COURSE STRUCTURE

and

DETAILED SYLLABI

for

Two Year PG Programme

M.Tech

CSE (Artificial Intelligence & Machine Learning)

(Applicable for batches admitted from 2025-26)

Department of Computer Science & Engineering
University College of Engineering Kakinada (A)
JNTUK, Kakinada - 533003

M.Tech CSE (AI & ML) I Semester

S. No.	Course Title	L	T	P	C	Assessment	
						Int	Ext
1	**Program Core-1** Mathematics for Machine Learning	3	1	0	4	40	60
2	**Program Core-2** Artificial Intelligence	3	1	0	4	40	60
3	**Program Core-3** Advanced Data Structures and Algorithms	3	1	0	4	40	60
4	**Program Elective – I**	3	0	0	3	40	60
5	**Program Elective – II**	3	0	0	3	40	60
6	**Laboratory-1** Artificial Intelligence Lab	0	0	4	2	40	60
7	**Laboratory-2** Data Wrangling Lab	0	0	4	2	40	60
8	**Seminar-I**	0	0	2	1	100	-
	TOTAL	**15**	**3**	**10**	**23**		

List of Program Elective Courses in I Semester (Electives – I & II)

S.No.	Course Title
1	Advanced Data Mining
2	Mining Massive Data Sets
3	High Performance Computing
4	Augmented Reality and Virtual Reality
5	Recommender Systems
6	Time Series Analysis
7	Any minimum12 weeks MOOCS/NPTEL courses with prior approval of BoS

M.Tech CSE (AI & ML) II – Semester

S.No.	Course Title	L	T	P	C	Assessment	
						Int	Ext
1	**Program Core-4** Machine Learning	3	1	0	4	40	60
2	**Program Core-5** Deep Learning	3	1	0	4	40	60
3	**Program Core-6** Generative AI	3	1	0	4	40	60
4	**Program Elective – III**	3	0	0	3	40	60
5	**Program Elective – IV**	3	0	0	3	40	60
6	**Laboratory-3** Machine Learning Lab	0	0	4	2	40	60
7	**Laboratory-4** Deep Learning Lab	0	0	4	2	40	60
8	**Seminar – II**	0	0	2	1	100	-
	TOTAL	**15**	**3**	**10**	**23**		

List of Program Elective Courses in II Semester (Electives - III & IV)

S.No.	Course Title
1	Cloud Computing
2	Reinforcement Learning
3	Data Science Applications
4	Computer Vision
5	Quantum Computing
6	Soft computing
7	Any minimum12 weeks MOOCS/NPTEL courses with prior approval of BoS

Note: Summer Internship/ Industrial Training will be done during *Year break (II sem to III Sem)* and evaluated in IIISem.

M.Tech CSE (AI & ML) III Semester

S.No.	Course Title	L	T	P	C	Assessment	
						Int	Ext
1	Research Methodology and IPR / *Swayam 12 week MOOC course – RM&IPR*	3	0	0	3	40	60
2	Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3	100	-
3	Comprehensive Viva#	-	-	-	2	100	-
4	Dissertation Part – A$	-	-	20	10	100	-
	TOTAL	**3**	**-**	**20**	**18**		

* Student attended during summer / year break and assessment will be done in 3rd Sem.
# Comprehensive viva can be conducted courses completed upto second sem.
$ Dissertation – Part A, internal assessment

M.Tech CSE (AI & ML) – IV Semester

Sl. No.	Course Title	L	T	P	C	Assessment	
						Int	Ext
1	Dissertation Part – B%	-	-	32	16	-	100
	TOTAL	**-**	**-**	**32**	**16**		

% External Assessment

I Semester	MATHEMATICS FOR MACHINE LEARNING	L	T	P	C
		3	1	0	4

Course Objectives:

The main objectives of this courseare to

- Develop a Strong Foundation in Linear Algebra and Analytic Geometry
- Apply Analytical and Geometric Concepts to Solve Real-World Problems
- Master Techniques for Solving Systems of Linear Equations and Matrix Computations
- Understand the Fundamentals of Vector Calculus and Their Applications
- Explore Probability Theory and Optimization for Applied Mathematical Modeling

UNIT	CONTENTS
UNIT – 1	Linear Algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces
UNIT – 2	Analytic Geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations
UNIT – 3	Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky, Decomposition, Eigend ecomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation, Matrix Phylogeny
UNIT – 4	Vector Calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Back propagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series
UNIT – 5	Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Gaussian Distribution, Conjugacy and the Exponential Family, Change of Variables/Inverse TransformContinuous Optimization: Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers, Convex Optimization

Text Books:

1. "Mathematics for Machine Learning", Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press.

2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd Edition, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer 2017.

Reference Books:

1. Machine Learning: An Applied Mathematics Introduction, Paul Wilmott, Panda Ohana Publishing, 2019.

I Semester	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	1	0	4

Course Objectives:

The main objective of this course to

1. Gain a historical perspective of Artificial Intelligence (AI) and its foundations.
2. Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
3. Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
4. Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool. Experiment with a machine learning model for simulation and analysis.
5. Explore the current scope, potential, limitations, and implications of intelligent systems

UNIT	CONTENTS
UNIT – 1	**Introduction to Artificial Intelligence(AI):** Introduction, history, intelligent systems, foundations of AI, applications, tic-tac-tie game playing, development of AI languages, current trends in AI, **Problem solving: state-space search and control strategies:** Introduction, general problem solving, characteristics of problem, exhaustive searches, heuristic search techniques, iterative-deepening a*, constraint satisfaction
UNIT – 2	**Problem reduction and game playing:** Introduction, problem reduction, game playing, alpha-beta pruning, two-player perfect information games, **Logic concepts:** Introduction, propositional calculus, proportional logic, natural deduction system, axiomatic system, semantic tableau system in proportional logic, resolution refutation in proportional logic, predicate logic
UNIT – 3	**Knowledge representation:** Introduction, approaches to knowledge representation, knowledge representation using semantic network, extended semantic networks for KR, knowledge representation using frames, **advanced knowledge representation techniques:** Introduction, conceptual dependency theory, script structure, cyc theory, case grammars, semantic web.
UNIT – 4	**Uncertainty measure: probability theory:** Introduction, probability theory, Bayesian belief networks, certainty factor theory, dempster-shafer theory
UNIT – 5	**Fuzzy sets and fuzzy logic:** Introduction, fuzzy sets, fuzzy set operations, types of membership functions, multi valued logic, fuzzy logic, linguistic variables and hedges, fuzzy propositions,inference rules for fuzzy propositions, fuzzy systems.

Text Books:

1. Artificial intelligence, A modern Approach, 2nd ed, Stuart Russel, Peter Norvig, Prentice Hall
2. Artificial Intelligence, Saroj Kaushik, 1stEdition, CENGAGE Learning, 2011.

Reference Books:

1. Artificial intelligence, structures and Strategies for Complex problem solving, 5th Edition, George F Lugar, PEA
2. Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer, 2017
3. Artificial Intelligence, A new Synthesis, 1st Edition, Nils J Nilsson, Elsevier.
4. Artificial Intelligence- 3rd Edition, Rich, Kevin Knight, Shiv Shankar B Nair, TMH
5. Introduction To Artificial Intelligence and Expert Systems, 1stEdition, Patterson, Pearson India, 2015

I Semester	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	1	0	4

Course Objectives:

From the course the student will learn concepts of Algorithms, Searching and Sorting techniques, Trees, Binary trees, representation, traversal, Dictionaries, ADT for List, Stack, Queue, Hash table representation, Hash functions, Priority queues, Priority queues using heaps, Search trees, AVL trees, operations of AVL trees, Red- Black trees, Splay trees, comparison of searchtrees.

UNIT	CONTENTS
UNIT – 1	**Introduction to Algorithms and Data Structures-** Algorithms, Asymptotic Notation- Big oh notation, Omega notation, Theta notation and Little oh notation, probabilistic analysis, Amortized analysis, Singly Linked Lists, Doubly Linked Lists, Circular Lists, Stacks and Queues- Algorithm Implementation using Linked Lists, Applications of Lists, Stacks and Queues.
UNIT – 2	Searching- Linear and Binary search methods, Sorting-Topological sorting, Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Trees- Binary trees, Operations- Insertion, Deletion, Properties, Representation and Traversals (DFT, BFT), Expression Trees (Infix, Prefix, Postfix), Graphs- Basic Concepts, Storage Structures and Traversals, Applications.
UNIT – 3	Dictionaries, ADT, The List ADT, Stack ADT, Queue ADT, Hash Table Representation, Hash Functions, Collision Resolution-Separate Chaining, Open Addressing- Linear Probing, Double Hashing
UNIT – 4	**Priority Queues**- Definition, ADT, Realising a Priority Queue Using Heaps, Definition, Insertion, Deletion, Search Trees- Binary Search Trees, Definition, ADT, Implementation, Operations- Searching, Insertion, Deletion
UNIT – 5	**Search Trees**- AVL Trees, Definition, Height of AVL Tree, Operations- Insertion, Deletion and Searching. Introduction to Red-Black and Splay Trees, B-Trees, Height of B-Tree, Insertion, Deletion and Searching, Comparison of Search Trees

Text Books:

1. Introduction to Algorithms, Thomas H Coremen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, 4th Edition, MIT Press, Cambridge
2. Data Structures: A Pseudocode Approach with C, 2nd Edition, Richard F.Gilberg, Behrouz A. Forouzon, Cengage Learning.
3. Data Structures, Algorithms and Applications in Java, 2nd Edition, Sartaj Sahni, University Press/Orient Black Swan.

Reference Books:

1. Data Structures and Algorithm Analysis, 2nd Edition, Mark Allen Weiss, Pearson.
2. Data Structures and Algorithms in C++, 3rd Edition, Adam Drozdek, Cengage Learning.
3. C and Data Structures: A Snap Shot Oriented Treatise Using Live Engineering Examples, 1st Edition, N.B.Venkateswarulu, E.V. Prasad, S Chand & Co.
4. Classic Data Structures, 2nd Edition, Debasis Samantha, PHI Learning.

I Semester	ADVANCED DATA MINING	L	T	P	C
		3	0	0	3

Course Objectives: The main objectives of the course are to

- Understand Data Warehousing and OLAP
- Master Data Preprocessing and Statistical Techniques
- Apply Classification Techniques and Model Evaluation
- Perform Association and Sequential Pattern Mining
- Explore Clustering and Advanced Data Mining

UNIT	CONTENTS
UNIT – 1	Data Warehousing and Online Analytical Processing: Basic concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation, Cloud Data Warehouse, Data Mining Methodologies: CRISP-DM and SEMMA, Comparison of Data Mining Methodologies. Statistical Limits on Data Mining, Introduction to Predictive Analytics, Technologies, Applications, Major issues (Text Book- 1)
UNIT – 2	Data Objects & Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity. Data Preprocessing: An Overview, Data Cleaning, Data Integration, Dimensionality Reduction, PCA, Data Transformation and Data Discretization. (Text Book- 1)
UNIT – 3	**Classification:** Basic Concepts, General Approach to solving a classification problem, Decision Tree Induction: Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Visual Mining for Decision Tree Induction, Bayesian Classification Methods: Bayes Theorem, Naïve Bayes Classification, Bayesian Belief Networks, Rule-Based Classification, Model Evaluation and Selection. (Text Book- 2)
UNIT – 4	**Association Rule Mining:** Problem Definition, Frequent Itemset Generation, Rule Generation: Confident Based Pruning, Rule Generation in Apriori Algorithm, Frequent Item Sets, FP-Growth Algorithm, *Sequential Patterns*: Preliminaries, Sequential Pattern Discovery, GSP Algorithm, Prefix-SPAN algorithm.(Text Book-2)
UNIT – 5	**Cluster Analysis:** Clustering techniques, Different Types of Clusters; K-means, K-means Additional Issues, Bi-secting K-Means, Agglomerative Hierarchical Clustering: BIRCH, DBSCAN: Traditional Density Center-Based Approach, DBSCAN Algorithm, Strengths and Weaknesses. Mining rich data types: Mining text data, Spatio-temporal data, Graph and networks. (Text Book- 2)

Text Books:

1. Data Mining Concepts and Techniques, 3rd Edition, Jiawei Han, Michel Kamber, Elsevier.
2. Introduction to Data Mining: Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson.

Reference Books:

1. Data Mining: Vikram Pudi, P. Radha Krishna, Oxford Publisher.
2. Data Mining Techniques, Arun K Pujari, 3rd Edition, Universities Press.

Online Resources: (NPTEL course by Prof. Pabitra Mitra)

1. http://onlinecourses.nptel.ac.in/noc17_mg24/preview
2. http://www.saedsayad.com/data_mining_map.htm

I Semester	MINING MASSIVE DATA SETS	L	T	P	C
		3	0	0	3

Course Objectives:

The main objectives of this course are to help students learn basic concepts and techniques for handling and analyzing large datasets, including data mining, distributed computing, data streams, frequent patterns, clustering, and dimensionality reduction, to solve practical problems.

UNIT	CONTENTS
UNIT – 1	Data Mining: Introduction, Statistical Modeling, Machine Learning, Computational Approaches to Modeling, Feature Extraction, Statistical Limits on Data Mining, Hash Functions, Indexes, Natural Logarithms, Power Laws.
UNIT – 2	Map Reduce and the New Software Stack: Distributed File Systems, MapReduce, Algorithms Using MapReduce, Extensions to MapReduce, Complexity Theory for MapReduce
UNIT – 3	Mining Data Streams: The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Counting Ones in a Window, Decaying Windows.
UNIT – 4	Frequent Item sets: The Market-Basket Model, Market Baskets and the A-Priori Algorithm, Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream.
UNIT – 5	Clustering: Introduction to Clustering Techniques, Hierarchical Clustering, K-means Algorithms, The CURE Algorithm, Clustering in Non-Euclidean Spaces, and Clustering for Streams and Parallelism, Dimensionality Reduction: Eigen values and Eigenvectors of Symmetric Matrices, Principal-ComponentAnalysis, Singular Value Decomposition,CUR Decomposition.

Text Books:

1. Mining of Massive Datasets - Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman.

I Semester	HIGH PERFORMANCE COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:

This course is aimed at enabling the students to

- Understand the fundamentals of parallel computing
- Explore the principles of parallel algorithm design
- Master basic parallel communication operations
- Learn to program shared-memory parallel systems
- Implement parallel algorithms for matrix operations and graph processing

UNIT	CONTENTS
UNIT – 1	**Introduction:** Motivating Parallelism, Scope of Parallel Computing, Parallel Programming Platforms: Implicit Parallelism, Trends in Microprocessor and Architectures, Limitations of Memory, System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Scalable design principles, Architectures: N-wide superscalar architectures, Multi-core architecture.
UNIT – 2	**Parallel Programming:** Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, The Age of Parallel Processing, the Rise of GPU Computing, A Brief History of GPUs, Early GPU.
UNIT – 3	**Basic Communication:** Operations- One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations. Programming shared address space platforms: threads- basics, synchronization, OpenMP programming
UNIT – 4	**Analytical Models:** Sources of overhead in Parallel Programs, Performance Metrics for Parallel Systems, and The effect of Granularity on Performance, Scalability of Parallel Systems, Minimum execution time and minimum cost, optimal execution time. **Dense Matrix Algorithms:** Matrix Vector Multiplication, Matrix-Matrix Multiplication.
UNIT – 5	**Parallel Algorithms- Sorting and Graph:** Issues in Sorting on Parallel Computers, Bubble Sort and its Variants, Parallelizing Quick sort, All-Pairs Shortest Paths, Algorithm for sparse graph, Parallel Depth-First Search, Parallel Best First Search. **CUDA Architecture:** CUDA Architecture, Using the CUDA

	Architecture, Applications of CUDA, Introduction to CUDA C- Write and launch CUDA C kernels, Manage GPU memory, Manage communication and synchronization, Parallel programming in CUDA- C.

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar, "Introduction to Parallel Computing", 2nd edition, Addison-Wesley, 2003, ISBN: 0-201-64865-2
2. Jason sanders, Edward Kandrot, “CUDA by Example”, Addison-Wesley, ISBN- 13: 978-0-13-138768-3

Reference Books

1. Kai Hwang, ”Scalable Parallel Computing”, McGraw Hill, ISBN:0070317984
2. Shane Cook, “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs”, Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 780124159884
3. David Culler, Jaswinder Pal Singh, ”Parallel Computer Architecture: A Hardware/ Software Approach”, Morgan Kaufmann, ISBN 978-1-55860-343-1
4. Rod Stephens, “Essential Algorithms”, Wiley, ISBN: ISBN: 978-1-118-61210-1

I Semester	AUGMENTED REALITY AND VIRTUAL REALITY	L	T	P	C
		3	0	0	3

Course Objectives:

The main objectives of this course to acquire the knowledge on augmented reality, demonstrate the augmented reality devices, acquire the knowledge on virtual reality, and illustrate the VR devices

UNIT	CONTENTS
UNIT – 1	Augmented Reality, origin of Augmented Reality, The Relationship Between Augmented Reality and Other Technologies, Augmented Reality Concepts, working of Augmented Reality, Ingredients of an Augmented Reality Experience.
UNIT – 2	Augmented Reality Hardware, Major Hardware Components for Augmented Reality Systems, Augmented Reality Software, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.
UNIT – 3	Virtual Reality (VR): The Three I's of Virtual Reality, A Short History of Early Virtual Reality, Early Commercial VR Technology, VR Becomes an Industry, The Five Classic Components of a VR System. Input Devices: Trackers, Navigation, and Gesture Interfaces: Three-Dimensional Position Trackers, Navigation and Manipulation Interfaces.
UNIT – 4	Output Devices: Graphics, Three-Dimensional Soundand Haptic Displays: Graphics Displays, Sound Displays, Haptic Feedback, Human Factors in VR: Methodology and Terminology, User Performance Studies, VR Health and Safety Issues, VR and Society.
UNIT – 5	Augmented Reality Applications, characteristics of a Good Augmented Reality Application, Application Areas, Magic Books, Magic Windows and Doors, Applying Augmented Reality to a Problem, Evaluating Augmented Reality Applications, VR Applications in Manufacturing, Applications of VR in Robotics.

Text Books:

1. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
2. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press.

Reference Books:

1. La Valle, "Virtual Reality", Cambridge University Press, 2016.
2. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann.

I Semester	RECOMMENDER SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

This course covers the basic concepts of recommender systems, including personalization algorithms, evaluation tools, and user experiences.

UNIT	CONTENTS
UNIT – 1	Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.
UNIT – 2	Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.
UNIT – 3	Content-based recommendation: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.
UNIT – 4	Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta- level, Limitations of hybridization strategies.
UNIT – 5	Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics.Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, social tagging recommender systems, Trust and recommendations.

Text Books:

1. Jannach D., Zanker M. and Fel Fering A., Recommender Systems: An Introduction, Cambridge University Press 1st ed.
2. RicciF, Rokach L.,Shapira D., Kantor B.P., Recommender Systems Handbook, Springer, 1st ed.

Reference Books:

1. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer,1st ed.

I Semester	TIME SERIES ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

This course is aimed at enabling the students to introduce a variety of statistical models for time series and cover the main methods for analyzing these models

UNIT	CONTENTS
UNIT – 1	**Introduction of Time series Analysis:** Introduction to Time Series and Forecasting, Different types of data, Internal structures of time series. Models for time series analysis, Autocorrelation and Partial autocorrelation. Examples of Time series, Nature and uses of forecasting, Forecasting Process, Data for forecasting, Resources for forecasting
UNIT – 2	**Statistics Background for Forecasting:** Graphical Displays, Time Series Plots, Plotting Smoothed Data, Numerical Description of Time Series Data, Use of Data Transformations and Adjustments, General Approach to Time Series Modeling and Forecasting, Evaluating and Monitoring Forecasting Model Performance
UNIT – 3	**Time Series Regression Model:** Introduction Least Squares Estimation in Linear Regression Models, Statistical Inference in Linear Regression, Prediction of New Observations, Model Adequacy Checking, Variable Selection Methods in Regression, Generalized and Weighted Least Squares, Regression Models for General Time Series Data, Exponential Smoothing, First order and Second order
UNIT – 4	**Autoregressive Integrated Moving Average (ARIMA) Models:** Autoregressive Moving Average Models, Stationarity and Invertibility of ARMA Models, Checking for Stationarity using Variogram, Detecting Nonstationarity, Autoregressive Integrated Moving Average (ARIMA) Models, Forecasting using ARIMA, Seasonal Data, Seasonal ARIMA Models, Forecasting using Seasonal ARIMA Models- Introduction, Finding the "BEST" Model.
UNIT – 5	**Multivariate Time Series Models and Forecasting:** Multivariate Time Series Models and Forecasting, Multivariate Stationary Process, Vector ARIMA Models, Vector AR (VAR) Models, Neural Networks and Forecasting Spectral Analysis, Bayesian Methods in Forecasting.

Text Books:

1. Introduction To Time Series Analysis and Forecasting, 2nd Edition, Wiley Series, Douglas C. Montgomery, Cheryl L. Jen, 2015.
2. Master Time Series Data Processing, Visualization, and Modeling Using Python, Dr.Avishek Pal Dr.PKS Prakash, 2017.

I Semester	ARTIFICIAL INTELLIGENCE LAB	L	T	P	C
		0	0	4	2

Course Objective:

The objective of this lab is to equip students with hands-on experience in implementing fundamental and advanced artificial intelligence algorithms using Python.

Exp No.	List of Experiments
1	Implementation of DFS for water jug problem using PYTHON.
2	Implementation of BFS for tic-tac-toe problem using PYTHON.
3	Implementation of TSP using heuristic approach using PYTHON.
4	Implementation of Hill-climbing to solve 8- Puzzle Problem using PYTHON.
5	Implementation of Monkey Banana Problem using PYTHON.
6	Implementation of A* Algorithm using PYTHON.
7	Implementation of AO* Algorithm using PYTHON.
8	Implementation of Min-Max Game playing algorithm using PYTHON.
9	Implementation Expert System with forward chaining using PYTHON.
10	Implementation Expert System with backward chaining using PYTHON.

Text Books:

1. Artificial intelligence, A modern Approach, 2nd ed, Stuart Russel, Peter Norvig, Prentice Hall
2. Artificial Intelligence, Saroj Kaushik, 1st Edition, CENGAGE Learning.

Reference Books:

1. Artificial Intelligence, Structures and Strategies for Complex problem solving, 5th Edition, George F Lugar, PEA.
2. Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer, 2017.
3. Artificial Intelligence, A new Synthesis, 1st Edition, Nils J Nilsson, Elsevier.
4. Artificial Intelligence- 3rd Edition, Rich, Kevin Knight, Shiv Shankar B Nair, TMH.
5. Introduction To Artificial Intelligence and Expert Systems, 1st Edition, Patterson, Pearson India, 2015.

I Semester	DATA WRANGLING LAB	L	T	P	C
		0	0	4	2

Course Objectives:
The main objective of this course is to equip students with practical skills in data handling, analysis, and visualization using Python, including file operations, data cleaning, and advanced techniques like web scraping and database integration.

Exp No	List of Experiments
1	Write a Python script to read each row from a given CSV file and print a list of strings.
2	Write a Python program to read a given CSV file as a dictionary.
3	Write a Python program to convert Python dictionary object (sort by key) to JSON data. Print the object members with indent level 4.
4	Write the python script to Read the XML file.
5	Write a Pandas program to import excel(child_labour_and_child_marriagedata.xlsx) data into a Pandas data frame and process the following. a. Get the data types of the given excel data. b. Display the last ten rows. c. Insert a column in the sixth position of the said excel sheet and fill it with NaN values
6	Develop the python script to parse the pdf files using pdfminer.
7	Extract the Table from the child_labour_and_child_marriagedata.xlsx using pdfables library.
8	Write a Python data wrangling scripts to insert the data into SQLite database.
9	Develop the Python Shell Script to do the basic data cleanup on child_labour_and_child_marriagedata.xlsx. a. Check duplicates and missing data. b. Eliminate Mismatches. c. Cleans line breaks, spaces, and special characters.
10	Import the data into `agate` then explores the table using agate methods and perform statistical correlations.
11	Draw the chart between perceived corruption scores compared to the child labour percentages using matplotlib.
12	Write the python script to Map the Child Labour Worldwide using pygal.

Text Books:

1. Jacqueline Kazil & Katharine Jarmul," Data Wrangling with Python", O'Reilly Media, Inc, 2016.

2. Dr.Tirthajyoti Sarkar, Shubhadeep," Data Wrangling with Python: Creating actionable data from raw sources", Packt Publishing Ltd,2019.

II Semester	MACHINE LEARNING	L	T	P	C
		3	1	0	4

Course Objectives:

The objectives of the course are to

- Define machine learning and its different types (supervised and unsupervised) and understand their applications.
- Apply supervised learning algorithms including decision trees and k-nearest neighbours (k-NN).
- Implement unsupervised learning techniques, such as K-means clustering

UNIT	CONTENTS
UNIT – 1	**Introduction:** Towards Intelligent Machines, well posed Problems, Example of Applications in diverse fields, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured / Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques.
UNIT – 2	**Supervised Learning:** Rationale and Basics: Learning from Observations, Bias and Why Learning Works: Computational Learning Theory, Occam's Razor Principle and Overfitting Avoidance Heuristic Search in inductive Learning, Estimating Generalization Errors, Metrics for assessing regression, Metrics for assessing classification.
UNIT – 3	**Statistical Learning:** Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, Bayesian Reasoning: A probabilistic approach to inference, K-Nearest Neighbor Classifier. Discriminant functions and regression functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Fisher's Linear Discriminant and Thresholding for Classification, Minimum Description Length Principle.
UNIT – 4	**Support Vector Machines (SVM):** Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Large Margin Classifier for linearly separable data, Linear Soft Margin Classifier for Overlapping Classes, Kernel Induced Feature Spaces, Nonlinear Classifier, Regression by Support vector Machines. **Learning with Neural Networks:** Towards Cognitive Machine, Neuron Models, Network Architectures, Perceptrons, Linear neuron and the Widrow-Hoff Learning Rule, The error correction delta rule.
UNIT – 5	**Multilayer Perceptron** Networks and error back propagation algorithm, Radial Basis Functions Networks. Decision Tree Learning: Introduction, Example of classification decision tree, measures of impurity for evaluating splits in decision trees, ID3, C4.5, and CART decision trees, pruning the tree, strengths and weakness of decision tree approach.

Text Books:

1. Applied Machine Learning, M. Gopal, McGraw Hill Education, 2019.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
3. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Taylor & Francis (CRC) 1st Edition-2014.

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer.
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.
3. Machine Learning Methods in the Environmental Sciences, Neural Networks, William WHsieh, Cambridge Univ Press. *1* edition.
4. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & SonsInc., 2nd Edition.

II Semester	DEEP LEARNING	L	T	P	C
		3	1	0	4

Course Objectives:

The objective of this course is to cover the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long short-term memory cells and convolution neural networks.

UNIT	CONTENTS
UNIT – 1	Basics: Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm.
UNIT – 2	Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders. Deep Neural Networks: Difficulty of training deep neural networks, Greedy layer wise training.
UNIT – 3	Better Training of Neural Networks: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).
UNIT – 4	Recurrent Neural Networks: Back propagation through time, Long Short-Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs. Convolutional Neural Networks: LeNet, AlexNet. Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.
UNIT – 5	Recent trends: Variational Autoencoders, Transformers, GPT Applications: Vision, NLP, Speech.

Text Books:

1. Deep Learning, Ian Good fellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

Reference Books:

1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996.
2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007.
3. Deep Learning with Python, François Chollet, Manning Publications, 2017.

II Semester	GENERATIVE AI	L	T	P	C
		3	1	0	4

Course Objectives:

The main objectives of the course are to

- Learn Python and TensorFlow skills for Generative AI.
- Study techniques for cleaning and preparing data for Generative AI tasks.
- Implement generative AI models
- Develop innovative applications using generative AI tools and techniques.

UNIT	CONTENTS
UNIT – 1	Introduction to Generative AI: “Drawing" Data from Models, Applications of AI, the rules of probability, why use generative models, Style transfer and image transformation.
UNIT – 2	Building Blocks of Deep Neural Networks Perceptrons — a brain in a function, multi-layer perceptrons and backpropagation, Varieties of networks: Convolution and recursive, Networks for seeing: Convolutional architectures, Networks for sequence data, RNNs and LSTMs
UNIT – 3	Image Generation with GANs, The taxonomy of generative models Generative adversarial networks, Vanilla GAN, Improved GANs, Progressive GAN
UNIT – 4	Deepfakes with GANs, Deepfakes overview, Modes of operation, Key feature set, High-level workflow, Replacement using autoencoders, Re-enactment using pix2pix
UNIT – 5	Composing Music with Generative Models, Getting started with music generation, Music generation using LSTMs, Music generation using GANs, MuseGAN — polyphonic music generation, Emerging applications in generative AI

Text books:

1. Generative AI with Python and TensorFlow 2, Joseph Babcock, Raghav Bali.
2. Hands-On Generative Adversarial Networks with Keras, Rafael Valle, Packt Publishing.

II Semester	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

Course Objective:
The main objectives of this course are to implement Virtualization, Task Scheduling algorithms, Apply Map-Reduce concept to applications, build Private Cloud.

UNIT	CONTENTS
UNIT – 1	Introduction: Network centric computing, Network centric content, peer-to –peer systems, cloud computing delivery models and services, Ethical issues, Vulnerabilities, Major challenges for cloud computing. Parallel and Distributed Systems: Introduction, architecture, distributed systems, communication protocols, logical clocks, message delivery rules, concurrency, model concurrency with Petri Nets.
UNIT – 2	Cloud Infrastructure: At Amazon, The Google Perspective, Microsoft Windows Azure, Open Source Software Platforms, Cloud storage diversity, Inter cloud, energy use and ecological impact, responsibility sharing, user experience, Software licensing.Cloud Computing: Applications and Paradigms: Challenges for cloud, existing cloud applications and new opportunities, architectural styles, workflows, The Zookeeper, The Map Reduce Program model, HPC on cloud, biological research.
UNIT – 3	Cloud Resource virtualization: Virtualization, layering and virtualization, virtual machine monitors, virtual machines, virtualization- full and para, performance and security isolation, hardware support for virtualization, Case Study: Xen, Blades. Cloud Resource Management and Scheduling: Policies and Mechanisms, Applications of control theory to task scheduling, Stability of a two-level resource allocation architecture, feedback control based on dynamic thresholds, coordination, resource bundling, scheduling algorithms, fair queuing, start time fair queuing, cloud scheduling subject to deadlines, Scheduling Map Reduce applications, Resource management and dynamic application scaling.
UNIT – 4	Storage Systems: of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system. Apache Hadoop, Big Table, Megastore (Text book 1), Amazon Simple Storage Service(S3) (Text book 2).Cloud Security: Cloud security risks, security – a top concern for cloud users, privacy and privacy impact assessment, trust, OS security, Virtual machine security, Security risks.
UNIT – 5	Cloud Application Development: Amazon Web Services : EC2 – instances, connecting clients, security rules, launching, usage of S3 in Java, Installing Simple

	Notification Service on Ubuntu 10.04, Installing Hadoop on Eclipse, Cloud based simulation of a Distributed trust algorithm, Cloud service for adaptive data streaming (Text Book 1). Google: Google App Engine, Google Web Toolkit (Text Book 2). Microsoft: Azure Services Platform, Windows live, Exchange Online, Share Point Services, Microsoft Dynamics CRM (Text Book 2).

Text Books:

1. Cloud Computing, Theory and Practice, Dan C Marinescu, MK Elsevier.
2. Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH.

Reference Books:

1. Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammarai selvi, TMH

II Semester	REINFORCEMENT LEARNING	L	T	P	C
		3	0	0	3

Course Objective:

The main objectives of this course are to

- Explain the fundamental concepts and components of reinforcement learning
- Understand and model finite Markov Decision process
- Apply Monte Carlo methods for prediction and control in reinforcement learning

UNIT	CONTENTS
UNIT – 1	The Reinforcement Learning Problem: Reinforcement Learning, Examples, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example: Tic-Tac-Toe, Summary, History of Reinforcement Learning.
UNIT – 2	Multi-arm Bandits: An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandits, Associative Search (Contextual Bandits).
UNIT – 3	Finite Markov Decision Processes: The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation.
UNIT – 4	Monte Carlo Methods: Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Returns.
UNIT – 5	Applications and Case Studies: TD-Gammon, Samuel's Checkers Player, The Acrobot, Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling.

Text Books:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning-An Introduction",2nd Edition, The MIT Press, 2018.
2. Marco Wiering, Martijn van Otterlo Reinforcement Learning: State-of-the-Art (Adaptation, Learning, and Optimization).

Reference Books:

1. Vincent François-Lavet, Peter Henderson, Riashat Islam, An Introduction to Deep Reinforcement Learning (Foundations and Trends(r) in Machine Learning), 2019.

II Semester	DATA SCIENCE APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:
The main objectives of the course are to

- Develop Proficiency in Python Programming Fundamentals
- Implement GUI and Internet-Based Applications in Python
- Utilize NumPy and Pandas for Scientific Computing and Data Analysis
- Create Effective Visualizations for Exploratory Data Analysis

UNIT	CONTENTS
UNIT – 1	PYTHON Basics and Programming Concepts: Introducing Python, Types and Operations, Numbers, Strings, Lists, Tuples, Dictionaries, Files, Numeric Types, Dynamic Typing; Statements and Syntax - Assignments, Expressions, Statements, Loops, iterations, comprehensions; Functions - Function Basics, Scopes, Arguments, Advanced Functions; Modules - Module Coding Basics, Module Packages, Advanced Module Topics; Classes and OOP - Class, Operator Overloading, Class Designing; Exceptions and Tools - Exception Basics, Exception Coding Details, Exception Objects, Designing With Exceptions, Parallel System Tools
UNIT – 2	GUI Programming: Graphical User Interface - Python gui development options, Adding Widgets, GUI Coding Techniques, Customizing Widgets; Internet Programming - Network Scripting, Client Side scripting, Pymail gui client, server-side scripting, Pymail cgi server; Tools and Techniques - databases and persistence, data structures, text and language, python/c integration
UNIT – 3	Pandas and NumPy: Numpy Basics - Fast Element wise array functions, Multidimensional Array, Data Processing using arrays, file i/o with arrays; Pandas - Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Handling Missing Data, Hierarchical Indexing
UNIT – 4	Data Preprocessing: Data Loading, Storage, and File Formats - Reading and Writing data in text format, binary data formats, interacting with html and web apis, interacting with databases; Data Wrangling: Clean, Transform, Merge, Reshape - Combining and Merging Data Sets, Reshaping and Pivoting, Data Transformation, String Manipulation; Data Aggregation and Group Operations – Group by Mechanics, Data Aggregation, Group by Operations and Transformations, Pivot Tables and Cross- Tabulation
UNIT – 5	Data Visualization: A Brief matplotlib API Primer, Plotting Functions in pandas, Time Series, Financial and Economic Data Applications

Text Books:

1. Learning Python , 5th Edition, Mark Lutz, OReilly.
2. Programming Python, 4th Edition, Mark Lutz, OReilly.
3. Python For Data Analysis, 2nd Edition, Wes Mckinney, O Reilly, 2017.

Reference Books:

1. Python: The Complete Reference,1st Edition, Martin C. Brown, McGraw Hill Education, 2018.
2. Head First Python, 2nd Edition, Paul Barry, O′Reilly, 2016.

II Semester	COMPUTER VISION	L	T	P	C
		3	0	0	3

Course Objectives:

The main objectives of this course are to

- Understand the physical principles of cameras, radiometry and light measurement
- Develop skills in model fitting and segmentation
- Gain proficiency in geometric camera models

UNIT	CONTENTS
UNIT – 1	CAMERAS: Pinhole Cameras Radiometry, Measuring Light: Light in Space, Light Surfaces, Important Special Cases Sources, Shadows, 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 – 2	The Geometry of Multiple Views: Two Views Stereopsis: Reconstruction, Human Stereopsis, Binocular Fusion, Using More Cameras Segmentation by Clustering: Segmentation, Human Vision: Grouping and Getstalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering,
UNIT – 3	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 – 4	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
UNIT – 5	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).

Reference Books:

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

II Semester	QUANTUM COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:
This course covers the basic concepts of quantum computing and problem-solving approach using finite dimensional mathematics.

UNIT	CONTENTS
UNIT – 1	Introduction to Essential Linear Algebra: Some Basic Algebra, Matrix Math, Vectors and Vector Spaces, Set Theory. Complex Numbers: Definition of Complex Numbers, Algebra of Complex Numbers, Complex Numbers Graphically, Vector Representations of Complex Numbers, Pauli Matrice, Transcendental Numbers.
UNIT – 2	Basic Physics for Quantum Computing: The Journey to Quantum, Quantum Physics Essentials, Basic Atomic Structure, Hilbert Spaces, Uncertainty, Quantum States, Entanglement, Basic Quantum Theory: Further with Quantum Mechanics, Quantum Decoherence, Quantum Electrodynamics, Quantum Chromodynamics, Feynman Diagram Quantum Entanglement and QKD, Quantum Entanglement, Interpretation, QKE.
UNIT – 3	Quantum Architecture: Further with Qubits, Quantum Gates, More with Gates, Quantum Circuits, The D-Wave Quantum Architecture. Quantum Hardware: Qubits, number of Qubits Needed, Addressing Decoherence, Topological Quantum Computing, Quantum Essentials.
UNIT – 4	Quantum Algorithms: Algorithm, Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Algorithm, Simon's Algorithm, Shor's Algorithm, Grover's Algorithm.
UNIT – 5	Current Asymmetric Algorithms: RSA, Diffie-Hellman, Elliptic Curve. The Impact of Quantum Computing on Cryptography: Asymmetric Cryptography, Specific Algorithms, Specific Applications.

Text Books:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.
2. Dr. Chuck Easttom, Quantum Computing Fundamentals, Pearson.

Reference Books:

1. Quantum Computing for Computer Scientists, Noson S. Yanofsky and Mirco A. Mannucci.
2. Principles of Quantum Computation and Information, Benenti G., Casati G. and Strini G.,
3. An Introduction to Quantum Computing Algorithms, Pittenger A. O.,

II Semester	SOFT COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:

The main objectives of the course are to introduce the concepts in Soft Computing such as Artificial Neural Networks, Fuzzy logic-based systems, genetic algorithm-based systems and their hybrids.

UNIT	CONTENTS
UNIT – 1	Introduction: soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. Basic tools of soft computing – Fuzzy logic, evolutionary computing. Neural networks, application scope of neural networks, fuzzy logic, genetic algorithm, and hybrid systems.
UNIT – 2	Fuzzy Sets : Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications and Defuzzifications. Fuzzy Controller, Fuzzy rule base and approximate reasoning: truth values and tables in fuzzy logic, fuzzy propositions formation of rules, decomposition of compound rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference system, fuzzy expert systems.
UNIT – 3	Evolutionary Computing: Basic Evolutionary Processes, EV: A Simple Evolutionary System, Evolutionary Systems as Problem Solvers, A Historical Perspective, Canonical Evolutionary Algorithms - Evolutionary Programming, Evolution Strategies, A Unified View of Simple Evolutionary Algorithms- A Common Framework, Population Size.
UNIT – 4	Genetic Algorithm(GA): Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Traditional algorithm vs genetic algorithm, simple GA, general genetic algorithm, schema theorem, Classification of genetic algorithm, Holland classifier systems, genetic programming, applications of genetic algorithm, Convergence of GA. Applications and advances in GA, Differences and similarities between GA and other traditional method, applications.
UNIT – 5	Swarm Intelligence: Introduction, Particle Swarm Optimization (PSO) Algorithm-Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant Colony Optimization (ACO)- Formulations, Pseudo-code. Applications of PSO and ACO

Text Books:

1. S. N. Sivanandam and S. N. Deepa, Principles of soft computing–John Wiley & Sons, ISBN- 9788126527410.

2. Timothy J. Ross, Fuzzy Logic with engineering applications, John Wiley & Sons, 2016.

Reference Books:

1. N.K. Sinha, M.M. Gupta, Soft Computing & Intelligent Systems: Theory & Applications, Academic Press /Elsevier.
2. Simon Haykin, Neural Network - A Comprehensive Foundation, Prentice Hall International, Inc.
3. R. Eberhart, Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/Elsevier.
4. Driankov D., Hellendoorn H, Reinfrank M., An Introduction to Fuzzy Control, Narosa Pub.
5. Bart Kosko, Neural Network and Fuzzy Systems, Prentice Hall,Inc., Englewood Cliffs,.
6. Goldberg D.E, Genetic Algorithms in Search, Optimization and Machine Learning Addison Wesley.

II Semester	MACHINE LEARNING LAB	L	T	P	C
		0	0	4	2

Course Objective:

The main objective of this course is to equip students with practical knowledge of machine learning techniques for data preprocessing, classification, clustering, and visualization using Python.

Sl.No	List of Experiments
1	Implement Principal Component Analysis (PCA) and Singular Value Decomposition (SVD) using NumPy.
2	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
3	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
4	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
5	Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
6	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
7	Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
8	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
9	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
10	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.

11	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
12	Create the following plots using Matplotlib, Pandas Visualization, Seaborn on iris dataset, wine reviews datasets. a. Scatter Plot b. Line chart c. Histogram

Text Books:

1. Applied Machine Learning, M. Gopal, McGraw Hill Education, 2019.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman. The Elements of Statistical Learning, Springer.
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.

II Semester	DEEP LEARNING LAB	L	T	P	C
		0	0	4	2

Course Objective:
The main objectives of this course are to enable students to design, implement, and evaluate deep learning models for diverse real-world applications using state-of-the-art techniques and tools.

Software Packages required:
- Keras
- TensorFlow
- PyTorch

S.No	List of Experiments
1	Implement multilayer perceptron algorithm for MNIST Hand written Digit Classification.
2	Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
3	Design a neural Network for classifying news wires (Multi class classification) using Reuters dataset.
4	Design a neural network for predicting house prices using Boston Housing Price dataset.
5	Build a Convolution Neural Network for MNIST Hand written Digit Classification.
6	Build a Convolution Neural Network for simple image (dogs and Cats) Classification.
7	Use a pre-trained convolution neural network (VGG16) for image classification.
8	Implement one hot encoding of words or characters.
9	Implement word embeddings for IMDB dataset.
10	Implement a Recurrent Neural Network for IMDB movie review classification problem.

TextBooks:

1. Reza Zadeh and Bharath Ramsundar, “Tensorflow for Deep Learning”, O’Reilly publishers, 2018.

References:

1. https://github.com/fchollet/deep-learning-with-python-notebooks

III Semester	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

Course Objectives:

The main objectives of the course are to make students to

- Understand the concept of a research problem
- Develop skills in the research process and learn effective literature review techniques
- Explore the nature and significance of intellectual property (IP)

UNIT	CONTENTS
UNIT – 1	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 – 2	Effective literature studies approaches, analysis Plagiarism, Research ethics, 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 – 3	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 – 4	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
UNIT – 5	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

Reference Books:

1. Stuart Melville, Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd.
5. Mayall, "Industrial Design", McGraw Hill.
6. Niebel, "Product Design", McGraw Hill.
7. Asimov, "Introduction to Design", Prentice Hall.