JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

R25 M.TECH CSE AI & ML COURSE STRUCTURE AND SYLLABUS

Vision and Mission of the University

VISION

The University is primarily promoting quality of education in the areas of Science, Technology, Engineering and Mathematics (STEM) as four academic pillars of education, to excel in teaching, learning, research, consultancy and placements through innovative practices with global perspective.

MISSION

1. Design an Industry relevant curriculum from time to time with a Global perspective
2. Promoting quality education by embracing ICT delivery mechanism with continuous pedagogy through e-learning mechanism
3. Spread across for industry collaborations with a focus to pre-training and placements for technology transfer to society
4. Establishing centers of excellence to promote research and innovations in multidisciplinary areas to bring in patent culture and consultancy practices
5. International Collaborations for student outreach
6. Facilitating international students to study in JNTUK to infuse cross culture learning practices.

Vision and Mission of the Institute

Vision and Mission of the Department

Programme Education Objectives (PEOs) of the M.Tech CSE (Artificial Intelligence & Machine Learning)

Mapping of Mission statements to PEOs

Mission Statement	PEO1	PEO2	PEO3	PEO4
MS1	✓	✓	✓	✓
MS2	✓	✓	✓	✓
MS3	✓	✓		✓
MS4		✓	✓	✓
MS5		✓	✓	✓
MS6			✓	✓

PEO 1: To impart a strong foundation in mathematics, basic sciences, and engineering principles for solving complex AIML problems with analytical thinking.

PEO 2: To enable graduates to design, develop, and deploy intelligent systems using advanced algorithms and AI/ML techniques for real-world applications.

PEO 3: To promote innovation, research aptitude, and critical thinking through hands-on labs, seminars, and project-based learning in AIML.

PEO 4: To nurture professionalism, ethics, teamwork, and communication skills, preparing graduates for success in industry, academia, and society.

Programme Outcomes (POs):

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

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

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

PO4: Apply principles of mathematics, science, and engineering to analyze and solve complex problems across diverse domains.

PO5: Design effective engineering solutions and systems with consideration for societal, environmental, and safety constraints.

PO6: Identify, formulate, research, and analyze complex problems in Computer Engineering using principles of mathematics, natural sciences, and engineering sciences.

Mapping of Programme Outcomes to PEOs

Programme Outcomes	PEO1	PEO2	PEO3	PEO4
PO1	✓	✓	✓	
PO2			✓	✓
PO3	✓	✓	✓	✓
PO4	✓	✓	✓	
PO5		✓		✓
PO6	✓	✓	✓	

M.Tech

CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Programme Course Structure & Syllabus

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I Semester

S. No.	Course Title	L	T	P	C
1	**Program Core-1** Mathematics for Machine Learning	3	1	0	4
2	**Program Core-2** Artificial Intelligence	3	1	0	4
3	**Program Core-3** Advanced data structures and algorithms	3	1	0	4
4	**Program Elective – I** • Advanced data mining • Mining Massive Data Sets • High performance computing	3	0	0	3
5	**Program Elective – II** • Augmented Reality and Virtual Reality • Recommender Systems • Time Series Analysis	3	0	0	3
6	**Laboratory-1** Artificial Intelligence Lab	0	1	2	2
7	**Laboratory-2** Data Wrangling Lab				
8	**Seminar-I**	0	0	2	1
	TOTAL	**15**	**5**	**6**	**23**

List of Professional 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

@ Minimum 2/3 themes per elective

II – Semester

S.No.	Course Title	L	T	P	C
1	**Program Core-4** Machine Learning	3	1	0	4
2	**Program Core-5** Deep Learning	3	1	0	4
3	**Program Core-6** Data Science Applications				
4	**Program Elective – III** • Cloud Computing • Reinforcement Learning • Generative AI	3	0	0	3
5	**Program Elective – IV** • Computer Vision • Quantum Computing • Soft computing	3	0	0	3
6	**Laboratory-3** Deep Learning Lab	0	1	2	2
7	**Laboratory-4** Machine Learning Lab	0	1	2	2
8	**Seminar – II**	0	0	2	1
	TOTAL	**15**	**5**	**6**	**23**

*During the summer break, students need to pursue Summer Internship/ Industrial Training, it will be evaluated in the III Sem.

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

S.No.	Course Title
1	Cloud Computing
2	Reinforcement Learning
3	Generative AI
4	Computer Vision
5	Quantum Computing
6	Soft computing

@ Minimum 2/3 themes per elective

III Semester

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

MTech. (Artificial Intelligence& Machine Learning) – IV Semester

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

% External Assessment

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

Course Objectives:

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

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand and apply linear mappings and transformations	K2
CO2	Apply orthogonal projections and understand projection operators	K3
CO3	Computethe determinant and trace of any square matrix and Decomposition	K3
CO4	Differentiateunivariate functions and compute higher-order derivatives	K3
CO5	Apply Bayes' theorem to update posterior probabilities in discrete or continuous domains.	K3

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	M	H	L	H
CO2	M	L	M	H	L	H
CO3	H	L	M	H	L	H
CO4	M	L	M	H	L	M
CO5	H	M	H	H	M	H
CO6						

UNIT	CONTENTS	**Contact Hours**
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	12
UNIT – 2	Analytic Geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement,	12

	Inner Product of Functions, Orthogonal Projections, Rotations	
UNIT – 3	Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky, Decomposition, Eigende composition and Diagonalization, Singular Value Decomposition, Matrix Approximation, Matrix Phylogeny	12
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, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series	12
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 Transform Continuous Optimization: Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers, Convex Optimization	12
	Total	60

Text Books:

1. "Mathematics for Machine Learning", Marc Peter Deisenroth, A. Aldo Faisal and 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.

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

Course Objectives:

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

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Analyse and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them	K2
CO2	Analyze and apply problem reduction techniques and game playing and adversarial search strategies in AI.	K4
CO3	Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing.	K3
CO4	Apply probabilistic and evidential reasoning techniques to handle uncertainty in intelligent systems..	K5
CO5	Understand the fundamental concepts of fuzzy sets and fuzzy logic.	K6

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	-	H	M	-	M
CO2	H	-	H	H	-	H
CO3	H	-	H	H	M	H
CO4	H	-	H	H	-	H
CO5	H	-	H	H	-	H
CO6	-	-	-	-	-	-

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	**Introduction to artificial intelligence:** 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	12
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	12
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.	12
UNIT – 4	**Uncertainty measure: probability theory:** Introduction, probability theory, Bayesian belief networks, certainty factor theory, dempster-shafer theory	12
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.	12
	Total	60

Text Books:

1. Artificial intelligence, A modern Approach, 2nded, Stuart Russel, Peter Norvig, Prentice Hall
2. Artificial Intelligence, Saroj Kaushik, 1st Edition, 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, 1998
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

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

Course Objectives: From the course the student will learn

1. Concepts of Algorithms, Searching and Sorting techniques, Trees, Binary trees,
2. representation, traversal.
3. Dictionaries, ADT for List, Stack, Queue, Hash table representation, Hash functions,
4. Priority queues, Priority queues using heaps, Searchtrees.
5. AVL trees, operations of AVL trees, Red- Black trees, Splay trees, comparison of searchtrees.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand, design, and analyze algorithms for efficient problem-solving in computing.	K4
CO2	Understand and apply fundamental algorithms and data structures, including searching, sorting, trees, and graphs, to organize and process data efficiently.	K3
CO3	Understand and apply Abstract Data Types (ADTs) and hashing techniques for efficient data storage and retrieval	K2
CO4	Design and implement variety of data structures including linked lists, binary trees, heaps, graphs and search trees	K6
CO5	Compare various search trees (AVL, Red-Black, Splay, B-Trees) based on performance and applications.	K4

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	-	H	H	-	H
CO2	M	-	H	M	-	H
CO3	M	-	H	M	M	H
CO4	H	-	H	M	H	H
CO5	M	-	H	M	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	The Role of Algorithms in Computing, Algorithms, Algorithms as technology, Insertion sort, Analyzing algorithms, Designing algorithms,	12

	Growth of Functions, Asymptotic notation, Standard notations and common functions	
UNIT – 2	Searching-Linear and Binary, Search Methods, Sorting-Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort. Trees- Binary trees, Properties, Representation and Traversals (DFT, BFT), Expression Trees (Infix, prefix, postfix). Graphs-Basic Concepts, Storage structures and Traversals.	12
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.	12
UNIT – 4	Priority queues- Definition, ADT, Realizing a Priority Queue Using Heaps, Definition, Insertion, Deletion, Search Trees- Binary Search Trees, Definition, ADT, Implementation, Operations Searching, Insertion, Deletion.	12
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.	12
	Total	60

Text Books:

1. Introduction to Algorithms, 3rd Edition, Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, The MIT Press.
2. Data Structures: A Pseudo Code Approach, 2nd Edition, Richard F.Gilberg, BehrouzA. Forouzon and Cengage

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

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Understand and compare major data mining methodologies such as CRISP-DM and SEMMA	K2
CO2	Perform covariance and correlation analysis in the context of association mining.	K1
CO3	Make use of association rule mining techniques on categorical and continuous data.	K6
CO4	Identify and apply clustering algorithm (with open-source tools), interpret, evaluate and report the result.	K3
CO5	Evaluate clustering algorithms based on cluster characteristics, data properties, and cluster quality metrics.	K4

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	H
CO2	M	M	H	M	M	H
CO3	M	-	H	M	L	M
CO4	H	H	H	M	M	H
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Data Mining Methodologies: CRISP-DM and SEMMA, Comparison of Data Mining Methodologies. Statistical Limits on Data Mining, Introduction to Predictive Analytics, Classification & Prediction: Predictive Modelling; Concepts, General Approach to solving a classification problem, - ZeroR, OneR, Decision Tree Induction: Attribute Selection Measures, Tree Pruning, Scalability and Decision Tree Induction, Bayesian Classification Methods: Bayes Theorem, Naïve Bayes Classification, Model Evaluation and Selection, Visualization techniques and experiments with weka.	12
UNIT –	Association Analysis: Problem Definition, Frequent Itemset Generation,	12

2	Rule Generation: Confident Based Pruning, Rule Generation in Apriori Algorithm, Compact Representation of frequent item sets, FP-Growth Algorithm, Generating item sets and rules efficiently, Covariance and Correlation analysis.	
UNIT – 3	Advanced Concepts on Association Analysis: Handling Categorical and Continuous Attributes, handling a Concept Hierarchy, Sequential Patterns: Preliminaries, Sequential Pattern Discovery, Timing Constraints, Alternative Counting Schemes; Subgraph Patterns: Preliminaries: Frequent Subgraph Mining, Candidate Generation, Candidate Pruning, Support Counting (Tan & Vipin Kumar)	12
UNIT – 4	Clustering: Importance of Cluster Analysis, Clustering techniques, Different Types of Clusters; K-means: The Basic K-means Algorithm, K-means Additional Issues, Agglomerative Hierarchical Clustering: Basic Agglomerative Hierarchical Clustering Algorithm DBSCAN: Traditional Density Center-Based Approach, DBSCAN Algorithm, Strengths and Weaknesses. (Tan & Vipin Kumar)	12
UNIT – 5	Cluster Analysis: Additional Issues and Algorithms: Cluster Evaluation, Characteristics of Data, Clusters, and Clustering Algorithms. (Tan &Vipin Kumar) Mining rich data types: Mining text data, Spatial-temporal data, Graph and networks (Han 4th ed) Mining real data: Preprocessing data from a real medical domain, data mining techniques to create a comprehensive and accurate model of data.	12
	Total	60

Text Books:

1. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, AnujKarpatne, Vipin Kumar, 2nd edition
2. Data Mining: Concepts and Techniques, J. Han and M. Kamber, Morgan Kaufmann C.J. Date, Database Systems, Pearson, 4th edition

Reference Books:

1. Fundamentals of Data Warehouses, 2nd edition, Jarke, Lenzerini, Vassiliou, Vassiliadis, Springer.

Suggested NPTEL Course:

https://nptel.ac.in/courses/106105174/

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

Course Objectives:

Help students learn basic concepts and techniques for handling and analyzing large datasets, including data mining, distributed computing, data stream To s, frequent patterns, clustering, and dimensionality reduction, to solve practical problems.

Course Outcomes:

		Knowledge Level (K)#
CO1	Understand the fundamentals of data mining, statistical modeling, and feature extraction for analyzing large datasets.	K2
CO2	Apply the MapReduce framework and distributed file systems for efficient processing of massive data.	K3
CO3	Analyze data streams using techniques like sampling, filtering, and counting distinct elements in real-time scenarios.	K4
CO4	Use frequent itemset mining algorithms to identify patterns in large datasets and optimize their computation	K3
CO5	Evaluate clustering techniques and dimensionality reduction methods to group data and reduce complexity in high-dimensional datasets.	K5

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	H
CO2	H	M	H	H	M	H
CO3	M	L	H	H	L	H
CO4	H	M	H	M	L	H
CO5	H	M	H	M	M	H

UNIT	CONTENTS	**Contact Hours**
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.	12
UNIT – 2	Map Reduce and the New Software Stack: Distributed File Systems, Map Reduce, Algorithms Using MapReduce, Extensions to MapReduce,	12

	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.	12
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.	12
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-Component, Analysis, Singula,-Value, Decomposition,CUR Decomposition.	12
	Total	60

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:

The main objectives of the course are to study parallel computing hardware and programming models, performance analysis and modeling of parallel programs.

Course Outcomes:

		Knowledge Level (K)#
CO1	Understand the need for parallelism and the scope of parallel computing. Explain various parallel programming platforms, architectures, and their limitations.	K2
CO2	Develop an efficient parallel algorithm to solve given problem analyze and measure performance of modern parallel computing system	K3
CO3	Understand fundamental communication operations in parallel computing and their performance implications. Explain the basics of shared address space programming using threads, synchronization, and OpenMP.	K2
CO4	Evaluate performance metrics, overheads, and scalability factors in parallel systems using analytical models	K5
CO5	Build the logic to parallelize the programming task Develop parallel algorithms for sorting, graph problems, and CUDA-based GPU programming to address computational challenges in modern systems.	K6

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	M	H	L	M
CO2	H	M	H	H	M	H
CO3	M	L	M	M	L	M
CO4	M	L	M	M	L	M
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
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	12

	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.	12
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.	12
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.	12
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.	12
	Total	60

Text Books:

1. Ananth Grama, Anshul Gupta, George Karypis, and 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 1998, ISBN:0070317984.
2. Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", Morgan Kaufmann Publishers Inc. San Francisco, CA, USA 2013 ISBN: 9780124159884.
3. David Culler Jaswinder Pal Singh," Parallel Computer Architecture: A Hardware/ Software Approach", Morgan Kaufmann,1999, ISBN 978-1-55860-343-1.
4. Rod Stephens, "Essential Algorithms", Wiley, ISBN: ISBN: 978-1-118-61210-1.

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

Course Objectives:

To acquire the knowledge on augmented reality.

1. To demonstrate the augmented reality devices.
2. To acquire the knowledge on virtual reality.
3. To illustrate the VR devices.
4. To explain how to apply VR/AR for various applications.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Explain the origin and fundamental concepts of Augmented Reality.Explain the working of Augmented Reality and identify its key ingredients	K1
CO2	Understand the relationship between Augmented Reality and other related technologies	K2
CO3	Understand the fundamental concepts, historical development, and key components of virtual reality systems and input interfaces.	K2
CO4	Apply knowledge of VR output devices and human factors to analyze user interaction, performance, and safety in virtual environments.	K3
CO5	Apply augmented and virtual reality concepts to identify, design, and evaluate applications in domains like manufacturing and robotics.	K3

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	L	M	M	L	L	M
CO2	M	L	M	M	M	M
CO3	L	M	M	L	L	M
CO4	M	L	H	M	M	M
CO5	M	M	H	H	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Augmented Reality, origin of Augmented Reality, The Relationship Between Augmented Reality and Other Technologies, Augmented Reality	12

	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.	12
UNIT – 3	Virtual Reality: 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.	12
UNIT – 4	Output Devices: Graphics, Three-Dimensional Sound, and 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.	12
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.	12
	Total	60

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, 2003/2006.

Reference Books:

1. LaValle, "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, 2009.
3. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
4. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.

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.

Course Outcomes:

		Knowledge Level (K)#
CO1	Understand the fundamentals, mathematical notations, and applications of recommender systems along with associated challenges.	K2
CO2	Evaluate different collaborative filtering approaches and assess the impact of attacks on recommender systems to improve their robustness and performance.	K5
CO3	Develop content-based and knowledge-based recommendation models using item profiles, feature extraction, and classification algorithms.	K3
CO4	Design and implement hybrid recommender systems by exploring various hybridization strategies.	K6
CO5	Evaluate recommender systems, and explore the integration of social tagging, trust, and community-driven recommendations for personalized web search.	K5

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	L	M	M	L	L	M
CO2	M	M	H	M	M	M
CO3	H	M	H	H	M	H
CO4	H	M	H	H	H	H
CO5	H	H	H	M	H	H

UNIT	CONTENTS	**Contact Hours**
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.	12
UNIT –	Collaborative Filtering: User-based nearest neighbor recommendation,	12

2	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.	12
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.	12
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.	12
	Total	60

Text Books:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
2. RicciF., Rokach L.,Shapira D., Kantor B.P., Recommender Systems Handbook, Springer (2011), 1st ed.

Reference Books:

1. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer (2013), 1st ed.

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

Course Objectives:

The main objective of the course is to introduce a variety of statistical models for time series and cover the main methods for analyzing these models.

Course Outcomes:

		Knowledge Level (K)#
CO1	Develop and design forecasting models using time series data by analyzing its structure, autocorrelation patterns, and applying appropriate techniques for accurate predictions.	K6
CO2	Use statistical software to estimate the models from real data, and draw conclusions and develop solutions from the estimated models.	K6
CO3	Evaluate and apply advanced regression techniques and time series models to analyze data, make predictions, and assess model adequacy.	K5
CO4	Communicate the statistical analyses of substantial data sets through explanatory text, tables and graphs. Apply ARIMA and Seasonal ARIMA models to analyze time series data, assess stationarity.	K3
CO5	Combine and adapt different statistical models to analyze larger and more complex data.	K6

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	M	H	H	M	H
CO3	H	L	M	M	L	M
CO4	M	H	M	L	L	M
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction of Timeseries 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	12

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.	12
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	12
UNIT – 4	Autoregressive Integrated Moving Average (ARIMA)Models: Autoregressive Moving Average (ARMA) Models, Stationarity and Invertibility of ARMA Models, Checking for Stationarity using Variogram, Detecting Non stationarity, Autoregressive Integrated Moving Average (ARIMA) Models, Forecasting using ARIMA, Seasonal Data, Seasonal ARIMA Models Forecasting using Seasonal ARIMA Models Introduction, Finding the "BEST" Model. Example: Internet Users Data Model Selection Criteria, Impulse Response Function to Study the Differences in Models Comparing Impulse Response Functions for Competing Models.	12
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.	12
	Total	60

Text Books:

1. Introduction To Time Series Analysis and Forecasting, 2nd Edition, Wiley Series in Probability and Statistics, By Douglas C. Montgomery, Cheryl L. Jen (2015).
2. Master Time Series Data Processing, Visualization, And Modeling Using Python Dr. Avishek Pallor. PksPrakash (2017)

I Semester	ARTIFICIAL INTELLIGENCE LAB	L	T	P	C
		0	1	2	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. Students will learn to solve real-world problems using search strategies, heuristic techniques, game-playing algorithms, optimization methods, and expert systems, fostering their ability to design intelligent systems for various applications**.**

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

		Knowledge Level (K)#
CO1	Implement and analyse classic AI search techniques, such as DFS and BFS, for solving structured problems using Python.	K3
CO2	Apply heuristic-based approaches, including TSP and simulated annealing, to optimize complex problem-solving scenarios.	K3
CO3	Develop and implement advanced AI algorithms like A*, AO*, and hill-climbing to address puzzles and decision-making tasks effectively.	K4
CO4	Design game-playing strategies using Min-Max algorithms and evaluate their performance in adversarial settings.	K4
CO5	Build and test expert systems utilizing forward and backward chaining methods to automate reasoning processes in Python.	K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
CO2	H	M	H	H	M	L
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M
CO6	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

Experiment No.	List of Experiments
1	Implementation of DFS for water jug problem using PYTHON.

2	Implementation of DFS for water jug problem using PYTHON.
3	Implementation of BFS for tic-tac-toe problem using PYTHON.
4	Implementation of TSP using heuristic approach using PYTHON.
5	Implementation of Hill-climbing to solve 8- Puzzle Problem using PYTHON.
6	Implementation of Monkey Banana Problem using PYTHON.
7	Implementation of A* Algorithm using PYTHON.
8	Implementation of AO* Algorithm using PYTHON.
9	Implementation of Min-Max Game playing algorithm using PYTHON.
10	Implementation Expert System with forward chaining using PYTHON.
11	Implementation Expert System with backward chaining using PYTHON.

Text Books:

1. Artificial intelligence, A modern Approach, 2nded, Stuart Russel, Peter Norvig, Prentice Hall
2. Artificial Intelligence, SarojKaushik, 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, 1998.
4. Artificial Intelligence- 3rd Edition, Rich, Kevin Knight, Shiv Shankar B Nair, TMH.
5. IntroductionToArtificialIntelligenceandExpertSystems,1stEdition,Patterson, Pearson India, 2015.

I Semester	DATA WRANGLING LAB	L	T	P	C
		0	1	2	2

Course Objectives:

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.

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

		Knowledge Level (K)#
CO1	Perform Read and write operations on CSV, JSON and XML files.	K3
CO2	Process the Excel file using Pandas.	K3
CO3	Parse and Extract the Tables using Python library.	K3
CO4	Apply the basis of Data cleanup operation on the given dataset.	K3
CO5	Explore the web scraping in Python.	K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	H	M	L
CO2	H	M	H	H	M	L
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

Experiment 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 data (child labour and child marriage data.xlsx) into a Pandas data frame and process the following.
6	Get the data types of the given excel data.
7	Display the last ten rows.
8	Insert a column in the sixth position of the said excel sheet and fill it with

	NaN values.
9	Develop the python script to parse the pdf files using pdf miner.
10	Extract the Table from the child labour and child marriage data.xlsx using pdfables library.
11	Write a Python data wrangling scripts to insert the data into SQLite database.
12	Develop the Python Shell Script to do the basic data cleanup on child labour and child marriagedata.xlsx.
13	Check duplicates and missing data.
14	Eliminate Mismatches.
15	Cleans line breaks, spaces, and special characters.
16	Import the data into `agate` then explores the table using agate methods and perform statistical correlations.
17	Draw the chart between perceived corruption scores compared to the child labour percentages using matplotlib.
18	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.TirthajyotiSarkar, 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:

Machine Learning course will

1. Develop an appreciation for what is involved in learning from data.
2. Demonstrate a wide variety of learning algorithms.
3. Demonstrate how to apply a variety of learning algorithms to data.
4. Demonstrate how to perform evaluation of learning algorithms and model selection.

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	Domain Knowledge for Productive use of Machine Learning and Diversity of Data.	K4
CO2	Demonstrate on Supervised and Computational Learning.	K2
CO3	Analyze on Statistics in learning techniques and Logistic Regression	K4
CO4	Illustrate on Support Vector Machines and Perceptron Algorithm.	K2
CO5	Design a Multilayer Perceptron Networks and classification of decision tree.	K6

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	M	H	H	M	H
CO3	H	L	H	H	L	H
CO4	M	L	H	H	L	H
CO5	H	M	H	H	L	H

UNIT	CONTENTS	**Contact Hours**
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.	12
UNIT –	**Supervised Learning:** Rationale and Basics: Learning from Observations,	12

2	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, Metris 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.	12
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.	12
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.	12
	Total	60

Text Books:

1. Applied Machine Learning, M. Gopal, McGraw Hill Education, 2019.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
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 2009. (freely available online)
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
3. Machine Learning Methods in the Environmental Sciences, Neural Networks, William WHsieh, Cambridge Univ Press. *1* edition (August 31,2009).
4. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley &SonsInc., 2nd Edition-2001.

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.

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

		Knowledge Level (K)#
CO1	Understand the structure of biological and computational neurons, perceptron models, and the fundamentals of perceptron learning and linear separability.	K2
CO2	Understand and explore feedforward networks Gain a mathematical understanding of deep learning approaches, algorithms, and paradigms.	K2
CO3	Apply deep learning techniques, including neural networks and advanced models, to real-world applications in various domains like computer vision, natural language processing, and speech recognition.	K3
CO4	Apply concepts of RNNs, LSTMs, CNNs, and generative models like RBMs to design and analyze deep learning architectures for sequential and image data..	K3
CO5	Analyze and implement advanced deep learning models such as recurrent neural networks, convolutional neural networks, and generative models for complex data processing.	K4

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	L	H	H	L	H
CO3	M	M	H	H	H	H
CO4	H	L	H	H	M	H
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
UNIT –	Basics: Biological Neuron, Idea of computational units, McCulloch–Pitts	12

1	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.	12
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).	12
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.	12
UNIT – 5	Recent trends: Variational Autoencoders, Transformers, GPT Applications: Vision, NLP, Speech.	12
	Total	60

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	DATA SCIENCE APPLICATIONS	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.

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

		Knowledge Level (K)#
CO1	Explain how data is collected, managed and stored for data science.	K2
CO2	Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists.	K2
CO3	Implement data collection and management scripts using Python Pandas	K3
CO4	Ability to efficiently preprocess, wrangle, and aggregate data from diverse sources for effective analysis and transformation.	K3
CO5	Ability to visualize and analyze data using matplotlib and pandas, including time series and financial data applications.	K4

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	L	H	H	L	H
CO3	M	M	H	H	H	H
CO4	H	L	H	H	M	H
CO5	H	M	H	H	M	H

UNIT	CONTENTS	**Contact Hours**
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;	12

	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, Pymailgui client, server-side scripting, Pymailcgi server; Tools and Techniques - databases and persistence, data structures, text and language, python/c integration	12
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	12
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, Groupby Operations and Transformations, Pivot Tables and Cross- Tabulation	12
UNIT – 5	Data Visualization: A Brief matplotlib API Primer, Plotting Functions in pandas, Time Series, Financial and Economic Data Applications	12
	Total	60

Text Books:

1. Learning Python , 5th Edition, Mark Lutz, OReilly, 2013.
2. Programming Python, 4th Edition, Mark Lutz, OReilly, 2010.
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	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

Course Objective:

1. To implement Virtualization.
2. To implement Task Scheduling algorithms.
3. Apply Map-Reduce concept to applications.
4. To build Private Cloud.
5. Broadly educate to know the impact of engineering on legal and societal issues involved.

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

		Knowledge Level (K)#
CO1	Understand the fundamentals of network-centric computing, cloud models, ethical concerns, and challenges in distributed systems.	K2
CO2	Analyze cloud infrastructure, platforms, applications, and paradigms to identify opportunities and challenges in various domains.	K4
CO3	Apply virtualization techniques and cloud scheduling policies to manage and allocate cloud resources effectively.	K3
CO4	Evaluate cloud storage systems and assess cloud security risks, privacy concerns, and protective mechanisms.	K5
CO5	Evaluate own organizations' needs for capacity building and training in cloud computing-related IT areas.	K5

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	M	M	H
CO2	H	M	H	M	H	M
CO3	H	M	H	H	M	H
CO4	M	M	H	M	H	H
CO5	M	H	M	L	H	M

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction: Network centric computing, Network centric content, peer-to –peer systems, cloud computing delivery models and services, Ethical	12

	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.	12
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.	12
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.	12
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).	12
	Total	60

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 Tammaraiselvi, TMH

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

Course Objective:
To provide the fundamentals of Reinforcement learning.
Course Outcomes: At the end of the course, student will be able to:

		Knowledge Level (K)#
CO1	Recall and define the key concepts, elements, and historical background of reinforcement learning and its foundational problems.	K1
CO2	Develop and implement strategies for solving n-armed bandit problems using advanced methods like UCB, gradient bandits, and contextual bandits.	K6
CO3	Understand the structure and components of finite Markov Decision Processes and explain the role of value functions and optimal policies.	K2
CO4	Design and evaluate Monte Carlo-based reinforcement learning algorithms for both on-policy and off-policy control scenarios.	K6
CO5	Analyze and interpret real-world reinforcement learning applications and case studies to assess algorithm effectiveness and performance.	K4

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	M	L	M
CO2	H	M	H	H	L	H
CO3	M	L	H	M	L	H
CO4	H	M	H	H	M	H
CO5	M	H	M	L	M	M

UNIT	CONTENTS	**Contact Hours**
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.	12
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).	12

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.	12
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.	12
UNIT – 5	Applications and Case Studies: TD-Gammon, Samuel's Checkers Player, The Acrobot, Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling.	12
	Total	60

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 (12)) 2012th Edition.

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	GENERATIVE AI	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the principles and concepts underlying Generative AI.
2. Explore various types of generative models and their applications.
3. Develop practical skills in implementing and training generative models.
4. Evaluate the performance and limitations of different generative AI techniques.
5. Analyse ethical considerations and emerging trends in Generative AI.

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

		Knowledge Level (K)#
CO1	Understand the basics of generative AI, its applications, and the role of probability in data generation and style transformation.	K2
CO2	Apply the building blocks of deep neural networks, including CNNs and RNNs, to handle vision and sequence-based data	K3
CO3	Evaluate and implement generative adversarial networks (GANs) for image generation using various advanced GAN architectures.	K5
CO4	Apply generative models such as GANs and autoencoders to create deepfakes and understand their operational workflows and features.	K3
CO5	Understand generative models used in music composition, including LSTMs and MuseGAN, and explore emerging applications in generative AI.	K2

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	H	M	L	M
CO2	H	M	H	H	L	H
CO3	M	M	H	M	M	H
CO4	H	M	H	H	M	H
CO5	M	H	M	L	H	M

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to Generative Al: “Drawing" Data from Models Applications of AI, the rules of probability, why use generative models, Style transfer	12

	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	12
UNIT – 3	Image Generation with GANs, The taxonomy of generative models Generative adversarial networks, Vanilla GAN, Improved GANs, Progressive GAN	12
UNIT – 4	Deepfakes with GANs, Deepfakes overview, Modes of operation, Key feature set, High-level workflow, Replacement using autoencoders, Re-enactment using pix2pix	12
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	12
	Total	60

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	COMPUTER VISION	L	T	P	C
		3	0	0	3

Course Objectives:

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

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

		Knowledge Level (K)#
CO1	Recall and understand the fundamental principles of radiometry, shading, and color in image formation using pinhole camera models.	K1
CO2	Apply concepts of lighting, shading, and color perception to analyze how light interacts with surfaces in computer vision applications.	K3
CO3	Apply stereo vision and clustering techniques for image segmentation and multi-view geometry in computer vision.	K3
CO4	Apply probabilistic models such as the Hough Transform, EM algorithm, and Kalman filtering for segmentation, fitting, and tracking in dynamic scenes.	K3
CO5	Apply geometric camera models and calibration techniques, including model-based vision methods, for applications like mobile robotics and medical image registration.	K3

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	M	L	H	M	L	H
CO3	M	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	M	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	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	12

	Shading Models Color: The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.	
UNIT – 2	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.	12
UNIT – 3	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,	12
UNIT – 4	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	12
UNIT – 5	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.	12
	Total	60

Text Books:

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

Reference Books:

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.

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.

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

		Knowledge Level (K)#
CO1	Understand the foundational concepts of linear algebra, complex numbers, and set theory relevant to quantum computing.	K2
CO2	Understand basic principles of quantum physics, quantum theory, and entanglement essential for quantum computation.	K2
CO3	Understand the architecture and hardware components of quantum computers, including qubits, gates, and decoherence challenges.	K2
CO4	Understand the structure and logic behind key quantum algorithms such as Deutsch-Jozsa, Shor's, and Grover's algorithms..	K2
CO5	Understand the implications of quantum computing on classical asymmetric cryptographic algorithms and their security.	K2

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	M
CO2	L	L	H	M	L	M
CO3	M	L	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	M	H	H

UNIT	CONTENTS	**Contact Hours**
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.	12
UNIT –	Basic Physics for Quantum Computing: The Journey to Quantum,	12

2	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.	12
UNIT – 4	Quantum Algorithms: Algorithm, Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Algorithm, Simon's Algorithm, Shor's Algorithm, Grover's Algorithm.	12
UNIT – 5	Current Asymmetric Algorithms: RSA, Diffie-Hellman, Elliptic Curve. The Impact of Quantum Computing on Cryptography: Asymmetric Cryptography, Specific Algorithms, Specific Applications.	12
	Total	60

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:

To introduce the concepts in Soft Computing such as Artificial Neural Networks, Fuzzy logic-based systems, genetic algorithm-based systems and their hybrids.

Course Outcomes:

At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Understand the fundamentals of soft computing, artificial neural networks, neuron models, and basic learning mechanisms.	K2
CO2	Analyze and compare different perceptron architectures and training algorithms including Adaptive Linear Neuron and Backpropagation Network.	K4
CO3	Recall basic concepts of fuzzy logic including fuzzy sets, relations, membership functions, and fuzzification methods.	K1
CO4	Understand fuzzy inference systems, rule formation, and hybrid neuro-fuzzy systems such as Mamdani and Sugeno models.	K2
CO5	Apply genetic algorithms and hybrid systems to optimization problems, including genetic-neuro and genetic-fuzzy rule-based systems.	K3

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	M	L	M
CO2	H	L	H	H	L	H
CO3	M	L	M	M	L	M
CO4	H	L	H	M	M	H
CO5	H	M	H	H	H	H

UNIT	CONTENTS	**Contact Hours**
UNIT – 1	Introduction to Soft Computing, Artificial neural networks, biological neurons, Basic models of artificial neural networks, Connections, Learning, Activation Functions, McCulloch and Pitts Neuron, Hebb network	12
UNIT – 2	Perceptron networks, Learning rule, Training and testing algorithm, Adaptive Linear Neuron, Back propagation Network, Architecture, Training algorithm.	12
UNIT – 3	Fuzzy logic, fuzzy sets, properties, operations on fuzzy sets, fuzzy relations, operations on fuzzy relations, Fuzzy membership functions, fuzzification, Methods of membership, value assignments, intuition, inference, rank ordering, Lambda – cuts for fuzzy sets, Defuzzification methods.	12
UNIT – 4	Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules, Decomposition of rules, Aggregation of rules, Fuzzy Inference Systems, Mamdani and Sugeno types, Neuro-fuzzy hybrid systems, characteristics, classification.	12
UNIT – 5	Introduction to genetic algorithm, operators in genetic algorithm, coding, selection, cross over, mutation, stopping condition for genetic algorithm flow, Genetic-neuro hybrid systems, GeneticFuzzy rule-based system.	12
	Total	60

Text Books:

1. S. N. Sivanandam and S. N.Deepa, Principles of soft computing – John Wiley & Sons,2007.
2. Timothy J. Ross, Fuzzy Logic with engineering applications, John Wiley & Sons, 2016.

Reference Books:

1. N. K. Sinha and M. M. Gupta, Soft Computing & Intelligent Systems: Theory & Applications-Academic Press /Elsevier. 2009.
2. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc.1998.
3. R. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/Elsevier, 2007.
4. Driankov D., Hellendoorn H. and Reinfrank M., An Introduction to Fuzzy ControlNarosa Pub., 2001.

5. Bart Kosko, Neural Network and Fuzzy Systems- Prentice Hall Inc., Englewood Cliffs, 1992.
6. Goldberg D.E., Genetic Algorithms in Search, Optimization, and Machine LearningAddison Wesley, 1989.

II Semester	DEEP LEARNING LAB	L	T	P	C
		0	1	2	2

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

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

		Knowledge Level (K)#
CO1	Implement deep neural networks to solve real world problems	K3
CO2	Utilize pre-trained models like VGG16 for efficient image recognition	K3
CO3	Apply embedding techniques to represent textual data for natural language processing tasks	K4
CO4	Interpret the results of two different deep learning models	K4
CO5	Choose appropriate pre-trained model to solve real time problem	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	H	M
CO2	M	M	H	H	M	L
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

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.

Text Books:

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

References:

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

II Semester	MACHINE LEARNING LAB	L	T	P	C
		0	1	2	2

Course Objective:

To equip students with practical knowledge of machine learning techniques for data preprocessing, classification, clustering, and visualization using Python.

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

		Knowledge Level (K)#
CO1	Implement dimensionality reduction techniques like PCA and SVD to preprocess and analyse data.	K3
CO2	Apply FIND-S and Candidate-Elimination algorithms to derive specific and consistent hypotheses from training data in .CSV files	K4
CO3	Build classification models using decision trees (ID3), k-NN, and Bayesian classifiers, and evaluate their performance on various datasets.	K3
CO4	Explore clustering techniques, including k-Means and the EM algorithm, to analyse data quality and patterns.	K4
CO5	Visualize and interpret data insights using regression models, scatter plots, line charts, and histograms with Python libraries like Matplotlib, Seaborn, and Pandas.	K4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	H	M
CO2	H	M	H	H	H	M
CO3	H	M	H	H	H	M
CO4	H	M	H	H	H	M
CO5	H	M	H	H	H	M

(Please fill the above with Levels of Correlation, viz., L, M, H)

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, 2012.

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman. The Elements of Statistical Learning, Springer 2009. (freely available online)
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer,2007

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

Course Objectives:

1. Students will be able to define what constitutes a research problem by identifying gaps, inconsistencies, or limitations in existing knowledge.
2. Students will conduct comprehensive literature reviews to pinpoint unresolved issues or future research directions, synthesizing information to formulate clear research questions.

3.Students will demonstrate the ability to convert broad topics or practical concerns into focused, manageable, and empirically investigable research problems

Course Outcomes: At the end of the course, student will be able to (Four to Six)

		Knowledge Level (K)#
CO1	*Identify and formulate research problems, design investigative approaches, and apply appropriate data collection and analysis methods.*	K2
CO2	*Conduct effective literature reviews, maintain research ethics, and prepare structured technical reports and research proposals.*	K3
CO3	*Explain the nature and types of Intellectual Property Rights and processes for patenting innovations nationally and internationally.*	K2
CO4	*Analyze patent rights, licensing processes, technology transfer, and the use of patent databases.*	K4
CO5	*Evaluate recent developments in IPR, including biological systems, software, and traditional knowledge through case studies.*	K5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H		M			
CO2		H				
CO3			M			M
CO4			M			M
CO5			M			M
CO6						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS	**Contact**

		Hours
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	12
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	12
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	12
UNIT – 4	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	12
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	12
	Total	60

REFERENCES:

(1) Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
(2) Wayne Goddard and 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 ,2007.
(5) Mayall, “Industrial Design”, McGraw Hill, 1992.
(6) Niebel, “Product Design”, McGraw Hill, 1974.
(7) Asimov, “Introduction to Design”, Prentice Hall, 1962.
(8) Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in NewTechnological Age”, 2016.T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.