Intelligence.
2. To give an 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.

Course Outcomes: After completion of course, students would be able to:

1. Solve basic AI based problems.
2. Define the concept of Artificial Intelligence.
3. Apply AI techniques to real-world problems to develop intelligent systems.
4. Select appropriately from a range of techniques when implementing intelligent systems.

UNIT - I

Introduction: Overview of AI problems, AI problems as NP, NP-Complete and NP Hard problems. Strong and weak, neat and scruffy, symbolic and sub-symbolic, knowledge-based and data-driven AI.

UNIT -II

Search Strategies: Problem spaces (states, goals and operators), problem solving by search, Heuristics and informed search, Min-max Search, Alpha-beta pruning. Constraint satisfaction (backtracking and local search methods).

UNIT - III

Knowledge representation and reasoning: propositional and predicate logic, Resolution and theorem proving, Temporal and spatial reasoning. Probabilistic reasoning, Bayes theorem. Totally-ordered and partially-ordered Planning. Goal stack planning, Nonlinear planning, Hierarchical planning.

UNIT - IV

Learning: Learning from example, Learning by advice, Explanation based learning, Learning in problem solving, Classification, Inductive learning, Naive Bayesian Classifier, decision trees.

Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Text classification. Information retrieval.

UNIT - V

Agents: Definition of agents, Agent architectures (e.g., reactive, layered, cognitive), Multi-agent systems- Collaborating agents, Competitive agents, Swarm systems and biologically inspired models.

Intelligent Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.

Key Application Areas: Expert system, decision support systems, Speech and vision, Natural language processing, Information Retrieval, Semantic Web.

TEXT BOOK:

1. Artificial Intelligence: A Modern Approach by S. Russell and P. Norvig, Prentice Hall

REFERENCES:

1. Artificial Intelligence by Elaine Rich, Kevin Knight and Shivashankar B Nair, Tata McGraw Hill.
2. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Pearson Education.

STATISTICAL FOUNDATIONS FOR DATA SCIENCE (PC - II)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Mathematics courses of first year of study.

Course Objectives:

1. The Number Theory basic concepts useful for cryptography etc
2. The theory of Probability, and probability distributions of single and multiple random variables
3. The sampling theory and testing of hypothesis and making inferences
4. Stochastic process and Markov chains.

Course Outcomes: After learning the contents of this course, the student must be able to

1. Apply the number theory concepts to cryptography domain
2. Apply the concepts of probability and distributions to some case studies
3. Correlate the material of one unit to the material in other units
4. Resolve the potential misconceptions and hazards in each topic of study.

UNIT - I

Greatest Common Divisors and Prime Factorization: Greatest common divisors, The Euclidean algorithm, The fundamental theorem of arithmetic, Factorization of integers and the Fermat numbers Congruences: Introduction to congruences, Linear congruences, The Chinese remainder theorem, Systems of linear congruences

UNIT - II

Simple Linear Regression and Correlation: Introduction to Linear Regression, The Simple Linear Regression Model, Least Squares and the Fitted Model, Properties of the Least Squares Estimators, Inferences Concerning the Regression Coefficients, Prediction, Simple Linear Regression Case Study Random Variables and Probability Distributions: Concept of a Random Variable, Discrete Probability Distributions, Continuous Probability Distributions, Statistical Independence. Discrete Probability Distributions: Binomial Distribution, Poisson distribution.

UNIT - III

Continuous Probability Distributions: Normal Distribution, Areas under the Normal Curve, Applications of the Normal Distribution, Normal Approximation to the Binomial, Fundamental Sampling Distributions: Random Sampling, Sampling Distributions, Sampling, Distribution of Means and the Central Limit Theorem, Sampling Distribution of S2, t–Distribution, F Distribution.

UNIT - IV

Estimation & Tests of Hypotheses: Introduction, Statistical Inference, Classical Methods of Estimation. Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Tolerance Limits, Estimating the Variance, Estimating a Proportion for single mean, Difference between Two Means, between Two Proportions for Two Samples and Maximum Likelihood Estimation.

UNIT - V

Stochastic Processes and Markov Chains: Introduction to Stochastic processes- Markov process. Transition Probability, Transition Probability Matrix, First order and Higher order Markov process, n step transition probabilities, Markov chain, Steady state condition, Markov analysis.

TEXT BOOKS:

1. Kenneth H. Rosen, Elementary number theory & its applications, sixth edition, Addison Wesley, ISBN 978 0-321-50031-1

2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Ed. Pearson Publishers.
3. S. D. Sharma, Operations Research, Kedarnath and Ramnath Publishers, Meerut, Delhi

REFERENCE BOOKS:

1. S C Gupta and V K Kapoor, Fundamentals of Mathematical statistics, Khanna publications
2. T.T. Soong, Fundamentals of Probability And Statistics For Engineers, John Wiley & Sons Ltd, 2004.
3. Sheldon M Ross, Probability and statistics for Engineers and scientists, Academic Press.

ADVANCED DATA STRUCTURES USING PYTHON (Professional Elective - I)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: UG level course in Data Structures

Course Objectives: This course will enable students to

1. Implement Object Oriented Programming concepts in Python.
2. Understand Lists, Dictionaries and Regular expressions in Python.
3. Understanding how searching and sorting is performed in Python.
4. Understanding how linear and non-linear data structures works.
5. To learn the fundamentals of writing Python scripts.

Course Outcomes: The students should be able to:

1. Examine Python syntax and semantics and apply Python flow control and functions.
2. Create, run and manipulate Python Programs using core data structures like Lists,
3. Apply Dictionaries and use Regular Expressions.
4. Interpret the concepts of Object-Oriented Programming as used in Python.
5. Master object-oriented programming to create an entire python project using objects and classes

UNIT - I

Oops Concepts- class, object, constructors, types of variables, types of methods. **Inheritance:** single, multiple, multi-level, hierarchical, hybrid, **Polymorphism:** with functions and objects, with class methods, with inheritance, **Abstraction:** abstract classes.

UNIT - II

Data Structures – Definition, Linear Data Structures, Non-Linear Data Structures
Python Specific Data Structures: List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings, slicing.

UNIT - III

Arrays - Overview, Types of Arrays, Operations on Arrays, Arrays vs List.
Searching -Linear Search and Binary Search.
Sorting - Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort.

UNIT - IV

Linked Lists – Implementation of Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists.
Stacks - Overview of Stack, Implementation of Stack (List & Linked list), Applications of Stack
Queues: Overview of Queue, Implementation of Queue (List & Linked list), Applications of Queues, Priority Queues.

UNIT - V

Graphs -Introduction, Directed vs Undirected Graphs, Weighted vs Unweighted Graphs, Representations, Breadth First Search, Depth First Search.
Trees - Overview of Trees, Tree Terminology, Binary Trees: Introduction, Implementation, Applications. Tree Traversals, Binary Search Trees: Introduction, Implementation, AVL Trees: Introduction, Rotations, Implementation.

TEXT BOOKS:

1. Data structures and algorithms in python by Michael T. Goodrich
2. Data Structures and Algorithmic Thinking with Python by Narasimha Karumanchi

REFERENCE BOOKS:

1. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition by Dr. Basant Agarwal, Benjamin Baka.
2. Data Structures and Algorithms with Python by Kent D. Lee and Steve Hubbard.
3. Problem Solving with Algorithms and Data Structures Using Python by Bradley N Miller and David L.Ranum.
4. Core Python Programming -Second Edition,R. Nageswara Rao, Dreamtech Press.

MACHINE LEARNING (Professional Elective - I)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To have a thorough understanding of the Supervised and Unsupervised learning techniques
3. To study the various probability based learning techniques
4. To understand graphical models of machine learning algorithms

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

1. Distinguish between, supervised, unsupervised and semi-supervised learning
2. Apply the apt machine learning strategy for any given problem
3. Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
4. Design systems that use the appropriate graph models of machine learning
5. Modify existing machine learning algorithms to improve classification efficiency

UNIT - I:

Introduction: Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants: – Perceptron – Linear Separability – Linear Regression.

UNIT - II:

Linear Models: Multi-layer Perceptron– Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines

UNIT - III:

Tree and Probabilistic Models: Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms

UNIT - IV:

Dimensionality Reduction and Evolutionary Models: Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example

UNIT - V:

Graphical Models: Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods

TEXT BOOKS:

1. Stephen Marsland, —Machine Learning – An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

2. Tom M Mitchell, —Machine Learning, First Edition, McGraw Hill Education, 2013.

REFERENCES:

1. Peter Flach, —Machine Learning: The Art and Science of Algorithms that Make Sense of Datal, First Edition, Cambridge University Press, 2012.
2. Jason Bell, —Machine learning – Hands on for Developers and Technical Professionalsl, First Edition, Wiley, 2014
3. Ethem Alpaydin, —Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014

DATABASE PROGRAMMING WITH PL/SQL (Professional Elective - I)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. Knowledge on significance of SQL fundamentals.
2. Evaluate functions and triggers of PL/SQL
3. Knowledge on control structures, packages in PL/SQL and its applications

Course Outcomes:

1. Understand importance of PL/SQL basics
2. Implement functions and procedures using PL/SQL
3. Understand the importance of triggers in database

UNIT - I

PL/SQL Basics: Block Structure, Behavior of Variables in Blocks, Basic Scalar and Composite Data Types, Control Structures, Exceptions, Bulk Operations, Functions, Procedures, and Packages, Transaction Scope.

UNIT - II

Language Fundamentals & Control Structures: Lexical Units, Variables and Data Types, Conditional Statements, Iterative Statements, Cursor Structures, Bulk Statements, Introduction to Collections, Object Types: Varray and Table Collections, Associative Arrays, Oracle Collection API.

UNIT - III

Functions and Procedures: Function and Procedure Architecture, Transaction Scope, Calling Subroutines, Positional Notation, Named Notation, Mixed Notation, Exclusionary Notation, SQL Call Notation, Functions, Function Model Choices, Creation Options, Pass-by-Value Functions, Pass-by-Reference Functions, Procedures, Pass-by-Value Procedures, Pass-by-Reference Procedures, Supporting Scripts.

UNIT - IV

Packages: Package Architecture, Package Specification, Prototype Features, Serially Reusable Precompiler Directive, Variables, Types, Components: Functions and Procedures, Package Body, Prototype Features, Variables, Types, Components: Functions and Procedures, Definer vs. Invoker Rights Mechanics, Managing Packages in the Database Catalog, Finding, Validating, and Describing Packages, Checking Dependencies, Comparing Validation Methods: Timestamp vs. Signature.

UNIT - V

Triggers: Introduction to Triggers, Database Trigger Architecture, Data Definition Language Triggers, Event Attribute Functions, Building DDL Triggers, Data Manipulation Language Triggers, Statement-Level Triggers, Row-Level Triggers, Compound Triggers, INSTEAD OF Triggers, System and Database Event Triggers, Trigger Restrictions, Maximum Trigger Size, SQL Statements, LONG and LONG RAW Data Types.

TEXT BOOKS:

1. Oracle Database 12c PL/SQL Programming Michael McLaughlin, McGrawHill Education

REFERENCES:

1. Benjamin Rosenzweig, Elena Silvestrova Rakhimov, Oracle PL/SQL by example Fifth Edition
2. Dr. P. S. Deshpande, SQL & PL / SQL for Oracle 11g Black Book

FUNCTIONAL PROGRAMMING (Professional Elective - II)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives

1. Understand the concepts and terms used to describe languages that support the imperative, functional, object-oriented, and logic programming paradigms.
2. Solve problems using the functional paradigm.
3. Solve problems using the object-oriented paradigm.
4. Solve problems using the logic programming paradigm.

Course Outcomes: At the end of the course the student will be able to:

1. Write programs in a functional style.
2. Reason formally about functional programs.
3. Use polymorphism and higher-order functions.
4. Reason about the time and space complexity of programs.

UNIT - I

Functional Programming: Introduction, Differences between Functional Programming and Object-Oriented Programming, concepts of functional programming, Functional Programming in Python: Introduction to Python, Built-in Functions, Dictionary Methods, String Methods, LIST/ARRAY Methods, Tuple Methods, Set Methods

UNIT - II

Python Exceptions, File Handling, Tuple Methods, Defining Iteration, Conditional Iterations, Random Module, Math Module, CMath Module, Python File I/O

UNIT - III

Python Sending Mail, Python CSV, Python OOP Concepts, Python Iterators, Python Generators, Python Decorators, Python Database Connections

UNIT - IV

Introduction to Haskell and Laziness, Structure, Modularity, Maintainability, Polymorphism, higher order functions, strings & characters, lazy evaluation, Data Types using Patterns

UNIT - V

LISP Programming: Basic LISP Programming, Data Types, Functions, Editing, Loading, Compiling LISP Programs, Control Structures: Recursions and Conditionals, LISTS, SETS, Structural Recursion with LISTS, Symbols

TEXT BOOKS:

1. The Haskell School of Expression: Learning Functional Programming through Multimedia, Paul Hudak.
2. Functional Programming in Python, David Mertz, O'Reilly Media.
3. LISP, Patrick Henry Winston, Bertbold Klaus Paul Horn, Pearson Education

GAME THEORY AND APPLICATIONS (Professional Elective - II)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Graph Theory

Course Objectives:

1. To teach students some strategic considerations to take into account making their choices.
2. To learn basic concepts of game theory.
3. To apply game theoretic models to real world problems

Course Outcomes:

1. Solve strategic games between two and more agents in non-cooperative scenario.
2. Analyze and solve both simultaneous-moves and sequential-moves games.
3. Learn different methods to solve games.

UNIT - I

Introduction: games and decisions, Games Strategies, Costs and Payoff, Basic Solution Concepts, Finding equilibria and Learning in Games

UNIT - II

Zero-Sum Games: secure strategy, Maximin, Maximax, and Minimax Regret Solvability, value of a game. Normal form games: dominance, iterated dominance, Nash equilibrium. N-player games, mixed strategy nash equilibria.

UNIT - III

Graphical Games: Computing Nash, equilibria in Tree Graphical Games, Graphical Games and correlated Equilibria. Extensive form games: subgame perfection, sequential equilibrium, Stackelberg Model of Duopoly, Buying Votes, Committee Decision-Making. Bargaining: Rubinstein bargaining, Nash bargaining.

UNIT - IV

Repeated Games: Folk theorem and repeated prisoner's dilemma. Tacit collusion. Incomplete information games: Bayesian equilibrium, higher order beliefs.

UNIT - V

Auctions and Mechanism Design: Basic auctions, voting, Vickrey-Clarke-Groves Auction. Cryptography and Game theory: cryptographic influence on game theory and Game theoretic influence on cryptography

TEXT BOOK:

1. A Course in Game Theory by M. J. Osborne & A. Rubinstein, MIT Press.

REFERENCES:

1. Algorithmic Game Theory by N. Nisan, T. Rougharden, E. Tardos and V. V. Vazirani, Cambridge University Press.
2. Game Theory and Applications by Tatsurolchiishi, Abraham Neyman and YairTauman, Elsevier.
3. Essentials of Game Theory: A Concise, Multidisciplinary Introduction by K. Leyton-Brown and Y.Shoham, Morgan & Claypool Publishers.

COMPUTATIONAL NEUROSCIENCE (Professional Elective - II)

M.Tech AI & DS I Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives: A survey of common modeling techniques, methods for extending traditional techniques

Course Outcomes: Students would be able to:

1. Acquire an introductory understanding of the basic principles of computational neuroscience (including extensions to parallel distributed processing (PDP), connectionist, and artificial neural network models).
2. Relate the formal properties of such models to known biological mechanisms as well as to behavioral phenomena, and they will possess intellectual tools for modifying such models in the light of new psychological and neuroscientific findings.

UNIT - I

Neural Encoding I: Introduction, Spike Trains and Firing Rates, What Makes a Neuron Fire?, Spike-Train Statistics, The Neural Code

Neural Encoding II: Introduction. Estimating Firing Rates, Introduction to the Early Visual System, Reverse-Correlation Methods: Simple Cells, Static Nonlinearities: Complex Cells, Receptive Fields in the Retina and LGN, Constructing V1 Receptive Fields

UNIT - II

Neural Decoding: Encoding and Decoding, Discrimination, Population Decoding, Spike-Train Decoding

Information Theory: Entropy and Mutual Information, Information and Entropy Maximization, Entropy and Information for Spike Trains

UNIT - III

Model Neurons I: Introduction, Electrical Properties of Neurons, Single-Compartment Models, Integrate-and-Fire Models, Voltage-Dependent Conductances, The Hodgkin-Huxley Model, Modeling Channels, Synaptic Conductances, Synapses on Integrate-and-Fire Neurons

Model Neurons II: Levels of Neuron Modeling, Conductance-Based Models, The Cable Equation, Multi-compartment Models

UNIT - IV

Network Models: Introduction, Firing-Rate Models, Feedforward Networks, Recurrent Networks, Excitatory-Inhibitory Networks, Stochastic Networks

Plasticity and Learning: Introduction, Synaptic Plasticity Rules, Unsupervised Learning, Supervised Learning

UNIT - V

Classical Conditioning and Reinforcement Learning: Introduction, Classical, Static Action Choice, Sequential Action Choice

Representational Learning: Introduction, Density Estimation, Causal Models for Density Estimation

TEXT BOOKS:

1. Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems, Peter Dayan, L.F Abott, MIT Press.
2. Computational Neuroscience-A Comprehensive Approach, Chapman & Hall/CRC.

ARTIFICIAL INTELLIGENCE AND INTELLIGENT SYSTEMS LAB (Lab - I)

M.Tech AI & DS I Year I Sem.

L	T	P	C
0	0	4	2

Course Objectives:

1. To provide skills for designing and analyzing AI based algorithms.
2. To enable students to work on various AI tools.
3. To provide skills to work towards solution of real-life problems

Course Outcomes:

1. Elicit, analyze and specify software requirements.
2. Simulate a given problem scenario and analyze its performance.
3. Develop programming solutions for given problem scenario.

List of Programs:

1. Installation and working on various AI tools viz. Python, R tool, GATE, NLTK, MATLAB, etc.
2. Data preprocessing and annotation and creation of datasets.
3. Learn existing datasets and Treebanks
4. Implementation of searching techniques in AI.
5. Implementation of Knowledge representation schemes.
6. Natural language processing tool development.
7. Application of Machine learning algorithms.
8. Application of Classification and clustering problem.
9. Working on parallel algorithms.
10. Scientific distributions used in python for Data Science - Numpy, scifi, pandas, scikit learn, statsmodels, nltk.

ADVANCED DATA STRUCTURES USING PYTHON LAB (Lab - II)

M.Tech AI & DS I Year I Sem.

L	T	P	C
0	0	4	2

Pre-Requisites: UG level course in Data Structures

Course Objectives: This course will enable students to

1. Implement Object Oriented Programming concepts in Python.
2. Understand Lists, Dictionaries and Regular expressions in Python.
3. Understanding how searching and sorting is performed in Python.
4. Understanding how linear and non-linear data structures works.
5. To learn the fundamentals of writing Python scripts.

Course Outcomes: The students should be able to:

1. Examine Python syntax and semantics and apply Python flow control and functions.
2. Create, run and manipulate Python Programs using core data structures like Lists,
3. Apply Dictionaries and use Regular Expressions.
4. Interpret the concepts of Object-Oriented Programming as used in Python.
5. Master object-oriented programming to create an entire python project using objects and classes

List of Experiments:

1. Write a Python program for class, Flower, that has three instance variables of type str, int, and float, that respectively represent the name of the flower, its number of petals, and its price. Your class must include a constructor method that initializes each variable to an appropriate value, and your class should include methods for setting the value of each type, and retrieving the value of each type.
2. Develop an inheritance hierarchy based upon a Polygon class that has abstract methods area( ) and perimeter( ). Implement classes Triangle, Quadrilateral, Pentagon, that extend this base class, with the obvious meanings for the area( ) and perimeter( ) methods. Write a simple program that allows users to create polygons of the various types and input their geometric dimensions, and the program then outputs their area and perimeter.
3. Write a python program to implement Method Overloading and Method Overriding.
4. Write a Python program to illustrate the following comprehensions:
   a) List Comprehensions b) Dictionary Comprehensions c) Set Comprehensions d) Generator Comprehensions
5. Write a Python program to generate the combinations of n distinct objects taken from the elements of a given list. Example: Original list: [1, 2, 3, 4, 5, 6, 7, 8, 9] Combinations of 2 distinct objects: [1, 2] [1, 3] [1, 4] [1, 5] [7, 8] [7, 9] [8, 9].
6. Write a python program for Linear Search and Binary search
7. Write a python program to implement Bubble Sort and Selection Sort.
8. Write a python program to implement Merge sort and Quicksort.
9. Write a python program to implement Stacks and Queues.
10. Write a python program to implement a Singly Linked List.
11. Write a python program to implement a Doubly Linked list.
12. Write a python program to implement Binary Search Tree.

TEXT BOOKS:

1. Data structures and algorithms in python by Michael T. Goodrich
2. Data Structures and Algorithmic Thinking with Python by Narasimha Karumanchi

REFERENCE BOOKS:

1. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition by Dr. Basant Agarwal, Benjamin Baka.
2. Data Structures and Algorithms with Python by Kent D. Lee and Steve Hubbard.
3. Problem Solving with Algorithms and Data Structures Using Python by Bradley N Miller and David L. Ranum.
4. Core Python Programming -Second Edition,R. Nageswara Rao, Dreamtech Press.

MACHINE LEARNING LAB (Lab - II)

M.Tech AI & DS I Year I Sem.

L	T	P	C
0	0	4	2

Course Objective:

1. The objective of this lab is to get an overview of the various machine learning
2. Techniques and can demonstrate them using python.

Course Outcomes:

1. Understand modern notions in predictive data analysis
2. Select data, model selection, model complexity and identify the trends
3. Understand a range of machine learning algorithms along with their strengths and weaknesses
4. Build predictive models from data and analyze their performance

List of Experiments:

1. Write a python program to compute Central Tendency Measures: Mean, Median, Mode Measure of Dispersion: Variance, Standard Deviation
2. Study of Python Basic Libraries such as Statistics, Math, Numpy and Scipy
3. Study of Python Libraries for ML application such as Pandas and Matplotlib
4. Write a Python program to implement Simple Linear Regression
5. Implementation of Multiple Linear Regression for House Price Prediction using sklearn
6. Implementation of Decision tree using sklearn and its parameter tuning
7. Implementation of KNN using sklearn
8. Implementation of Logistic Regression using sklearn
9. Implementation of K-Means Clustering
10. Performance analysis of Classification Algorithms on a specific dataset (Mini Project)

TEXT BOOK:

1. Machine Learning – Tom M. Mitchell, - MGH

REFERENCE:

1. Machine Learning: An Algorithmic Perspective, Stephen Marshland, Taylor & Francis

Database Programming with PL/SQL Lab (Lab - II)

M.Tech AI & DS I Year I Sem.

L	T	P	C
0	0	4	2

Course Objectives:

1. Knowledge on significance of SQL fundamentals.
2. Evaluate functions and triggers of PL/SQL
3. Knowledge on control structures, packages in PL/SQL and its applications

Course Outcomes:

1. Understand importance of PL/SQL basics
2. Implement functions and procedures using PL/SQL
3. Understand the importance of triggers in database

List of Experiments:

1. Write a PI/SQL program using FOR loop to insert ten rows into a database table.
2. Given the table EMPLOYEE (EmpNo, Name, Salary, Designation, DeptID), write a cursor to select the five highest paid employees from the table.
3. Illustrate how you can embed PL/SQL in a high-level host language such as C/Java And demonstrates how a banking debit transaction might be done.
4. Given an integer i, write a PL/SQL procedure to insert the tuple (i, 'xxx') into a given relation.
5. Write a PL/SQL program to demonstrate Exceptions.
6. Write a PL/SQL program to demonstrate Cursors.
7. Write a PL/SQL program to demonstrate Functions.
8. Write a PL/SQL program to demonstrate Packages.
9. Write PL/SQL queries to create Procedures.
10. Write PL/SQL queries to create Triggers.

RESEARCH METHODOLOGY & IPR

M.Tech AI & DS I Year I Sem.

L	T	P	C
2	0	0	2

Course Objectives:

1. To understand the research problem
2. To know the literature studies, plagiarism and ethics
3. To get the knowledge about technical writing
4. To analyze the nature of intellectual property rights and new developments
5. To know the patent rights

Course Outcomes: At the end of this course, students will be able to

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

UNIT- I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT- II:

Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT- III:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT- IV:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT- V:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"

2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

REFERENCE BOOKS:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

DEEP LEARNING (PC - III)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: students will be able

1. To understand complexity of Deep Learning algorithms and their limitations
2. To be capable of performing experiments in Deep Learning using real-world data.

Course Outcomes:

1. Implement deep learning algorithms, understand neural networks and traverse the layers of data
2. Learn topics such as convolutional neural networks, recurrent neural networks, training deep networks and high-level interfaces
3. Understand applications of Deep Learning to Computer Vision
4. Understand and analyze Applications of Deep Learning to NLP

UNIT - I

Introduction: Feed forward Neural networks, Gradient descent and the back propagation algorithm, Unit saturation, the vanishing gradient problem, and ways to mitigate it. RelU Heuristics for avoiding bad local minima, Heuristics for faster training, Nestors accelerated gradient descent, Regularization, Dropout

UNIT - II

Convolutional Neural Networks: Architectures, convolution/pooling layers, Recurrent Neural Networks: LSTM, GRU, Encoder Decoder architectures. Deep Unsupervised Learning: Auto encoders, Variational Auto-encoders, Adversarial Generative Networks, Auto-encoder and DBM Attention and memory models, Dynamic Memory Models

UNIT - III

Applications of Deep Learning to Computer Vision: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models, Attention Models for computer vision tasks

UNIT - IV

Applications of Deep Learning to NLP: Introduction to NLP and Vector Space Model of Semantics, Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of-Wordsmodel (CBOW), Glove, Evaluations and Applications in word similarity

UNIT - V

Analogy reasoning: Named Entity Recognition, Opinion Mining using Recurrent Neural Networks: Parsing and Sentiment Analysis using Recursive Neural Networks: Sentence Classification using Convolutional Neural Networks, Dialogue Generation with LSTMs

TEXT BOOKS:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
2. The Elements of Statistical Learning by T. Hastie, R. Tibshirani, and J. Friedman, Springer.
3. Probabilistic Graphical Models. Koller, and N. Friedman, MIT Press.

REFERENCES:

1. Bishop, C, M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

DATA ANALYTICS (PC - IV)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Pre-requisites:

1. A course on "Database Management Systems".
2. Knowledge of probability and statistics.

Course Objectives:

1. To explore the fundamental concepts of data analytics.
2. To learn the principles and methods of statistical analysis
3. Discover interesting patterns, analyze supervised and unsupervised models and estimate the accuracy of the algorithms.
4. To understand the various search methods and visualization techniques.

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

1. Understand the impact of data analytics for business decisions and strategy
2. Carry out data analysis/statistical analysis
3. To carry out standard data visualization and formal inference procedures
4. Design Data Architecture
5. Understand various Data Sources

UNIT - I

Data Management: Design Data Architecture and manage the data for analysis, understand various sources of Data like Sensors/Signals/GPS etc. Data Management, Data Quality (noise, outliers, missing values, duplicate data) and Data Processing & Processing.

UNIT - II

Data Analytics: Introduction to Analytics, Introduction to Tools and Environment, Application of Modeling in Business, Databases & Types of Data and variables, Data Modeling Techniques, Missing Imputations etc. Need for Business Modeling.

UNIT - III

Regression: Concepts, Blue property assumptions, Least Square Estimation, Variable Rationalization, and Model Building etc. Logistic Regression: Model Theory, Model fit Statistics, Model Construction, Analytics applications to various Business Domains etc.

UNIT - IV

Object Segmentation: Regression Vs Segmentation – Supervised and Unsupervised Learning, Tree Building – Regression, Classification, Overfitting, Pruning and Complexity, Multiple Decision Trees etc. Time Series Methods: Arima, Measures of Forecast Accuracy, STL approach, Extract features from generated model as Height, Average Energy etc and Analyze for prediction

UNIT - V

Data Visualization: Pixel-Oriented Visualization Techniques, Geometric Projection Visualization Techniques, Icon-Based Visualization Techniques, Hierarchical Visualization Techniques, Visualizing Complex Data and Relations.

TEXT BOOKS:

1. Student's Handbook for Associate Analytics – II, III.
2. Data Mining Concepts and Techniques, Han, Kamber, 3rd Edition, Morgan Kaufmann Publishers.

REFERENCES:

1. Introduction to Data Mining, Tan, Steinbach and Kumar, Addison Wesley, 2006.
2. Data Mining Analysis and Concepts, M. Zaki and W. Meira
3. Mining of Massive Datasets, Jure Leskovec Stanford Univ. Anand Rajaraman Milliway Labs Jeffrey D Ullman Stanford Univ.

SOCIAL MEDIA MINING (Professional Elective - III)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives The objective of the course is to study the techniques to model, analyze, and understand large-scale social media along with dynamic processes over social and information networks, and understand the link between qualitative and quantitative methods of social media mining.

Course Outcomes:

1. Understand the social media mining and its challenges
2. Analyze how to detect communities and influencers
3. Understand Community analysis
4. Measuring Assortative, Influence, Homophily, Recommendation in Social Media

UNIT - I

Introduction: What is Social Media Mining, New Challenges for social media Mining
Graph Essentials: Graph Basics, Graph Representation, Types of Graphs, Connectivity in Graphs, Special Graphs, Graph Algorithms.

UNIT - II

Network Measures: Centrality, Transitivity and Reciprocity, Balance and Status, Similarity.
Network Models: Properties of Real-World Networks, Random Graphs, Small-World Model, Preferential Attachment Model.

UNIT - III

Data Mining Essentials: Data, Data Preprocessing, Data Mining Algorithms, Supervised Learning, Unsupervised Learning
Community Analysis: Community Detection, Community Evaluation, Community Evaluation

UNIT - IV

Information Diffusion in Social Media: Herd Behavior, Information Cascades, Diffusion of innovations, Epidemics
Influence and Homophily: Measuring Assortativity, Influence, Homophily, Distinguishing Influence and Homophily

UNIT - V

Recommendation in Social Media: Challenges, Classical Recommendation Algorithms, Recommendation Using Social Context, Evaluating Recommendations
Behavior Analytics: Individual Behavior, Collective Behavior.

TEXT BOOKS:

1. Social Media Mining (An Introduction), Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Cambridge University Press, Draft Version: April 20, 2014

REFERENCES:

1. Mining the Social Web, 2nd Edition Data Mining Face book, Twitter, LinkedIn, Google+, GitHub, and More, Matthew A. Russell Publisher: O'Reilly Media.
2. Social Media Mining with R [Kindle Edition] Nathan Danneman Richard Heimann

VISUAL ANALYTICS (Professional Elective - III)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: Basic Programming.

Course Outcomes: After completion of course, students would be able to:

1. Critically evaluate visualizations and suggest improvements and refinements.
2. Use standalone visualization applications to quickly explore data.
3. Apply a structured design process to create effective visualizations.
4. Conceptualize ideas and interaction techniques using sketching.
5. Create web-based interactive visualizations using JavaScript and D3.

UNIT - I

Introduction: Data Analytics, Data Visualization, Data and Tasks, Data Types, Dataset Types, Spatial Data-Scivis and Infovis, Static Graphics, Data Visualization Through Their Graph Representations
Interaction Techniques - Brushing and Linking, Dynamic Queries, Animation, Trees and Networks, Radial Layouts, Tree Maps, Linear Layouts, Maps, Cartograms, Symbol Maps, Flow Maps, Real-Time Maps

UNIT -II

High Dimensional Data Visualization, Filtering, Parallel Coordinates, Mosiac Plots, Time Series, Aggregation
Text Visualization, Document Visualization, Images & Video, Selecting Video Points, Zooming and Panning, Perception, Visual Channels. Weber's Law, Visual Channel Rankings

UNIT - III

Color Processing: Color Spaces, Color Aesthetics, Colors for Visualization, Cognition, Looking vs. Seeing, Image Gist, Gestalt Principles, Visual Attention, Visual Working & Long-Term Memory

UNIT - IV

Advanced Analytics: Introduction to Tableau, Adding Data Sources in Tableau, Creating Data Visualizations, Aggregate Functions, Table Calculations, Maps, Trends, Trend Lines, Forecasts, Clusters Analysis, Dashboards and Other Statistical Tools

UNIT - V

Data Visualization System: Visual Storytelling, Messaging, Effective Presentations, Design for Information Visualization and Arts, Visualization Systems- Database Visualization

TEXT BOOKS:

1. Visualizing Data: Exploring and Explaining Data with the Processing Environment, Ben Fry, O'Reilly Media, 2007.
2. Interactive Data Visualization for the Web, Scott Murray, O'Reilly Media, 2013.

REFERENCE:

1. Handbook of Data Visualization, Chun-houh Chen, Wolfgang Hardle, Antony Unwin, Springer.

ENTERPRISE CLOUD CONCEPTS (Professional Elective - III)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: Knowledge on significance of cloud computing and its fundamental concepts and models.

Course Outcomes:

1. Understand importance of cloud architecture
2. Illustrating the fundamental concepts of cloud security
3. Analyze various cloud computing mechanisms
4. Understanding the architecture and working of cloud computing.

UNIT - I

Understanding Cloud Computing: Origins and influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges.

Fundamental Concepts and Models: Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models.

UNIT - II

Cloud-Enabling Technology: Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology.

Cloud Computing Mechanisms:

Cloud Infrastructure Mechanisms: Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud Usage Monitor, Resource Replication.

UNIT - III

Cloud Management Mechanisms: Remote Administration System, Resource Management System, SLA Management System, Billing Management System, Case Study Example

Cloud Computing Architecture

Fundamental Cloud Architectures: Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture, Case Study Example

UNIT - IV

Cloud-Enabled Smart Enterprises: Introduction, Revisiting the Enterprise Journey, Service-Oriented Enterprises, Cloud Enterprises, Smart Enterprises, The Enabling Mechanisms of Smart Enterprises

Cloud-Inspired Enterprise Transformations: Introduction, The Cloud Scheme for Enterprise Success, Elucidating the Evolving Cloud Idea, Implications of the Cloud on Enterprise Strategy, Establishing a Cloud-Incorporated Business Strategy

UNIT - V

Transitioning to Cloud-Centric Enterprises: The Tuning Methodology, Contract Management in the Cloud

Cloud-Instigated IT Transformations

Introduction, Explaining Cloud Infrastructures, A Briefing on Next-Generation Services, Service Infrastructures, Cloud Infrastructures, Cloud Infrastructure Solutions, Clouds for Business Continuity, The Relevance of Private Clouds, The Emergence of Enterprise Clouds

TEXT BOOKS:

1. Erl Thomas, Puttini Ricardo, Mahmood Zaigham, Cloud Computing: Concepts, Technology & Architecture 1st Edition,
2. Pethuru Raj, Cloud Enterprise Architecture, CRC Press

REFERENCES:

1. James Bond,The Enterprise Cloud, O'Reilly Media, Inc.

REINFORCEMENT LEARNING (Professional Elective - IV)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: Knowledge on fundamentals of reinforcement learning and the methods used to create agents that can solve a variety of complex tasks.

Course Outcomes

1. Understand basics of RL
2. Understand RL Framework and Markov Decision Process
3. Analyzing ning through the use of Dynamic Programming and Monte Carlo
4. Understand TD(0) algorithm, TD(λ) algorithm

UNIT - I

Basics of probability and linear algebra, Definition of a stochastic multi-armed bandit, Definition of regret, Achieving sublinear regret, UCB algorithm, KL-UCB, Thompson Sampling.

UNIT - II

Markov Decision Problem, policy, and value function, Reward models (infinite discounted, total, finite horizon, and average), Episodic & continuing tasks, Bellman's optimality operator, and Value iteration & policy iteration

UNIT - III

The Reinforcement Learning problem, prediction and control problems, Model-based algorithm, Monte Carlo methods for prediction, and Online implementation of Monte Carlo policy evaluation

UNIT - IV

Bootstrapping; TD(0) algorithm; Convergence of Monte Carlo and batch TD(0) algorithms; Model-free control: Q-learning, Sarsa, Expected Sarsa.

UNIT - V

n-step returns; TD(λ) algorithm; Need for generalization in practice; Linear function approximation and geometric view; Linear TD(λ). Tile coding; Control with function approximation; Policy search; Policy gradient methods; Experience replay; Fitted Q Iteration; Case studies.

TEXT BOOKS:

1. "Reinforcement learning: An introduction," First Edition, Sutton, Richard S., and Andrew G. Barto, MIT press 2020
2. "Statistical reinforcement learning: modern machine learning approaches," First Edition, Sugiyama, Masashi. CRC Press 2015

REFERENCES:

1. "Bandit algorithms," First Edition, Lattimore, T. and C. Szepesvári. Cambridge University Press. 2020
2. "Reinforcement Learning Algorithms: Analysis and Applications," Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021
3. Alexander Zai and Brandon Brown "Deep Reinforcement Learning in Action," First Edition, Manning Publications 2020

MACHINE TRANSLATION (Professional Elective - IV)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To teach students machine translation approaches.
2. To evaluate the performance of machine translation Systems.
3. To develop translation models for Indian Languages.

Course Outcomes: Upon the Successful Completion of the Course, the Students would be able to:

1. Understand machine translation approaches.
2. Apply and assess manual and automatic evaluation methods for machine translation.
3. Build machine translation model using existing tools for machine translation.

UNIT - I

Introduction to Machine Translation, MT Approaches: vauquois Triangle, Three major paradigms of Machine Translation, MT Evaluation

UNIT - II

Learning Bilingual word Mappings:

A Combinatorial Argument, Deeper look at one- one alignment, Heuristic based Computation of the V_E *V_F Table, Iterative Computation of the V_E *V_F Table, EM: Study of progress in Parameter values

UNIT - III

Phrase based Machine Translation:

Need for phrase alignment, An example to illustrate phrase alignment technique, Phrase table, Mathematics of Phrase based SMT, Decoding, Moses.

UNIT - IV

Rule based Machine Translation (RBMT):

Two kinds of RBMT: Interlingua and Transfer, Universal networking Language (UNL), UNL expressions as binary predicates, Interlingua and Word Knowledge, Translation using Interlingua, Details of english to UNL Conversion: with illustration, Transfer based MT.

UNIT - V

Example based Machine Translation:

Essential steps of EBMT, EBMTs working, EBMT and case based reasoning, Text similarity computation, EBMT and Translation Memory, EBMT and SMT.

TEXT BOOK:

1. Pushpak Bhattacharyya, Machine Translation, CRC Press

REFERENCES:

1. Statistical Machine Translation by Philipp Koehn, Cambridge University Press.
2. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
3. Linguistic Fundamentals for Natural Language Processing by Emily Bender, Morgan & Claypool.

NATURE INSPIRED COMPUTING (Professional Elective - IV)

M.Tech AI & DS I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: Knowledge on significance of intelligence, genetic algorithms Ant Colony algorithms

Course Outcomes:

1. Familiar with Genetic algorithm and its applications.
2. Compare different Ant Colony Optimization algorithmic models.
3. Compare different Artificial Bee Colony Optimization algorithmic models.
4. Illustrate Particle swam optimization algorithm with an example.

UNIT - I:
Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-organization, swarm and evolutionary algorithms. Optimisation problems – single and multi-objective optimisation, heuristic, meta-heuristic and hyper heuristic functions.

UNIT - II:
Genetic algorithms - Mathematical foundation, Genetic problem solving, crossover and mutation. genetic algorithms and Markov process, applications of genetic algorithms

UNIT - III:
Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO, case studies.

UNIT - IV:
Particle Swarm algorithms - particles moves, particle swarm optimisation, variable length PSO, applications of PSO, case studies. Artificial Bee Colony algorithms - ABC basics, ABC in optimisation, multi-dimensional bee colony algorithms, applications of bee algorithms, case studies.

UNIT - V:
Selected nature inspired techniques - Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Firey algorithm, SDA algorithm, bat algorithm, case studies. Other nature inspired techniques - Social spider algorithm, Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm, Artificial immune system, Flower pollination algorithm, case studies.

TEXT BOOKS:

1. Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
2. Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories, methods, and Technologies" IT Press, 2008

REFERENCES:

1. Leandro Nunes de Castro - " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
2. Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005
3. Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioner's Approach", Prentice Hall of India, New Delhi, 2020

DEEP LEARNING LAB (Lab - III)

M.Tech AI & DS I Year II Sem.

L	T	P	C
0	0	4	2

Course Objectives:

1. To Build The Foundation Of Deep Learning.
2. To Understand How To Build The Neural Network.
3. To enable students to develop successful machine learning concepts.

Course Outcomes:

1. Upon the Successful Completion of the Course, the Students would be able to:
2. Learn The Fundamental Principles Of Deep Learning.
3. Identify The Deep Learning Algorithms For Various Types of Learning Tasks in various domains.
4. Implement Deep Learning Algorithms And Solve Real-world problems.

LIST OF EXPERIMENTS:

1. Setting up the Spyder IDE Environment and Executing a Python Program
2. Installing Keras, Tensorflow and Pytorch libraries and making use of them
3. Applying the Convolution Neural Network on computer vision problems
4. Image classification on MNIST dataset (CNN model with Fully connected layer)
5. Applying the Deep Learning Models in the field of Natural Language Processing
6. Train a sentiment analysis model on IMDB dataset, use RNN layers with LSTM/GRU notes
7. Applying the Autoencoder algorithms for encoding the real-world data
8. Applying Generative Adversial Networks for image generation and unsupervised tasks.

TEXT BOOKS:

1. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
2. The Elements of Statistical Learning by T. Hastie, R. Tibshirani, and J. Friedman, Springer.
3. Probabilistic Graphical Models. Koller, and N. Friedman, MIT Press.

REFERENCES:

1. Bishop, C, M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Golub, G.H., and Van Loan C.F., Matrix Computations, JHU Press, 2013.
4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Extensive Reading:

- http://www.deeplearning.net
- https://www.deeplearningbook.org/
- https://developers.google.com/machine-learning/crash-course/ml-intro
- www.cs.toronto.edu/~fritz/absps/imagenet.pdf
- http://neuralnetworksanddeeplearning.com/

SOCIAL MEDIA MINING LAB (Professional Elective - III Lab)

M.Tech AI & DS I Year II Sem.

L	T	P	C
0	0	4	2

Course Objectives: The objective of the course is to study the techniques to model, analyze, and understand large-scale social media along with dynamic processes over social and information networks, and understand the link between qualitative and quantitative methods of social media mining.

Course Outcomes:

1. Understand the visualization of complex social networks
2. Analyze how to detect communities and influencers
3. Implementing K-means clustering
4. Implement classification with network information.

List of Experiments: Implement the following exercises using NodeXL / Python:

1. Collect and visualize complex social networks from Twitter, Wikipedia.
2. Compute vertex metrics and network metrics for the social graphs.
   (i) Degree centrality (ii)Eigenvector centrality (iii)Betweenness centrality (iv)PageRank
   (v) Closeness centrality (vi) Group centrality (vii) clustering coefficient
3. Visualize the social graphs reflecting the metrics.
4. Detect Bridge in a social graphs.
5. Detect communities and influencers: Brute-Force Clique Identification on Enron email data.
6. Girvan-Newman Algorithm for community detection.
7. Perform classification with network information: weighted vote relational neighbor classifier for Twitter data.
8. Perform sentiment analysis on IMDb dataset.
9. Apply k-means clustering algorithm on IMDb dataset.
10. Apply user-based collaborative filtering on Amazon review data/Amazon product data.
11. Apply item-based collaborative filtering on Amazon review data/Amazon product data.
12. Predict individual behavior of users in social media.

TEXT BOOK:

1. Social Media Mining (An Introduction), Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Cambridge University Press, Draft Version: April 20, 2014

REFERENCES:

1. Mining the Social Web, 2nd Edition Data Mining Face book, Twitter, LinkedIn, Google+, GitHub, and More, Matthew A. Russell Publisher: O'Reilly Media.
2. Social Media Mining with R [Kindle Edition] Nathan Danneman Richard Heimann.

VISUAL ANALYTICS LAB (Professional Elective - III Lab)

M.Tech AI & DS I Year II Sem.

L	T	P	C
0	0	4	2

Course Objectives: This course will introduce the main concepts of visual analytics with a hands using Tableau, a leading self-service data visualization tool. Further, it aims at learning about how to create effective charts and interactive dashboards will provide the student a very useful skill applicable in many business scenarios.

Course Outcomes: The student will be able to:

1. Understand and describe the main concepts of data visualization
2. Create ad-hoc reports, data visualizations, and dashboards using Tableau Desktop
3. Publish the created visualizations to Tableau Server and Tableau Public Skills:
4. How to recognize good (and bad) data visualizations
5. How to interpret a data visualization

List of Experiments:

Task-1: Introduction to Tableau

- Course introduction
- Dataviz best practices
- Getting started with Tableau Desktop
- Connecting to the tutorial dataset
- Creating the first charts
- Filtering and sorting data

Task-2: Common charts

- Creating common visualizations (bar charts, line charts etc.)
- Assembling a dashboard layout
- Using dashboard filters

Task-3: Transform the data

- Dataviz best practices
- Creating simple calculations in Tableau
- Using table calculations

Task-4: Interactions

- Interactivity with text and visual tooltips
- Interactivity with actions (filter, highlight, URL)
- Drilldown between dashboards

Task-5: Advanced visualizations

- Dataviz best practices
- Creating more advanced chart types
- Using multiple source tables

Task-6: Data Storytelling

- Intro to data storytelling
- Creating a data story in Tableau
- Overview of the Tableau ecosystem
- Further learning opportunities

System Requirements:

1. System requirements are listed here under Tableau Desktop and Tableau Prep: https://www.tableau.com/products/techspecs
2. The latest version of Tableau Desktop as well as Tableau Prep should be downloaded and installed from here: https://www.tableau.com/tft/activation

TEXT BOOKS:

1. Visualization Analysis & Design by Tamara Munzner (2014) (ISBN 9781466508910)

REFERENCES BOOKS:

1. Interactive Data Visualization for the Web by Scott Murray 2nd Edition (2017)
2. D3.js in Action by Elijah Meeks 2nd Edition (2017)
3. Semiology of Graphics by Jacques Bertin (2010)
4. The Grammar of Graphics by Leland Wilkinson
5. ggplot2 Elegant Graphics for Data Analysis by Hadley Wickham

ENTERPRISE CLOUD CONCEPTS LAB (Professional Elective - III Lab)

M.Tech AI & DS I Year II Sem.

L	T	P	C
0	0	4	2

Course Objectives: Knowledge on significance of cloud computing and its fundamental concepts and models.

Course Outcomes:

1. Understand importance of cloud architecture
2. Illustrating the fundamental concepts of cloud security
3. Analyze various cloud computing mechanisms
4. Understanding the architecture and working of cloud computing.

List of Experiments:

1. Install Virtualbox/VMware Workstation with different flavors of linux or windows OS on top of windows7 or 8.
2. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs
3. Install Google App Engine. Create a hello world app and other simple web applications using python/java..
4. Find a procedure to transfer the files from one virtual machine to another virtual machine.
5. Find a procedure to launch virtual machine using trystack (Online Openstack Demo Version)
6. Install Hadoop single node cluster and run simple applications like word count.

E-Resources:

1. https://www.iitk.ac.in/nt/faq/vbox.htm
2. https://www.google.com/urlsa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjqrNG0za73AhXZt1YBHZ21DWEQFnoECAMQAQ&url=http%3A%2F%2Fwww.cs.columbia.edu%2F~sedwards%2Fclasses%2F2015%2F1102-fall%2Flinuxvm.pdf&usg=AOvVaw3xZPuF5xVgk-AQnBRsTtHz
3. https://www.cloudsimtutorials.online/cloudsim/
4. https://edwardsamuel.wordpress.com/2014/10/25/tutorial-creating-openstack-instance-in-trystack/
5. https://www.edureka.co/blog/install-hadoop-single-node-hadoop-cluster

PREDICTIVE ANALYTICS (Professional Elective - V)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives: The course serves to advance and refine expertise on theories, approaches and techniques related to prediction and forecasting

Course Outcomes

1. Understand prediction-related principles, theories and approaches.
2. Learn model assessment and validation.
3. Understand the basics of predictive techniques and statistical approaches.
4. Analyze supervised and unsupervised algorithms.

UNIT - I

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection, Ridge regression, Lasso regression, Linear Discriminant Analysis, Logistic regression, Perceptron learning algorithm.

UNIT - II

Model Assessment and Selection: Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate, Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation, Bootstrap methods, conditional or expected test error.

UNIT - III

Additive Models, Trees, and Boosting: Generalized additive models, Regression and classification trees, Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, New Zealand fish, Demographic data)

UNIT - IV

Neural Networks (NN), Support Vector Machines (SVM), and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest – Neighbor classifiers (Image Scene Classification)

UNIT - V

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis.

TEXT BOOK:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning-Data Mining, Inference, and Prediction, Second Edition, Springer Verlag, 2009

REFERENCES:

1. C. M. Bishop –Pattern Recognition and Machine Learning, Springer, 2006
2. L. Wasserman - All of statistics
3. Gareth James. Daniela Witten. Trevor Hastie Robert Tibshirani. An Introduction to Statistical Learning with Applications in R

CONVERSATIONAL AI (Professional Elective - V)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To be familiar with the basic knowledge about conversational systems.
2. To understand the different techniques of natural language processing

UNIT - I

Introducing Dialogue Systems: What's a Dialogue System? A Brief History Of Dialogue Systems, Present-Day Dialogue Systems, Modeling Conversation Dialogue Systems, Designing and Developing Dialogue Systems

UNIT - II

Rule-Based Dialogue Systems: Architecture, Methods, and Tools: A Typical Dialogue Systems Architecture, Designing a Dialogue System, Tools for Developing Dialogue Systems, Rule-Based Techniques in Dialogue Systems Participating in the Alexa Prize

UNIT - III

Statistical Data-Driven Dialogue Systems: Motivating the Statistical Data-Driven Approach, Dialogue Components in the Statistical Data-Driven Approach, Reinforcement Learning (RL), Representing Dialogue as a Markov Decision Process, From MDPs to POMDPs, Dialogue State Tracking, Dialogue Policy, Problems and Issues with Reinforcement Learning in POMDPs

UNIT - IV

Evaluating Dialogue Systems: How to Conduct the Evaluation, Evaluating Task-Oriented Dialogue Systems, Evaluating Open-Domain Dialogue Systems, Evaluation Frameworks- PARADISE, Quality of Experience (QoE), Interaction Quality, Best Way to Evaluate Dialogue Systems.

UNIT - V

End-to-End Neural Dialogue Systems: Neural Network Approaches to Dialogue Modeling, A Neural Conversational Model, Introduction to the Technology of Neural Dialogue, Retrieval-Based Response Generation, Task-Oriented Neural Dialogue Systems, Open-Domain Neural Dialogue Systems, Some Issues and Current Solutions, Dialogue Systems: Datasets, Competitions, Tasks, and Challenges.

TEXT BOOKS:

1. Michael McTear, "Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots", Second Edition, Moran and Claypool Publishers, 2020.

REFERENCE:

1. Cathy Pearl, "Designing Voice User Interfaces: Principles of Conversational Experiences", O'REILLY, 2016.

COMPUTER VISION AND ROBOTICS (Professional Elective - V)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Pre-requisites: UG level Course in Linear Algebra and Probability.

Course Objectives:

1. To understand the Fundamental Concepts Related To sources, shadows and shading
2. To understand the The Geometry of Multiple Views

Course Outcomes:

1. Implement fundamental image processing techniques required for computer vision
2. Implement boundary tracking techniques
3. Apply chain codes and other region descriptors, Hough Transform for line, circle, and ellipse detections.
4. Apply 3D vision techniques and Implement motion related techniques.
5. Develop applications using computer vision techniques.

UNIT - I

Cameras: Pinhole Cameras
Radiometry – Measuring Light: Light in Space, Light Surfaces, Important Special Cases
Sources, Shadows, And Shading: Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models
Color: The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.

UNIT - II

Linear Filters: Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing, Filters as Templates,
Edge Detection: Noise, Estimating Derivatives, Detecting Edges
Texture: Representing Texture, Analysis (and Synthesis) Using Oriented Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture.

UNIT - III

The Geometry of Multiple Views: Two Views
Stereopsis: Reconstruction, Human Stereopsis, Binocular Fusion, Using More Cameras
Segmentation by Clustering: What Is Segmentation?, Human Vision: Grouping and Getstalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering,

UNIT - IV

Segmentation by Fitting a Model: The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness
Segmentation and Fitting Using Probabilistic Methods: Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice,
Tracking With Linear Dynamic Models: Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications and Examples

UNIT - V

Geometric Camera Models: Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations
Geometric Camera Calibration: Least-Squares Parameter Estimation, A Linear Approach to Camera

Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry,
Case study: Mobile Robot Localization
Model- Based Vision: Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Case study: Registration In Medical Imaging Systems, Curved Surfaces and Alignment.

TEXT BOOKS:

1. David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

REFERENCES:

1. E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.
2. R. C. Gonzalez and R. E. Woods "Digital Image Processing" Addison Wesley 2008.
3. Richard Szeliski "Computer Vision: Algorithms and Applications" Springer-Verlag London Limited 2011.

IPR (Open Elective)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To explain the art of interpretation and documentation of research work
2. To explain various forms of intellectual property rights
3. To discuss leading International regulations regarding Intellectual Property Rights

Course Outcomes: Upon the Successful Completion of the Course, the Students would be able to:

1. Understand types of Intellectual Property
2. Analyze trademarks and its functionality
3. Illustrate law of copy rights and law of patents

UNIT- I

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT - II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT - III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT - IV

Trade Secrets: Trade secret law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

UNIT - V

New development of intellectual property: new developments in trade mark law; copy right law, patent law, intellectual property audits.

International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

TEXT BOOKS & REFERENCES:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.

FAULT TOLERANCE SYSTEMS (Open Elective)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To know the different advantages and limits of fault avoidance and fault tolerance techniques.
2. To impart the knowledge about different types of redundancy and its application for the design of computer system being able to function correctly even under presence of faults and data errors.
3. To understand the relevant factors in evaluating alternative system designs for a specific set of requirements.
4. To understand the subtle failure modes of "fault-tolerant" distributed systems.

Course Outcomes: Upon the Successful Completion of the Course, the Students would be able to:

1. Become familiar with general and state of the art techniques used in design and analysis of fault tolerant digital systems.
2. Be familiar with making system fault tolerant, modeling and testing, and benchmarking to evaluate and compare systems.

UNIT - I

Introduction to Fault Tolerant Computing: Basic concepts and overview of the course; Faults and their manifestations, Fault/error modeling, Reliability, availability and maintainability analysis, System evaluation, performance reliability tradeoffs.

UNIT - II

System level fault diagnosis: Hardware and software redundancy techniques. Fault tolerant system design methods, Mobile computing and Mobile communication environment, Fault injection methods.

UNIT - III

Software fault tolerance: Design and test of defect free integrated circuits, fault modeling, built in self-test, data compression, error correcting codes, simulation software/hardware, fault tolerant system design, CAD tools for design for testability.

UNIT - IV

Information Redundancy and Error Correcting Codes: Software Problem. Software Reliability Models and Robust Coding Techniques, Reliability in Computer Networks Time redundancy. Re execution in SMT, CMP Architectures, Fault Tolerant Distributed Systems, Data replication.

UNIT - V

Case Studies in FTC: ROC, HP Non-Stop Server. Case studies of fault tolerant systems and current research issues.

TEXT BOOK:

1. Fault Tolerant Computer System Design by D. K. Pradhan, Prentice Hall.

REFERENCES:

1. Fault Tolerant Systems by I. Koren, Morgan Kauffman.
2. Software Fault Tolerance Techniques and Implementation by L. L. Pullum, Artech House Computer Security Series.
3. Reliability of Computer Systems and Networks: Fault Tolerance Analysis and Design by M. L. Shooman, Wiley.

INTRUSION DETECTION SYSTEMS (Open Elective)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Computer Networks, Computer Programming

Course Objectives:

1. Compare alternative tools and approaches for Intrusion Detection through quantitative analysis to determine the best tool or approach to reduce risk from intrusion.
2. Identify and describe the parts of all intrusion detection systems and characterize new and emerging IDS technologies according to the basic capabilities all intrusion detection systems share.

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

1. Possess a fundamental knowledge of Cyber Security.
2. Understand what vulnerability is and how to address most common vulnerabilities.
3. Know basic and fundamental risk management principles as it relates to Cyber Security and Mobile Computing.
4. Have the knowledge needed to practice safer computing and safeguard your information using Digital Forensics.
5. Understand basic technical controls in use today, such as firewalls and Intrusion Detection systems.
6. Understand legal perspectives of Cyber Crimes and Cyber Security.

UNIT - I

The state of threats against computers, and networked systems-Overview of computer security solutions and why they fail-Vulnerability assessment, firewalls, VPN's -Overview of Intrusion Detection and Intrusion Prevention, Network and Host-based IDS

UNIT - II

Classes of attacks - Network layer: scans, denial of service, penetration Application layer: software exploits, code injection-Human layer: identity theft, root access-Classes of attackers-Kids/hackers/sop Hesitated groups-Automated: Drones, Worms, Viruses

UNIT - III

A General IDS model and taxonomy, Signature-based Solutions, Snort, Snort rules, Evaluation of IDS, Cost sensitive IDS

UNIT - IV

Anomaly Detection Systems and Algorithms-Network Behavior Based Anomaly Detectors (rate based)-Host-based Anomaly Detectors-Software Vulnerabilities-State transition, Immunology, Payload Anomaly Detection

UNIT - V

Attack trees and Correlation of alerts- Autopsy of Worms and Botnets-Malware detection -Obfuscation, polymorphism- Document vectors.

Email/IM security issues-Viruses/Spam-From signatures to thumbprints to zero-day detection-Insider Threat issues-Taxonomy-Masquerade and Impersonation Traitors, Decoys and Deception-Future: Collaborative Security

TEXT BOOKS:

1. Peter Szor, The Art of Computer Virus Research and Defense, Symantec Press ISBN 0-321-

30545-3.
2. Markus Jakobsson and Zulfikar Ramzan, Crimeware, Understanding New Attacks and Defenses.

REFERENCE BOOKS:

1. Saiful Hasan, Intrusion Detection System, Kindle Edition.
2. Ankit Fadia, Intrusion Alert: An Ethical Hacking Guide to Intrusion Detection.

Online Websites/Materials:

1. https://www.intechopen.com/books/intrusion-detection-systems/

Online Courses:

1. https://www.sans.org/course/intrusion-detection-in-depth
2. https://www.cybrary.it/skill-certification-course/ids-ips-certification-training-course

DIGITAL FORENSICS (Open Elective)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: Cybercrime and Information Warfare, Computer Networks

Course Objectives:

1. provides an in-depth study of the rapidly changing and fascinating field of computer forensics.
2. Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
3. Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools
4. E-evidence collection and preservation, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics

Course Outcomes: On completion of the course the student should be able to

1. Understand relevant legislation and codes of ethics.
2. Computer forensics and digital detective and various processes, policies and procedures.
3. E-discovery, guidelines and standards, E-evidence, tools and environment.
4. Email and web forensics and network forensics.

UNIT - I

Digital Forensics Science: Forensics science, computer forensics, and digital forensics.
Computer Crime: Criminalistics as it relates to the investigative process, analysis of cyber criminalistics area, holistic approach to cyber-forensics

UNIT - II

Cyber Crime Scene Analysis:
Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.

UNIT - III

Evidence Management & Presentation:
Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.

UNIT - IV

Computer Forensics: Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, Complete a case, Critique a case,
Network Forensics: open-source security tools for network forensic analysis, requirements for preservation of network data.

UNIT - V

Mobile Forensics: mobile forensics techniques, mobile forensics tools.
Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008.
Recent trends in mobile forensic technique and methods to search and seizure electronic evidence

TEXT BOOKS:

1. John Sammons, The Basics of Digital Forensics, Elsevier
2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

REFERENCES:

1. William Oettinger, Learn Computer Forensics: A beginner's guide to searching, analyzing, and securing digital evidence, Packt Publishing; 1st edition (30 April 2020), ISBN: 1838648178.
2. Thomas J. Holt, Adam M. Bossler, Kathryn C. Seigfried-Spellar, Cybercrime and Digital Forensics: An Introduction, Routledge.

OPTIMIZATION TECHNIQUES (Open Elective)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisite: Mathematics –I, Mathematics –II

Course Objectives:

1. To introduce various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming
2. Constrained and unconstrained optimization techniques for solving and optimizing electrical and electronic engineering circuits design problems in real world situations.
3. To explain the concept of Dynamic programming and its applications to project implementation.

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

1. explain the need of optimization of engineering systems.
2. understand optimization of electrical and electronics engineering problems.
3. apply classical optimization techniques, linear programming, simplex algorithm, transportation problem.
4. apply unconstrained optimization and constrained non-linear programming and dynamic programming.
5. Formulate optimization problems.

UNIT - I

Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surface - classification of Optimization problems.

Linear Programming: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

UNIT - II

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems. Degeneracy.

Assignment problem – Formulation – Optimal solution - Variants of Assignment Problem; Traveling Salesman problem.

UNIT - III

Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints: Solution by method of Lagrange multipliers – Multivariable Optimization with inequality constraints: Kuhn – Tucker conditions.

Single Variable Nonlinear Unconstrained Optimization: Elimination methods: Uni Model function-its importance, Fibonacci method & Golden section method.

UNIT - IV

Multi variable nonlinear unconstrained optimization: Direct search methods – Univariant method, Pattern search methods – Powell's, Hooke - Jeeves, Rosenbrock's search methods. Gradient methods: Gradient of function & its importance, Steepest descent method, Conjugate direction methods: Fletcher-Reeves method & variable metric method.

UNIT - V

Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

TEXT BOOKS:

1. Optimization Techniques & Applications by S.S.Rao, New Age International.
2. Optimization for Engineering Design by Kalyanmoy Deb, PHI

REFERENCES:

1. George Bernard Dantzig, Mukund Narain Thapa, "Linear programming", Springer series in Operations Research 3rd edition, 2003.
2. H. A. Taha, "Operations Research: An Introduction", 8th Edition, Pearson/Prentice Hall, 2007.
3. Optimization Techniques by Belegundu & Chandrupatla, Pearson Asia.
4. Optimization Techniques Theory and Practice by M.C. Joshi, K.M. Moudgalya, Narosa Publications

CYBER PHYSICAL SYSTEMS (Open Elective)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Course Objective: To learn about design of cyber-physical systems

Course Outcomes: Upon the Successful Completion of the Course, the Students would be able to:

1. Understand the core principles behind CPS
2. Identify Security mechanisms of Cyber physical systems
3. Understand Synchronization in Distributed Cyber-Physical Systems

UNIT - I

Symbolic Synthesis for Cyber-Physical Systems

Introduction and Motivation, Basic Techniques - Preliminaries, Problem Definition, Solving the Synthesis Problem, Construction of Symbolic Models, Advanced Techniques: Construction of Symbolic Models, Continuous-Time Controllers, Software Tools

UNIT - II

Security of Cyber-Physical Systems

Introduction and Motivation, Basic Techniques - Cyber Security Requirements, Attack Model, Countermeasures, Advanced Techniques: System Theoretic Approaches

UNIT - III

Synchronization in Distributed Cyber-Physical Systems: Challenges in Cyber-Physical Systems, A Complexity-Reducing Technique for Synchronization, Formal Software Engineering, Distributed Consensus Algorithms, Synchronous Lockstep Executions, Time-Triggered Architecture, Related Technology, Advanced Techniques

UNIT - IV

Real-Time Scheduling for Cyber-Physical Systems

Introduction and Motivation, Basic Techniques - Scheduling with Fixed Timing Parameters, Memory Effects, Multiprocessor/Multicore Scheduling, Accommodating Variability and Uncertainty

UNIT - V

Model Integration in Cyber-Physical Systems

Introduction and Motivation, Causality, Semantic Domains for Time, Interaction Models for Computational Processes, Semantics of CPS DSMLs, Advanced Techniques, ForSpec, The Syntax of CyPhyML, Formalization of Semantics, Formalization of Language Integration.

TEXT BOOKS:

1. Raj Rajkumar, Dionisio De Niz, and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional.
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015

GRAPH ANALYTICS (Open Elective)

M.Tech AI & DS II Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To explore the concept of Graphs and related algorithms.
2. To learn new ways to model, store, retrieve and analyze graph-structured data.
3. To be aware of advanced concepts in graph analytic techniques and its applications.

Course Outcomes: Upon the Successful Completion of the Course, the Students would be able to:

1. Understand Large-scale Graph and its Characteristics
2. Analyze Breadth-First Search Algorithm
3. Illustrate Recent Advances in Scalable Network Generation

UNIT - I

Introduction and Application of Large-scale Graph: Characteristics, Complex Data Sources - Social Networks, Simulations, Bioinformatics; Categories- Social, Endorsement, Location, Co-occurrence graphs; Graph Data structures, Parallel, Multicore and Graph Algorithms

UNIT - II Algorithms: Search and Paths

A Work-Efficient Parallel Breadth-First Search Algorithm (or How To Cope With the Nondeterminism of Reducers), Multi-Objective Shortest Paths

UNIT - III Algorithms: Structure

Multicore Algorithms for Graph Connectivity Problems, Distributed Memory Parallel Algorithms for Massive Graphs, Massive-Scale Distributed Triangle Computation and Applications

UNIT - IV Models

Recent Advances in Scalable Network Generation, Computational Models for Cascades in Massive Graphs, Executing Dynamic Data-Graph Computations Deterministically Using Chromatic Scheduling.

UNIT - V Frameworks and Software

Graph Data Science Using Neo4j, A Cloud-Based Approach to Big Graphs, Interactive Graph Analytics at Scale in Arkouda

TEXT BOOKS:

1. David A. Bader, Massive Graph Analytics, CRC Press

REFERENCES:

1. Stanley Wasserman, Katherine Faust, "Social Network Analysis: Methods and Applications", (Structural Analysis in the Social Sciences), Cambridge University Press, 1995.
2. Matthew O. Jackson, "Social and Economic Networks", Princeton University Press, 2010.
3. Tanja Falkowski, "Community Analysis in Dynamic Social Networks", (Dissertation), University Magdeburg, 2009.