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RAMDEOBABA UNIVERSITY, NAGPUR

Formerly Shri Ramdobaba College of Engineering & Management (RCOEM) Est. 1984

RAMDEOBABA UNIVERSITY, NAGPUR – 440013

PROGRAMME SCHEME & SYLLABI
2026 – 2027

M. Tech. Computer Science and Engineering
(Artificial Intelligence & Machine Learning)

M. Tech. Computer Science and Engineering (AI&ML)

Teaching Scheme for First Year (Semester I) Master of Technology

Sr. No.	Category	CourseCode	Course Name	Hrs./Week			Credits	Maximum marks			ESE Duration (Hrs)
				L	T	P		Continuous Assessment	End Sem / Internal Eval	Total	
1.	PCC	26CS50TH1175	Probability and Statistics	4	0	0	4	50	50	100	3
2.	PCC	26CS50TH1176	Advanced Data Structures	4	0	0	4	50	50	100	3 Hou
3.	PCC	26CS50PR1176	Advanced Data Structures Lab	0	0	2	1	25	25	50	--
4.	PCC	26CS50TH1177	Artificial Intelligence	4	0	0	4	50	50	100	3 Hou
5.	PCC	26CS50PR1177	Artificial Intelligence Lab	0	0	2	1	25	25	50	--
6.	PCC	26CS50TH1178	Cloud Computing	4	0	0	4	50	50	100	3 Hours
7.	PCC	26CS50PR1179	Advanced Programming Lab-I	0	0	2	1	25	25	50	--
8.	SEC	26CS50PR1180	Software Lab – I	0	0	2	1	25	25	50	--
9.	AEC	26HS02TH1175	Technical Communication	3	0	0	3	50	50	100	3 Ho
			TOTAL	**19**	**0**	**8**	**23**	**350**	**350**	**700**	

M. Tech. Computer Science and Engineering (AI&ML)

Teaching scheme for First Year (Semester II) Master of Technology

Sr. No.	Category	CourseCode	Course Name	Hrs./Week			Credits	Maximum marks			ESE Duration (Hrs)
				L	T	P		Continuous Assessment	End Sem / Internal Eval	Total	
1.	PCC	26CS50TH1281	Machine Learning	4	0	0	4	50	50	100	3 Hours
2.	PCC	26CS50PR1281	Machine Learning Lab	0	0	2	1	25	25	50	
3.	MLC	26CS50TH1282	Research Methodology	4	0	0	4	50	50	100	3 Hours
4.	PEC	26CS50TH1283	Program Elective – I	4	0	0	4	50	50	100	3 Hours
5.	PEC	26CS50TH1284	Program Elective – II	4	0	0	4	50	50	100	3 Hours
6.	OE	26ID50TH1275	Open Elective – I/NPTEL/SWAYAM /MOOC	3	0	0	3	50	50	100	3 Hours
7.	PCC	26CS50PR1285	Advanced Programming Lab – II	0	0	2	1	25	25	50	--
8.	PCC	26CS50PR1286	Software Lab – II	0	0	2	1	25	25	50	--
9.	VSEC	26CS50PR1287	Mini Project and Seminar	0	0	6	3	25	25	50	--
			TOTAL	**19**	**0**	**12**	**25**	**350**	**350**	**700**	--

Course Code	Program Elective – I
26CS50TH1283-1	Optimization Techniques in Artificial Intelligence
26CS50TH1283-2	Trustworthy and Explainable AI
26CS50TH1283-3	Agentic AI
26CS50TH1283-4	Artificial Intelligence in Healthcare

Course Code	Program Elective – II
26CS50TH1284-1	Data Mining and Knowledge Discovery
26CS50TH1284-2	Natural Language Processing
26CS50TH1284-3	Social Network Analysis
26CS50TH1284-4	Business and Web Analytics

Exit option: PG diploma in Artificial Intelligence and Machine Learning

Eight weeks domain-specific internship after successfully completing the first year of the programme with minimum 40 credits.

M. Tech. Computer Science and Engineering (AI&ML)

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Teaching scheme for Second Year (Semester III) Master of Technology

Sr. No.	Category	CourseCode	Course Name	Hrs./Week			Credits	Maximum marks			ESE Duration (Hrs)
				L	T	P		Continuous Assessment	End Sem / Internal Eval	Total	
1.	PEC	26CS50TH1388	Program Elective - III/NPTEL/SWAYAM/MOOC	4	0	0	4	50	50	100	3 Hours
2.	PEC	26CS50TH1389	Program Elective – IV /NPTEL/SWAYAM /MOOC	4	0	0	4	50	50	100	3 Hours
3.	PRJ	26CS50PR1390	Project Phase-I	0	0	24	12	100	100	200	--
			TOTAL	**8**	**0**	**24**	**20**	**200**	**200**	**400**	--
	OR										
1.	PEC	26CS50TH1388	Program Elective - III/NPTEL/SWAYAM /MOOC	4	0	0	4	50	50	100	3 Hours
2.	PEC	26CS50TH1389	Program Elective – IV /NPTEL/SWAYAM/ MOOC	4	0	0	4	50	50	100	3 Hours
3.	Internship	26CS50PR1391	Industry Internship	0	0	24	12	100	100	200	--
			TOTAL	**8**	**0**	**24**	**20**	**200**	**200**	**400**	--

***Students can opt for Project Phase-I or Industry Internship of 12 credits.**

Course code	Program Elective -III
26CS50TH1388-1	Information Retrieval
26CS50TH1388-2	Advanced Digital Image Processing
26CS50TH1388-3	Big Data Analytics
26CS50TH1388-4	Deep Learning

Course code	Program Elective-IV
26CS50TH1389-1	Computer Vision
26CS50TH1389-2	Generative AI
26CS50TH1389-3	System Design
26CS50TH1389-4	Multiplayer Game Development

M. Tech. Computer Science and Engineering (AI&ML)

Teaching scheme for Second Year (Semester IV) Master of Technology

Sr. No.	CourseCode	Course Name	Hrs./Week			Credits	Maximum marks			ESE Duration (Hrs)	Category
			L	T	P		Continuous Assessment	End Sem / Internal Eval	Total		
1.	26CS50PR1492	Project Phase-II	0	0	24	12	200	200	400	--	PRJ
		TOTAL	**0**	**0**	24	12	200	200	**400**	--	--

OR

Sr. No.	CourseCode	Course Name	Hrs./Week			Credits	Maximum marks			ESE Duration (Hrs)	Category
			L	T	P		Continuous Assessment	End Sem / Internal Eval	Total		
1.	26CS50PR1493	Industry Internship/Research Internship/TBI Internship	0	0	24	12	200	200	400	--	Internship
		TOTAL	0	0	24	12	200	200	**400**	--	--

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1175 **Course: Probability and Statistics**
L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 4**

Course Pre-requisite : Basics of Probability and Statistics.

Course Objective:

The objective of this course is to expose student to understand the basic importance fundamental principles of probability, including probability distributions, random variables, basic statistical methods used for data analysis, inferential statistics, hypothesis testing, confidence intervals, and regression analysis in computer science and Information technology.

Course Outcomes:

On successful completion of the course, student shall be able to

1. Grasp the meaning of discrete and continuous random variables, probability distribution. Interpret the meaning of probabilities derived from distributions. This involves understanding what the calculated probabilities represent in practical terms and drawing conclusions from the results.
2. To analyze and interpret stochastic models, including calculating probabilities, transition probabilities, and steady-state probabilities within stochastic systems.
3. Grasp the fundamental concepts of curve fitting like regression techniques, model selection, and the use of different types of curves or functions to approximate data. 4. Understand the fundamental concept of hypothesis testing, including the null hypothesis (H0) and alternative hypothesis (H1), significance levels, p-values, and the basic logic behind hypothesis testing.
5. To apply MLE to various statistical models, such as linear regression, exponential distribution, etc. They should understand how to formulate likelihood functions and derive estimators for unknown parameters.

Syllabus:

Module 1 (8 hours)

Measure of central tendency, quartile, inter quartile range and outliers**,** Probability spaces, conditional probability, independence, Discrete random variables, Binomial distribution, Poisson distribution, Normal distribution and their applications.

Module 2: (8 Lectures)

Joint probability function, Introduction to stochastic process, random walk, stationary and auto regressive process, transition probability Matrix, Discrete time Markov chain and its applications in queueing problems.

Module 3: (**8 hours)**

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression – Rank correlation, Multiple regression and

correlation and its application in analysis of data.

Module 4: (8 Lectures)

Sampling Distributions, Point and Interval Estimations, Testing of Hypothesis for single mean and proportion.

Module 5: (7 Lectures):

Testing of Hypothesis for difference of mean and proportion, Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes, maximum likelihood estimation.

Text Books:

1. M R. Spiegal , Theory and Problems of probability and statistics :,2nded :,Schaum series
2. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Reference Books:

1. Maurtis Kaptein, Statistics for data science, An introduction to probability, statistics and Data Analysis, Springer 2022.
2. Jay L Devore, Probability and Statistics for Engineering and sciences, 8th edition, Cenage learning.

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1176 **Course: Advanced Data Structures**
L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 4**

Course Outcomes

On successful completion of the course, students will be able to

1. Implement dynamic list ADTs and planar graphs.
2. Evaluate different static and dynamic hashing techniques.
3. Analyze tree-based structures using red-black trees, B+-trees and splay trees.
4. Apply dynamic programming to a varied set of problems.

Syllabus

Unit-I

Linked Lists: Singly Linked Lists and Operations, Doubly Linked Lists and Operation, Linked Stacks and Linked Queues.

Unit-II

Graphs: Classification, Representation, Breadth First Search, Depth First Search, Connected Components, Spanning Trees, Shortest Paths.

Unit-III

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.
Hashing: Open Addressing and Separate Chaining, Collision Resolution, Cuckoo Hashing, Hopscotch Hashing, Extendible Hashing.

Unit-IV

Red Black Trees: Height of a Red Black Tree, Bottom-Up Red Black Tree & Operations: Insertion, Deletion and Searching.

2-3 Trees: Advantage of 2-3 trees over Binary Search Trees, Search and Update Operations on 2-3 Trees.

B+-Trees: Advantage of B+-trees over BSTs, Height of B+-Tree, Search and Update Operations on B+-Trees.

Splay Trees: Splaying, Search and Update Operations on Splay Trees.

Unit-V

Dynamic Programming: Basic Strategy, Multistage Graphs, All Pairs Shortest Path, Optimal Binary Search Trees, Traveling Salesman Problem, String Editing, Longest Common Subsequence Problem and its variations.

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Text Books

1. Thomas Cormen, Charles Leiserson, Ronald Rivest and Clifford Stein, Introduction to Algorithm, Third Edition, PHI, 2009
2. Michael Goodrich and Roberto Tamassia, Algorithm Design and Applications, Wiley Publishers, 2015.

Reference Books

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Fourth Edition, Pearson Education, 2002.
2. Ellis Horowitz, Sartaj Sahni and Sengunthar Rajasekaran, Computer Algorithms, Universities Press, 2000.

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50PR1176 | **Course: Advanced Data Structures Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week | **Total Credits: 1**

Course Prerequisite:
Basic knowledge of computer programming and common programming concepts.

Course Outcomes:

On successful completion, of course student will able to:
1. Identify different ADTs, their operations and specify their complexities.
2. Apply linear data structures to address practical challenges and analyze their complexity.
3. Analyze non-linear data structures to develop solutions for real-world applications.
4. Implement different dictionaries and hashing methods and analyze their time and space requirements.

Syllabus:

Experiments based on theory Syllabus in C, C++, Java or Python.
Few lab sessions shall be conducted using virtual lab platforms to enhance learning experiences and accessibility.

Text Books

1. Adam Drozdek, Data Structures and Algorithms in C++, Fourth Edition, Cengage Learning, 2013.
2. G.A.V. Pai, Data Structures and Algorithms: Concepts, Techniques and Application, First Edition, McGraw Hill, 2017.
3. Thomas H Cormen, Algorithms Unlocked, MIT Press, 2013
4. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.

Reference Books

1. Reema Thareja, Data Structures using C, Third Edition, Oxford University Press, 2023
2. Narasimha Karumanchi, Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles Fifth Edition, CareerMonk Publications, 2016.
3. Aditya Bhargava, Grokking Algorithms: An Illustrated Guide for Programmers and Other Curious People, First Edition, Manning Publications, 2016.
4. K. R. Venugopal and Sudeep R. Prasad, Mastering C, Second Edition, McGraw Hill, 2015.
5. A. K. Sharma, Data Structures using C, Second Edition, Pearson Education, 2013.
6. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Third Edition, Pearson Education, 2007.

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1177 **Course: Artificial Intelligence**
L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 4**

Course Outcomes :

On successful completion of course student will be able to:

1. Apply uninformed and informed search techniques and represent given problem using state space representation.
2. Utilize different AI techniques to solve fully informed two player games and constraint satisfaction problems.
3. Solve the AI problems by using logic programming.
4. Identify the uncertainty theory-based techniques for solving diverse problems.

Syllabus:

UNIT I: Introduction to Artificial Intelligence

History, applications, task domains, Basics of problem solving, problem characteristics, problem representation (toy problems and real-world problems); Structure of agent, rational agent, specifying task environment, Properties of task environment; measuring problem solving performance.

UNIT II: Searching Techniques

Uninformed Search: Depth, Breadth, Uniform Cost, Depth Limited, Iterative deepening DFS, Bidirectional Search.

Informed Search: Heuristic Based Search, Greedy Best First Search, A* Search; Local Search algorithms: Hill-climbing, Genetic Algorithms.

UNIT III: Adversarial Search

Two player Games, The min-max algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems: Constraint propagation, backtracking search.

UNIT IV: Knowledge Representation

Knowledge representation, Propositional logic, First Order Logic: Syntax and Semantics of FOL, Inference in FOL: Unification Algorithm, Resolution, Forward Chaining, Backward Chaining, Prolog programming, semantic net, frames, script.

UNIT V: Uncertain Knowledge and Reasoning

Probability and Baye's Theorem, Statistical reasoning: Bayesian networks, Bayes optimal classifier, Naïve bayes algorithm, Fuzzy Logic: properties and operations, Expert system. Expert systems: Introduction, basic concepts, structure of expert systems, types of expert systems, examples.

Text Books

1. Stuart Russel and Peter Norvig; Artificial Intelligence: A Modern Approach; Fourth Edition; Pearson Education, 2022.
2. E. Rich, K. Knight, S.B. Nair; Artificial Intelligence ,3rd Edition, Tata McGraw Hill, 2009.
3. G. Luger, Artificial Intelligence: Structures and Strategies for complex problem solving, Sixth Edition, Pearson Education, 2009.

Reference Books

1.Dan W Patterson, Introduction to Artificial Intelligence & Expert System, Pearson Education India; First Edition, 2015.
2. By Patrick D. Smith, David Dindi, Hands-On Artificial Intelligence for Beginners: An introduction to AI concepts, algorithms, and their implementation, First edition, Packt Publishing Ltd, 2018.
3. Denis Rothman; Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases; Kindle Edition, Packt Publishing Ltd, 2018.
4. Richard E. Neapolitan, Xia Jiang, Artificial Intelligence with an Introduction to Machine Learning, Chapman and Hall/CRC; 2nd edition, 2018.

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50PR1177 **Course: Artificial Intelligence Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week **Total Credits: 1**

Course Prerequisite:
Basic knowledge of the data structure and probability.

Course Outcomes :
On successful completion of course student will be able to:

1. Apply uninformed and informed search techniques and represent given problems using state space representation.
2. Utilize different AI techniques to solve fully informed two player games and constraint satisfaction problems.
3. Solve the AI problems by using logic programming.
4. Identify the uncertainty theory-based techniques for solving diverse problems.

Syllabus:
Experiments based on "Artificial Intelligence" course syllabus.

Text Books
1. Stuart Russel and Peter Norvig; Artificial Intelligence: A Modern Approach; Fourth Edition; Pearson Education, 2022.
2. E. Rich, K. Knight, S.B. Nair; Artificial Intelligence ,3rd Edition, Tata McGraw Hill, 2009.
3. G. Luger, Artificial Intelligence: Structures and Strategies for complex problem solving, Sixth Edition, Pearson Education, 2009.

Reference Books
1. Dan W Patterson, Introduction to Artificial Intelligence & Expert System, Pearson Education India; First Edition, 2015.
2. By Patrick D. Smith, David Dindi, Hands-On Artificial Intelligence for Beginners: An introduction to AI concepts, algorithms, and their implementation, First edition, Packt Publishing Ltd, 2018.
3. Denis Rothman; Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases; Kindle Edition, Packt Publishing Ltd, 2018.
4. Richard E. Neapolitan, Xia Jiang, Artificial Intelligence with an Introduction to Machine Learning, Chapman and Hall/CRC; 2nd edition, 2018.

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1178 **Course: Cloud Computing**

L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 4**

Course Objectives

1. Understand virtualization and containerization technologies used in cloud environments.
2. Explain and apply cloud architecture principles and service models.
3. Design and configure secure cloud networking and infrastructure.
4. Use AWS and Azure services for deploying applications and managing data.
5. Develop and evaluate scalable cloud-based application solutions.

Syllabus

Unit I: Virtualization & Containerization

Traditional vs virtualized infrastructure, Hypervisors (Type 1 & Type 2), Types of virtualization: Server, Storage, OS-level, Limitations of virtualization, Containerization concepts, Containers vs Virtual Machines, Docker basics: images, containers, lifecycle, Introduction to container orchestration, Kubernetes basics (Pods, Deployments, Services), Industry use cases.

Unit II: Cloud Fundamentals & Architecture

Introduction to cloud computing, Cloud service models: IaaS, PaaS, SaaS, Deployment models: Public, Private, Hybrid, Multi-cloud, Cloud architecture principles: Scalability, High availability, Fault tolerance, Elasticity, Cloud infrastructure: Regions, Availability Zones, Edge locations, High availability within data center, Cloud migration, Shared responsibility model, Introduction to public cloud platforms (AWS, Microsoft Azure, GCP), Introduction to core services in public cloud platforms, Different methods of deploying services in AWS and Azure, Concept of subscription and resource groups in Microsoft Azure.

Unit III: Cloud Networking, Security & Costing

Cloud networking: Virtual Private Cloud (VPC) / Virtual Network, Subnets and CIDR, Internet gateway, NAT gateway, Cloud security: Identity and Access Management (IAM), Security groups and Network ACLs, Data security basics, Costing: Pay-as-you-go pricing, Total Cost of Ownership (TCO), Cost optimization basics.

Unit IV: Core Cloud Services (AWS & Azure)

Compute services: AWS EC2, Azure Virtual Machines, VM configuration (Windows/Linux), Remote access: SSH, RDP, Storage services: AWS S3, EBS, EFS, Azure Blob Storage, Database services: AWS RDS, DynamoDB, Azure Cosmos DB.

Unit V: Cloud Application Deployment & Modern Practices

Application deployment in cloud: Hosting web applications on VM, Platform services (Elastic Beanstalk, Azure App Services), Serverless computing: AWS Lambda, Azure Functions, Load balancing and auto scaling, Infrastructure as Code (CloudFormation, ARM Templates), Cloud application architecture: Monolithic vs Microservices (conceptual), Basic API-based applications, Case studies: Cloud architecture examples (e-commerce, media applications).

Course Outcomes

On successful completion of the course, students will be able to:

1. Explain virtualization and container technologies in cloud computing.
2. Analyse and design cloud architectures based on performance and availability needs.
3. Implement cloud networking and security configurations.
4. Deploy and manage applications using cloud platforms (AWS/Azure).
5. Evaluate cloud solutions based on scalability, cost, and efficiency**.**

Text Books

1. Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Cloud Computing: Concepts, Technology & Architecture, Pearson, 1st Edition, 2013.
2. Thomas Erl, Eric Barceló Monroy, Cloud Computing: Concepts, Technology, Security and Architecture, Pearson, 2nd Edition, 2023.
3. Rajkumar Buyya et al., Mastering Cloud Computing, McGraw Hill, 1st Edition, 2013.
4. A. Srinivasan, J. Suresh, Cloud Computing: A Practical Approach, Pearson India, 1st Edition, 2014.

Reference Books

1. Naresh Kumar Sehgal, P.C.P. Bhatt, Cloud Computing: Concepts and Practices, Springer, 1st Edition, 2018.
2. Kai Hwang et al., Distributed and Cloud Computing, Elsevier, 1st Edition, 2012.
3. Kris Jamsa, Cloud Computing, Jones & Bartlett Learning, 1st Edition, 2012.
4. Kelsey Hightower et al., Kubernetes Up and Running, O'Reilly, 2nd Edition, 2022.
5. Nigel Poulton, Docker Deep Dive, Latest Edition, 2023.

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50PR1179 **Course: Advanced Programming Lab-I**
L: 0Hrs, T: 0 Hrs, P:2 Hrs, Per Week **Total Credits: 01**

Course Outcomes:

On successful completion of the course, students will be able to:

1. Design Python programs using different data and control structures.
2. Use Python Files, Modules and Packages to develop complex python programs.
3. Develop Python program using various libraries for data analytics, data visualization and scientific applications.
4. Implement the Object-Oriented Programming concepts in Python.

Syllabus:

Python Data Structures and its Applications: Lists, Tuples, Sets, Dictionaries, Slicing. Handling Strings in Python,String Operations, List Comprehension.

Basics of Python Programming: Operators, Control structures, Functions, Creating and importing Modules in program.

Dealing with files in Python, Modules and Packages.

Working with Open Source Python based libraries: Scipy, Pandas, Numpy, Matplotlib and Seaborn. Data Pre-Processing and visualization using Python libraries.

Python object oriented features: concepts of classes, methods, objects and inheritance.

Web scrapping: Introduction to Web scrapping and its need in application development to scrape the web with thehelp of standard libraries like Requests and Beautiful Soup.

EDA: A library for exploratory data analysis. It provides tools for visualizing and summarizing data.

Text Books

1. Python Programming Using Problem Solving Approach: Reema Thareja, Oxford University, Press; First edition.
2. Learning Python: Powerful object oriented programming, Mark Lutz, O'REILLY publications 5th addition.
3. Problem Solving with Algorithms and Data Structures using Python by Brad Miller and David Ranum, 2nd addition.

Reference Books

1. Allen Downey, Jeffrey Elkner, Chris Meyers, Learning with Python, Dreamtech Press

Syllabus for Semester I, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50PR1180 **Course: Software Lab – I**
L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week **Total Credits: 1**

Course Prerequisite:
Basic knowledge of computer programming and common programming concepts.

Course Objectives

1. Understand UI/UX basics and its use in software industry.
2. Understand basic use cases of UI/UX.
3. Develop small utilities using UI/UX tools.
4. Develop and integrate UI/UX with basic programs.

Syllabus

HTML5

Creation of headers, paragraphs, links, importing of images, tables, designing of forms, and document structure of HTML, Multimedia based tags- audio, video, iframe, Creating Animations,

Style Sheets

CSS3 - Introduction to Cascading Style Sheets- Features-Core syntax - Style Sheets and HTML Style Rule, Text Properties

Client- Side Programming

Introduction to JavaScript, Syntax, Variables and Data Types, Statements, Operators, Literals, Functions, Objects-Arrays-Built-in Objects, Form Validation, DOM Manipulation, jQuery

Data Visualization

CanvasJS Library, HighChartsLibrary

Angular JS

Introduction, Features of AngularJS ,Model-View-Controller, Built-In Filters, Using AngularJS Filters, Controllers & Modules, Working with Angular Forms, Model Binding

React JS

React and JSX, React components – class and functional,
lifecycle methods, props vs. state, event handling

Course Outcomes

On successful completion of the course, students will be able to:

1. Design stylized static and dynamic web pages.
2. Develop web applications and libraries with efficient DOM manipulation.
3. Use data visualization tools to develop interfaces for use cases
4. Develop single page applications using voice technology, motion design, and animation.

Text Books

1. "HTML and CSS: Design and Build Websites" by Jon Duckett, Wiley & Sons, 2011
2. "JavaScript and jQuery: Interactive Front-End Web Development", by Jon Duckett, John Wiley & Sons, 2011.
3. UI/UX design for designer and developers: by Nathan Clark

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1281 **Course: Machine Learning**
L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 4**

Course Outcomes:

On successful completion of the course, students will be able to:

1. Solve the problems related to the fundamental concepts in machine learning.
2. Analyze the strengths and weaknesses of various machine learning approaches.
3. Apply machine learning algorithms to solve classification, regression and clustering problems.
4. Implement various machine learning models to efficiently solve real-world problems.

Syllabus:

UNIT - I

The concept learning task: General-to-specific ordering of hypotheses, Version spaces, Inductive bias, Decision Tree Learning, Over-fitting, Cross-Validation, and Experimental Evaluation of Learning Algorithms.

UNIT - II

Instance-Based Learning: k-Nearest neighbor algorithm, weighted k-NN algorithm, Radial basis function network (RBFN).

Regression: Linear Regression, Logistic Regression.

UNIT – III

Artificial Neural Networks: Linear threshold units, Perceptron, Multilayer networks and back-propagation, recurrent networks.

UNIT - IV

Probabilistic Machine Learning: Maximum Likelihood Estimation, MAP Bayes Classifiers, Naive Bayes, Bayes optimal classifiers, Minimum description length principle.

Bayesian Networks, Inference in Bayesian Networks, Expectation Maximization (EM) algorithm.

UNIT - V

Unsupervised Learning: K-means Clustering, Hierarchical Clustering. Support Vector Machine, Hidden Markov Models, and Ensemble learning: boosting, bagging, Random Forest.

Text Books

1. Tom Mitchell; Machine Learning- an Artificial Intelligence Approach, Volume-II; Morgan Kaufmann, 1986.
2. Christopher Bishop, Pattern Recognition and machine learning; Springer Verlag, 2006.

Reference Books

1. Soumen Chakrabarti; Mining the Web: Discovering Knowledge from Hypertext Data, Morgan-Kaufmann, 2003.
2. A. K. Jain and R. C. Dubes; Algorithms for Clustering Data; Prentice Hall PTR, 1988.
3. Ethem Alpaydin, Introduction to Machine Learning, PHI.

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50PR1281 **Course: Machine Learning Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week **Total Credits: 1**

Course Outcomes:
On successful completion of course student will be able to:

1. Implement fundamental concepts used in machine learning algorithms.
2. Implement python programs for various learning algorithms.
3. Apply appropriate machine learning algorithms to various data sets.
4. Apply machine learning algorithms to solve real world problems.

Syllabus:
Experiments based on **25CS50TH1281 Machine Learning** course syllabus.

Text Books

3. Tom Mitchell; Machine Learning- an Artificial Intelligence Approach, Volume-II; Morgan Kaufmann, 1986.
4. Christopher Bishop, Pattern Recognition and machine learning; Springer Verlag, 2006.

Reference Books

4. Soumen Chakrabarti; Mining the Web: Discovering Knowledge from Hypertext Data, Morgan-Kaufmann, 2003.
5. A. K. Jain and R. C. Dubes; Algorithms for Clustering Data; Prentice Hall PTR, 1988.
6. Ethem Alpaydin, Introduction to Machine Learning, PHI.

Syllabus for Semester II, M. Tech - Computer Science and Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1282 **Course: Research Methodology**
L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 4**

Course Outcomes:

On Successful completion of course, students will be able to:

1. Formulate research problems and understand research objectives.
2. Develop a research design and identify appropriate methodologies.
3. Analyze and interpret data using statistical tools.
4. Analyze ethical issues in research and IP regulations.
5. Write a research paper/thesis using standard formats.

Syllabus:

Unit I: Introduction to Research

Definition and objectives of research, Types of research (basic, applied, exploratory, descriptive, etc.), Research process and steps in research, Criteria for good research. **Research Problem Formulation:** Problem identification and formulation, Review of literature and gap analysis, Research questions, hypotheses, and objectives, Feasibility and ethical considerations.

UNIT II: Research Design and Methodology

Types of research design (qualitative, quantitative, mixed-methods), Sampling methods and techniques, Data collection methods (survey, interview, experiment, observation), Reliability and validity.

Unit III: Data Analysis and Interpretation

Descriptive and inferential statistics, Use of software tools (e.g., SPSS, MATLAB, R), Hypothesis testing, correlation, regression, Interpretation of results.

Unit IV: Research Ethics and IPR

Ethical issues in research, Plagiarism, citation styles, Copyrights, patents, trademarks, Filing patents and publication ethics.

Unit V: Technical Writing and Presentation

Structure of thesis/dissertation, writing research papers and reports, Presenting research findings, Conferences, journals, and indexing (SCI, Scopus).

Text Books

1. **C.R. Kothari**, *Research Methodology: Methods and Techniques*, second revised edition , New Age International.
2. **Ranjit Kumar**, *Research Methodology: A Step-by-Step Guide for Beginners*, Sage Publications.
3. **Wayne Goddard and Stuart Melville**, *Research Methodology: An Introduction*.
4. **John -W. Creswell**, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.

Reference Books

1. Introduction to Probability and Statistics by William Mendenhall, Robert J. Beaver, Barbara M. Beaver
2. Probability and Statistics by Morris H. DeGroot and Mark J. Schervish.
3. *Deep Learning* by Ian Goodfellow, Yoshua Bengio, Aaron Courville
4. *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by* Aurélien Geron.

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1283-1 **Course: Optimization Techniques in Artificial Intelligence**
L: 4 Hrs, T: 0 Hr, P:0 Hrs, Per Week **Total Credits: 4**

Course Outcomes:

On successful completion of the course, students will be able to:

1. Understand the basics of optimization and natural computing.
2. Apply genetic algorithm for optimization problem.
3. Solve optimization problem using Particle Swarm Optimization and Ant Colony Optimization algorithm.
4. Demonstrate the concepts of Fuzzy logic and Artificial Neural Network.

Syllabus:

Unit - I

Introduction: Optimization problem definition, fundamental concepts of search and optimization, Classification of Optimization Problem, Constraints, Feasible Region, Natural computing, Classification of Natural Computing and Evolutionary computing.

Unit - II

Genetic Algorithm: Basic Genetic Algorithm, Fitness function, Evaluation, Selection, Crossover and Mutation, Chromosome Encoding, Roulette wheel selection, genotype and phenotype. Optimization problem solving using Genetic Algorithm.

Unit - III

Fuzzy Set and Fuzzy Logic : Crisp sets and fuzzy sets, Fuzzy set and Operations on fuzzy sets, Fuzzy relations, Uncertainty and Fuzzy, Alpha Cuts, Linguistic variables, Fuzzy logic, Fuzzy Languages, Approximate Reasoning, Expert systems, Uncertainty modeling in expert system, Fuzzy control, Fuzzy clustering. Methods of Defuzzification, Fuzzy Logic based Optimization.

Unit - IV

Swarm Intelligence: Collective Behavior and Swarm Intelligence, Social Insects, Particle Swarm Optimization (PSO) Algorithm, Optimization using PSO. Ant Colony Optimization concepts, Artificial Pheromone, Ant model to solve the traveling salesman problem.

Unit - V

Artificial Neural Network: Artificial Neuron, Activation function, Supervised and Unsupervised Learning methods, Single layer and Multilayer Perceptron, Gradient Descent and Stochastic Gradient Descent (SGD), ADAM.

Text Books and Reference Books

1. Leandro Nunes De Castro, Fernando Jose Von Zuben, "Recent Developments in Biologically Inspired Computing", Idea Group Publishing, 2005.
2. Klir and Yuan, "Fuzzy sets and Fuzzy logic – Theory and Applications", Prentice Hall of India (2000).
3. Jacek M. Zurada, "Introduction to Artificial Neural System", West Publishing Company.
4. S. Rajasekaran, G.A. VijayaLakshmi Pai, "Neural Network, Fuzzy Logic and Genetic Algorithm Synthesis and Applications", PHI publication.

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1283-2 Course: Trustworthy and Explainable AI
L: 4 Hrs, T: 0 Hr, P:0 Hrs, Per Week Total Credits: 4

Course Objectives

1. Introduce concepts of trust, safety, fairness, and explainability in AI systems.
2. Provide practical tools and methods for interpretable ML models.
3. Discuss ethical implications, accountability, and regulations in AI deployment.
4. Prepare students to design AI systems that are transparent and trustworthy.

Unit I

Introduction to Trustworthy AI: Need for trustworthy AI, Principles of trustworthy AI (fairness, accountability, transparency, ethics), Overview of AI risks including bias, safety, and adversarial attacks, Trust challenges in AI applications, Real-world case studies of AI failures due to lack of trust

Unit II

Fundamentals of Explainable AI (XAI): Explainability in AI systems, Black-box vs white-box models, Importance of model interpretability, Types of explanations (local vs global, model-specific vs model-agnostic), Introduction to LIME, SHAP, partial dependence plots, Saliency maps and rule-based explanations

Unit III

Fairness, Bias, and Ethical Considerations: Types and sources of bias in AI systems, Fairness metrics (statistical parity, equal opportunity, equalized odds), Techniques for mitigating bias (pre-processing, in-processing, post-processing), Ethical implications of biased AI, Introduction to ethical frameworks and responsible AI design

Unit IV

Robustness, Safety, and Accountability: Adversarial examples and vulnerabilities in AI, Model robustness techniques, Explainability for debugging and validation, Human-in-the-loop systems, Accountability and auditability in AI, Overview of AI regulations (GDPR, AI Act), Safety and compliance in deployed AI systems

Unit V

Applications and Tools for Trustworthy AI: Practical tools for XAI and fairness (AIF360, What-If Tool, Interpret ML), Use cases in healthcare, finance, and criminal justice, Explainability in NLP and computer vision, Causal inference and counterfactual explanations, Design of fair and interpretable ML systems, Hands-on mini-project on building a trustworthy AI model

Course Outcome

On successful completion of the course, students will be able to:

1. Understand the principles and challenges involved in designing trustworthy and ethical AI systems.
2. Apply explainable AI techniques to interpret predictions of machine learning models.
3. Analyze and mitigate bias and fairness issues in datasets and AI algorithms.
4. Evaluate the robustness, accountability, and regulatory compliance of AI systems.
5. Use open-source tools and frameworks to de

Text Books

1. “Interpretable Machine Learning” by Christoph Molnar, Leanpub.
2. The Ethical Algorithm: The Science of Socially Aware Algorithm Design by Michael Kearns and Aaron Roth, Oxford University Press, 1st Edition, 2019.
3. Fairness and Machine Learning: Limitations and Opportunities by Solon Barocas, Moritz Hardt, and Arvind Narayanan, fairmlbook.org, Online Edition, 2023.

Reference Books

1. Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way by Virginia Dignum, Springer, 1st Edition, 2019.
2. Explainable AI: Interpreting, Explaining and Visualizing Deep Learning edited by Wojciech Samek, Grégoire Montavon, Andrea Vedaldi, Lars Kai Hansen, and Klaus-Robert Müller, Springer, 1st Edition, 2019.

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1283-3 **Course: Agentic AI**
L: 4 Hrs, T: 0 Hr, P:0 Hrs, Per Week **Total Credits: 4**

Course Objectives

1. To introduce the core concepts and design principles of agentic AI systems.
2. To understand how agents perceive, act, and learn in dynamic environments.
3. To explore the architectures and algorithms enabling autonomous decision-making.
4. To analyze ethical implications and real-world applications of agent-based AI.

Unit I: Foundations of Agentic AI: Definition and scope of agentic AI, Rational agents and agent-based systems, PEAS (Performance measure, Environment, Actuators, Sensors), Types of agents – reflex, model-based, goal-based, utility-based, learning agents, Agent architectures and design paradigms

Unit II: Environment and Agent Interactions: Agent-environment interface, Task environments and their classification, Properties of environments – deterministic vs stochastic, fully vs partially observable, discrete vs continuous, multi-agent systems and communication, Cooperation, competition, and coordination in agent systems

Unit III: Learning and Planning in Agentic Systems: Introduction to planning in intelligent agents, Search algorithms for planning, Reactive vs deliberative planning, Learning agents and reinforcement learning basics, Exploration vs exploitation, Model-based and model-free learning in agentic systems

Unit IV: Autonomous and Goal-Oriented Behavior: Autonomy in agents, Goal formulation andintention recognition, Goal hierarchies and utility-based decision making, Agent deliberation cycles, Meta-reasoning and self-adaptive agents, Integration of learning and reasoning in autonomous agents

Unit V: Applications and Ethics in Agentic AI: Applications in robotics, smart assistants, autonomous vehicles, multi-agent simulation and gaming, Trust, safety, and ethics in agentic behavior, Value alignment and human-agent collaboration, Future directions in AGI and agent-based AI

Course Outcomes (COs):

On successful completion of the course, students will be able to:

1. Explain the foundational models and types of intelligent agents.
2. Classify environments and describe agent-environment interactions.
3. Apply planning and learning algorithms within agentic systems.
4. Design autonomous agents capable of goal-driven behavior.
5. Evaluate ethical, safety, and application aspects of agentic AI systems.

Text Books

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, Pearson, 4th Edition
2. Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations by Yoav Shoham and Kevin Leyton-Brown, Cambridge University Press, 1st Edition

Reference Books

1. Intelligent Agents: Foundations and Applications by Gerhard Weiss, Springer, 1st Edition
2. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto, MIT Press, 2nd Edition

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1284-1 **Course: Data Mining and Knowledge Discovery** **L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week** **Total Credits: 4**

Course Objectives:
To learn the basics of Data Mining, to describe and demonstrate basic data mining algorithms, methods and tools, use of Data Mining as a business intelligence tool for building competitive advantage through proactive analysis, predictive modelling, identifying new trends and behaviours.

Unit 1: Data Mining: Introduction, Importance of Data Mining, Kinds of Data and Patterns to be Mined, Technologies used in Data Mining, Data Mining Applications, Major issues in Data Mining.

Data Preprocessing: Data Preprocessing: An overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization.

Unit 2: Mining Frequent Patterns, associations and Correlations: Basic Concepts, Frequent Itemset Mining Methods, Pattern Evaluation Methods.

Advanced Pattern Mining: Pattern Mining in Multilevel and Multidimensional Space, Constraint-Based Frequent Pattern Mining.
Introduction: Mining High-Dimensional Data and Colossal Patterns, Mining Compressed Patterns, Pattern Exploration and Application

Unit 3: Classification: Basic Concepts, Decision Tree Induction, Rule Based Classification, Model Evaluation & Selection, Techniques to Improve Classification Accuracy.
Introduction: Bayesian Belief Networks, Support Vector Machines, Classification using Frequent Patterns, Lazy Learners, Other Classification Methods.

Unit 4: Cluster Analysis: Cluster Analysis basic concepts, **Partitioning Methods:** k-Means and k-Medoids, **Hierarchical Methods:** BIRCH, CHAMELEON, Probabilistic Hierarchical Clustering, **Density-Based Methods:** DBSCAN, OPTICS, DENCLUE, **Grid-Based Methods:** STING, CLIQUE, Evaluation of Clustering.

Unit 5: Data Mining Trends and Research Frontiers: Mining Complex Data Types, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining Trends.

Course Outcomes:
On the successful completion of the subject students will be able to:
1. Conceptualize need and utility of Data Mining.
2. Familiarize with the concepts of various types of data used in Data Mining.
3. Discover interesting patterns from large amounts of data to analyze and extract patterns to solve problems, make predictions of outcomes.
4. Conceptualize latest technologies & techniques in Data Mining.

Text Books:

1. Data Mining- Concepts and Techniques: Jiawei Han, Micheline Kamber Morgan Kaufmann Publishers, Third Edition.
2. Mining of Massive Datasets: Anand Rajaraman, Jeff Ullman, Jure Leskovec.

Reference Books:

1. Advances In Knowledge Discovery And Data Mining,: Usama M.Fayyad, Gregory Piatetsky Shapiro, Padhrai Smyth And Ramasamy Uthurusamy, The M.I.T Press, 1996.

2. The Data Warehouse Life Cycle Toolkit

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1284-2 **Course: Natural Language Processing**
L: 4 Hrs, T: 0 Hr, P: 0 Hr, Per Week **Total Credits: 4**

Course Outcomes:

On Successful completion of course, students will be able to:

1. Understand core NLP concepts and techniques.
2. Apply various POS tagging approaches and parsing techniques to analyze sentence structure and utilize probabilistic models for syntactic analysis.
3. Analyze various semantic and pragmatic analysis techniques and discourse phenomena to enhance text representation and understanding.
4. Implement N-Gram language models and Transformer-based models for effective language modeling and text generation.
5. Design and develop innovative NLP solutions to address real-world challenges across industries like finance, healthcare, e-commerce, education, and research.

Syllabus:

UNIT I

Introduction to NLP, Definition and Scope, A Brief History, Importance, Challenges, Tasks, Significance, NLP Pipeline and Applications, Morphological Analysis and Generation using Finite State Automata, Finite State Transducer, Hidden Markov model, Viterbi Algorithm, Applications of Tagging.

UNIT II

Lexical Analysis, Part-of-Speech (POS) Tagging, Approaches for POS Tagging, Rule-Based, Stochastic, Hybrid Approach, Taggers Evaluations, Tokenization with NLTK.

Syntax and Parsing, Types of Constituents in Sentences, Context-Free Grammar (CFG), CFG Parsing, Top-Down Parser, Bottom-Up Parser, Shallow Parsing and Chunking, Thematic Roles, Conditional Random Fields, Maximum Likelihood Estimation, Lexical and Probabilistic Parsing, Probabilistic Context Free Grammars, The Probability of a String, Inside-Outside Algorithm, CKY Parsing.

UNIT III

Semantic Analysis, Lexical Vs Compositional Semantic Analysis, Word Senses and Relations, Types of Lexical Semantics, Word Sense Disambiguation, WordNet and Online Thesauri, Word Similarity and Thesaurus Methods, Text Representation, Word Embedding, TF-IDF, Bag of Words, Word2Vec, *Skip-gram and* Continuous Bag of Words, FastText, Glove, BERT, Other Word Embedding Techniques.

Pragmatic Analysis and Discourse, Discourse Phenomena, Coherence and Coreference, Importance of Coreference Relations, Discourse Segmentation, Algorithms for Coreference Resolution.

UNIT IV

N-Gram Language Model, Language Modeling and Chain Rule, Markov Chain in N-Gram Model, Shannon's Method in N-Gram Model, Language Model Evaluation, Entropy, Perplexity, Smoothing Techniques, Extrinsic Evaluation Scheme, Zero Counts Problems, Smoothing Techniques, Laplace (Add-One) Smoothing, Add-k Smoothing, Backoff and Interpolation Smoothing, Good Turing Smoothing, The Transformer, Large Language Models, Masked Language Models, ROUGE, BLEU.

UNIT V

Major NLP Applications, Information Retrieval Systems, Social Network Analysis, Sentiment Analysis, Information Extraction, Named Entity Recognition, Text Classification, Text Summarization Systems, Machine Translation, Word Alignment, Content Recommendation System, Next-Word Prediction, Answering Questions with RAG, Chatbots and Dialogue Systems, Automatic Speech Recognition and Text-to-Speech, Language Detection, Applications in Finance, E-Commerce, Travel and Hospitality, Marketing, Insurance, Healthcare, Law, Supply Chain, Telecommunication, Education and Research.

Text Books

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models, Third Edition, 2025, https://web.stanford.edu/~jurafsky/slp3.
2. Raymond ST. Lee, Natural Language Processing: A Textbook with Python Implementation, Springer Nature Singapore Pte Ltd. 2024, ISBN 978-981-99-1998-7.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, and Harshit Surana, Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems, O'Reilly Media, Inc., United States of America, First edition, June 2020, ISBN 978-1-492-05405-4.
4. Dipanjan Sarkar, Text Analytics with Python: A Practitioner's Guide to Natural Language Processing, Second Edition, Apress Media, LLC, California, 2019, ISBN 978-1-4842-4353-4.

Reference Books

1. Natural Language Processing with Python: From Basics to Advanced Projects, Second Edition, 2024, Cuantum Technologies LLC. Plano, ISBN: 979-8-89496-848-3.
2. Jyotika Singh, Natural Language Processing in the Real World: Text Processing, Analytics, and Classification, First edition, 2023, CRC Press is an imprint of Taylor & Francis Group, LLC, ISBN: 978-1-003-26477-4.
3. Gerhard Paaß and Sven Giesselbach, Foundation Models for Natural Language Processing: Pre-trained Language Models Integrating Media, Artificial Intelligence: Foundations, Theory, and Algorithms, Springer Nature Switzerland Pte Ltd. 2022, ISBN 978-3-031-23189-6.
4. Lewis Tunstall, Leandro von Werra, and Thomas Wolf, Natural Language Processing with Transformers: Building Language Applications with Hugging Face, O'Reilly Media, Inc., United States of America, Revised First edition, May 2022, ISBN 978-1-098-13679-6.

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1284-3 **Course: Social Network Analysis**
L: 4 Hrs, T: 0 Hr, P: 0 Hr, Per Week **Total Credits: 4**

Course Outcomes:

On completion of the course the student will be able to

1. Analyze network data and complex graphs structures.
2. Apply the basics of social network analysis at various levels.
3. Model various interactions between individuals and actors.
4. Preprocess network data for meaningful insights into the OSNs.

SYLLABUS

UNIT – I: Networks and Society

Network preliminaries; Social Networks: Introduction and Applications; Overview of Social Network Analysis; Social Media Content and Levels of Network Analysis.

Networks and Graphs: Types of Networks; Representation of Networks; Network Properties.

UNIT – II: Network Measures

Node Centrality: Degree, Closeness, Betweenness, Edge Betweenness, Katz, Eigen Vector Centrality; Edge and Flow Betweenness; PageRank; Hub and Authority.

Associativity, Transitivity and Reciprocity; Similarity: Structural and Regular Equivalence; Degeneracy: k-Core, Coreness, Core Periphery.

UNIT – III: Network Growth Models

Properties of Real World Networks: Small World Property, Scale Free Property; Random Network Model; Ring Lattice Network Model; Preferential Attachment Model; Price's Model; Six Degrees of Separation.

UNIT – IV: Link Analysis and Network Cohesion

Applications of Link Analysis; Signed Networks: Triadic Balance, Balance and Status Theory; Strong and Weak Ties; Link Analysis and PageRank.

Network Cohesion: Density, Homophily; Bridges, Krackhardt's Graph Theoretical Dimensions of Hierarchy, Positions and Roles.

Link Predictions and Community Detection

Application of Link Prediction; Link Prediction Methods and Metrics; Evaluating Link Prediction Methods; Heuristic Models; Probabilistic Models.

Types of Communities; Community Detection Methods: Disjoint Community Detection, Overlapping Community Detection, Local Community Detection; Community Detection versus Community Search; Community Evaluation.

UNIT – V: Ego Networks and Information Diffusion

Ego Network – Overview and Characteristics; Ego Network Measures: Structural Holes, Density, Brokerage.

Information Diffusion Overview; Explicit Networks: Herd Behavior, Information Cascades; Implicit Networks: Epidemical Models, Diffusion of Innovation.

Text Books:

1. Tanmoy Chakraborty; Social Network Analysis; First Edition; Wiley India; 2021.
2. Niyati Aggarwal and Adarsh Anand; Social Networks: Modeling and Analysis; CRC Press; 2022.

References:

1. David Easley and Jon Kleinberg; Networks, Crowds, and Markets: Reasoning about a Highly Connected World; Cambridge University Press; 2001.
2. Stanley Wasserman and Katherine Faust; Social Network Analysis: Methods and Applications; Cambridge University Press; 1994.
3. John Scott; Social Network Analysis; Fourth Edition; Sage Publication; 2017.
4. Mohd. Gouse Galety, et. al.; Social Network Analysis: Theory and Applications; Wiley Global; 2022.

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50TH1284-4 **Course: Business and Web Analytics**
L: 4 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 4**

Course Outcomes:
On Successful completion of course, students will be able to:

1. Apply the fundamentals of Business analytics to address real-world business challenges, and optimize decision-making.
2. Perform data-driven decision-making using Statistical and Predictive Analytics.
3. Analyze web and digital marketing metrics through web analytics techniques.
4. Utilize web analytics tools to collect and interpret data.

Syllabus:
Unit I: Introduction to Business Analytics- Overview of Business Analytics: Types (Descriptive, Predictive, Prescriptive), quantitative analysis in business, Benefits of Data Analytics, Descriptive statistics - graphical approaches, measures of central tendency, measures of dispersion (Range, Quartiles, Outliers, and Boxplots, Variance and Standard Deviation), Practice with python.

Unit II: Statistical and Predictive Analytics- Probability Distributions: Bernoulli Distribution, Gaussian Distribution, Poisson Distribution. Predictive Modeling Techniques: Decision Trees, Random Forest, Gradient Boosting. Correlation -Coefficient of correlation, Rank correlation, Coefficient of multiple Correlation, multiple regression.

Unit III: Web Analytics and Digital Marketing Analytics- Introduction to Web Analytics- Clickstream Analysis, User Behavior Analysis, Link Analysis - Page Rank, Modified page rank, Search Engine Optimization using page rank. Search Analytics—Internal Search, SEO, and PPC Performing Internal Site Search Analytics, Beginning Search Engine Optimization, Measuring SEO Efforts, Analyzing Pay per Click Effectiveness.

Unit IV: Analytics strategies and Testing- Segmentation, measuring macro and micro conversions, measuring success on non-economic website, User Behaviour Analysis - Analyzing user behaviour through pageviews, sessions, and bounce rates, Heatmaps and session recordings for user interaction analysis, Identifying user engagement patterns, Advanced Web Analytics, Multichannel attribution and marketing ROI. Testing- A/B testing, Multivariate testing, Search and keyword analysis

Unit V: Web Metrics and web analytics tools- Setting up and configuring web analytics accounts, implementing tracking codes and goals, Web Traffic Analytics, Analysing website traffic sources (organic, direct, referral, paid), Web Metrics- Visits and visitors, Time on page, time on site,Bounce Rate, exit rate, conversion rate, Stratergic elements related to web metric – diagnosing root cause, leveraging customer reports, leveraging customer reports, macro view of site's performance.
Sample Tools: Google Analytics, Adobe Analytics, MyMetrix, PlanMetrix, AdMetrix

Text Books

1. Business Analytics: The Science of Data-Driven Decision Making by U. Dinesh Kumar
2. Introduction to Probability & Statistics by William Mendenhall, Robert J. Beaver, Barbara M. Beaver
3. Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, by Avinash Kaushik: A comprehensive guide to web analytics concepts and practices, Wiley Publising, Ind. 1st ed.
4. Clifon B., Advanced web metrics with google Analytics, Wiley Publising, Ind. 2nd ed.

Reference Books

1. Web Analytics: An Hour a Day by Avinash Kaushik ,2007, Publisher(s): Sybex, ISBN: 9780470130650
2. Actionable Web Analytics: Using Data To Make Smart Business Decisions by Jason Burby and Shane Atchison,2007, Publisher(s): Sybex
3. Probability and Statistics by Morris H. DeGroot and Mark J. Schervish.
4. Data Science for Business, by Foster Provost, Tom Fawcett

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50PR1286 **Course: Software Lab – II**
L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Weeks **Total Credits: 1**

Course Prerequisite:
Basic knowledge of computer programming and common programming concepts.

Course Outcomes:
After successful completion of this lab course, the student will be able to:
1. Understand the philosophy and licensing of open-source software and apply this knowledge in research and development.
2. Utilize open-source programming tools for implementing algorithms and conducting experiments, scientific writing.
3. Analyze and visualize research data using open-source data analysis tools.
4. Evaluate open-source alternatives for software commonly used in proprietary research environments.

Syllabus:

Module 1: Introduction to Open Source Ecosystem
- Open source vs proprietary software
- Licenses: GPL, MIT, Apache, Creative Commons
- Finding and contributing to open-source projects

Module 2: Scientific Computing Tools
- Python for research computing (NumPy, SciPy, Pandas)
- R for statistical computing and visualization
- Jupyter Notebooks for research documentation

Module 3: Document Preparation and Publishing
- LaTeX for writing technical papers and theses
- Bibliography management with BibTeX/Zotero
- Open-source reference managers (JabRef, Mendeley)

Module 4: Version Control and Collaboration
- Git and GitHub for version control and collaboration
- Markdown and README files for research projects

Module 5: Data Visualization and Analysis
- Matplotlib, Seaborn, Plotly (Python)
- ggplot2, Shiny (R)
- OpenRefine for data cleaning

Text Books
1. Unix Concepts and Applications by Sumitabha Das, Tata McGraw Hill Education,2006
2. The official Ubuntu Book, 8 th Edition

Syllabus for Semester II, M. Tech - Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: 26CS50PR1287 **Course: Mini Project and Seminar**
L: 0 Hrs, T: 0 Hr, P: 6 Hrs, Per Weeks **Total Credits: 3**

Course Objectives
The objective of Mini project is to let the students map and utilize the technical knowledge acquired in the previous semesters to solve a real-world problem through team effort.

Course Outcomes:
On successful completion of the course, students will be able to:
1. Identify and finalize the problem statement by investigating various domains and society needs.
2. Perform requirement analysis and design methodology for solving the identified problem.
3. Apply programming techniques and modern tools for the development of the solution.
4. Apply ethical principles, project management skills and demonstrate the ability to work in teams for project development within the confines of a deadline.
5. Communicate technical information employing written reports and presentations.