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Shri Ramdeobaba College of
Engineering and Management, Nagpur

**SHRI RAMDEOBABA COLLEGE OF
ENGINEERING AND MANAGEMENT,
NAGPUR – 440013**

**An Autonomous College affiliated to Rashtrasant Tukadoji
Maharaj Nagpur University, Nagpur, Maharashtra (INDIA)**

**PROGRAMME SCHEME & SYLLABI
2023-24**

**B. TECH. (CSE)
ARTIFICIAL INTELLIGENCE AND
MACHINE LEARNING**

B. Tech. Computer Science and Engineering (Artificial Intelligence and Machine Learning) [2023-24]
Teaching & Evaluation Scheme and Syllabus [B. Tech CSE-AIML]

Semester – I

S. N.	Category	Course Code	Course Name	Hours/ week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuo us Evaluatio n	End Sem Exam	Total	
1.	BSC	CHT1001	Chemistry of Smart Materials	2	0	0	2	50	50	100	2
2.	BSC	CHP1001	Chemistry of Smart Materials Lab	0	0	2	1	50	-	50	-
3.	BSC	MAT1002	Calculus	3	0	0	3	50	50	100	3
4.	ESC	CAT1001	Digital Electronics	3	0	0	3	50	50	100	3
5.	ESC	CAP1001	Digital Electronics Lab	0	0	2	1	50	-	50	-
6.	ESC	CAT1002	Programming for Problem Solving	3	0	0	3	50	50	100	3
7.	ESC	CAP1002	Programming for Problem Solving Lab	0	0	2	1	50	-	50	-
8.	VSEC	CAT1003	Computer Workshop – I	1	0	0	1	50	-	50	-
9.	VSEC	CAP1003	Computer Workshop – I Lab	0	0	2	1	50	-	50	-
10.	HSSM-IKS	HUT1001	Foundational Literature of Indian Civilization	2	0	0	2	50	50	100	2
11.	CCA	PET1001	Sports-Yoga- Recreation	1	0	0	1	50	-	50	-
12.	CCA	PEP1001	Sports-Yoga- Recreation	0	0	2	1	50	-	50	-
			TOTAL	15	0	10	20			850	-

Semester – II

Sr. No.	Category	Course Code	Course Name	Hours/ week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	BSC	PHT2001	Introduction to Quantum Computing	2	1	0	3	50	50	100	3
2.	BSC	PHP2001	Quantum Computing Lab	0	0	2	1	50	-	50	-
3.	BSC	MAT2002	Discrete Mathematics	3	0	0	3	50	50	100	3
4.	BSC	MAP2001	Computational Mathematics Lab	0	0	2	1	50	-	50	-
5.	BSC	CHT2007	Bioinformatics	2	0	0	2	50	50	100	2
6.	ESC	CAT2001	Object Oriented Programming	3	0	0	3	50	50	100	3
7.	ESC	CAP2001	Object Oriented Programming Lab	0	0	2	1	50	-	50	-
8.	PCC	CAT2002	Computer Architecture	2	0	0	2	50	50	100	2

9.	VSEC	CAT2003	Computer Workshop - II	1	0	0	1	50	-	50	-
10.	VSEC	CAP2003	Computer Workshop – II Lab	0	0	2	1	50	-	50	-
11.	AEC	HUT2002	English for Professional Communication	2	0	0	2	50	50	100	2
12.	AEC	HUP2002	English for Professional Communication Lab	0	0	2	1	50	-	50	-
13.	CCA	HUP0001	Liberal/Performing Art	0	0	2	1	50	-	50	-
14.	VEC	HUT2004	Foundational Course in Universal Human Values	1	0	0	1	50	-	50	-
TOTAL				16	1	12	23			1000	-

Scheme for Liberal/Performing Arts basket

Sr. No.	Course Code	Course Name	Hours/ week	Credits	Maximum Marks
1.	HUP0001-1	Fundamentals of Indian Classical Dance: Bharatnatayam	2	1	50
2.	HUP0001-2	Fundamentals of Indian Classical Dance: Kathak	2	1	50
3.	HUP0001-3	Introduction to Digital Photography	2	1	50
4.	HUP0001-4	Introduction to Japanese Language and Culture	2	1	50
5.	HUP0001-5	Art of Theatre	2	1	50
6.	HUP0001-6	Introduction to French Language	2	1	50
7.	HUP0001-7	Introduction to Spanish Language	2	1	50
8.	HUP0001-8	Art of Painting	2	1	50
9.	HUP0001-9	Art of Drawing	2	1	50
10.	HUP0001-10	Nature camp	2	1	50
11.	PEP0001-21	Disaster Management Through Adventure Sports	2	1	50
12.	PEP0001-22	Self-Defense Essentials and Basics Knowledge of Defense Forces	2	1	50
13.	CHP0001-31	Art of Indian Traditional Cuisine	2	1	50
14.	CHP0001-32	Introduction to Remedies by Ayurveda	2	1	50

Exit option: Award of UG Certificate in Major with 43 credits and an additional 8 credits.

Exit Courses			
1.	Web Designer	Online/offline certification Course	8
2.	IT Support Engineer		8
3.	Certified Programmer (language learned in Sem-1 and/or Sem-2 [C,C++,Java, Python])		8

Semester – III

Sr. No.	Category	Course Code	Course Name	Hours/ week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1	PCC	CAT3001	Data Structures	3	1	0	4	50	50	100	3
2	PCC	CAP3001	Data Structures Lab	0	0	2	1	50	-	50	-
3	PCC	CAT3002	Operating Systems	3	0	0	3	50	50	100	3
4	PCC	CAP3002	Operating Systems Lab	0	0	2	1	50	-	50	-
5	VSEC	CAP3003	Software Lab-I	0	0	4	2	50	-	50	-
6	MDM	MAT3002	Probability and Statistics	3	0	0	3	50	50	100	3
7	OE	Open Elective	Open Elective I	2	0	0	2	50	50	100	2
8	EEM	CAP3004	Idea Lab	0	0	4	2	50	-	50	-
9	VEC	CAT3005	Cyber Law and Ethics	2	0	0	2	50	50	100	2
10	AEC	HUT3001	Business Communication	2	0	0	2	50	50	100	2
			TOTAL	15	1	12	22			800	-

Semester – IV

Sr. No.	Category	Course Code	Course Name	Hours/ week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1	PCC	CAT4001	Artificial Intelligence	3	0	0	3	50	50	100	3
2	PCC	CAP4001	Artificial Intelligence Lab	0	0	2	1	50	-	50	-
3	PCC	CAT4002	Design and Analysis of Algorithms	3	0	0	3	50	50	100	3
4	PCC	CAT4003	Theory of Computation	3	0	0	3	50	50	100	3
5	MDM	MAT4001	Linear Algebra	3	0	0	3	50	50	100	3
6	OE	Open Elective	Open Elective II	3	0	0	3	50	50	100	3
7	VSEC	CAP4004	Software Lab-II	0	0	2	1	50	-	50	-
8	VSEC	CAP4005	Software Lab-III	0	0	2	1	50	-	50	-
9	CEP	CAP4006	Community Engagement Project	0	0	4	2	50	-	50	-
10	VEC	HUT4002	Environment Education	2	0	0	2	50	50	100	2
11	EEM	HUT4003	Managerial Economics	2	0	0	2	50	50	100	2
			TOTAL	19	0	10	24			900	-

Exit option : Award of UG Diploma in Major with 90 credits and an additional 8 credits

Exit Courses			
1	Application Development (Android)	Online/offline certification Course	8
2	Certified software Engineer (Devop)		8

Semester – V

Sr. No.	Category	Course Code	Course Name	Hours/week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	PCC	CAT5001	Machine Learning	3	0	0	3	50	50	100	3
2.	PCC	CAP5001	Machine Learning Lab	0	0	2	1	50	-	50	-
3.	PCC	CAT5002	Computer Networks	3	0	0	3	50	50	100	3
4.	PCC	CAP5002	Computer Networks Lab	0	0	2	1	50	-	50	-
5.	PCC	CAT5003	Database Management Systems	3	0	0	3	50	50	100	3
6.	PCC	CAP5003	Database Management Systems Lab	0	0	2	1	50	-	50	-
7.	PEC	CAT5004	Program Elective-1	3	0	0	3	50	50	100	3
8.	PCC	CAT5005	Microcontroller Design	3	0	0	3	50	50	100	3
9.	PCC	CAP5005	Microcontroller Design Lab	0	0	2	1	50	-	50	-
10.	OE	Open Elective	Open Elective III	3	0	0	3	50	50	100	3
TOTAL				18	0	8	22			800	-

Semester – VI

Sr. No.	Category	Course Code	Course Name	Hours/week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	PCC	CAT6001	Deep Learning-I	3	0	0	3	50	50	100	3
2.	PCC	CAP6001	Deep Learning-I Lab	0	0	2	1	50	-	50	-
3.	PCC	CAT6002	Computer Vision	3	0	0	3	50	50	100	3
4.	PCC	CAP6002	Computer Vision Lab	0	0	2	1	50	-	50	-
5.	PEC	CAT6003	Program Elective-2	3	0	0	3	50	50	100	3
6.	PEC	CAP6003	Program Elective-2 Lab	0	0	2	1	50	-	50	-
7.	PEC	CAT6004	Program Elective-3	3	0	0	3	50	50	100	3
8.	PEC	CAP6004	Program Elective-3 Lab	0	0	2	1	50	-	50	-
9.	PCC	CAT6005	Internet of Things	2	0	0	2	50	50	100	2
10.	PRJ	CAP6006	Mini Project	0	0	4	2	25	25	50	-
TOTAL				14	0	12	20			750	

Exit option : Award of UG Degree in Major with 131 credits and an additional 8 credits				
Exit Courses				
1	Certified Network Engineer (CCNA,CISCO)		Online/offline certification Course	8
2	Certified Database Engineer (Oracle, DB2)			8
3	Certified Cloud Engineer (AWS, AZURE)			8
4	Certified AIML Engineer			8
5	Certified Data Science Engineer			8

List of Open Electives		
Sr. No.	Subject Code	Name of Subject
Open Elective-I	CAT2980	Statistical Computing with R
Open Elective-II	CAT2990	Fundamentals of Machine Learning
Open Elective-III	CAT3980	Big Data Analytics

Semester – VII

Sr. No.	Category	Course Code	Course Name	Hours/week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	PCC	CAT7001	Deep Learning-II	3	0	0	3	50	50	100	3
2.	PCC	CAP7001	Deep Learning-II Lab	0	0	2	1	50	-	50	-
3.	PCC	CAT7002	Cloud Computing	3	0	0	3	50	50	100	3
4.	PCC	CAP7002	Cloud Computing Lab	0	0	2	1	50	-	50	-
5.	PCC	CAT7003	Data Analytics & Visualization	1	0	0	1	50	-	50	-
6.	PCC	CAP7003	Data Analytics & Visualization Lab	0	0	2	1	50	-	50	-
7.	PEC	CAT7004	Program Elective-4	3	0	0	3	50	50	100	3
8.	PCC	CAT7005	Robotics and Intelligent Systems	2	0	0	2	50	50	100	2
9.	PRJ	CAP7006	Major Project-1	0	0	8	4	50	50	100	-
TOTAL				12	0	14	19			700	-

Semester – VIII

Sr. No.	Category	Course Code	Course Name	Hours/week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	PEC	CAT8001	Program Elective-5	3	0	0	3	50	50	100	3
2.	PEC	CAT8002	Program Elective-6	3	0	0	3	50	50	100	3
3.	PRJ	CAP8003	Major Project-2	0	0	12	6	50	50	100	-
OR											
1.	Internship	CAP8006	Industry / TBI / Research Internship	0	0	24	12	200	100	300	-
TOTAL							12			300	

Electives Basket

Elective-I	Elective-II	Elective-III	Elective-IV	Elective-V	Elective-VI
Software Engineering	Natural Language Processing	Customer Relationship Management	Big Data Analytics	Human Computer Interaction	Financial Analysis
Design Pattern	Data Mining and Warehousing	Software Testing	Reinforcement Learning	Generative Adversarial Network	Time Series Analysis
Robotic Process Automation	Compiler Design	Blockchain Technology	System Design	Information Retrieval	Edge Computing

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

Course Code: CAT3001

L: 3 Hrs, T: 1 Hr, P: 0 Hrs, Per Week

Course: Data Structures

Total Credits: 4

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. Implement different sorting, searching, and hashing methods and analyze their time and space requirements.
4. Analyse non-linear data structures to develop solutions for real-world applications.

Syllabus:

UNIT I: Data Structures and Algorithms Basics

Introduction: Basic terminologies, elementary data organizations, data structure operations; abstract data types (ADT) and their characteristics.

Algorithms: Definition, characteristics, analysis of an algorithm, asymptotic notations, time and space trade-offs.

Array ADT: Definition, operations and representations – row-major and column-major.

UNIT II: Sorting, Searching and Hashing

Sorting: Different approaches to sorting, properties of different sorting algorithms (insertion, Shell, quick, merge, heap, counting), performance analysis and comparison.

Searching: Necessity of a robust search mechanism, searching linear lists (linear search, binary search) and complexity analysis of search methods.

Hashing: Hash functions and hash tables, closed and open hashing, randomization methods (division method, mid-square method, folding), collision resolution techniques.

UNIT III: Stacks and Queues

Stack ADT: Allowable operations, algorithms and their complexity analysis, applications of stacks—expression conversion and evaluation (algorithmic analysis), multiple stacks.

Queue ADT: Allowable operations, algorithms and their complexity analysis for simple queue and circular queue, introduction to double-ended queues and priority queues.

UNIT IV: Linked Lists

Singly Linked Lists: Representation in memory, algorithms of several operations: traversing, searching, insertion, deletion, reversal, ordering, etc.

Doubly and Circular Linked Lists: Operations and algorithmic analysis.

Linked representation of stacks and queues.

UNIT V: Trees and Graphs

Trees: Basic tree terminologies, binary tree and operations, binary search tree (BST) and operations with time analysis of algorithms, threaded binary trees.

Self-balancing Search Trees: Tree rotations, AVL tree and operations,

Graphs: Basic terminologies, representation of graphs, traversals (DFS, BFS) with complexity analysis, path finding (Dijkstra's SSSP, Floyd's APSP), and spanning tree (Prim's and Kruskal's algorithms).

Text Books

1. G.A.V. Pai, Data Structures and Algorithms: Concepts, Techniques and Application, First Edition, McGraw Hill, 2017.
2. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Third Edition, Pearson Education, 2007.
4. Thomas H Cormen, Algorithms Unlocked, MIT Press, 2013

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.

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

Course Code: CAP3001

Course: 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. Implement different sorting, searching, and hashing methods and analyze their time and space requirements.
4. Analyse non-linear data structures to develop solutions for real-world applications.

Syllabus:

Experiments based on **CAT3001** Syllabus in C, C++, Java.

Few lab sessions shall be conducted using virtual lab platforms to enhance learning experiences and accessibility.

Text Books

1. G.A.V. Pai, Data Structures and Algorithms: Concepts, Techniques and Application, First Edition, McGraw Hill, 2017.
2. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Third Edition, Pearson Education, 2007.
4. Thomas H Cormen, Algorithms Unlocked, MIT Press, 2013

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.

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

Course Code: CAT3002

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Course: Operating Systems

Total Credits: 3

Course Prerequisite

Basic knowledge of the Computer Architecture

Course Outcomes:

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

1. Demonstrate LINUX system calls and implement system commands.
2. Implement processes and process schedulers.
3. Design and implement solution to handle synchronization and deadlock
4. Implement Memory management and File management solutions.

Syllabus:

UNIT I: Introduction: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine.

File Management: File System structure, Allocation methods, Free-space management, and case study on File Systems in LINUX operating System.

Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK,

UNIT II: Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching. Threads: Definition, Various states, Benefits of threads, Types of threads, Concept of multi threads. Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non-pre-emptive, FCFS, SRTF, Priority, RR, Case study on Process Management in LINUX Operating System.

UNIT III: Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Peterson's solution, Hardware Solution, Semaphores, Monitors, Message Passing, Classical IPC Problems: Producer- Consumer Problem, Reader-Writer Problem, Dining Philosopher Problem etc.

UNIT IV: Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock Detection and Recovery.

UNIT V: Memory Management: Basic concept, Logical and Physical address mapping, Memory allocation: Contiguous Memory allocation – Fixed and variable partition, Internal and External fragmentation and Compaction, Paging: Principle of operation – Page allocation, Hardware support for paging, Protection and sharing, Advantages and Disadvantages of paging. Virtual Memory: Basics of Virtual Memory, Hardware and control structures, Locality of reference, Page fault, Dirty page/ Dirty bit, Demand paging; Page Replacement, algorithms: First in First Out (FIFO), Least Recently used (LRU), and Optimal.

Text Books

1. Operating System Concepts, 8th Edition by A. Silberschatz, P. Galvin, G. Gagne, Wiley India.
2. Modern Operating Systems, 2nd Edition by Andrew Tanenbaum, PHI.

Reference Books:

1. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
2. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly

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

Course Code: CAP3002

Course: Operating System Lab

L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week

Total Credits: 1

Course Outcomes

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

1. Demonstrate LINUX system calls and implement system commands.
2. Implement processes and process schedulers.
3. Design and implement solution to handle synchronization and deadlock
4. Implement Memory management and File management solutions.

Syllabus:

Experiments based on **CAT3002** Syllabus in C/C++/Java, etc.

Text Books

1. Operating System Concepts, 8th Edition by A. Silberschatz, P. Galvin, G. Gagne, Wiley India.
2. Modern Operating Systems, 2nd Edition by Andrew Tanenbaum, PHI. Reference Books:
 1. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
 2. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly

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

Course Code: CAP3003

L: 0 Hrs, T: 0 Hr, P: 4 Hrs, Per Week

Course: Software Lab - I

Total Credits: 2

Course Outcomes

On successful completion, of course student will able to:

1. Use Python libraries for data manipulation, visualization, and statistical analysis.
2. Create and manage virtual machines using VMWare and VirtualBox.
3. Write shell scripts using TCL for automating tasks and creating user interfaces.
4. Design and simulate VHDL models using Modelsim.

Syllabus:

Python Basic Libraries

- **NumPy:** A library for scientific computing with Python. It provides a high- performance multidimensional array object, and tools for working with these arrays.
- **Pandas:** A library for data analysis and manipulation. It provides data structures and operations for manipulating numerical tables and time series.
- **Seaborn:** A library for data visualization. It provides a high-level interface for drawing statistical graphics.
- **Matplotlib:** A library for creating static, animated, and interactive visualizations in Python.
- **Scipy:** A library for scientific computing with Python. It provides modules for optimization, linear algebra, statistics, and signal processing.
- **EDA:** A library for exploratory data analysis. It provides tools for visualizing and summarizing data.
- **Virtual Machine**
- **VMWare:** A software for creating and running virtual machines. It allows you to run multiple operating systems on a single computer.
- **VirtualBox:** A software for creating and running virtual machines. It is free and open-source.
- **Jira:** A software for project management and issue tracking. It is used to plan, track, and release software.
- **Shell Scripting (TCL)**
- **TCL:** A scripting language for Unix-like operating systems. It is used for automating tasks and creating user interfaces.
- **VHDL**
- **VHDL:** A hardware description language used to describe the behavior of electronic circuits. It is used in the design and verification of integrated circuits.
- **Modelsim**
- **Modelsim:** A software for simulating VHDL designs. It allows you to verify the behavior of electronic circuits before they are manufactured.

Text/Reference Books

1. "Python Data Science Handbook" by Jake VanderPlas
2. "The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
3. "Data Visualization with Seaborn" by Michael Waskom
4. "VHDL: A Tutorial and Practical Guide" by William J. Dally and John W. Poulton
5. "ModelSim User's Guide" by Mentor Graphics Corporation
6. "TCL Programming for System Administration" by Brent B. Welch

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

Course Code: MAT3002
L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Course: Probability and Statistics
Total Credits: 3

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 (H_0) and alternative hypothesis (H_1), 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)

Probability spaces, conditional probability, independence; Discrete random variables, Binomial distribution, Poisson distribution, Normal distribution. Relation between binomial, Poisson and Normal distributions.

Module 2: (8 Lectures)

Joint probability function, Introduction to stochastic process, random walk, stationary and autoregressive process, transition probability Matrix, Discrete time Markov chain.

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.

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. Spiegel, 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 III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

Course Code: CAP3004

Course: Idea Lab

L: 0 Hrs, T: 0 Hr, P: 4 Hrs, Per Week

Total Credits: 2

Course Outcomes

On successful completion, of course student will able to:

1. Identify problems across various domains and effectively frame them that facilitates creative solution generation.
2. Understand business models, pricing strategies, and ethical considerations in innovations.
3. Apply for patents/copyrights under IPR activities.
4. Design prototypes or proof-of-concepts to test and validate their ideas.
5. Enhance their presentation and communication skills as they pitch ideas, articulate concepts, and engage with stakeholders.

Syllabus:

1. Introduction of idea generation techniques and methodologies based on case studies of successful innovations.
2. Conducting market research, such as surveys, interviews, focus groups, and observational studies.
3. Brainstorming exercises and group discussions on problem framing and the solutions.
4. Hands-on activities for developing prototypes and refining ideas through user feedback.
5. Technical report writing and research proposals that match technology readiness levels (TRLs).
6. Practice sessions for pitching ideas and receiving constructive feedback.
7. Discussion on concepts such as business models, value proposition, pricing strategies and ethical implications for scalable innovations.

Text Books

1. Jacob Goldenberg and David Mazursky, Creativity in Product Innovation, Cambridge University Press, 2022.
2. Jessica Livingston, Founders at Work: Stories of Startups' Early Days", Fourth Edition, Apress, 2008.
3. Bill McGowan, Pitch Perfect: How to Say It Right the First Time, Every Time, Reprint Edition, Harper Business, 2016.

Reference Books

1. Bjarki Hallgrímsson, Prototyping and Modelmaking for Product Design, Laurence King Publishing Ltd, 2012.
2. David Bornstein and Susan Davis, Social Entrepreneurship: What Everyone Needs to Know, Oxford University Press, 2010.

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

Course Code: CAT3005

L: 2 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Course: Cyber Law and Ethics

Total Credits: 2

Prerequisites: Basic Knowledge of Internet

Course Outcomes

On successful completion, of course student will able to learn:

1. Analyse the role of ethics in IT organization.
2. Identify various cyber laws with respect to legal dilemmas in the Information Technology field.
3. Interpret various intellectual property rights, Privacy, Protection issues in Information Technology field.
4. Describe the ways of precaution and prevention of Cyber Crime as well as Human Rights.

Syllabus:

UNIT I: Ethics in business world & IT professional malpractices, Introduction to firewalls, IDS System, Distortion and fabrication of information

UNIT II: Ethics of IT Organization: Contingent Workers H- IB Workers, Whistle- blowing, Protection for Whistle- Blowers, Handling Whistle- blowing situation, Digital divide.

UNIT III: Intellectual Property: Copyrights, Patents, Trade Secret Laws, Key Intellectual property issues, Plagiarism, Privacy: The right of Privacy, Protection, Key Privacy and K-Anonymity issues, Identity Theft, Consumer Profiling,

UNIT IV: Cyber laws and rights in today's digital age, Emergence of Cyberspace, Cyber Jurisprudence, Cyber Crimes against Individuals, Institution and State, Hacking, Digital Forgery, Cyber Stalking/Harassment, Cyber terrorism, cyber tort, Cyber Defamation & hate speech, Competitive Intelligence, Cybersquatting, The Indian information technology act 2000 IT Act.

Text Books:

1. George Reynolds, "Ethics in information Technology", 5th edition, Cengage Learning
2. Hon C Graff, Cryptography and E-Commerce - A Wiley Tech Brief, Wiley Computer Publisher, 2001.

Reference Books:

1. Michael Cross, Norris L Johnson, Tony Piltzecker, Security, Shroff Publishers and Distributors Ltd.
2. Debora Johnson, "Computer Ethic s", 3/e Pearson Education.
3. Sara Baase, "A Gift of Fire: Social, Legal and Ethical Issues, for Computing and the Internet," PHI Publications.
4. Chris Reed & John Angel, Computer Law, OUP, New York, (2007).
5. Dr Pramod Kr. Singh, "Laws on Cyber Crimes [Along with IT Act and Relevant Rules]" Book Enclave Jaipur India.

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

Course Code: HUT3001
L: 2 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Course: Business Communication
Total Credits: 2

Course Objective

The course aims to develop the skills of students to proficiently craft compelling business documents and employ strategic verbal communication techniques. By honing these skills, students will gain the ability to convey ideas persuasively and interact confidently in diverse business contexts.

Course Outcomes

On successful completion of the course the students will be able to achieve the following: CO1: Understand the fundamentals of business communication.

CO2: Apply tools and techniques to create effective workplace correspondence. CO3: Analyse and apply visual design principles to create business documents. CO4: Understand and evaluate information to draft reports.

CO5: Apply and evaluate strategies for effective communication for employment.

Syllabus:

UNIT 1: Fundamentals of Business Communication

Definition of communication, Emergence of communication as a key concept in the Corporate and Global world, Types- Internet, Blogs, E-mails, social media, Channels- Formal and Informal: Vertical, Horizontal, Diagonal, Grapevine, Persuasive Communication- Negotiation Skills, PAC concept

UNIT 2: Business Correspondence

Planning, Writing, and Completing Business Messages

Personnel Correspondence: Job Application Letter, Letter of Acceptance of Job Offer, Letter of Resignation, Letter of Appointment, Promotion and Termination, Letter of Recommendation

Trade Correspondence: Inquiry, Order, Credit and Status Enquiry, Complaints, Claims, Adjustments, Consumer Grievance Letters

UNIT 3: Visual and Content Creation

Visual design principles, Ethics of visual communication, selecting visuals for presenting data, Content Creation: Website, Help file, User Guides, Promotional leaflets and fliers

UNIT 4: Reports

Basic formats and types of reports - Feasibility, Progress, Project, Case Study Evaluation, Agenda, Notices, Minutes of Meeting, Organizational announcements, Statement of Purpose.

UNIT 5: Communication for Employment

Pre-interview technique- NOISE Analysis, Job Description and Resume, Creating LinkedIn Profile, Effective use of job portals, Business etiquette.

Text Books

1. Sharon Gerson, Steven Gerson, “Technical Communication: Process and Product”, 2018, Pearson
2. Courtland L Bovee, John V Thill and Roshan Lal Raina “Business Communication Today”, 14th edition Pearson
3. P.D. Chaturvedi and Mukesh Chaturvedi, Fundamentals of Business Communication, Pearson Publications, 2012.

Reference Books

1. Shalini Verma, Business Communication, Vikas Publishing House Pvt. Ltd., 2015.
2. Sanjay Kumar, Pushpa Lata, Communication Skills, 2nd Edition, Oxford Publication, 2018
3. William Strunk Jr. and E.B. White, The Elements of Style, Allyn & Bacon, A Pearson Education Company, 2000

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

Course Code: CAT4001

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Course: Artificial Intelligence

Total Credits: 3

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 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.

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

Propositional logic, First Order Logic: Syntax and Semantics of FOL, Inference in FOL: Unification Algorithm, Resolution, Forward Chaining, Backward Chaining.

UNIT V: Uncertain Knowledge and Reasoning

Probability and Bayes' Theorem, Statistical reasoning: Bayesian networks, Bayes optimal classifier, Naïve bayes algorithm, Fuzzy Logic: properties and operations, Introduction to expert system.

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 IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

Course Code: CAP4001

L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week

Course: Artificial Intelligence Lab

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 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:

Experiments based on **CAT4001** 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 IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

Course Code: CAT4002

Course: Design and Analysis of Algorithms

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 3

Course Prerequisite

Basic knowledge of the algorithms and its complexity, computer programming and common programming concepts.

Course Outcomes

On successful completion, of course student will be able to:

1. Describe mathematical formulation, complexity analysis and methodologies to solve the recurrence relations for algorithms.
2. Design Greedy and Divide & Conquer algorithms and their usage in real life examples.
3. Apply the principles of dynamic programming for problem-solving and optimization.
4. Utilize the graph theory, traversal, search algorithms, and backtracking techniques in real life usages.
5. Understand the NP class problems and formulate solutions using standard approaches.

Syllabus:

UNIT I: Recurrence relations and their solutions, Principles of designing algorithms and complexity calculation, Asymptotic notations for analysis of algorithms, worst case and average case analysis, amortized analysis and its applications.

UNIT II: Divide and Conquer - basic strategy, Strassen's matrix multiplication, Maximum subarray problem, Closest pair of points problem.

Greedy method – basic strategy, fractional knapsack problem, Huffman Coding, activity selection problem, Find maximum sum possible equal to sum of three stacks.

UNIT III: Dynamic Programming -basic strategy, Bellman-Ford algorithm, all pairs shortest path, multistage graphs(backward), optimal binary search trees, traveling salesman problem, Longest Common Subsequence problem and its variations.

UNIT IV: Basic Traversal and Search Techniques, breadth first search and depth first search, connected components. Backtracking basic strategy, 8-Queens' problem, graph coloring, Hamiltonian cycles, sum of subset problem.

UNIT V: NP-hard and NP-complete problems, basic concepts, non-deterministic algorithms, NP-hard and NP complete, decision and optimization problems, polynomial reduction, graph based problems on NP Principle, vertex cover problem, clique cover problem.

Text Books:

1. Thomas H. Cormen et.al; "Introduction to Algorithms": 3 Edition, Prentice Hall, 2009.
2. Horowitz, Sahani and Rajasekaran; "Computer Algorithms", Silicon Press, 2008.
3. Brassard and Bratley; "Fundamentals of Algorithms", 1 Edition; Prentice Hall, 1995.
4. Richard Johnsonbaugh, "Algorithms", Pearson Publication, 2003.

Reference Books

1. Parag Himanshu Dave, Balchandra Dave, "Design and Analysis of Algorithms", Pearson Education, O'relly Publication.
2. Richard Johnson Baugh, "Algorithms", Pearson Publication, 2003.

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

Course Code: CAT4003

L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week

Course: Theory of Computation

Total Credits: 3

Course Prerequisite

Basic knowledge of the algorithms and its complexity, computer programming and common programming concepts.

Course Outcomes

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

1. Describe the formal relationships among machines, languages and grammars.
2. Design and Optimize finite automata for given regular languages.
3. Design context free grammar for a given language.
4. Design Pushdown Automata, Turing Machine for given languages.

SYLLABUS

UNIT-I: Basics of Theory of Computation, Basics of Sets and Relation, Countability and Diagonalization, Principle of mathematical induction, Pigeon- hole principle. Fundamentals of formal languages and grammars, Chomsky hierarchy of languages.

UNIT-II: Finite Automata, Deterministic finite automata (DFA), Nondeterministic finite automata (NFA) and equivalence with DFA, Minimization of finite automata, NFA with Epsilon Transitions, Finite Automata with output.

UNIT-III: Regular expressions and Regular languages, Regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, Context-free grammars (CFG) and language (CFL), parse trees, ambiguity in CFG, Reduction of CFGs, Chomsky and Greibach normal forms.

UNIT-IV: Push Down Automata, Deterministic pushdown automata and Non-Deterministic pushdown automata, Acceptance by two methods: Empty stack and Final State, Equivalence of PDA with CFG, closure properties of CFLs.

UNIT-V: Turing Machines, The basic model for Turing machines (TM), Turing recognizable (recursively enumerable) and Turing-decidable (recursive) languages, variants of Turing machines, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.

Text Books

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.

Reference Books

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia.
2. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
3. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
4. John Martin, Introduction to Languages and the Theory of Computation, Tata McGraw Hill

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

Course Code: MAT4001
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week

Course: Linear Algebra
Total Credits: 3

Course Pre-requisite: Basic knowledge of Matrices and MAT2002 (Discrete Mathematics)

Course Objective:

The objective of this course is to provide a foundational understanding and application of linear algebra concepts relevant to various aspects of computer science and related fields

Course Outcomes

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

1. Check the consistency of system of equations and able to solve systems of linear equations by using Gaussian elimination method.
2. Determine which set is a vector space and able to find the basic elements of vector space.
3. Understand the fundamental concepts of linear transformations including mappings, kernel, image, null space, rank, and linear independence.
4. Find the orthogonal basis elements from given basis elements.
5. To find eigen values, eigen vectors and singular value decomposition of matrix

Syllabus

Module 1

Row echelon form, Reduced row echelon form of Matrix, rank of matrix, system of Linear Equations.

Module 2:

Vector space, subspace, properties of subspaces, spanning set, Linearly independent and dependent vectors, Basis and dimensions of vector space.

Module 3:

Linear Transformation, range space and null space of Linear Transformation, Rank-Nullity Theorem, matrix representation of linear transformation.

Module 4:

Inner Product Spaces, Norm; Orthonormal Sets, Gram Schmidt orthogonalization process, projections, positive definite matrices, QR decomposition.

Module 5:

Eigen values and eigenvectors, diagonalization, spectral theorem of Matrix, Singular value decomposition, Least square method and introduction to PCA.

Text Books:

1. Hoffman and Kunze : Linear Algebra, Prentice Hall of India, New Delhi
2. Gilbert Strang : Linear Algebra And Its Applications (Paperback) , Nelson Engineering (2007)

Reference Books:

1. Seymour Lipschutz et al: Linear Algebra, 3rded: Schaum series.
2. V. Krishnamoorthy et al : An introduction to linear algebra , Affiliated East West Press, New Delhi P.G. Bhattacharya, S.K. Jain and S.R.

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

Course Code: CAP4004

Course: Software Lab - II

L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week

Total Credits: 1

Course Outcomes

On successful completion, of course student will able to:

1. Demonstrate proficiency in utilizing popular machine learning tools and libraries such as Scikit-learn, Keras, TensorFlow, and PyTorch
2. Apply natural language processing techniques using NLTK and Spacy libraries to process, analyze, and extract information from textual data
3. Develop skills in web scraping by utilizing tools like BeautifulSoup and Scrapy to extract relevant data from websites and understand the fundamentals
4. Gain hands-on experience in Internet of Things (IoT) development by working with Arduino, Raspberry Pi, and related tools

Syllabus:

1. Introduction to Machine Learning Tools
 - Overview of Scikit-learn library, Exploring various machine learning algorithms, Data preprocessing and feature engineering techniques
2. Deep Learning Frameworks
 - Introduction to Keras, TensorFlow, and PyTorch, Neural network architectures and training, Transfer learning and fine-tuning pre-trained models
3. Natural Language Processing (NLP) Libraries
 - a. Introduction to NLTK (Natural Language Toolkit), Text preprocessing and cleaning, Text classification and sentiment analysis using NLTK
4. Advanced NLP with Spacy
 - Overview of Spacy library for NLP tasks, Named Entity Recognition (NER), Dependency parsing and text processing
5. Web Scraping Techniques
 - Introduction to web scraping, Extracting data using BeautifulSoup library, Building web spiders with Scrapy
6. Data Visualization and Monitoring
 - Introduction to data visualization with Grafana, Monitoring and analyzing data using Grafana dashboards, Integrating data sources with Minikube
7. Internet of Things (IoT) Development
 - Introduction to Arduino and Raspberry Pi platforms, Building IoT applications using Python, Sensor integration and data acquisition
8. Project Work
 - Hands-on project to apply the learned concepts and tools
 - Students will work on a real-world problem using the acquired skills

Text/Reference Books

1. Scikit-learn: Machine Learning in Python. Pedregosa, F., et al. (2011). Journal of Machine Learning Research, 12, 2825-2830.
2. Deep Learning with Python. Chollet, F. (2017). Manning Publications.
3. Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit. Bird, S., et al. (2009). O'Reilly Media.
4. Web Scraping with Python: A Comprehensive Guide. Ryan Mitchell. (2018). O'Reilly Media.

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

Course Code: CAP4005

L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week

Course: Software Lab - III

Total Credits: 1

Course Outcomes

On successful completion, of course student will able to:

1. Master version control using Git/GitHub for effective collaboration and code management.
2. Containerize applications seamlessly using Docker and Portainer for efficient deployment and scalability.
3. Automate CI/CD pipelines proficiently with Jenkins to enhance software delivery and integration.
4. Develop web applications using Flask/Django and Docker Compose, alongside advanced FPGA development using Xilinx Vivado for comprehensive software engineering skills.

Syllabus: DevOps

- **Version Control (Git/GitHub):** Learn the basics of version control using Git and how to use GitHub for collaboration and code sharing.
- **Implementation of Flask application:** Learn how to create and deploy a simple web application using the Flask framework and Python.
- **Containerization (Docker, Portainer):** Understand the concept of containerization and how to use Docker to create and manage containers. Learn how to use Portainer to manage Docker containers.
- **Integration, Development, and Building (Jenkins):** Learn how to use Jenkins for continuous integration and continuous development. Understand how to build and test software projects using Jenkins.
- **Django, Docker Compose:** Learn how to create and deploy a more complex web application using the Django framework and Python. Learn how to use Docker Compose to manage multiple containers for a Django application.
- **FPGA, Xilinx, Vivado:** Learn the basics of FPGA (Field-Programmable Gate Array) technology and how to use Xilinx Vivado to design and implement digital circuits on FPGAs.

Text/Reference Books

1. "Version Control with Git" by Jon Loeliger
2. "Flask Web Development" by Miguel Grinberg
3. "Docker: Up and Running" by Scott Lowe
4. "Jenkins: The Definitive Guide" by John Ferguson Smart
5. "Django: The Complete Beginner's Guide" by William S. Vincent
6. "Vivado Design Suite User Guide" by Xilinx, Inc.

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

Course Code: CAP4006
L: 0 Hrs, T: 0 Hr, P: 4 Hrs, Per Week

Course: Community Engagement Project
Total Credits: 2

Course Outcomes

On successful completion, of course student will able to:

1. Gain an understanding of rural life, Indian culture & ethos and social realities
2. Develop a sense of empathy and bonds of mutuality with local community
3. Appreciate significant contributions of local communities to Indian society and economy
4. Learn to value the local knowledge and wisdom of the community
5. Identify opportunities for contributing to community's socioeconomic improvements

Syllabus:

Week 1-2: Appreciation of Rural Society: Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages" (Gandhi), rural infrastructure.

Week 3-4: Understanding rural and local economy & livelihood: Agriculture, farming, land ownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets, migrant labour.

Week 5-7: Rural and local Institutions: Traditional rural & community organisations, Self- help Groups, Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees), Nagarpalikas and municipalities, local civil society, local administration.

Week 8-10: Rural & National Development Programmes: History of various /development in India, current national programmes: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swachh Bharat, PM Awaas Yojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA, SHRAM, Jal Jeevan Mission, SFURTI, Atma Nirbhar Bharat, etc.

Teaching/ Learning Methodology

- Classroom discussions, Group discussions, Field visit, Group presentation, Written assignment
- Interaction with self-help groups women members, and study of their functions and challenges; planning for their skill building and livelihood activities
- Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan (GPDP)
- Participate in Gram Sabha meetings, and study community participation
- Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries
- Visit MGNREGS project sites, interact with beneficiaries and interview functionaries at the site
- Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures
- Visit Rural Schools / mid-day meal centres, study academic and infrastructural resources and gaps
- Visit local Anganwadi Centre and observe the services being provided
- Visit local NGOs, civil society organisations and interact with their staff and beneficiaries,
- Organize awareness programmes, health camps, Disability camps and cleanliness camps
- Organise orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers and promotion of traditional species of crops and plants
- Formation of committees for common property resource management, village pond maintenance and fishing

Online Reference Course

- https://onlinecourses.swayam2.ac.in/ugc23_ge04/preview

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

Course Code: HUT4002
L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week

Course: Environment Education
Total Credits: 2

Course Outcomes

On successful completion, of course student will able to do the following:

CO1: Understand and appreciate the historical context of human interactions with the environment.

CO2: Understand the concept of natural resources and their sustainable development CO3: Develop a critical understanding of the environmental issues of concern

CO4: Understand the concepts of ecosystems, biodiversity and conservation

CO5: Understand broad aspects of environmental management and assessment systems

Syllabus:

UNIT I: Humans and the Environment

Great ancient civilizations and the environment, Indic Knowledge and Culture of sustainability; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change; emergence of environmentalism

UNIT II: Natural Resources and Sustainable Development

Definition of resource; Classification of natural resources

Water resources; Soil and mineral resources; Energy resources; Sustainable Development Goals (SDGs)

UNIT III: Environmental Issues: Local, Regional and Global

Environmental issues and scales, Pollution, Land use and Land cover change, Global change, case studies/field visit

UNIT IV: Conservation of Biodiversity and Ecosystems

Biodiversity and its distribution – India and the world; Ecosystems and ecosystem services, Threats to biodiversity and ecosystems; Major conservation policies and practises, case studies/field visit

UNIT V: Environmental Management

Introduction to environmental laws and regulation, Concept of Circular Economy, Life cycle analysis; Cost-benefit analysis; Environmental audit and impact assessment; Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme, case studies/field visit.

Books

1. Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press.
2. Headrick, Daniel R. (2020) Humans versus Nature- A Global Environmental History, Oxford University Press.
3. Simmons, I. G. (2008). Global Environmental History: 10,000 BC to AD 2000. Edinburgh University Press

4. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications <https://sdgs.un.org/goals>
5. Harris, Frances (2012) Global Environmental Issues, 2nd Edition. Wiley- Blackwell.
6. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
7. Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK
8. Singh, Kartar and Anil Shishodia (2007) 'Environmental Economics: Theory and Applications', Sage,
9. Karpagam. M (2019) Environmental Economics: A textbook, Sterling
10. Jørgensen, Sven Marques, Erik João Carlos and Nielsen, Søren Nors (2016) Integrated Environmental Management, A transdisciplinary Approach. CRC Press.
11. Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2nd Edition. CRC Press.
12. Barrow, C. J. (1999). Environmental management: Principles and practice. Routledge.
13. Tiefenbacher, J (ed.) (2022), Environmental Management - Pollution, Habitat, Ecology, and Sustainability, Intech Open, London. 10.5772/
14. Richard A. Marcantonio, Marc Lame (2022). Environmental Management: Concepts and Practical Skills. Cambridge University Press.
15. N. Mani (2020) Environmental Economics, New NC Century
16. Subhashini Muthukrishnan (2015) Economics of Environment, PHI
17. Rabindra N. Bhattacharya (2001) Environmental Economics: An Indian Perspective, Oxford University press

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

Course Code: HUT4003

L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week

Course: Managerial Economics

Total Credits: 2

Course Outcomes

On successful completion, of course student will able to learn:

CO1: Gain basic knowledge of Economics to take managerial decisions.

CO2: Apply the knowledge of the mechanics of supply and demand to explain working of markets

CO3: To understand the concepts of production, cost, and revenue from a business perspective

CO4: To understand the various market types

CO5: Understand the concepts of macroeconomics for better understanding of the functioning of the economy for taking informed managerial decisions.

Syllabus:

UNIT 1: Introduction to Managerial Economics:

Nature & scope of Managerial Economics: Concepts of Managerial Economics.

Economic theory & Managerial theory. Role & responsibilities of Managerial Economists

UNIT 2: Micro Economics:

Demand Analysis: Individual & market, Law of demand. Elasticity of demand its meaning and importance. Price elasticity, Income elasticity & Cross elasticity Using elasticity in Managerial decisions

Supply Analysis: Supply and Stock, Law of supply, supply function, determinants and elasticity of supply, Equilibrium of Demand and Supply.

UNIT 3: Theory of Production, Costs, and Revenue:

Meaning of production, factors of production, laws of variable proportion, Economies and diseconomies of scale, Cost and Revenue concepts

UNIT 4: Market System:

Meaning of Market, Types of market - Perfect Competition Market, Monopoly and Monopolistic market, Oligopoly, Duopoly

Unit 5: Macroeconomics for Management

Concepts and Issues: Consumer Price Index, Wholesale Price Index, BOP, Current and Capital account, GDP, GNP, PI, Inflation, Business cycles, Monetary policy

Text Books:

1. Ahuja H.L., (2017) Managerial Economics, Analysis of managerial Decision making, S. Chand and company Limited, New Delhi, 9th ed.
2. Dwivedi D.N., (2015). Managerial Economics, Vikas publishing house Pvt. Ltd, Nodia, 8th ed.

Reference Books

1. Mankiw G., (2008) Principles of Economics (Kindle Edition) South Western Cengage Learning, Nodia 6th ed.
2. Salvatore, D., (2007) Managerial Economics. London: Oxford University Press, 6th ed.

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT5001

Course : Machine Learning

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To introduce the basic concepts and techniques of machine learning.
2. To understand major machine learning algorithms.
3. To identify machine learning techniques suitable for a given problem.

Syllabus

UNIT – I

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

UNIT - II

Instance-Based Learning: K-Nearest neighbor algorithm, Radial basis functions, Case-based learning. Computational Learning Theory: probably approximately correct (PAC) learning, Sample complexity, Computational complexity of training, Vapnik Chervonenkis dimension.

UNIT - III

Artificial Neural Networks: Linear threshold units, Perceptron, Multilayer networks and backpropagation, recurrent networks.

UNIT - IV

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

Bayesian Networks, Inference in Bayesian Networks.

UNIT - V

Expectation Maximization algorithm, preventing over fitting, Gaussian Mixture Models, K-means and Hierarchical Clustering.

Hidden Markov Models, Reinforcement Learning, Support Vector Machines, Ensemble learning: boosting, bagging.

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. Apply machine learning algorithms to solve classification, regression and clustering problems.
3. Analyse the strengths and weaknesses of various machine learning approaches.
4. Apply various machine learning models to efficiently solve real-world problems.

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 V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP5001

Course : Machine Learning Lab

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Total Credits: 01

Course Objectives

1. To implement basic machine learning algorithm for solving problem.
2. To understand the usage of datasets in implementing machine learning problems.
3. To learn various modern tools, packages and techniques for machine learning.

Technology: Python. Syllabus

1. To implement Find-S algorithm to find maximally specific hypothesis on given dataset.
2. To implement Candidate Elimination algorithm on Enjoy Sports dataset and find candidate hypothesis.
3. To implement linear regression algorithm on given dataset.
4. To implement decision tree classifier on given dataset and display generated tree.
5. To Implement KNN algorithm for classification and regression on given datasets.
6. To implement the perceptron algorithm for AND, OR and NOR Boolean functions.
7. To implement the backpropagation algorithm for machine learning using suitable dataset.
8. To implement the Naïve Bayes algorithm on given dataset.
9. To implement the support vector machine algorithm on given dataset.

Course Outcomes:

On successful completion of the course, students 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.

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 V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT5002

Course : Computer Networks

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To Introduce the fundamental concepts of each layer in the OSI and TCP/IP models.
2. To implement, and troubleshoot network topologies and examine network and transport Layer protocol working.
3. To learn about network security, firewalls, and intrusion detection.
4. To Investigate applications of AI in computer network.

Syllabus

UNIT - I

Data communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Data Link Layer: Error Detection and Error Correction - Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ. IEEE 802.3.

UNIT – II

Network Layer: Internet Protocol (IP) – Logical Addressing: IPV4, IP addressing and subnetting, IPV6, ARP, RARP, BOOTP and DHCP–Delivery, Routing protocols.

UNIT – III

Transport Layer: Elements of Transport protocols: Addressing, Connection establishment, Connection release, User Datagram Protocol (UDP), Transmission Control Protocol (TCP). TCP congestion control. Traffic shaping Leaky Bucket and token bucket. Algorithm.

UNIT IV

Application Layer: Domain Name Space (DNS), File Transfer Protocol (FTP), WWW, HTTP, Network security principles and threats, Cryptographic techniques (symmetric/asymmetric encryption), SSL/TLS protocols.

UNIT – V

Firewalls, VPNs, and IPS/IDS (Intrusion Detection and Prevention Systems), Bluetooth. Load Balancing Optimization using AI/ML, AI-based Threat Hunting in Network Security.

Course Outcomes:

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

1. Implement the computer network protocols with topologies.
2. Apply error detection and correction mechanisms related to data Link Layer and implement Routing algorithm.
3. Analyze TCP protocol related to traffic shaping and routing algorithms.
4. Implement network security mechanisms to protect data and infrastructure.

Text Books

1. "Computer Networks" by Andrew S. Tanenbaum, David J. Wetherall (5th Edition), Pearson Education
2. "Data and Computer Communications" by William Stallings (10th Edition), Pearson Education
3. Data Communication and networking by Behrouz Forouzan (4th Edition) Mc Graw Hill Publication.
4. Cryptography And Network Security by Behrouz Forouzan (3rd Edition) Mc Graw Hill Publication.

Reference Books

1. "Computer Networking: A Top-Down Approach" by James F. Kurose, Keith W. Ross (7th Edition), Pearson Education.
2. "Network Security Essentials" by William Stallings (5th Edition), Pearson Education.

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP5002

Course : Computer Networks Lab

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Total Credits: 01

Course Objectives:

1. To implement different types of network topologies and configurations, ensuring scalability, reliability, and security.
2. To analyze common network protocols and communication technologies
3. To optimize the allocation of resources in networks and Simulate routing algorithm.

Experiments may include, but are not limited to the following:

1. Design of topologies and network troubleshooting:(CISCO PACKET TRACER).
2. Implementation of Packet capture tool: Wireshark.
3. Implementation of Data Link Layer (Error Correction).
4. Design of Virtual LAN.
5. Implementation of IP subnetting
6. Configuring static and dynamic Routing at Network Layer.
7. Implementation on Transport Layer.
8. Setting up SDN network and perform network virtualization

Tools & Platforms to Use:

- Cisco Packet Tracer
- GNS3
- Wireshark
- Wi-Fi Analyzers (inSSIDer)
- Python & Netmiko for Network Automation
- VMWare/VirtualBox for Virtualized Labs

Course outcomes

1. To design network topologies and perform troubleshooting on the network
2. To Analyze the working of Data link Layer and Routing protocol
3. To Simulate the TCP and UDP protocol working related to congestion control
4. Implement network security mechanisms to protect data and infrastructure.
5. Simulate SDN network for dynamic network control and management.

Text Books

1. "Computer Networks" by Andrew S. Tanenbaum, David J. Wetherall (5th Edition), Pearson Education
2. "Data and Computer Communications" by William Stallings (10th Edition), Pearson Education
3. Data Communication and networking by Behrouz Forouzan (4th Edition) Mic Graw Hill Publication.

Reference Books

1. "Computer Networking: A Top-Down Approach" by James F. Kurose, Keith W. Ross (7th Edition), Pearson Education.
2. "Network Security Essentials" by William Stallings (5th Edition), Pearson Education.
3. "Software-Defined Networking: Design and Deployment" by Patricia A. Morreale, Daniele Ceccarelli, Wiley.

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT5003

Course : Database Management Systems

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To understand the role of a database management system in an organization.
2. To construct simple and advanced database queries using a data language.
3. To understand and apply logical database design principles and database normalization.
4. To recognize the need for transaction management and query processing.

SYLLABUS

UNIT-I Introduction to Database System Concepts and Architecture: Databases and Database Users, Characteristics of the Database Approach, Advantages of Using the DBMS Approach, When Not to Use a DBMS, Data Models, Schemas, and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, The Database System Environment.

UNIT-II The Relational Data Model and SQL: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions, and Dealing with Constraint Violations, SQL Data Definition, Data Types and Constraints, Data Management in SQL, Transforming ER Model into Relational Model.

UNIT-III Database Design and Normalization: Functional Dependencies, Inference Rules, Equivalence, and Minimal Cover, Properties of Relational Decomposition, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Other Dependencies and Normal Forms.

UNIT IV Indexing and Hashing: Ordered Indices, B+-Tree Index Files and its Extensions, Static Hashing and Dynamic Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices, Some General Issues Concerning Indexing.

UNIT V Query Processing and Optimization: Measures of Query Cost, Query Operation: Selection, Sorting and Join Operation, Transformation of Relational Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans.

UNIT VI Transaction Processing, Concurrency Control and Recovery: Introduction to Transaction Processing, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Two-Phase Locking Techniques for Concurrency Control, Deadlock Handling and Multiple Granularity, Database Recovery Techniques.

Course Outcomes:

On completion of the course the student will be able to

1. Identify the basic concepts and various data model used in database design.
2. Recognize the use of normalization and functional dependency.
3. Understand the purpose of query processing and optimization.
4. Apply and relate the concept of transaction, concurrency control and recovery in database.

Text Books:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan; "Database System Concepts" Sixth Edition, Tata McGraw Hill, 2011.
2. Ramez Elmasri and Shamkant Navathe; "Fundamentals of Database Systems", Sixth Edition, Addison Wesley 2011.

Reference Books:

1. Raghu Ramakrishnan and Johannes Gehrke; "Database Management Systems"; Third Edition; Tata McGraw Hill Publication, 2003.
2. C. J. Date; "Database in Depth – Relational Theory for Practitioners"; O'Reilly Media, 2005.

**Syllabus for Semester III, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code :CAP 5003

Course : Database Management Systems Lab

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Total Credits: 01

Course Objectives

1. To understand the role of a database management system in an organization.
2. To construct simple and advanced database queries using a data language.
3. To understand and apply logical database design principles and database normalization.
4. To recognize the need for transaction management and query processing

SYLLABUS

Practicals Based on Above Syllabus of CAT 5003

Course Outcomes:

On completion of the course the student will be able to

1. Identify the basic concepts and various data model used in database design.
2. Recognize the use of normalization and functional dependency.
3. Understand the purpose of query processing and optimization.
4. Apply and relate the concept of transaction, concurrency control and recovery in database.

Text Books:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan; "Database System Concepts" Sixth Edition, Tata McGraw Hill, 2011.
2. Ramez Elmasri and Shamkant Navathe; "Fundamentals of Database Systems", Sixth Edition, Addison Wesley 2011.

Reference Books:

1. Raghu Ramakrishnan and Johannes Gehrke; "Database Management Systems"; Third Edition; Tata McGraw Hill Publication, 2003.
2. C. J. Date; "Database in Depth – Relational Theory for Practitioners"; O'Reilly Media, 2005.

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT5004

Course : Software Engineering(Program Elective-I)

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To familiarize students with the fundamentals of software engineering principles and practices.
2. To aid students in designing software systems using structured and object-oriented approaches.
3. To apprise students with different software testing and debugging strategies in building a quality software.
4. To introduce students to the practice of software project management.

Syllabus

Unit-I: The Evolving Role of Software - Software Characteristics, Applications, Principles and Myths; Software Engineering as a Layered Technology; Software Process Framework. Software Process Models - Waterfall Model, Evolutionary Models, Unified Process Model, Agile Process Models, Extreme Programming (XP), Scrum Model; Requirements Engineering.

Unit-II: Requirements Analysis, Analysis Modeling Approaches; Data Modeling, Object-Oriented Analysis, Scenario-Based Modeling, Flow-Oriented Modeling, Class-based Modeling, Behavioral Model, Design Concepts, The Design Model, Component Level Design, User Interface Design.

Unit-III: Basic concepts of Testing, Software Testing Life Cycle (STLC), Verification and Validation, Unit Testing, Integration Testing, Validation Testing, System Testing, Art of Debugging. White-Box Testing, Basis Path Testing, Control Structure Testing, Black- Box Testing, Equivalence Partitioning, Boundary Value Analysis, Web Testing, Test case design, Building, Execution, Automated Testing.

Unit-IV: Software Project management- Plans, Methods and Methodology; Project Success and Failure, Project Evaluation, Cost-benefit evaluation technique, Project Planning & Scheduling. Software Effort Estimation- Albrecht Function Point Analysis, COSMIC Function Point, Cost Estimation, COCOMO Model, Project Scheduling. Software Quality. A Framework for Product Metrics, Metrics for Analysis & Design Models, Metrics for Source Code, Metrics for Testing & Maintenance. Metrics for process & project - Software measurement.

Unit-V: Risk management - Risk strategies, Software risks, Risk identification, Risk refinement, RMMM Risk Response development & Risk Response Control, Risk Analysis. Change Management- Software Configuration Management, SCM Repository, SCM Process, Estimation, Reengineering- Software reengineering, Reverse engineering.

Course Outcomes:

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

1. Elucidate software engineering practices and various process models.
2. Use software design approaches for designing real-time solutions.
3. Demonstrate White Box Testing and Black Box Testing for building bug-free quality software.
4. Integrate software project management practices in software product development.

Text Books

1. Roger S. Pressman and Bruce R. Maxim; Software Engineering – A Practitioner's Approach; Eighth Edition, McGraw Hill; 2015.
2. Ian Somerville; Software Engineering; Seventh Edition; Pearson Education. 2008.

Reference Books

1. Pankaj Jalote; An Integrated Approach to Software Engineering; Third Edition, Springer, 2005.

2. Rajib Mall; Software Project Management, 5th Edition, McGrawHill.
3. David Gustafsan; Software Engineering;Schaum's Series,Tata McGraw Hill,2002.

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT5004

Course : Design Pattern (Program Elective-I)

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To learn the fundamentals of software design by referring a catalog of design patterns
2. Demonstrate how to use design patterns to address code development issues.
3. Identify the most suitable design pattern to address a given application design problem.
4. Apply design principles (e.g., open-closed, dependency inversion, substitution, etc).
5. Critique code by identifying and refactoring anti-patterns.

Syllabus UNIT-I

Elements of Design Pattern, Describing Design Pattern, Design Pattern Classification, Role of design patterns in software design, Selection and usage of Design Patterns, Example implementation of design pattern using UML, Case Study: Designing a Document Editor.

UNIT-II

Creational Patterns: Introduction, Role of Creational patterns, Creational Pattern types: Factory method, Abstract Factory, Builder, Prototype, Singleton, Comparative study of creational patterns, and examples based on real life applications.

UNIT-III

Structural Design Patterns: Introduction, Role of Structural patterns, Encapsulating complex structures to simplify interactions between components, Decoupling Components, Structural Pattern types: Adapter, Bridge, Composite, Decorator, Façade, Proxy, Comparative study of structural patterns, and examples based on real life applications.

UNIT-IV

Behavioral Patterns-I: Introduction, Role of Behavioral pattern, Encapsulation of Behavior, Behavioral Pattern types: Chain of Responsibility, Template Method, State, Strategy, and Iterator.

UNIT-V

Behavioral Patterns-II: Effect of single object on set of objects, Analysis of mutual behavior of classes and object's state, Reference control between objects, Behavioral Pattern types: Observer, Mediator, Memento, Interpreter, Comparative study of Behavioral patterns, and examples based on real life applications.

Course Outcomes:

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

1. Analyze the need and ability of design patterns in the software design process.
2. Implement various solutions for creation of objects, their structure and the interaction between objects.
3. Develop a loosely coupled application using design patterns.
4. Analyze the tradeoffs of applying a design pattern to a given problem.

Text Books:

1. Design Patterns: Elements of reusable object-oriented software by Gamma Erich, Helm Richard, Johnson Ralph, and Vlissides John, Pearson Education
2. Design Patterns Explained by Alan Shallowly and James Trott, Addison-Wesley

Reference Books:

1. Pattern's in JAVA Vol-I by Mark Grand, WileyDreamTech.
2. JAVA Enterprise Design Patterns Vol-III by Mark Grand, WileyDreamTech.
3. Head First Design Patterns by Eric Freeman, O'Reilly.

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT5004

Course : Robotic Process Automation (Program Elective-I)

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Prerequisites

Basic knowledge of Artificial Intelligence and Machine Learning

Course Objectives

1. To introduce the fundamentals of Robotic Process Automation (RPA) and its applications.
2. To understand RPA techniques, tools, and platforms for automation.
3. To develop skills in designing, implementing, and deploying RPA solutions.

Syllabus

Unit I: Introduction to Robotic Process Automation (RPA): Overview of RPA: Definition, Scope, and Benefits, Automation Techniques: What and How to Automate?, Components and Platforms of RPA, Introduction to UiPath: Installation and Setup, Recording and Playback: Task Recorder, Automating Gmail Trash & Recycle Bin

Unit II: Workflow and Data Manipulation: Workflow Design: Sequences, Flowcharts, and Control Flow, Looping and Decision-Making Mechanisms, Data Manipulation: Variables, Scope, Collections, Arguments, Working with Data Tables, Clipboard Management, and File Operations, CSV/Excel Integration: Data Table Conversion

Unit III: UI Interaction and Plugins: Identifying and Interacting with UI Controls, Techniques for Waiting and Acting on Controls, Screen Scraping and Optical Character Recognition (OCR), Integrating Plugins: SAP, Java, Citrix, Mail, PDF, Web, Excel, Word, Credential Management and Security Considerations

Unit IV: Bot Development and Exception Handling: Assistant Bots and Event Monitoring, Exception Handling: Common Errors and Debugging Techniques, Logging and Crash Reporting, Debugging Strategies and Error Reporting

Unit V: Deployment and Maintenance of RPA Bots: Project Organization and Workflow Reusability, Best Practices: Commenting, Config Files, State Machines, Publishing and Deploying Bots Using UiPath, Orchestration Server: Bot Management and Control, Monitoring and Maintaining Automated Processes

Course Outcomes:

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

1. Apply RPA concepts to automate various applications.
2. Analyze and choose suitable RPA techniques for different automation scenarios.
3. Design and implement automation workflows using UiPath.
4. Handle exceptions and optimize bot performance.
5. Deploy and maintain RPA solutions effectively.

Text Books

1. Alok Mani Tripathi, Learning Robotic Process Automation, 1st Edition, Packt Publishing, 2018.
2. Ed Freitas, Robotic Process Automation Succinctly, Succinctly EBook Series, 2020.

Reference Books

1. Robotic Process Automation, Nividous, 2018.
2. Vaibhav Srivastava, Getting Started with RPA using Automation Anywhere, BPB Publications, 2021.

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT5005

Course : Microcontroller Design

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To introduce the fundamentals of microcontrollers and the ARM Cortex-M architecture.
2. To develop an understanding of the ARM instruction set and programming using Embedded C.
3. To explore hardware interfacing techniques with various peripherals and sensors.
4. To understand the implementation of timers, interrupts, and communication protocols in ARM-based systems.
5. To provide knowledge on advanced ARM features, RTOS concepts, and real-time embedded applications.

Syllabus

Unit I Introduction to Microcontrollers

Overview of Microcontrollers and ARM-based Processors, Comparison of Microprocessors and Microcontrollers, ARM Cortex-M Family Overview (M0, M3, M4, M7), Architecture of ARM Cortex-M: Registers, ALU, Instruction Pipeline, Functional Pin Diagram and Description, Memory Organization: RAM, ROM, Flash, and Stack

Unit II ARM Instruction Set and Embedded C Programming

Introduction to Embedded C for ARM: Data Types, Pointers, Bitwise Operations, Functions, and Structures. ARM Instruction Set Architecture (ISA), Addressing Modes: Immediate, Register, Direct, Indirect. Data Transfer Instructions (LDR, STR, PUSH, POP). Data Processing Instructions (ADD, SUB, MUL, DIV). Control Flow Instructions (B, BL, BX, CMP)

Unit III Hardware Interfacing and Peripherals

GPIO Programming and Port Operations in ARM, Interfacing LEDs, Switches, and Buzzer, Matrix Keypad and Seven-Segment Display, LCD (Alphanumeric and Graphical), Analog-to-Digital (ADC) and Digital-to-Analog (DAC). Interfacing Sensors (Temperature, Ultrasonic, Accelerometer), Stepper Motor and DC Motor.

Unit IV Timers, Interrupts, and Communication Protocols

Basics of Timers and Counters in ARM Cortex-M, Timer Modes: Periodic, Capture, Compare, PWM Generation. Interrupts: NVIC (Nested Vectored Interrupt Controller), ISR (Interrupt Service Routines), Serial Communication Protocols: UART, SPI, I2C. Wireless Communication: Bluetooth, Wi-Fi, Zigbee.

Unit V Advanced ARM Features, RTOS, and Applications

ARM Cortex-M Pipeline: 3-stage, 5-stage Execution, ARM Memory Interface and Bus Architecture, Basics of Real-Time Operating Systems (RTOS), RTOS Concepts: Task Scheduling, Mutex, Semaphores, Handling Priority Inversion and Deadlocks.

Course Outcomes:

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

1. Understand microcontrollers & ARM Cortex-M architecture.
2. Develop Embedded C programs for ARM.
3. Interface and control peripherals like LEDs, LCDs, motors, and sensors using GPIO, ADC, and DAC.
4. Implement timers, interrupts, and communication protocols such as UART, SPI, I2C, and wireless interfaces.
5. Design ARM microcontroller based systems using advanced ARM features, RTOS concepts, and real-time embedded applications.

Text Books

1. "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors", Joseph Yiu.
2. "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly and C ", Yifeng Zhu.
3. "Real-Time Operating Systems for ARM Cortex-M Microcontrollers", Qing Li & Carolyn Yao.

Reference Books

1. "ARM Assembly Language: Fundamentals and Techniques", William Hohl & Christopher Hinds.
2. "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers", Jonathan W. Valvano.
3. "Embedded Systems Fundamentals with ARM Cortex-M based Microcontrollers – Alexander G. Dean

**Syllabus for Semester V, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP5005

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Course : Microcontroller Design Lab

Total Credits: 01

Course Objectives

1. To introduce the fundamentals of microcontrollers and the ARM Cortex-M architecture.
2. To develop an understanding of the ARM instruction set and programming using Embedded C.
3. To explore hardware interfacing techniques with various peripherals and sensors.
4. To understand the implementation of timers, interrupts, and communication protocols in ARM-based systems.
5. To provide knowledge on advanced ARM features, RTOS concepts, and real-time embedded applications.

Syllabus

Practical's are based on Theory Syllabus CAT 5005 Course Outcomes:

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

1. Understand microcontrollers & ARM Cortex-M architecture.
2. Develop Embedded C programs for ARM.
3. Interface and control peripherals like LEDs, LCDs, motors, and sensors using GPIO, ADC, and DAC.
4. Implement timers, interrupts, and communication protocols such as UART, SPI, I2C, and wireless interfaces.
5. Design ARM microcontroller based systems using advanced ARM features, RTOS concepts, and real-time embedded applications.

Text Books

1. "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors", Joseph Yiu.
2. "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly and C", Yifeng Zhu.
3. "Real-Time Operating Systems for ARM Cortex-M Microcontrollers", Qing Li & Carolyn Yao.

Reference Books

1. "ARM Assembly Language: Fundamentals and Techniques", William Hohl & Christopher Hinds.
2. "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers", Jonathan W. Valvano.
3. "Embedded Systems Fundamentals with ARM Cortex-M based Microcontrollers – Alexander G. Dean

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6001

Course : Deep Learning I

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To introduce basic deep learning algorithms.
2. To understand real-world problems which can be solved by deep learning methods.
3. To identify deep learning techniques suitable for a real-world problem.

Syllabus:

UNIT I: Basics of Deep Learning

History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons.

UNIT II: Training of Feedforward Neural Networks

Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Training of Feedforward Neural Networks, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam

UNIT III: Optimization Algorithm

Activation Function and Initialization Methods: Sigmoid, Tanh, ReLU, Xavier and He Initialization, Regularization: Bias and Variance, Overfitting, Hyperparameters Tuning, L1 and L2 Regularization, Data Augmentation and Early Stopping, Parameter Sharing and Tying.

UNIT IV: Convolutional Neural Network (CNN)

Convolutional Neural Networks, 1D and 2D Convolution, Visualizing Convolutional Neural Networks, Guided Backpropagation.

UNIT V: Recurrent Neural Network (RNN)

Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Long Short-Term Memory (LSTM) Cells, Gated Recurrent Units (GRUs) variants of CNN and RNN, Encoder-Decoder Models, Attention Mechanism, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet.

Course Outcomes:

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

1. Apply fully connected deep neural networks to real-world problem-solving scenarios.
2. Evaluate the performance of various deep learning models in terms of optimization, bias-variance trade-off, overfitting, and underfitting.
3. Analyze the role of convolutional and recurrent neural networks in addressing different real-world problems.
4. Create advanced deep learning models by designing variants of CNNs and RNNs tailored to specific applications.

Text Books

1. Sandro Skansi, *Introduction to Deep Learning*, Springer
2. Charu C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, Springer, 2019
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press, 2016
4. Dr. S. Lovelyn Rose, Dr. L. Ashok Kumar, Dr. D. Karthika Renuka, *Deep Learning using Python*, Wiley Publication

Reference Books:

1. Bishop, C. M., *Pattern Recognition and Machine Learning*, Springer, 2006
2. Yegnanarayana, B., *Artificial Neural Networks*, PHI Learning Pvt. Ltd., 2009
3. A. Ravindran, K. M. Ragsdell, and G. V. Reklaitis, *Engineering Optimization: Methods and Applications*, John Wiley & Sons, Inc., 2016

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP6001

Course : Deep Learning I Lab

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Total Credits: 01

Course Objectives:

1. To solve problems in linear algebra, probability, optimization using artificial neurons.
2. To understand the usage of publically available datasets.
3. To use various python packages and tools for deep learning.

Course Syllabus:

Experiments based on

- Implementation of Linear Algebra, Probability etc.
- CDT/CST/CAT (Deep Learning-I) Syllabus. Technology: Python, Tensorflow/Pytorch

Course Outcomes:

On completion of the course the student will be able to

1. Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
2. Implement deep learning models in Python using the PyTorch/Tensorflow library and train them with real-world datasets.
3. Analyze and evaluate deep learning model's.

Text Books:

1. Sandro Skansi, Introduction to Deep Learning, Springer
2. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Reference Books:

1. Francois Chollet, Deep Learning with Python, Manning Publications Co.
2. Golub, G., H., and Van Loan, C., F., Matrix Computations, JHU Press, 2013.

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6002

Course : Computer Vision

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To Learn the core principles of computer vision, image formation, transformations, camera geometry, including stereo vision and depth estimation.
2. To gain proficiency in image alignment techniques, feature detection and feature matching for object recognition and tracking.
3. To explore motion analysis, optical flow methods, and object tracking using algorithms such as Lucas-Kanade, Kalman filter, and background subtraction.
4. To utilize classification and clustering techniques for pattern analysis, along with dimensionality reduction methods.

Syllabus

Unit I: Introduction to Computer Vision & Image Formation

Introduction to computer vision, Digital Image Formation and Camera Geometry: Fundamentals of Image Formation, Transformations in 2D: translation, rotation, scaling, shearing; affine and rigid transformations, Transformations in 3D: translation, rotation about X,Y,Z axis, rotation about arbitrary axis, 3D affine, homogeneous coordinates in 2D and 3D, Concept of pinhole camera, camera calibration, Homography, Stereo Geometry, Binocular Stereopsis: Camera and Epipolar Geometry, Depth estimation.

Unit II: Image Alignment & Feature Detection

Image Alignment: Physically and digitally corresponding points, Feature detection and description: Line detectors (Hough Transform), Corners - Harris and Hessian Affine, SIFT, SURF, HOG, Feature matching and model fitting, RANSAC, Control point-based image alignment using least squares - derivation for pseudo-inverse, Applications of image alignment.

Unit III: Motion Analysis & Object Tracking

Motion and Optical Flow: Motion Analysis: Background Subtraction and Modeling, Horn and Shunck method, Lucas-Kanade algorithm, Feature Point Tracking, moving object detection and tracking; Kalman filter

Unit IV: Object Detection & Recognition

Adaboost algorithm: binary classification, face detection, Adaboost for Computation of Haar-like features; Image Segmentation; Object recognition and shape representation, Viola Jones algorithm for face detection and Boosting: Features, Integral images, Boosting, cascade; Activity Recognition in videos.

Unit V: Pattern Analysis & Dimensionality Reduction

Pattern Analysis: Clustering: K-Means, K-Medoids, Classification: Supervised, Un-supervised, Semi-supervised; Classifiers: KNN, ANN models. Dimensionality Reduction: PCA, LDA; Non-parametric methods; deep neural architectures and applications.

Course Outcomes:

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

1. Use the fundamental concepts of computer vision to solve different problems.
2. Apply feature detection, image alignment, motion analysis, and object tracking techniques to solve real-world problems.
3. Analyze the different object detection and recognition techniques to determine their effectiveness in different real-world scenarios.
4. Apply machine learning based techniques to perform pattern analysis and dimensionality

reduction.

Text Books

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2nd edition, 2022.
2. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education; Fourth edition, 2018.
3. D. Forsyth and J. Ponce, Computer Vision: A modern approach, Pearson Education India, 2nd ed., 2015.
4. E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Pearson, 1998.

Reference Books

1. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
2. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, 1982.
3. E. R. Davies, Computer & Machine Vision: Theory, Algorithms, Practicalities, Academic Press, Fourth Edition, 2012

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP6002

Course : Computer Vision Lab

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Total Credits: 01

Course Objectives

1. To apply the core principles of computer vision, image formation, transformations, camera geometry, including stereo vision and depth estimation.
2. To gain proficiency in image alignment techniques, feature detection and feature matching for object recognition and tracking.
3. To explore motion analysis, optical flow methods, and object tracking using algorithms such as Lucas-Kanade, Kalman filter, and background subtraction.
4. To utilize classification and clustering techniques for pattern analysis, along with dimensionality reduction methods.

Syllabus: Experiments based on the syllabus of Computer Vision Theory CAT6002. Course Outcomes:

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

1. Use the fundamental concepts of computer vision to solve different problems.
2. Apply feature detection, image alignment, motion analysis, and object tracking techniques to solve real-world problems.
3. Analyze the different object detection and recognition techniques to determine their effectiveness in different real-world scenarios.
4. Apply machine learning based techniques to perform pattern analysis and dimensionality reduction.

Text Books

1. Joseph Howse, Learning OpenCV 4 Computer Vision with Python 3, Packt Publishing; 3rd Edition, 2020.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2nd edition, 2022.
3. D. Forsyth and J. Ponce, Computer Vision: A modern approach, Pearson Education India, 2nd ed., 2015.
4. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education; Fourth edition, 2018.

Reference Books

1. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
2. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, 1982.
3. E. R. Davies, Computer & Machine Vision: Theory, Algorithms, Practicalities, Academic Press, Fourth Edition, 2012.

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6003

Course : Natural Language Processing(PE-II)

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To familiarize the concepts and techniques of natural language processing.
2. To learn computational techniques that enable machines to process, understand, and generate human language efficiently.
3. To apply the statistical learning methods and cutting-edge research models to solve natural language processing problems.
4. To integrate natural language processing into real-world systems to develop, evaluate, and enhance applications.

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.

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, 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, Language Model Evaluation, Entropy, Perplexity, 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, Answering Questions, Applications in Finance, E- Commerce, Travel and Hospitality, Marketing, Insurance, Healthcare, Law, Supply Chain, Telecommunication, Education and Research.

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.

Textbooks

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- 9819919987.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, and Harshit Surana, Practical Natural Language Processing: A Comprehensive Guide to Building
4. Real-World NLP Systems, O'Reilly Media, Inc., USA, First edition, 2020, ISBN: 978-1492054054.
5. Dipanjan Sarkar, Text Analytics with Python: A Practitioner's Guide to Natural Language Processing, Second Edition, Apress Media, LLC, California, 2019, ISBN: 978-1484243534.

Reference Books

1. Natural Language Processing with Python: From Basics to Advanced Projects, Second Edition, 2024, Cuquantum Technologies LLC. Plano, ISBN: 979- 8894968483.
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- 1003264774.
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: 978-3031231896.
4. Lewis Tunstall, Leandro von Werra, and Thomas Wolf, Natural Language Processing with Transformers: Building Language Applications with Hugging Face, O'Reilly Media, Inc., USA, Revised First edition, May 2022, ISBN: 978- 1098136796.

Syllabus for Semester VI, B. Tech. Computer Science & Engineering (Artificial Intelligence & Machine Learning)

Course Code : CAP6003

Course :Natural Language Processing Lab(PE-II)

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week Total Credits: 01

Syllabus:

Experiments based on the syllabus of CAP6003

1. Few lab sessions shall be conducted using virtual lab platforms to enhance learning experiences and accessibility.
2. Utilise Hugging Face, Stanford, Kaggle, MIT OpenCourseWare, OpenAI Learning, Fast.ai, AllenNLP like repositories and platforms.

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6003

Course : Data Warehousing and Mining(PE-II)

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Pre-requisite: Database Management Systems Course Objectives

1. Understand and implement techniques for preprocessing of classical data models and algorithms in data warehouses and data mining
2. Characterize the kinds of patterns that can be discovered by association rule mining, classification and clustering.
3. Master data mining techniques in various applications like social, scientific and environmental context.

Syllabus

Unit I: Introduction to Data Warehouse, Data Warehouse basic Concepts, Architecture of Data Warehouse, Overview of ETL and OLAP OLTP integration – comparison of OLAP with OLTP systems, ROLAP, MOLAP and HOLAP, Multidimensional modeling, Data Cube, Data Cube Computation methods, Advanced SQL support for OLAP

Unit II: Data Cleaning methods, Descriptive Data Summarization, Data Reduction, Data Discretization, Data partitions, and Concept hierarchy generation Space Management in Data warehouse - Schemas for storing data in warehouse using different storage structures, B-tree index, hash index, clusters, Bitmap index functional index, domain index.

Unit III: Introduction: - What is Data mining? Data Mining on what kind of data, Data mining Functionalities, Classification of Data Mining Systems, Major Issues on Data mining, KDD Process, Association Rule mining, Association Rule Generation, APRIORI Algorithm, The Partition Algorithms, FP-Growth Algorithms.

Unit IV: Classification and Prediction: - Classification by decision tree induction, Bayesian Classification, Rule based Classification, Associative Classification, Classification by Back propagation, Support Vector Machines.

Unit V: Clustering: Measuring Data Similarity and Dissimilarity Partition based Clustering, Hierarchical based clustering, Density based clustering, Grid-Based Clustering.

Course Outcomes:

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

1. Use the fundamental theories and concepts of data warehousing in real life application.
2. Apply multi-dimensional modeling techniques in designing data warehouses and learn the process of data cleaning and pre-processing for mining applications.
3. Use the principles of data mining for designing data mining applications and Apply different methods and techniques involved in data mining.
4. Distinguish problems related to classification and clustering and evaluate accuracy of various classification and clustering algorithms.

Text Books

1. Jaiwei Han and Micheline Kamber; Data Mining Concepts and Techniques; 2 edition; Morgan Kaufmann Publishers, 2006.
2. Introduction to Data Mining, Pang-Ning Tan, Vipin Kumar, Michael Steinbach, Pearson Education.

Reference Books

1. Tang and MacLennan, Data Mining with SQL Server 2005, Wiley Publishing, 2005
2. Data Warehousing and Fundamentals by Paulraj Ponniah, A Wiley-Interscience Publication
3. Margaret H Dunham, "Data Mining Introductory and advanced topics", 6th Edition, Pearson Education, 2009.
4. Arun K Pujari, "Data Mining Techniques", 1st Edition, University Press, 2005.

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP6003

Course : Data Warehousing and Mining Lab (PE-II)

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Total Credits: 01

Course Pre-requisite: Database Management Systems Course Objectives

1. Understand and implement techniques for preprocessing of classical data models and algorithms in data warehouses and data mining
2. Characterize the kinds of patterns that can be discovered by association rule mining, classification and clustering.
3. Master data mining techniques in various applications like social, scientific and environmental context.

Syllabus

Experiments based on the syllabus. Course Outcomes:

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

1. Use the fundamental theories and concepts of data warehousing in real life application.
2. Apply multi-dimensional modeling techniques in designing data warehouses and learn the process of data cleaning and pre-processing for mining applications.
3. Use the principles of data mining for designing data mining applications and Apply different methods and techniques involved in data mining.
4. Distinguish problems related to classification and clustering and evaluate accuracy of various classification and clustering algorithms.

Text Books

1. Jaiwei Han and Micheline Kamber; Data Mining Concepts and Techniques; 2 editions; Morgan Kaufmann Publishers, 2006.
2. Introduction to Data Mining, Pang-Ning Tan, Vipin Kumar, Michael Steinbach, Pearson Education.

Reference Books

1. Tang and MacLennan, Data Mining with SQL Server 2005, Wiley Publishing, 2005
2. Data Warehousing and Fundamentals by Paulraj Ponniah, A Wiley-Interscience Publication
3. Margaret H Dunham, "Data Mining Introductory and advanced topics", 6th Edition, Pearson Education, 2009.
4. Arun K Pujari, "Data Mining Techniques", 1st Edition, University Press, 2005.

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6003

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Course : Compiler Design (PE-II)

Total Credits: 03

Course Objectives

The main objective of this course is to introduce the fundamental concepts of compiler design and language translation. It aims to develop an understanding of the structure, function, and complexity of modern compilers. The students will learn the various phases of compilation with practical implementation using compiler writing tools.

Syllabus

Unit I: Introduction to Compilers, Phases of Compiler, Relating Compilation Phases with Formal Systems, Lexical Analysis, tokens, pattern and lexemes, Design of Lexical analyser, Regular Expression, transition diagram, recognition of tokens, Lexical Errors.

Unit II: Syntax Analysis- Specification of syntax of programming languages using CFG, Top- down parser, design of LL (1) parser, bottom-up parsing technique, LR parsing, Design of SLR, CLR, LALR parsers, Handling Ambiguous Grammars, Applications of the LR Parser.

Unit III: Syntax directed translation- Study of syntax directed definitions & syntax directed translation schemes, Type and Type Checking, Implementation of SDTS, Intermediate notations, translation of Assignment Statement, controls structures, Array reference.

Unit IV: Code optimization- machine independent Optimisation, Local optimization techniques, loop optimization- control flow analysis, data flow analysis, Loop invariant computation, Induction variable removal, other loop optimization techniques, Machine-dependent Optimization techniques. Code generation- Problems in code generation, Simple code generator, code generation using labelling algorithm, code generation using gencode algorithm

Unit V: Storage allocation & Error Handling- Run time storage administration, stack allocation, Activation of Procedures, Storage Allocation Strategies, Garbage Collection, symbol table management, Error handling, Error detection and recovery- lexical, syntactic and semantic, Error recovery in LL & LR Parser

Course Outcomes:

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

1. Exhibit role of various phases of compilation, with understanding of types of grammars and design complexity of compiler.
2. Design various types of parses and perform operations like string parsing and error handling.
3. Demonstrate syntax directed translation schemes, their implementation for different programming language constructs.
4. Implement different code optimization and code generation techniques using standard data structures.

Text Books

1. Aho, Sethi, and Ullman; Compilers Principles Techniques and Tools; Second Edition, Pearson education, 2008.
2. Alfred V. Aho and Jeffery D. Ullman; Principles of Compiler Design; NarosaPub.House, 1977.
3. Vinu V. Das; Compiler Design using Flex and Yacc; PHI Publication, 2008.
4. Manoj B Chandak, Khushboo P Khurana; Compiler Design; Universities Press, 2018.

Reference Books

1. Vinu V. Das; Compiler Design using Flex and Yacc; PHI Publication
2. V. Raghavan; Principles of Compiler Design, McGraw Hill Education (India)

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP6003

Course : Compiler Design Lab (PE-II)

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Total Credits: 01

Course Objectives

This laboratory course is designed to provide students with hands-on experience in the fundamental techniques of compiler construction. Through a series of experiments and practical implementations, students will explore the core phases of a compiler. The course also introduces various compiler development tools which enables students to understand and build components of a working compiler.

Syllabus

Practical's based on syllabus of Compiler Design CAT6003

Course Outcomes:

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

1. Use Open-Source tools to design lexical analyzer and parser.
2. Implement different types of Parsing techniques.
3. Implement various syntax directed translation schemes to generate intermediate code .
4. Implement various code optimization and code generation techniques.

Text Books

1. Doug Brown, John Levine, Tony Mason, Lex and Yacc, O'Reilly Media, 2nd Edition, 2012
2. Des Watson, A Practical Approach to Compiler Construction, Springer, 1st ed. edition, 2017

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6004 Course : Customer Relationship Management (PE-III)
L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week Total Credits: 03

Course Objectives

1. To make the students understand the organizational need, benefits and process of creating long-term value for individual customers.
2. To disseminate knowledge regarding the concept of Salesforce and Salesforce technologies.
3. To enable the students understand the technological and human issues relating to implementation of Customer Relationship Management in the organizations.

Syllabus

UNIT I : Introduction to CRM and Salesforce: Definition and importance of CRM, Key CRM concepts, Benefits of CRM for businesses, Introduction to Salesforce, Salesforce's role in business processes, Salesforce Cloud offerings, Overview of Salesforce architecture, Multi-tenant cloud architecture, Salesforce Data Model (Objects, Records, Fields), Understanding Tabs, Apps, and Objects

UNIT II : Salesforce Administration Basics: Understanding Salesforce Setup menu, Creating and managing users, Profiles, Roles, and Permission Sets, Organizing security settings (Organization-Wide Defaults, Sharing Rules), Data Validation Rules, Creating and customizing Objects, Object Relationships, Creating and managing Fields, Workflow Rules, Process Builder, and Flow.

UNIT III: Introduction to Apex Programming: Apex basics (Syntax, Variables, Methods), Apex classes and triggers, Working with SOQL and SOSL (Salesforce Object Query Language, Handling exceptions in Apex, Apex Triggers, Writing Apex triggers to handle database events, Trigger context variables and best practices, Governor limits and optimization techniques.

Unit IV: Advanced Salesforce Development – Lightning Web Components (LWC) Overview of Lightning Web Components (LWC), LWC architecture and lifecycle, Creating and deploying LWC components, Handling events in LWC, Working with Apex from LWC, LWC Integration with Salesforce Data, Displaying Salesforce data in LWC, Handling record pages and lightning layouts, Best practices for LWC development.

UNIT V : Salesforce Integration and Deployment, Salesforce Reports: Overview of integration in Salesforce, Integration tools: REST API, SOAP API, and Bulk API, Salesforce Connect, Introduction to Mulesoft for Salesforce integration, Introduction to Salesforce DX, Source-driven development and version control, Continuous Integration and Continuous Delivery (CI/CD) in Salesforce., Introduction to reports, types of reports, report builder, formatting reports, dashboard introduction, dashboard generation, charts in dashboards, limitations of Salesforce reports.

Course Outcomes:

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

1. Understand the fundamentals of Salesforce and its role in CRM.
2. Gain practical skills in configuring and managing Salesforce environments.
3. Apply the basics of Salesforce development using Apex to customize the platform.
4. Develop modern web applications on the Salesforce platform using Lightning Web Components.
5. Integrate Salesforce with external systems and deploy applications in a production environment.

Text Books

1. Jason Ouellette; Development with the Force.com Platform, Second Edn, Addison Wesley, 2011.
2. Mohith Shrivastava; Salesforce Lightning Application Development, 2018.
3. Judith W .Kincaid , Customer Relationship Management Getting it Right, Pearson Education
4. Customer Centricity –Focus on right customer for strategic advantage, by Peter Fader, Wharton Digital Press, 2012

Reference Books

1. Learning Salesforce Development with Apex – Paul Battisson
2. Salesforce for Beginners – Sharif Shaalan

Course Code : CAP6004 Course : Customer Relationship Management Lab
L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week Total Credits: 01

1. To make the students understand the organizational need, benefits and process of creating long-term value for individual customers.
2. To disseminate knowledge regarding the concept of Salesforce and Salesforce technologies.
3. To enable the students understand the technological and human issues relating to implementation of Customer Relationship Management in the organizations.

1. Creating and navigating a Salesforce Developer account and exploring Salesforce Classic and Lightning Experience interfaces
2. Basic Salesforce configurations and customizations
3. Creating custom objects and fields and setting up user roles and profiles
4. Implementing workflow rules and process automation
5. Writing basic Apex classes and triggers and Developing Visualforce pages to customize user interface
6. Building triggers for automation
7. Building basic LWC components and creating interactive user interfaces using LWC

1. Understand the fundamentals of Salesforce and its role in CRM.
2. Gain practical skills in configuring and managing Salesforce environments.
3. Apply the basics of Salesforce development using Apex to customize the platform.
4. Develop modern web applications on the Salesforce platform using Lightning Web Components.

1. Jason Ouellette; Development with the Force.com Platform, Second Edn, Addison Wesley, 2011.
2. Mohith Shrivastava; Salesforce Lightning Application Development, 2018.
3. Mohith Shrivastava; Salesforce Lightning Application Development, 2018
4. Judith W .Kincaid , Customer Relationship Management Getting it Right, Pearson Education
5. Customer Centricity –Focus on right customer for strategic advantage, by Peter Fader, Wharton Digital Press, 2012

1. Learning Salesforce Development with Apex – Paul Battison
2. Salesforce for Beginners – Sharif Shaalan

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6004

Course : Software Testing(PE-III)

L: 3Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 03

Course Objectives

1. To familiarize the students with the strong fundamental knowledge of software testing and practices.
2. To understand the strategies and approaches of Industry Level Testing.
3. To enable the students to apply the advanced testing approaches on Live applications and to channelize solutions to challenging real- world problems.

Syllabus

Unit I: Fundamentals of Software Testing: Introduction to Software Testing, Software Development Life Cycle (SDLC) & Testing Life Cycle (STLC), Testing Principles & Objectives, Defect, Bug, Error, and Failure, Test Plan, Test Case, and Test Strategy, Verification vs. Validation, Levels of Testing i.e. Unit Testing, Integration Testing, System Testing, Acceptance Testing, Types of Testing i.e. Manual vs. Automation, Functional vs. Non-Functional, Black Box vs. White Box Testing, Regression & Smoke Testing, Alpha & Beta Testing.

Unit II: Test Case Design & Execution: Agile Methodology, Writing Effective Test Cases, Test Data & Test Environment Setup, Equivalence Partitioning & Boundary Value Analysis, Decision Table Testing & State Transition Testing, Error Guessing Technique, Test Execution & Bug Reporting, Defect Life Cycle & Bug Tracking Tools (JIRA, Bugzilla), Test Metrics & Reporting.

Unit III: Database Testing: Approach For Database testing, Introduction of basic of Database commands (DDL, DML, DCL), Application of Software Testing Techniques in Database Testing, Types of testing perform in DB i.e. White box testing and Black Box Testing, Typical Test scenario in DB Testing.

Unit IV: Automation Testing & Tools: Introduction to Automation Testing, Benefits & Challenges of Automation, Introduction to Selenium WebDriver, Writing First Test Script in Selenium, Handling Elements (Buttons, Text Fields, Dropdowns, Alerts), Data- Driven Testing using Excel, CI/CD in Testing (Jenkins, Git).

Unit V: API Testing & Performance Testing: Introduction to API Testing, Basics of REST APIs and HTTP Methods (GET, POST, PUT, DELETE), Testing APIs using Postman, Introduction to Performance Testing, Load Testing using Apache JMeter.

Course Outcomes:

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

1. Understand core software testing principles, methodologies, and techniques to ensure software quality and reliability.
2. Design and execute effective test cases using various test case design techniques to ensure comprehensive test coverage and defect identification.
3. Implement database testing techniques to ensure robust, secure, and high- performing backend systems.
4. Utilize automation testing tools to design and execute test scripts, enhancing software testing efficiency and reliability.
5. Apply API and performance testing techniques to ensure functionality, reliability, and scalability of software systems.

Text Books

1. Software Testing: A Craftsman's Approach, Paul C. Jorgensen, Auerbach Publications; 4th edition, 2013.
2. Foundations of Software Testing, Aditya P. Mathur, Pearson, 1st edition, 2011.
3. The Art of Software Testing, Glenford J. Myers, Tom Badgett, Corey Sandler, John Wiley & Sons Inc; 3rd edition, 2011.

Reference Books

1. Software Engineering: A Practitioner's Approach, Roger S. Pressman, Bruce R. Maxim Dr., McGraw Hill, 8th edition, 2014.
2. Software Testing: Principles and Practices, Srinivasan Desikan & Gopalaswamy Ramesh, Pearson, 1st edition, 2005.
3. Practical Software Testing: A Process-Oriented Approach, Ilene Burnstein, Springer-Nature New York Inc, 1st Edition, 2003.
4. Software Testing Techniques, Boris Beizer, Wiley India, Second edition 2002.

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP6004

L: 0Hrs, T: 0 Hr, P: 2Hrs, Per Week

Course : Software Testing Lab(PE-III)

Total Credits: 01

Course Objectives

1. To gain hands-on experience in designing, executing, and automating test cases to ensure software quality.
2. To utilize manual and automated testing tools for functional, database, API, and performance testing.
3. To enable the students to gain practical knowledge and hands-on experience in software testing methodologies and tools, preparing them for industry roles in quality assurance and software testing.

Course Outcomes:

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

1. Demonstrate an understanding of software testing principles, testing life cycle, and defect management.
2. Design, document, and execute effective test cases using various test design techniques.
3. Perform database testing to ensure data accuracy, consistency, and constraint validation using SQL queries.
4. Utilize automation tools to develop and execute test scripts, enhancing test coverage and efficiency.
5. Implement API testing and performance testing methodologies to ensure software reliability and scalability.

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code: CAT6004-3

Course: Blockchain Technology (PE-III)

L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week

Total Credits: 3

Course Objectives

This course aims to provide a survey on blockchain and the topics around such as history of blockchain, cryptography it uses, Bitcoin and other currencies, consensus algorithms, smart contracts, Ethereum, scalability and various use cases.

Syllabus:

UNIT I: Blockchain Introduction: Blockchain Technology Mechanisms & Networks, Blockchain Origins, Blockchain Objectives, Blockchain Users & Adoption, Blockchain Challenges, P2P Systems, Hash Pointers and Data Structures, Blockchain Transactions

UNIT II: Consensus Mechanism: Permissioned Blockchain, Permissionless Blockchain, Different Consensus Mechanism- Proof of Work, Proof of Stake, Proof of Activity, Proof of Burn, Proof of Elapsed Time, Proof of Authority, Proof of Importance.

UNIT III: Cryptography Fundamentals: Encryption, Digital Signatures, Public-Key Cryptography, Private Key Cryptography, Distributed Denial-of-Service (DDoS) Attack, 51% Attack, Double spending problem, Merkel Tree, Security Threats to Blockchain Technology.

UNIT IV: Crypto currency and Wallet: Types of Wallets, Desktop Wallet, App based Wallet, Browser based wallet, MetaMask, Creating an account in MetaMask, Use of faucet to fund wallet, transfer of cryptocurrency in MetaMask.

UNIT V: Smart contract and Ethereum: Overview of Ethereum, Writing Smart Contract in Solidity, Remix IDE, Different networks of Ethereum, understanding blocks in blockchain, compilation and deployment of smart contracts in Remix

Course Outcomes

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

1. Realize importance of blockchain technology and consensus mechanism.
2. Identifying the security risks and challenges associated with blockchain technology.
3. Implement browser-based wallets and smart contracts in Remix IDE.
4. Recognize the importance of blockchain security in various enterprise applications.

Textbooks

1. Mastering Blockchain: Third Edition by Imran Bashier, Packt Publishing, 2020, ISBN: 9781839213199.

Reference Books

1. Blockchain: Blueprint for a New Economy by Melanie Swan, Oreilly Publication
2. Mastering Ethereum, by Andreas M. Antonopoulos, Gavin Wood
3. Bitcoin and Cryptocurrency Technologies (Princeton textbook) by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code: CAP6004-3

Course: Blockchain Technology Lab (PE-III)

L: 0 Hr, T: 0 Hr, P: 2 Hrs, Per Week

Total Credits: 1

Course Objectives

This course aims to provide hands-on experience with blockchain development tools and frameworks and will be able to use them to build and test their own blockchain projects.

Syllabus:

Experiments based on the above syllabus **CAT6004-3 Course Outcome:**

On completion of the course the student will be able to

1. Realize different blockchain tools and framework
2. Implement smart contracts for the development of enterprise applications
3. Apply different wallets for the deployments of smart contracts

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT6005

Course : Internet of Things

L: 2Hrs, T: 0 Hr, P: 0Hrs, Per Week

Total Credits: 02

Course Objectives

Understand the fundamentals of IoT, including sensing, actuation, networking, and communication protocols, along with machine-to-machine communication and interoperability. To develop hands-on experience with Arduino and Raspberry Pi by designing IoT applications using sensors, actuators, and communication modules while programming in Arduino IDE and Raspberry Pi environments. To explore cloud and fog computing, data analytics, and real-world IoT applications in smart cities, healthcare, agriculture, and industrial automation.

Syllabus:

UNIT-I: Fundamentals of Internet of Things

Introduction to Internet of Things (IoT); Characteristics, IoT Architecture (Physical and Logical) , IoT System Components and IoT Levels (Level 1-6 architectures); IoT Communication Models (Request-Response, Publish-Subscribe, Push-Pull, and Exclusive Pair); IoT Communication APIs (REST, WebSocket etc);

UNIT-II: IoT Hardware and Software

Sensor and Actuator Interfacing; ESP Platform Overview and Programming; Basic IoT Applications (LED, Button, Analog operations, DHT, Ultrasonic, Relay, PWM, Motor, LCD/OLED etc.), IoT Communication Interfaces (Bluetooth, Wi-Fi, I2C, SPI); Introduction to Raspberry Pi and Programming; IoT System Implementation.

UNIT-III: IoT Protocols

Basics of Networking; IoT Protocol stack, Application Layer protocol (HTTP, CoAP and MQTT); Sensor Networks; Machine-to-Machine Communications (M2M System Architecture, ZigBee 3.0, Zigbee full stack, ZigBee Architecture, 6LowPAN, Bluetooth, LoRa), Interoperability in IoT, Cloud Integration.

UNIT-IV: Data Management and Analytics

Data Handling and Analytics for IoT; Cloud Computing and Fog Computing; Introduction to Industrial Internet of Things (IIoT).

UNIT-V: IoT Applications and Case Studies

Case Studies on Smart Cities and Smart Homes; Connected Vehicles; Smart Grid; Smart Agriculture; Healthcare Systems; Activity Monitoring Applications, ethical practises.

Course Outcomes:

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

- CO1: Analyse IoT architectures, and communication models in practical scenarios.
- CO2: Implement IoT systems by interfacing sensors and actuators with Controller platforms.
- CO3: Integrate IoT protocols and networking technologies for IoT and M2M deployments.
- CO4: Evaluate data management and Computing platforms for IoT applications.
- CO5: Design IoT-based solutions for real world problems.

Text Books:

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
3. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895Reference

Reference books:

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
2. Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014.
3. Editors Ovidiu Vermesan

**Syllabus for Semester VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP6006

Course : Mini Project

L: 0Hrs, T: 0 Hr, P: 4Hrs, Per Week

Total Credits: 02

Course Objectives

The objective of the 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.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT7001

Course : Deep Learning-II

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

1. To provide a deep understanding of how complex joint probability distributions are represented using Bayesian Networks (Directed) and Markov Networks (Undirected).
2. To understand rules of independence, such as d-separation and local independencies, and how to perform causal and evidential reasoning within these structures.
3. To introduce stochastic neural architectures like Restricted Boltzmann Machines (RBMs) and explain how they function as both graphical models and unsupervised learning tools.
4. To develop proficiency in training advanced generative architectures, including Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs), through sampling techniques like Gibbs and Contrastive Divergence.

Syllabus

Unit I: Directed Graphical Models Recap of Probability Theory, Joint Distributions, representations of joint distribution, graphical representation of joint distribution, reasoning in a Bayesian network, Causal Reasoning, Evidential Reasoning, Independencies encoded by a Bayesian network (Case 1: Node and its parents), Independencies encoded by a Bayesian network (Case 2: Node and its non- parents), Independencies encoded by a Bayesian network (Case 3: Node and its descendants)

Unit -II: Markov Networks Markov Networks: Motivation, Factors in Markov Network, Local Independencies in a Markov Network, Using joint distributions for classification and sampling, concept of a latent variable.

Unit -III: Restricted Boltzmann Machines Introduction to Restricted Boltzmann Machines, RBMs as Stochastic Neural Networks, Unsupervised Learning with RBMs, Computing the gradient of the log likelihood, Motivation for Sampling.

Unit - IV: Markov Chains Introduction to Markov Chains, Need of Markov Chains, Setting up a Markov Chain for RBMs, Training RBMs using Gibbs Sampling, Training RBMs using Contrastive Divergence.

Unit -V: Variational Autoencoders Revisiting Autoencoders, Variational Autoencoders: The Neural Network Perspective, Variational autoencoders: (The graphical model perspective), Neural Autoregressive Density Estimator, Masked Autoencoder Density Estimator. Introduction to Generative Adversarial Networks, Applications of GAN.

Course Outcomes

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

1. Construct and decompose Bayesian and Markov Networks, identifying the specific conditional independencies encoded between nodes, parents, and descendants.
2. Apply unsupervised learning techniques to Restricted Boltzmann Machines (RBMs), including computing log-likelihood gradients and using RBMs for feature extraction.
3. Design and set up Markov Chains to train models using Gibbs Sampling and Contrastive Divergence, enabling efficient parameter estimation in latent variable models.
4. Synthesize modern generative models like Variational Autoencoders (VAEs) and GANs, evaluating their performance from both the neural network and graphical model perspectives

Text Books

1. Ian Good fellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT Press book. 2016.
2. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019.
3. Christopher Bishop, Pattern Recognition and machine learning; Springer Verlag, 2006.

Reference Books

1. Deep Learning from Scratch: Building with Python from First Principles by Seth Weidman published by O'Reilly.
2. Grokking Deep Learning by Andrew W. Trask published by Manning Publications.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP7001

Course : Deep Learning-II Lab

L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week

Total Credits: 01

Course Objectives

1. To implement Bayesian and Markov Networks for performing causal and evidential inference.
2. To develop and train Restricted Boltzmann Machines (RBMs) using unsupervised learning techniques.
3. To apply Gibbs Sampling and Contrastive Divergence for parameter estimation in latent models.
4. To build and deploy VAEs and GANs for data generation and density estimation tasks.

Practical's based on syllabus of CAT7001

Course Outcomes:

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

1. Perform automated reasoning and independence checks in Directed and Undirected graphical models.
2. Implement RBMs to extract features and compute log-likelihood gradients from raw data.
3. Utilize Markov Chains and sampling algorithms to train complex stochastic neural networks.
4. Create functional Variational Autoencoders and GANs to generate synthetic data samples

Text Books

1. Nikhil Buduma, Fundamentals of Deep Learning, O'reilly
2. François Chollet, Deep Learning with Python
3. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, Deep Learning using Python, Willey Publication

Reference Books

1. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019.
2. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT Press book. 2016.
3. Sandro Skansi, Introduction to Deep Learning, Springer

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT7002

Course : Cloud Computing

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

1. Understand virtualization concepts, hypervisors, containerization, and various virtualization types across systems and applications.
2. Apply virtualization technologies, data center operations, migration strategies, and networking fundamentals.
3. Gain practical knowledge of cloud computing models and implement core services in AWS and Microsoft Azure.

Syllabus:

Unit I: Introduction: Traditional server concept: pros and cons. Need of Virtualized Technology, Benefits of Virtualization. Hypervisors, Types of Hypervisors, Full Virtualization, Para Virtualization, Hardware Assisted Virtualization, Types of virtualizations: Various forms of virtualization: Desktop, Application, Server, Hardware, Storage, Memory and I/O virtualization. Virtualization at different levels. Virtualization Vs Containerization, Concept of Containers, Container Orchestration.

Unit II: Virtualization Technologies: Software Virtualization, Hardware Virtualization, Application Virtualization, Storage Virtualization, OS Virtualization. Accomplishing Virtualization. High availability of Data Centers, Planned and unplanned maintenance activities in a datacenter. Migration: Migration consideration, Things to do before migration of servers-Discovery, Assessment and Migration. Concepts of Networking: CIDR Blocks, Subnet Mask, Designing a network.

Unit III: Cloud Computing Fundamental: Cloud deployment models, Cloud service models. Benefits and challenges of cloud computing. Regions, Availability zones, Edge locations. Fundamentals of pricing: Total cost of ownership (TCO) and monthly calculator.

Unit IV: Amazon Web services (AWS): AWS core services: Storage: Simple Storage service (S3), Elastic Block Store (EBS), Elastic File Store (EFS), Content Delivery Network (CDN), Cloudfront, Snowball, Snowmobile, Route53.

Unit V: Introduction to Microsoft Azure, Subscription, Resource Group, Resource Deployment Models, Different methods of creating resources: Azure portal, Cloud shell, ARM templates, Virtual Networking in cloud. Compute Services in AWS and Azure: Elastic Compute Cloud (EC2) in AWS and VMs in Azure, Virtual Machine creation in Windows and Linux platform, Remote Desktop Protocol (RDP), Secure Shell (SSH) protocol, Security Groups, Load balancer, Auto scaling.

Course Outcomes:

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

1. Exhibit an understanding of virtualization technologies.
2. Apply the existing virtualization technologies to solve real-world problems.
3. Analyze architecture, services, and challenges in Cloud computing.
4. Know the services of the AWS platform and their usage.
5. Know services on the Microsoft Azure platform and their usage.

Text Books:

1. Distributed and Cloud Computing : Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, 1st Edition Elsevier
2. Cloud Computing Basics: A Non-Technical Introduction, Anders Lisdorf, Apress Publication.
3. Cloud Computing Bible : Barrie sosinsky, Wiley- India Edition
4. Cloud Computing : A Practical approach for learning and Implementation, A. Srinivasan, J. Suresh, 1st Edition, Pearson Publication

Reference Books:

1. The Complete Cornerstone Guide to Virtualization Best Practices: Ivanka Menken, Paperback, 2nd Edition, Emereo Pty Ltd.
2. Cloud Computing Explained: Implementation Handbook for Enterprise, 2013 Edition, Recursive Press Publication.
3. Enterprise Cloud Computing: Technology, Architecture, Applications, Gautam Shroff, 1st Edition, Cambridge University Press
4. Cloud Computing: Dr. Kumar Saurabh, 2nd Edition, Wiley- India Edition

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP7002

Course : Cloud Computing Lab

L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week

Total Credits: 01

Course Objectives

1. Perform hands-on setup and management of virtual machines, containers, and virtualization tools across different platforms.
2. Implement and test networking, migration, and high-availability concepts in virtualized and cloud environments.
3. Deploy and manage cloud resources and services in AWS and Microsoft Azure using practical tools and interfaces.

Course Outcomes:

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

1. Use the appropriate cloud service for a given application.
2. Demonstrate the use of Virtualization technology.
3. Demonstrate the need for high availability in the Cloud environment.
4. Designing a Virtual Network in the Cloud
5. Deploy Storage and application services on the Cloud platform.

Practical's based on syllabus of CAP7002.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT7003

Course : Data Analytics & Visualization

L: 1 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 01

Course Objectives

1. To understand data analytics life cycle for solving challenging business problems.
2. To adopt appropriate statistical procedures for analysis based on goals and nature of data.
3. To employ best practices in data visualization to develop charts, maps tables and other visual representations of data.

Syllabus

Unit I: Introduction and Overview: Importance of analytics and visualization, data preprocessing, Basic Analysis Techniques, Data Analytics Lifecycle and Different Phases, Association Rules and Regression Association Rules, Validation and Testing, Diagnostics. Regression, Choice of a Model.

Unit II: Classification and Clustering : Overview, k-Means, k-Modes, Partitioning around Medoids (PAM), Hierarchical Agglomerative and Density Clustering Methods. Classification: Decision Trees – Overview, Detecting Significant Split, Algorithms and Evaluation; Naïve-Bayes– Bayes' Theorem, Naïve Bayes Classifier, Smoothing; Diagnostics of Classifiers.

Unit III: Time Series Analysis: Box-Jenkins Methodology, ARIMA (Auto Regressive Integrated Moving Average) Model, Choice of a Model, Overview of ARMAX, Spectral Analysis and GARCH.

Unit IV: Data Visualization Understanding: Understanding Data Visualization Principles, Mapping Data onto Aesthetics, Visualizing - Distributions, Proportions, Time Series, Trends and Uncertainty; Commonly used File Formats and Software.

Unit V: Creating Stories with Data :Why Planning?, Creating Interesting Stories with Data – Reader driven Narratives, Author-driven Narratives; Perceptions and Presentation Methods, Best Practices in Visualization, Interactive Visualization, Event Listeners and Layouts, Case Studies for Visualization.

Course Outcomes:

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

1. Apply data preprocessing and basic data analysis techniques.
2. Conduct data analytics using scientific methods.
3. Analyze time series data.
4. Create presentations and visualizations.

Text Books

1. David Dietrich, Barry Heller and Beibel Yang, - Data Science and Big Data Analytics Discovering, Analyzing, Visualizing, and Presenting Data, John Wiley and Sons [EMC Education Services], 2015.
2. Claus O. Wilke, - Fundamentals of Data Visualization – A Primer on Making Informative and Compelling Figures, O'Reilly, 2019.
3. Python: Data Analytics and Visualization, Packt Publishing, 2017.

Reference Books

1. Jiawei Han, Micheline Kamber and Jian Pei, - Data Mining Concepts and Techniques, 3rd edition; Morgan Kaufmann Publishers, 2011.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP7003

Course : Data Analytics & Visualization Lab

L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week

Total Credits: 01

Course Objectives

1. To apply statistical methods for data analytics to provide business solutions.
2. To develop insights based on analytical results to facilitate better understanding of consumer attitude, perceptions and behavior.
3. To create data visualizations for effective communication to user.

Syllabus

Experiments based on Data Visualization and Analytics Theory Syllabus preferably using R, Python.

Course Outcomes:

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

1. Apply different data preparation techniques.
2. Apply various data analysis techniques.
3. Apply analytics on time series data.
4. Design effective presentations and visualizations.

Reference Books

1. David Dietrich, Barry Heller and Beibel Yang, - Data Science and Big Data Analytics – Discovering, Analyzing, Visualizing, and Presenting Data, John Wiley and Sons [EMC Education Services], 2015.
2. Kyran Dale, - Data Visualization with Python and JavaScript – Scrape, Clean and transform Your Data, O'Reilly, 2016.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT7004-1

Course : Big Data Analytics (PE-IV)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Prerequisite

Course on Operating System, Python/Java Programming

Course Objectives

1. To understand the basic concepts of big data analytics and the big data landscape.
2. To become proficient in the most popular big data computing frameworks in order to apply technology to solve various big data analytic problems.

Syllabus

Unit – I: Introduction to Big Data & Apache Hadoop:

Understanding Big Datatypes of Data, Different sources and rate of data generation, Why RDBMS is failing for Big Data, Big Data industry use cases Commerce Industry, Banking Sector, Medical Sector and Entertainment Sector, Tools and Technology required for Big Data, Apache Hadoop Ecosystem, Need for Hadoop, Apache Hadoop 1.0 Architecture, Hadoop Distributed File System, Check-pointing in Hadoop ,Architectural description for Hadoop Cluster, Read and Write operation in HDFS, Advantages of Hadoop

Unit -II: Map Reduce Programming:

Map Reduce Internal Architecture, Mapper Phase, Reducer Phase, Optimisation Techniques, Scheduling, Map Reduce program, Limitations of MapReduce, YARN / Hadoop 2.0,YARN Architecture Hadoop 1.0 and 2.0 Architecture.

Unit -III: Big Data processing Tools:

Apache Pig, Apache Pig Architecture, Data types in Apache Pig, Different Operations in Apache Pig, Apache Hive, Features of Apache Hive, Hive Data Types & Files Formats, Types of Table, Optimisation Techniques, Views and Indexes

Unit – IV: Data Ingestion & Streaming Technologies:

Apache Sqoop, Sqoop Architecture, Sqoop Features, Import & Export, Apache Flume, Flume Architecture, Integrating Flume with Applications, Apache Kafka: architecture, producers, consumers, Data pipelines and ETL concepts

Unit -V: Real Time Data Analytics & Applications:

Apache Spark, Features of Apache, Spark Deployment, Spark Components, Resilient Distributed Dataset (RDD), Data Processing in Apache Spark, Spark SQL, Spark Streaming, Link Analysis - Page Rank, Modified page rank, Search Engine Optimization using page rank; Analysing a Web Graph, Introduction to Machine Learning in Big Data.

Course Outcomes:

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

1. Explain big data concepts, characteristics, and the Hadoop ecosystem including HDFS architecture and data storage mechanisms.
2. Analyze distributed data processing frameworks such as MapReduce and YARN for handling large-scale data.
3. Apply big data tools and technologies including Apache Hive, Pig, Sqoop, Flume, and Kafka for data processing and ingestion.
4. Implement real-time data analytics using Apache Spark and apply analytical techniques such as PageRank and machine learning for solving real-world problems.

Text Books

1. "Big Data Analytics, Introduction to Hadoop, Spark and Machine Learning", Rajkamal and Preeti Saxena, McGraw Hill Publication, 2019.
2. "Big data and Analytics", Seema Acharya and Subhashini Chellappan, Wiley India Publishers, 2nd Edition, 2019.
3. Beginning Apache Spark 2: With Resilient Distributed Datasets, Hien Luu, Spark SQL, Structured Streaming and Spark Machine Learning Library, Apress, 2018
4. "Hadoop: The Definitive Guide", Tom White, 4th Edition, O'reilly Media, 2015
5. Programming Pig, By: Alan Gates, Published by O'REILLY

Reference Books

1. Mining of Massive Datasets, Leskovec, Rajaraman, Ullman, Cambridge University Press
2. "MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems", Adam Shook and Donald Mine, - O'Reilly 2012
3. Big Data for Dummies, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman; Wiley India, 2015.
4. Data Mining: Practical Machine learning tools and techniques, I.H. Witten and E. Frank.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT7004-2

Course : Reinforcement Learning (PE-IV)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Pre-requisite

Python Programming, Foundations of Machine Learning

Course Objectives

1. Reinforcement learning is a paradigm that aims to model the trial-and-error learning process that is needed in many problem situations where explicit instructive signals are not available. It has roots in operations research, behavioral psychology and AI.
2. The goal of the course is to introduce the basic mathematical foundations of reinforcement learning, as well as highlight some of the recent directions of research.

Syllabus:

Unit-1: Introduction: Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning. **Probability Primer:** Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

Unit 2: Markov Decision Process: Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

Unit 3: Prediction and Control by Dynamic Programming: Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.

Unit 4: Monte Carlo Methods for Model Free Prediction and Control: Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling. **TD Methods:** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning.

Unit 5: Function Approximation Methods: Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, Afterstates, Control with function approximation, Least squares, Experience replay in deep Q-Networks.

Policy Gradients: Getting started with policy gradient methods, Log-derivative trick, Naïve REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

Course Outcomes:

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

1. Learn how to define RL tasks and the core principals behind the RL
2. Use markov decision process
3. Apply dynamic programming for prediction and control problems
4. Implement Monte Carlo methods
5. Apply function approximation methods for ML problems

Text Books

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", Second Edition, MIT Press, 2018

Reference Books.

1. Csaba Szepesvari, "Algorithms for Reinforcement Learning", Morgan and Claypool, 2010.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT7004-3

Course : System Design (PE-IV)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

1. To introduce reliable software systems.
2. The objective of this course is to equip students with the knowledge and skills required to design scalable, reliable, and maintainable software systems.
3. Illustrate the benefits and drive the adoption of solutions for industry based real world problems.

Syllabus:

Unit I: Introduction to System Design, System Design fundamentals, System Design Life Cycle, components of System Design, Scalability in System Design and System Design patterns.

Unit II: Databases in Designing Systems: Relational databases, non-relational databases, How to choose a database, Database sharding and partitioning, Database indexing.

Unit III: Distributed system basics: Distributed system fundamentals, Distributed system failures, MapReduce Stateless and stateful systems, Distributed system design patterns

Unit IV: High level Design (HLD) and LLD (Low Level Design)

Unit V: Event management, message passing, log file , Scalable web applications, DNS and load balancing, N-tier applications, HTTP and REST, Stream processing, Caching, Machine learning and System Design, Containerization and System Design, The cloud and System Design

Course Outcomes:

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

1. Understand the fundamental principles of system design including scalability, reliability, maintainability and performance.
2. Perform exceptional scenarios building using appropriate databases and Distributed system fundamentals.
3. Ability to Perform High-level Low-Level Design.
4. Ability to do Event management, message passing and load balancing.

Text Books:

1. System Design Interview Volume 1 and 2 by Alex Xu.
2. Designing Data-Intensive Applications, Martin Kleppmann.
3. Patterns of Enterprise Application Architecture 1st Edition by Martin Fowler.

Reference Books

1. Clean Architecture: A Craftsman's Guide to Software Structure and Design, Robert C. Martin , Pearson.
2. Systems Analysis and Design, Scott Tilley, Cengage Learning.
3. System Analysis and Design, Alan Dennis, Barbara Wixom, Roberta M. Roth, Wiley.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT7005

Course : Robotics and Intelligent Systems

L: 2 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 02

Course Objectives

1. Understand fundamentals of robotics including kinematics, dynamics, sensors, perception, and navigation techniques.
2. Apply algorithms for mapping, path planning, control systems, and intelligent decision-making in robotic systems.
3. Analyze advanced robotic applications, human-robot interaction, and ethical implications of automation and AI.

Syllabus

Unit – I: Fundamentals of Robotics

Introduction to Robotics: History, components of a robotic system, classification of robots, and degrees of freedom (DoF); **Robot Kinematics:** Homogeneous transformations, D-H parameters, Forward and Inverse kinematics for serial manipulators; **Dynamics:** Jacobian matrix, singularity, and velocity analysis.

Unit – II: Robot Perception and Sensing

Sensors in Robotics: Internal vs. external sensors, vision sensors, LiDAR, ultrasonic, and IMUs; **Computer Vision for Robotics:** Object detection, tracking, and localization; **Sensor Fusion:** Introduction to Kalman Filters and Extended Kalman Filters (EKF) for state estimation.

Unit – III: Navigation and Path Planning

Environment Mapping: Occupancy grid mapping and SLAM (Simultaneous Localization and Mapping) fundamentals; **Path Planning Algorithms:** A*, Dijkstra, RRT (Rapidly-exploring Random Trees), and Artificial Potential Fields; **Obstacle Avoidance:** Reactive vs. deliberate navigation strategies.

Unit – IV: Intelligence in Robotics

Control Systems: PID control and feedback loops; **Reinforcement Learning (RL) in Robotics:** Markov Decision Processes (MDP), Q-Learning, and Policy Gradients for robot gait and manipulation; **Robot Operating System (ROS):** Architecture, nodes, topics, and simulation environments (Gazebo/PyBullet).

Unit – V: Advanced Applications and Ethics

Swarm Robotics: Multi-agent systems and coordination; **Human-Robot Interaction (HRI):** Social robotics, cobots, and safety protocols; **Case Studies:** Warehouse automation (AMRs), surgical robots, and autonomous drones; **Ethics in Robotics:** Responsibility, transparency, and the impact of automation on the workforce.

Course Outcomes:

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

CO1: Understand the fundamental components, kinematics, and dynamics of robotic systems.

CO2: Apply sensor fusion and perception techniques for robot environment mapping.

CO3: Implement path planning and navigation algorithms for autonomous mobile robots.

CO4: Integrate machine learning and reinforcement learning for intelligent robot control.

CO5: Design end-to-end intelligent robotic solutions for industrial automation and human-robot interaction.

Textbooks

1. Introduction to Robotics: Mechanics and Control, John J. Craig, Pearson Education, 4th Edition, 2017.
2. Probabilistic Robotics, Sebastian Thrun, Wolfram Burgard, and Dieter Fox, MIT Press, 2005.
3. Robot Dynamics and Control, Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Wiley, 2nd Edition, 2020.

Reference Books

1. Programming Robots with ROS, Morgan Quigley, Brian Gerkey, and William D. Smart, O'Reilly Media, 2015.
2. Robotics, Vision and Control: Fundamental Algorithms in Python, Peter Corke, Springer, 3rd Edition, 2023.
3. Hands-On Intelligent Robotics, Sebastian van Delden, Mercury Learning & Information, 2024.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP7006

L: 0 Hrs, T: 0 Hr, P: 8 Hrs, Per Week

Course : Major Project-1

Total Credits: 04

Course Objectives

The objective of the Major Project-1 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 the problem statement by investigating various domains and society needs.
2. Perform requirement analysis and design methodology for solving the identified
3. problem.
4. Apply programming techniques and modern tools for the development of the solution.
5. Apply ethical principles, project management skills and demonstrate the ability to work in teams for project development within the confines of a deadline.
6. Communicate technical information employing written reports and presentations

**Syllabus for Semester VIII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT8001-1

Course : Human Computer Interaction (PE-V)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

1. To introduce students to understand systems that interact effectively with humans -unimodal as well as multi-modal.
2. Enable students to implement, evaluate and provide long lasting solutions to support such HCI systems.

Unit I: Introduction: Importance of user Interface - definition, importance of good design. Benefits of good design. A brief history of Screen design, The graphical user interface - popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user - Interface popularity, characteristics- Principles of user interface.

Unit II: Foundations - Human reasoning and psychology for design of interactive systems, Human interaction speeds, and understanding business junctions, experience and engagement. Computers - Controls, sensors, display devices, virtual reality devices, printing, scanning, etc. Models of interaction with computers, Interaction styles - 2D and 3D, Paradigms for interaction.

Unit III: Screen Designing- Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, visually pleasing composition, amount of information, focus and emphasis. HCI - Software Lifecycle, Iterative design and prototyping, Heuristics, HCI patterns.

Unit IV: Implementation: Windows - Navigation schemes, selection of window, selection of devices based and screen-based controls. Components - text and messages, Icons, Multimedia, Colors. Multi-modal interactive system, Universal designs- design to fit diversity.

Unit V: Evaluation: Goals- Usability, functionality, acceptability, Types Expert Analysis, analytic, review based and model-based methods. User Participation, Experimental, Observational and Query methods. User Support: Issues to handle Presentation, Implementation, Requirements, Features and Styles, Command based, Context sensitive, help, documentation, wizards and assistants. Ubiquitous computing: virtual reality, augmented reality, Tools and techniques.

Course Outcomes:

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

1. Design effective user interfaces for HCI.
2. Select the most suitable hardware and software for human computer interactive systems.
3. Implement a universally acceptable design for human interaction.
4. Evaluate the functionality of an HCI system to provide user support.

Text Books

1. Wilbert O Galitz; The essential guide to user interface design; 2nd Edition; Wiley
1. DreamTech, 2002.
2. Ben Shneidermann; Designing the user interface; 3rd Edition; Pearson Education, 2009.
3. Alan Dix, et.al; Human - Computer Interaction; 3rd Edition; Pearson Education, 2003.

Reference Books

1. Prece, Rogers and Sharps; Interaction Design; 3rd Edition; Wiley Dreamtech, 2011.
2. Soren Lauesen; User Interface Design; Pearson Education, 2005.

**Syllabus for Semester VIII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT8001-2

Course : Generative Adversarial Network (PE-V)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

1. Understand basic concepts of Generative Adversarial Networks.
2. Identify the role of generator and discriminator in a GAN system
3. Apply possible solutions to real problems with GAN.

Syllabus

Unit-I

Unsupervised Learning with GAN: Automating human tasks with deep neural networks, The purpose of GAN, An analogy from the real world, The building blocks of GAN, Generator, Discriminator Implementation of GAN: Applications of GAN, Image generation with DCGAN using Keras, Implementing SSGAN using TensorFlow, Setting up the environment. Challenges of GAN models: Setting up failure and bad initialization, Mode collapse, Problems with counting, Improved training approaches and tips for GAN: Feature matching, Mini batch, Historical averaging One-sided label smoothing, Discriminative versus generative models Summary.

Unit-II

Transfer Image Style Across Various Domains, Bridging the gap between supervised and unsupervised learning, Introduction to Conditional GAN, Generating a fashion wardrobe with GAN, Stabilizing training with Boundary Equilibrium GAN, The training procedure of BEGAN Architecture of BEGAN, Implementation of BEGAN using Tensorflow, Image to image style transfer with CycleGAN, Model formulation of CycleGAN, Transforming apples into oranges using Tensorflow, Transfiguration of a horse into a zebra with CycleGAN

Unit-III

Building Realistic Images from Text, Introduction to StackGAN, Conditional augmentation, Stage-I Stage-II Architecture, details of StackGAN, Synthesizing images from text with TensorFlo, Discovering cross-domain relationships with DiscoGAN, The architecture and model formulation of DiscoGAN .

Unit-IV

Using Various Generative Models to Generate Images, Introduction to Transfer Learning, The purpose of Transfer Learning, Various approaches of using pre-trained models, Classifying car vs cat vs dog vs flower using Keras, Large scale deep learning with Apache Spark, Running pre-trained models using Spark, deep learning Handwritten digit recognition at a large scale using Big DL, High resolution image generation using SRGAN, Architecture of the SRGAN.

Unit-V

Taking Machine Learning to Production Building, an image correction system using DCGAN, Steps for building an image correction system, Challenges of deploying models to production, Micro service architecture using containers.

Course Outcomes:

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

1. Understand the basic concept and need of Generative Adversarial Networks
2. Analyze the roles of the generator and discriminator in a GAN system
3. Identify possible solutions to real problems with GAN.

Text Books

1. Learning Generative Adversarial Networks: Next-generation deep learning simplified by Kuntal Ganguly, Packt Publishing.

**Syllabus for Semester VIII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT8001-3

Course : Information Retrieval (PE-V)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Pre-requisite: Python Programming, Foundations of Machine Learning

Course Objectives

1. To learn fundamentals of information retrieval, indexing, relevance, classification, organization, storage and browsing.
2. To focus on prominent computer algorithms and methods used in information retrieval from a computer scientist's perspectives.

Unit – I:

Boolean retrieval, term vocabulary and postings list.

Unit – II:

Dictionaries and tolerant retrieval, index construction, index compression.

Unit – III:

Scoring, term weighting and the vector space model computing scores in a complete search System, Evaluation in information retrieval,

Unit – IV:

Relevance feedback and query expansion, Probabilistic information retrieval, language models for information retrieval.

Unit – V:

Web search basics, Web crawling and indexes, Link analysis.

Course Outcomes:

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

1. Analyze various requirements in designing an information retrieval system.
2. Apply methods of metadata organization for effective information access.
3. Implement Machine learning and numerical methods in information retrieval.
4. Evaluate information retrieval Systems
5. Design web search system.

Text and Reference Books

1. An Introduction to Information Retrieval : Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press.
2. Foundation of Statistical Natural Language Processing, Christopher D. Manning,
3. Hinrich Schütze, The MIT Press.
4. Information Retrieval: Implementing and Evaluating Search Engines, Stefan Buttcher, Charles, L.A. Clarke, Gordon V. Cormack, MIT Press.

**Syllabus for Semester VIII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT8002-1

Course : Financial Analysis (PE-VI)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

This course aims to equip students with the skills to apply data-driven techniques, statistical models, and financial theories to analyze and interpret financial data for informed decision-making.

Syllabus

Unit I: Introduction to Financial Analytics: Overview of Financial Analytics and its Applications, Importance of Data Analytics in Finance, Financial Data Sources and Types, Financial Metrics and Key Performance Indicators. Financial Data Management and Visualization: Data Acquisition and Cleaning (Excel, SQL, Python/R), Exploratory Data Analysis in Finance, Financial Data Visualization Techniques (Matplotlib, Seaborn).

Unit II: Financial Statement Analysis: Understanding Balance Sheets, Income Statements, and Cash Flow Statements, Ratio Analysis and Performance Evaluation, Time Series Analysis for Financial Data. Investment Analytics and Portfolio Management: Modern Portfolio Theory (MPT), Risk and Return Analysis, Portfolio Optimization Techniques, Asset Pricing Models (CAPM, APT)

Unit III: Risk Management and Fraud Detection: Financial Risk Types (Market, Credit, Operational), Value at Risk (VaR) Models, Credit Risk Modeling, Fraud Detection using Machine Learning

Unit IV: Predictive Analytics in Finance: Regression Analysis for Financial Forecasting, Time Series Forecasting (ARIMA, GARCH), Sentiment Analysis for Financial Markets

Unit V: Machine Learning in Financial Analytics: Introduction to Machine Learning for Finance, Supervised vs. Unsupervised Learning in Finance, Algorithmic Trading Strategies using ML, Deep Learning Applications in Finance

Course Outcomes:

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

1. Apply data visualization techniques on financial data.
2. Analyze financial statements and investment portfolios using data analytics techniques.
3. Utilize programming and statistical tools for risk management and fraud detection.
4. Develop predictive models for financial forecasting.
5. Apply machine learning techniques in financial decision-making.

Text Books

1. "Financial Data Analysis Using Python", by Dmytro Zherlitsyn, publisher Mercury Learning and Information, First edition, 2025
2. "Financial Data Analytics with Machine Learning, Optimization and Statistics", by Sam Chen, Ka Chun Cheung, Phillip Yam, and Kaiser Fan, first edition 2024.
3. "Python for Finance", by Yves Hilpisch, publisher O'Reilly Media, First edition 2015.
4. M. J., & Hugen, D. L . Financial analytics with R: building a laptop laboratory for data science Bennett, Cambridge University Press.
5. Consoli, S., Reforgiato Recupero, D., & S. Data Science for Economics and Finance. Methodologies and Applications, Springer Nature.

Reference Books

1. Machine Learning for Asset Managers" by Marcos López de Prado, O'Reilly Media Second edition 2019.
2. Aldridge, I., & Avellaneda, M. John Big data science in finance- Wiley & Sons.
2. Lukomnik, J., & Hawley, J. P Moving Beyond Modern Portfolio Theory- Investing that Matters,. :. Routledge.
3. Reilly, F. K., & Brown, K. C Investment Analysis and Portfolio Management., Cengage Learning.
4. Rees, M. John. Principles of financial modelling: model design and best practices using Excel and VBA. Wiley & Sons.

**Syllabus for Semester VIII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT8002-2

Course : Time Series Analysis (PE-VI)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

This course aims to provide an understanding of time-series data, its components, and statistical properties. It focuses on modelling and forecasting using classical methods such as ARIMA, along with machine learning and deep learning techniques for complex data. The course also emphasizes model evaluation and the development of end-to-end time-series solutions in Python for real-world AIML applications.

Syllabus:

Unit I: Introduction to Time Series Data

Definition, examples, and applications in AIML (stock prices, sensor/IoT data, sales forecasting, healthcare vitals, anomaly detection), Components: Trend, seasonality, cyclical, irregular/residual, Time-series visualization and descriptive statistics, Stationarity vs non-stationarity; tests (Augmented Dickey-Fuller (ADF), KPSS, Phillips-Perron), Ergodicity and weak/strong stationarity concepts (IIT-level rigour), Autocorrelation Function (ACF), Partial ACF (PACF), and correlograms.

Unit II: Classical Linear Time Series Models

White noise, random walk, and basic stochastic processes, Moving Average (MA(q)), Autoregressive (AR(p)), and ARMA(p,q) models, ARIMA(p,d,q) model Box-Jenkins methodology (identification, estimation, diagnostic checking), Seasonal ARIMA (SARIMA) and SARIMAX (with exogenous variables), Exponential smoothing: Simple, Holt's linear, Holt-Winters (additive/multiplicative), Parameter estimation (MLE, conditional least squares) and model diagnostics (Ljung-Box test, residual analysis).

Unit III: Forecasting, Evaluation & Advanced Statistical Models

Point and interval forecasting; multi-step ahead prediction, Forecast accuracy metrics: MAE, RMSE, MAPE, sMAPE, MASE; time-series cross-validation (rolling/windowed), Volatility modelling: ARCH/GARCH family (basic introduction for financial time series), Multivariate time series: Vector Autoregression (VAR), Granger causality, Brief overview of state-space models and Kalman filter.

Unit IV: Machine Learning Approaches for Time Series

Feature engineering for time series: lag features, rolling statistics, Fourier terms, calendar features, trend/seasonality decomposition (STL), Supervised ML models: Linear regression with time features, Decision Trees, Random Forest, XGBoost/LightGBM/CatBoost for forecasting, Handling non-stationarity and seasonality in ML pipelines, Facebook Prophet library additive model with uncertainty, Hybrid approaches (statistical + ML).

Unit V: Deep Learning for Time Series

Sequence modelling fundamentals: RNNs, vanishing/exploding gradient problem, LSTM and GRU architectures theory and implementation, Encoder-Decoder models, multi-step forecasting, Attention mechanisms and Transformers for time series (Temporal Fusion Transformer, Informer modern AIML focus), Multivariate and multi-horizon forecasting. Handling irregular time series, missing values, and long-sequence challenges, Libraries: TensorFlow/Keras, PyTorch; practical tips for hyperparameter tuning and training.

Course Outcomes

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

1. Decompose time-series data, test stationarity, and perform exploratory analysis.
2. Build, diagnose, and forecast using classical ARIMA/SARIMA and exponential smoothing models.
3. Engineer features and apply ML algorithms (tree-based, ensemble) for time-series forecasting.
4. Design and train RNN/LSTM/Transformer-based deep learning models for univariate/multivariate time-series.
5. Develop a complete end-to-end project with model deployment/comparison and present results.

Textbooks

1. Hyndman, R.J. & Athanasopoulos, G. Forecasting: Principles and Practice (3rd ed., 2021) – Free online (OTexts).
2. Box, G.E.P., Jenkins, G.M., Reinsel, G.C. & Ljung, G.M. Time Series Analysis: Forecasting and Control (5th ed., Wiley, 2015).
3. Brockwell, P.J. & Davis, R.A. Introduction to Time Series and Forecasting (3rd ed., Springer, 2016).

Reference Books

1. Deep Learning for Time Series Forecasting – Jason Brownlee (Machine Learning Mastery).
2. Fawaz, H.I. et al. (papers on deep learning for time series, arXiv).
3. Documentation: statsmodels, pmdarima, Prophet, Darts library, GluonTS.

**Syllabus for Semester VIII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAT8002-3

Course : Edge Computing (PE-VI)

L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week

Total Credits: 03

Course Objectives

The course aims to introduce the fundamentals of edge computing and its role in modern distributed systems. It focuses on deploying AI/ML models closer to data sources for real-time, low-latency applications. The course also emphasizes practical understanding of edge devices, frameworks, and real-world AI-driven use cases.

Syllabus

Unit I: Introduction to Edge Computing

Overview of cloud vs edge computing; need and benefits (low latency, bandwidth efficiency); edge-fog-cloud architecture; 5G/MEC integration; workload partitioning (edge vs cloud).

Unit II: Edge Devices and Platforms

Characteristics of edge environments (compute, memory, power, real-time constraints); edge accelerators; sensor data acquisition; edge OS/RTOS and runtime environments; containerization (Docker) and basic data flow in edge systems.

Unit III: AI/ML at the Edge

Need for AI at the edge; machine learning deployment pipeline; model optimization techniques (quantization, pruning); TinyML: Machine Learning on Microcontrollers (ESP32, ARM Cortex-M); edge AI frameworks (TensorFlow Lite); On-device inference; Applications in vision and sensor-based systems.

Unit IV: Edge Communication and System Design

Communication models—device-to-edge, edge-to-cloud; lightweight protocols (MQTT, CoAP, gRPC); edge analytics and data filtering; real-time constraints (latency, throughput); system design pipeline; scalability; resource constraints (CPU, memory, power) and trade-offs.

Unit V: Security, Applications and Case Studies

Security challenges in edge computing (privacy, authentication, device security); basic security mechanisms; device management (monitoring, OTA updates); Real-world edge AI use cases; future trends in edge computing.

Course Outcomes

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

1. Differentiate between cloud, fog, and edge architectures.
2. Design lightweight containerized applications for resource-constrained environments.
3. Optimize AI/ML models for on-device inference using quantization and pruning.
4. Implement robust communication pipelines using IoT-specific protocols
5. Analyse security vulnerabilities and privacy-preserving techniques

Textbooks:

1. Rajkumar Buyya and Amir Vahid Dastjerdi, *Internet of Things: Principles and Paradigms*, Elsevier — includes edge/fog concepts.
2. Instructor's notes.

Reference Books

1. K. Anshul & S. Kumar., *Edge Computing: Fundamentals, Design and Applications*, 1st edition, CRC Press (Taylor & Francis) in 2024.
2. Sabella D., Reznik A., Frazao R., *"Multi-access Edge Computing in Action"*, 1st edition, Kindle, 2019.
3. Al-Turjman F. (ed.): *"Edge Computing: from hype to reality"*, Springer, 2019.

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP8003

Course : Major Project-2

L: 0 Hrs, T: 0 Hr, P: 12 Hrs, Per Week

Total Credits: 06

Course Objectives

1. The objective of Major Project-2 is to let the students apply theoretical knowledge and practical skills acquired in the previous semesters to solve a real-world problem by developing an innovative, efficient solution while enhancing problem-solving, teamwork, and research capabilities.
2. To enhance the students' knowledge and skills in solving problem through structured project research to produce a competent and productive engineer.

Course Outcomes:

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

1. Identify and describe the problem and scope of project clearly
2. Collect, analyze and present data into meaningful information using relevant tools
3. Select, plan and execute a proper methodology in problem solving
4. Work independently and ethically
5. Present the results in written and oral format effectively
6. Identify basic entrepreneurship skills in project management

**Syllabus for Semester VII, B. Tech. Computer Science & Engineering
(Artificial Intelligence & Machine Learning)**

Course Code : CAP8006

Course : Industry / TBI / Research Internship

L: 0 Hrs, T: 0 Hr, P: 24 Hrs, Per Week

Total Credits: 12

Course Objectives

The purpose of Industrial Training is to expose students to real work of environment experience and at the same time, to gain the knowledge through hands on observation and job execution. From the industrial training, the students will also develop skills in work ethics, communication, management and others. Moreover, this practical training program allows students to relate theoretical knowledge with its application in the industry.

1. To enable students to explore opportunities for alternative career development.
2. To assess interests and abilities in the respective field of study and to integrate theory and practice.
3. To learn workplace habits and develop attitudes and skills necessary for job success.

Objectives of industrial training are:

1. To provide students the opportunity to test their interest in a particular career before permanent commitments are made.
2. To develop skills in the application of theory to practical work situations.
3. To develop skills and techniques directly applicable to their careers.
4. Internships will increase a student's sense of responsibility and good work habits.
5. To expose students to real work environment experience gain knowledge in writing report in technical works/projects.
6. Internship students will have higher levels of academic performance.
7. Internship programs will increase student earning potential upon graduation.
8. To build the strength, teamwork spirit and self-confidence in students' life.
9. To enhance the ability to improve students' creativity skills and sharing ideas.
10. To build a good communication skill with group of workers and learn to learn proper behaviour of corporate life in industrial sector.
11. The student will be able instilled with good moral values such as responsibility, commitment and trustworthy during their training.

Course Outcomes:

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

1. Apply fundamental science and engineering, AI and ML principles to identify and evaluate real-world challenges.
2. Design and implement effective solutions while assessing their impact on projects and industry practices.
3. Use modern tools and demonstrate a continuous learning approach.
4. Apply ethical principles and 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.

Mode of Conduction:

Each student will be evaluated through Seminar-cum-Presentations on the following parameters

1. Technology
2. Domain Understanding
3. Outcomes