RCOEM

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
2022 – 2023

B. TECH. - COMPUTER SCIENCE & ENGINEERING
(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

About the Department:

The Department of Computer Science & Engineering was established in 2002, is well-equipped with state-of-the-art infrastructure. The programme in Computer Science & Engineering with specialization in Artificial Intelligence & Machine Learning (AL & ML) was established in 2020. The state of art infrastructure includes latest configuration desktops. The programme is designed to enable students to build intelligent machines, software, or applications with a cutting-edge combination of Artificial Intelligence, Machine learning and Deep Learning technologies after equipping them with the basic fundamentals of Computer Science and Engineering.

The department hosts computers, laptops and lab with internet facility. The 24X7 network managed with Cyberoam UTM firewall, and CISCO router offers intranet and internet connectivity. The computer laboratories have high-end servers of IBM and WIPRO along with industry-standard software, viz., Oracle, NetSim, Wireshark, AIX, Robotics Platform, IOT Kit and MSDN. The department promotes high-end computing through Open Source technologies and hosts NVIDIA DGX DL Workstation.

The major focus of the programme is to create skilled engineers to innovate, design, think and provide intelligent solutions to problems in a variety of domains such as Education, healthcare, security, information forensics, Data virtualization, Agriculture, efficient transportation, smart cities and business applications, in various government and public sectors etc.

Departmental Vision:

To continually improve the education environment, in order to develop graduates with strong academic and technical background needed to achieve distinction in the discipline. The excellence is expected in various domains like workforce, higher studies or lifelong learning. To strengthen links between industry through partnership and collaborative development works.

Department Mission:

To develop strong foundation of theory and practices of computer science amongst the students to enable them to develop into knowledgeable, responsible professionals, lifelong learners and implement the latest computing technologies for the betterment of the society.

Program Education Objectives:

1. To be able to comprehend, understand and analyze Computer Science Engineering problems related to real life which can be better resolved by artificial intelligence and machine learning.
2. To impart exhaustive knowledge of Computer Science Engineering, AI and Machine Learning to cater the industrial needs and excel in innovation and management fields by prediction analysis.
3. To promote collaborative learning and spirit of team work through multidisciplinary AI based projects and diverse professional ethics.
4. To inculcate a conviction to believe in self, impart professional and ethical attitude and nurture to be an effective team member, infuse leadership qualities, and build proficiency in soft skills and the abilities to relate engineering with the social, political and technical issues as per the current scenario.

Programme Outcomes (POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis ofthe information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need forsustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and normsof the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage inindependent and lifelong learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs):

1. The ability to understand, analyze and demonstrate the knowledge of human cognition, Artificial Intelligence and Machine Learning in terms of real world problems to meet the challenges of the future.
2. The ability to develop computational knowledge and project development skills using innovative tools and techniques to solve problems in the areas related to Artificial Intelligence, Machine learning, Deep Learning.

Teaching Scheme for B. Tech Computer Science and Engineering (AIML)

Semester - I

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CHT152	Chemistry	3	1	0	4	40	60	100	03
2.	CHP152	Chemistry Lab	0	0	3	1.5	25	25	50	-
3.	MAT152	Differential Equation, Linear Algebra, Statistics & Probability	3	0	0	3	40	60	100	03
4.	CAT101	Programming for Problem Solving	4	0	0	4	40	60	100	03
5.	CAP101	Programming for Problem Solving Lab	0	0	2	1	25	25	50	-
6.	IDT151	Creativity, Innovation & Design Thinking	1	0	0	1	20	30	50	1.5
7.	CAT102	Computer Workshop	1	0	0	1	20	30	50	1.5
8.	CAP102	Computer Workshop Lab	0	0	2	1	25	25	50	-
9.	HUT151	English	2	0	0	2	40	60	100	03
10.	HUP151	English Lab	0	0	2	1	25	25	50	-
		TOTAL	**14**	**1**	**9**	**19.5**			**700**	

Semester - II

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	PHT154	Introduction to Quantum Computing	3	1	0	4	40	60	100	03
2.	PHP154	Introduction to Quantum Computing Lab	0	0	3	1.5	25	25	50	-
3.	MAT151	Calculus	3	1	0	4	40	60	100	03
4.	MAP151	Computational Mathematics Lab	0	0	2	1	25	25	50	-
5.	CAT103	Digital Electronics	3	0	0	3	40	60	100	03
6.	CAP103	Digital Electronics Lab	0	0	2	1	25	25	50	-
7.	CAT104	Object Oriented Programming	3	0	0	3	40	60	100	03
8.	CAP104	Object Oriented Programming Lab	0	0	2	1	25	25	50	-
9.	HUT152	Constitution of India	2	0	0	0	-	-	-	-
10.	PEP151	Yoga / Sports	0	0	2	0	-	-	-	-
		TOTAL	**14**	**2**	**11**	**18.5**			**600**	

Semester - III

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CAT201	Data Structures	3	1	0	4	40	60	100	03
2.	CAP201	Data Structures Lab	0	0	2	1	25	25	50	-
3.	CAT202	Computer Architecture	3	0	0	3	40	60	100	03
4.	MAT271	Mathematics for Machine Learning	3	0	0	3	40	60	100	03
5.	CAT203	Operating System	3	0	0	3	40	60	100	03
6.	CAP203	Operating System Lab	0	0	2	1	25	25	50	-
7.	HUT253	Business Communication	3	0	0	3	40	60	100	03
8.	HUT257	Cyber Laws & Ethics in IT	2	0	0	2	40	60	100	03
9.	CAP204	Python Programming Lab	0	0	4	2	25	25	50	-
		TOTAL	**17**	**1**	**8**	**22**			**750**	

Semester - IV

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CAT205	Computer Networks	3	1	0	4	40	60	100	03
2.	CAP205	Computer Networks Lab	0	0	2	1	25	25	50	-
3.	CAT206	Artificial Intelligence: Principles and Techniques	3	1	0	4	40	60	100	03
4.	CAP206	Artificial Intelligence Lab	0	0	2	1	25	25	50	-
5.	CAT207	Theory of Computation	3	1	0	4	40	60	100	03
6.	CAT208	Design and Analysis of Algorithms	3	1	0	4	40	60	100	03
7.		Open Elective-I / MOOC (Related to AI-ML)	3	0	0	3	40	60	100	03
8.	CAP209	Software Lab-1	0	0	2	1	25	25	50	-
9.	CHT252	Environment Sciences	2	0	0	0	-	-	-	-
		TOTAL	**17**	**4**	**6**	**22**			**650**	

	Recommended course from MOOC
1	Computer Graphics
2	Software Engineering

Semester - V

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CAT301	Database Management Systems	3	0	0	3	40	60	100	03
2.	CAP301	Database Management Systems Lab	0	0	2	1	25	25	50	-
3.	CAT302	Machine Learning	3	0	0	3	40	60	100	03
4.	CAP302	Machine Learning Lab	0	0	2	1	25	25	50	-
5.	CAT303	Microcontroller Design	3	0	0	3	40	60	100	03
6.	CAP303	Microcontroller Design Lab	0	0	2	1	25	25	50	-
7.	CAT304	Compiler Design	3	0	0	3	40	60	100	03
8.	CAP304	Compiler Design Lab	0	0	2	1	25	25	50	-
9.		Open Elective-II / MOOC (Related to AI-ML)	3	0	0	3	40	60	100	03
10.	CAP305	Mini Project-1	0	0	4	2	25	25	50	-
11.	HUT353	Indian Traditional Knowledge	2	0	0	0	-	-	-	-
		TOTAL	17	0	12	21			750	

Semester - VI

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CAT306	Deep Learning	3	0	0	3	40	60	100	03
2.	CAP306	Deep Learning Lab	0	0	2	1	25	25	50	-
3.	CAT307	Data mining and Warehousing	3	0	0	3	40	60	100	03
4.	CAP307	Data mining and Warehousing Lab	0	0	2	1	25	25	50	-
5.	CAT308	Natural Language Processing	3	0	0	3	40	60	100	03
6.	CAP308	Natural Language Processing Lab	0	0	2	1	25	25	50	-
7.	CAT309	Fundamentals of Digital Image and Video Processing	3	0	0	3	40	60	100	03
8.	CAP309	Fundamentals of Digital Image and Video Processing Lab	0	0	2	1	25	25	50	-
9.		Open Elective-III/MOOC	3	0	0	3	40	60	100	03
10.	CAP310	Mini Project-2	0	0	4	2	25	25	50	-
11.	CAP311	Comprehensive Viva	0	0	2	1	25	25	50	-
		TOTAL	15	0	14	22			800	

List of Open Electives

SN	Semester	Course Code	Course
1	IV	CAT299	Statistical Computing with R
2	V	CAT398	Machine Learning - Tools and techniques
3	VI	CAT399	Data Analytics
4	VII	CAT498	Software Engineering

Semester - VII

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CAT401	Data Analytics and Visualization	3	0	0	3	40	60	100	03
2.	CAP401	Data Analytics and Visualization Lab	0	0	2	1	25	25	50	-
3.	IDT453	Bio-Informatics	2	0	0	2	20	30	50	1.5
4.		Open Elective IV/MOOC	3	0	0	3	40	60	100	03
5.	CAT402	Program Elective-I	3	0	0	3	40	60	100	03
6.	CAP402	Program Elective-I Lab	0	0	2	1	25	25	50	-
7.	CAT403	Program Elective-II	3	0	0	3	40	60	100	03
8.	CAP403	Program Elective-II Lab	0	0	2	1	25	25	50	-
9.	CAP404	Project Phase I	0	0	12	6	50	50	100	-
		TOTAL	14	0	18	23			700	

Semester - VIII

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CAT405	Program Elective-III	3	0	0	3	40	60	100	03
2.	CAT406	Program Elective-IV	3	0	0	3	40	60	100	03
3.	CAP407	Project Phase II	0	0	12	6	50	50	100	-
OR										
1	CAP408	Industry Internship (One semester)	-	-	12	12	150	150	300	-
		TOTAL	**0**	**0**	12	**12**			**300**	

Program Elective-I	
Subject Code	**Subject Name**
CAT402-1	Cloud Computing
CAP402-1	Cloud Computing Lab
CAT402-2	Social Network Analysis
CAP 402-2	Social Network Analysis Lab
CAT402-3	Distributed Systems
CAP 402-3	Distributed Systems Lab
CAT402-4	Computer Vision
CAP 402-4	Computer Vision Lab

Program Elective-II	
Subject Code	**Subject Name**
CAT403-1	Financial Analysis
CAP403-1	Financial Analysis Lab
CAT403-2	Customer Relationship Management
CAP403-2	Customer Relationship Management Lab
CAT403-3	Blockchain Technology
CAP403-3	Blockchain Technology Lab
CAT403-4	Information Security
CAP403-4	Information Security Lab

Program Elective-III	
Subject Code	**Subject Name**
CAT405-1	Introduction to GAN [Generative Adversarial Networks]
CAT405-2	Reinforcement Learning
CAT405-3	Human Computer Interaction
CAT405-4	Game Theory
CAT405-5	Information Retrieval

Program Elective-IV	
Subject Code	**Subject Name**
CAT406-1	Robotics
CAT406-2	Cyber Security Intelligence
CAT406-3	Time Series Analysis
CAT406-4	Introduction to IOT
CAT406-5	Big Data Analytics using Hadoop

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

Course Code : CAT201 Course : Data Structure

L: 3Hrs, T: 1Hr, P: 0Hr, Per Week Total Credits : 04

Course Objectives

1. To impart to students the basic concepts of data structures and algorithms.
2. To familiarize students on different searching and sorting techniques.
3. To prepare students to use linear (stacks, queues, linked lists) and non-linear (trees, graphs) data structures.
4. To enable students to devise algorithms for solving real-world problems.

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

UNIT II 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 III 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, header node linked lists.

UNIT IV Sorting and Searching

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.

UNIT V Trees

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, B+-tree: definitions, characteristics, and operations (introductory).

UNIT VI Graphs and Hashing

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 method) algorithms.

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

Course Outcomes

On completion of the course the student will be able to

1. Recognize different ADTs and their operations and specify their complexities.
2. Design and realize linear data structures (stacks, queues, linked lists) and analyze their computation complexity.
3. Devise different sorting (comparison based, divide-and-conquer, distributive, and tree- based) and searching (linear, binary) methods and analyze their time and space requirements.
4. Design traversal and path finding algorithms for Trees and Graphs.

Text Books

1. Ellis Horowitz, Sartaj Sahni & Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.
2. Mark Allen Weiss; Data Structures and Algorithm Analysis in C; Second Edition; Pearson Education; 2002.
3. G.A.V. Pai; Data Structures and Algorithms: Concepts, Techniques and Application; First Edition; McGraw Hill; 2008.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein; Introduction to Algorithms; Third Edition; PHI Learning; 2009.
2. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran; Fundamentals of Computer Algorithms; Second Edition; Universities Press; 2008.
3. A. K. Sharma; Data Structures using C, Second Edition, Pearson Education, 2013.

Syllabus for Semester III, B. E. Computer Science & Engineering (AIML)

Course Code : CAP201 Course : Data Structure Lab

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

Course Objectives

1. To enable students to employ different searching and sorting methods.
2. To prepare students to identify and apply linear (stacks, queues, linked lists) and non- Linear (trees,graphs)datastructuresinsolvingproblems.
3. To encourage students to design and execute tree-based algorithms for solving real- world problems.

SYLLABUS

Experiments based on CAT201 Syllabus in C | C++.

Course Outcomes

On completion of the course the student will be able to

1. Design and realize different linear data structures.
2. Identify and apply specific methods of searching and sorting to solve a problem.
3. Implement and analyze operations on binary search trees and AVL trees.
4. Implement graph traversal algorithms, find shortest paths and analyze them.

Reference Books

1. K R. Venugopal and Sudeep. R Prasad; Mastering C; Second Edition; McGraw Hill; 2015.
2. Ellis Horowitz, Sartaj Sahni & 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; Second Edition; Pearson Education; 2002.

Syllabus for Semester III, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAT202 Course : Computer Architecture

L: 3Hrs, T: 0Hr, P: 0Hr, Per Week Total Credits : 03

Course Objectives

1. To familiarize student with computer architecture and organization.
2. Prepare student to perform mathematical operation and execute complete instruction in computer.
3. Prepare students to analyse performance of various memories.
4. To familiarize student with input/output operation and interrupt handling mechanism.

SYLLABUS

UNIT I : Basic Structure Of Computers: Functional units of computer. Instructions set architecture ofa CPU-Instruction sequencing, Addressing modes, and instruction set classification, subroutine & parameter passing, expanding opcode, RISC and CISC.

UNIT II : Basic Processing Unit: Bus architecture, Execution of a Complete Instruction, sequencing of control signals, Hardwired control, Micro-programmed Control.

UNIT III : Data Representation : signed number representations and their operations, Computer arithmetic – integer addition and subtraction, design of Fast Adders, Multiplication- shift and add,booth's Algorithm, bit-pair recoding, Integer Division- restoring and non-restoring division. Floating point numbers-representation, arithmetic, guard bits and rounding.

UNIT IV : Concept of hierarchical memory, Memory System Design: Semiconductor RAM memories, Static and Dynamic Memories, ROM, higher order memory design, multi-module memories, Memory interleaving, Cache memory, Cache size vs. block size, mapping functions, replacement algorithms, Cache read/write policy, Virtual Memory. Secondary storage – Magnetic disk, Optical disk.

UNIT V : Input/output Organization: I/O mapped I/O and memories mapped I/O, interrupt and interrupt handling mechanisms, vectored interrupts, synchronous vs. asynchronous data transfer, Bus Arbitration, Direct Memory Access,

UNIT VI : Pipelining: Basic concepts of pipelining, throughput and speedup, Introduction of Parallel Computing: SISD, MISD, SIMD, MIMD

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

1. Describe basic components of a computer, including CPU, memories, and input/output, and their organization.
2. Execute complete instruction and design control unit.

3. Perform mathematical operations on arithmetic and floating point numbers.
4. Analyse cost performance trade off in designing memory hierarchy and instruction sets.

Text Books

1. V.C.Hamacher, Z.G.Vranesic and S.G.Zaky; Computer Organisation; 5th edition; Tata McGrawHill, 2002.
2. W. Stallings; Computer Organization & Architecture; PHI publication; 2001.
3. J. P. Hayes; Computer Architecture & Organization; 3rd edition; McGraw-Hill; 1998.
4. Reference Books
5. M Mano; Computer System and Architecture; PHI publication; 1993.
6. A.S.Tanenbaum; Structured Computer Organization; Prentice Hall of India Ltd.ProgrammeScheme & Syllabi for B.E. (Computer Science & Engineering)

Syllabus for Semester III, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : MAT271 Course : Mathematics for Machine Learning L: 3Hrs, T: 0Hr, P: 0Hr, Per Week Total Credits : 03

Course Objective:

The objective of this course is to familiarize the prospective engineers with techniques in linear algebra and optimization. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes

On successful completion of the course, the students will learn:

Computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigen values and eigenvectors, orthogonality and diagonalization.

Visualization, spatial reasoning, as well as geometric properties and strategies to model, solve problems, and view solutions, especially in R^2 and R^3, as well as conceptually extend these results to higher dimensions.

Understand the optimization formulations and methods to vital in designing algorithms to extract essential knowledge from huge volumes of data.

Syllabus :

Module - 1 (9 - Lectures) Vector Space; Subspaces; Linear Dependence and Independence; Basis; Dimension; Linear transformation; Range Space and Rank; Null Space and Nullity; Rank nullity theorem, Matrix Representation of a linear transformation; Linear Operators on and their representation as square matrices; Invertible linear operators.

Module - 2 (9-Lectures) : Eigenvalues and Eigenvectors of a linear operator; Inner Product Spaces, Norm; Orthonormal Sets, Gram Schmidt orthogonalisation process; projections, positive definite matrices, and Singular Value Decomposition.

Module - 3 (9 - Lectures) : Dimentionality Reduction with PCA : Properties and application of SVD, Least square approximation, principal component analysis ,Linear discriminant analysis ,Low rank approximation.

Module -4 (9 - Lectures) : Continuous Optimizations : Optimization using gradient descent, Constrained optimization, Convex optimization, Linear programming , Quadratic programming .

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)
3. Mark Peter Deisenroth,A.Aldo Faisal,Chen Soon Ong :Mathematics for Machine Learning.Cambridge University Press.

4. Stephen Boyd and Lieven Vandenberghe: Convex optimization .Cambridge University Press.

Reference Books

1. Seymour Lipschutz et al: Linear Algebra, 3rded: Schaum outlinevseries.
2. V. Krishnamoorthy et al : An introduction to linear algebra , Affiliated East West Press, New Delhi
3. P.G. Bhattacharya, S.K. Jain and S.R.
4. Nagpaul : First course in Linear Algebra, Wiley Eastern Ltd., New Delhi
5. K.B.Datta : Matrix and Linear Algebra, Prentice Hall of India, New Delhi

Syllabus for Semester III, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAT203 Course : Operating System

L: 3Hrs, T: 0Hr, P: 0Hr, Per Week Total Credits : 03

Course Objectives

1. The course focuses on developing a fundamental knowledge of operating systems.
2. The course targets at the detail understanding of the basic tasks such as scheduling, memory management and File systems
3. It also covers the complex concepts of inter process communication and deadlocks.

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, Case study on LINUX and Windows Operating System.

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 multithreads. 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, Dinning 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 & Disadvantages of paging. Virtual Memory: Basics of Virtual Memory, Hardware and control structures, Locality of reference, Page fault, Working Set, Dirty page/ Dirty bit, Demand paging; Page Replacement, algorithms: First in First Out (FIFO), Least Recently used (LRU), and Optimal.

UNIT VI:

File Management : Concept of File, Access methods, File types, File operations, Directory structure, File System structure, Allocation methods, Free-space management.
Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK, Disk reliability, Disk formatting, Boot block, Bad blocks, case study on File Systems in LINUX operating System.

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

1. Describe and Classify differing structures for operating systems.
2. Understand the role of various components (process, page, file systems etc) of operating system.
3. Analyze and apply resource (CPU, Memory, Disk) management policies.
4. Determine challenges in inter process communication and design solution for it.

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. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAP203 Course : Operating System Lab

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

Course Objectives

1. The course provides practical exposure to design and implementation of concepts in operating systems such as system calls, CPU scheduling, process/thread management.
2. It focuses on implementation of resource management methodologies such as concurrency management, memory management, and File management.

SYLLABUS

Experiments based on CAT203 Syllabus.

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 for Semester III, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : HUT253 Course : Business Communication

L: 3Hrs, T: 0Hr, P: 0Hr, Per Week Total Credits : 03

SYLLABUS

UNIT I Fundamentals of Business Communication
Definition of communication and business communication, Objectives of Business Communication, Audience recognition, Barriers of Communication, Product Promotion, Usage of Social Media, Negotiation Skills, Persuasive Communication, PAC concept.

UNIT II Technical Writing
Process of Technical Writing, Types of Technical Writing. Letters: Job application, Job Description and CV, enquiry, complaint, order, follow-up, cover/transmittal letters, and e-mails. Writing to Persuade: Proposals and Sales Letters. Other Forms of Technical Writing: Notices, Circulars, Memos, Organizational announcements, Minutes of Meeting.

UNIT III Grammar for Writing
Functional Grammar: Punctuations, Mechanics, Active/ Passive, Transformation of Sentences, Subject-Verb Agreement, Articles, Prepositions.

UNIT IV Business Reports
Basic formats and types (Annual, Progress, Project (Project Charter, Project Timeline), Market Search, Sales, Feasibility/Recommendation), Case Study evaluation.

UNIT V Preparation of Documents
Visual Appeal: Document Design, Graphics, Tables, User Manuals, Brochures, Fliers.

UNIT VI Effective Oral Communication
Non-Verbal Communication, Public speaking, Presentation, Group Discussion.

Course Outcomes

1. Students will understand the fundamentals and objectives of business communication, and role of audience in effective communication.
2. Students will develop technical writing skills and produce effective workplace documents.
3. Students will learn the application of grammar in writing.
4. Students will develop skills to enhance visual appeal of documents.
5. Students will understand strategies for effective oral communication for professional needs.

Syllabus for Semester III, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : HUT257 Course : Cyber Laws and Ethics in IT

L: 2Hrs, T: 0Hr, P: 0Hr, Per Week Total Credits : 02

Course Objectives

1. Describe laws governing cyberspace and analyze the role of Internet Governance in framing policies for Internet security
2. Identify intellectual property right issues in the cyberspace and design strategies to protect your intellectual property
3. Understand the importance of freedom of expression, defamation and hate speech in Cyber world.
4. Recognize the importance of digital divide, contingent workers and whistle blowing situations.

SYLLABUS

UNIT I

Cyber laws and rights in today's digital age; IT Act, Intellectual Property Issues connected with use and management of Digital Data, Emergence of Cyberspace, Cyber Jurisprudence.

UNIT II

Cyber Crimes against Individuals, Institution and State, Hacking, Digital Forgery, Cyber Stalking/Harassment, Cyber terrorism, Cyber Defamation, Different offences under IT Act, 2000,Cyber Torts.

UNIT III

Ethics in business world, Ethic s in IT, Ethics for IT professionals and IT users, IT professional malpractices, communications eavesdropping, computer break-ins, denial-of-service, destruction and modification of data, distortion and fabrication of information, Types of Exploits and Perpetrators.

UNIT IV

Intellectual Property: Copy rights, Patents, Trade Secret Laws, Key Intellectual property issues, Plagiarism, Competitive Intelligence, Cybersquatting, Information warfare policy and ethical Issues.

UNIT V

Privacy: The right of Privacy, Protection, Key Privacy and Anonymity issues, Identity Theft, Consumer Profiling, Defamation, Freedom of Expression, Anonymity, National, Security Letters, Defamation and Hate Speech.

UNIT VI

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

Course Outcomes

On successful completion of the course, students will be able

1. To identify and analyze statutory, regulatory, constitutional, and organizational laws that affectsthe softwareprofessional.
2. To understand carious cyber laws with respect to legal dilemmas in the Information Technology field.
3. To interpret various intellectual property rights, Privacy, Protection issues in software developmentfield.
4. To understand role of ethics in IT organization.

Text Books

1. George Reynolds, "Ethic s 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).

Syllabus for Semester III, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAP204 Course : Python Programming Lab

L: 0Hrs, T: 0Hr, P: 4Hr, Per Week Total Credits : 02

Course Objective

The course focuses on developing the python programming skills to do a variety of programming tasks where the students are encouraged to develop application using python. Apart from the basic constructs of python programming, data structures, object oriented programming, exception handling is covered. The course also targets the coverage of important modules and libraries available in python.

Syllabus

- Arithmetic, logical operations, Control statements, Functions, Class and OOM
- String, List, Array, Tuples, Dictionary, Set
- Collections, Files, Exception Handling
- Module, Packages, Library
- Plotting, Web scrapping, Multimedia services
- Matplotlib, Pandas, Request, Numpy
- Beautifil soup, Pyglet, Scrapy, PyGame
- Pywin32, PyGTK, Geopy

Course Outcome

On Successful completion of course student will be able to :

1. Identify, Recall syntax of various constructs in python programming
2. Understand the usage of various instructions, functions, modules, packages and libraries in python programming
3. Write, debug and execute python program to solve given problem
4. Select an appropriate instruction, function, module and libraries for writing an efficient and correct code in python
5. Design a small python based software to solve a numerical, multimedia, games, location, web based problems.

Reference Books

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", Second Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.
2. Shroff "Learning Python: Powerful Object-Oriented Programming; Fifth edition, 2013.
3. David M.Baezly "Python Essential Reference". Addison-Wesley Professional; Fourth Edition, 2009.
4. David M. Baezly "Python Cookbook" O'Reilly Media; Third edition, 2013.

Syllabus for Semester IV, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAT205 Course : Computer Network

L: 3Hrs, T: 1Hr, P: 0Hr, Per Week Total Credits : 04

Course Objectives

1. To develop an understanding of modern network architectures from a design and performance perspective.
2. To introduce the student to the major concepts involved in network protocols.
3. To provide an opportunity to do network programming

SYLLABUS

UNIT - I

Data communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN,Wireless LANs, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Timedivision and Wavedivision

UNIT - II

Data Link Layer : Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, SelectiveRepeatARQ.

UNIT - III

Medium Access Sub Layer : Switching, Random Access, Multiple access protocols - Pure ALOHA,Slotted ALOHA,CSMA/CD,CDMA/CA,IEEE 802 standard protocols.

UNIT - IV

Network Layer : Internet Protocol (IP) – Logical Addressing: IPV4, IPV6; Address mapping: ARP, RARP, BOOTPand DHCP–Delivery,Forwardingand UnicastRoutingprotocols.

UNIT - V

Transport Layer : Elements of Transport protocols: Addressing, Connection establishment,Connection release, Crash recovery, User Datagram Protocol (UDP), Transmission Control Protocol(TCP), TCP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

UNIT - VI

Application Layer : Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP),WWW, HTTP, SNMP, Bluetooth, Firewalls; AI in network infrastructure, Self-Healing Networks

Course Outcomes

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

1. Understandbasicsofcomputernetworksandreferencemodels

2. Identify the Design issues of each layer of OSI model
3. Implement the protocols of OSI model

Text Books

1. Computer Networks: 5th ed by Andrew. S. Tanenbaum. PHI Publication.
2. Data Communications and Networks: 3rd ed by Behrouz A. Forouzan. TataMcGraw Hill publication.

Reference Books

1. James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition.
2. William Stallings, "Data and Computer Communications", PHI 6th Edition

Syllabus for Semester IV, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAP205 Course : Computer Network Lab

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

Course Objectives

1. To introduce use of different network simulation software.
2. To analyze performance of different protocols at various layers of a network architecture.
3 To demonstrate the implementation of various networking concepts.

Prerequisites: Basic knowledge of computer network, equipment

SYLLABUS

Experiments based on CAT205 Syllabus.

Course Outcomes

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

1. Simulate and then configure different types of networks.
2. Implement algorithms present in different layers of OSI model
3. Implement networking concepts like server, client and addressing mechanism.

Syllabus for Semester IV, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAT206 Course : Artificial Intelligence Principles and Techniques

L: 3Hrs, T: 1Hr, P: 0Hr, Per Week Total Credits : 04

Course Objectives

1. To introduce artificial intelligence and challenges involved in designing intelligent systems.
2. To learn state space representation and problem solving by using various search techniques.
3. To cover basic knowledge representation methods using logic programming.
4. To understand uncertainty theory in designing AI systems.

Syllabus

UNIT - I

Introduction : Basics of problem solving, problem representation (toy problems and real world problems); Structure of agent, rational agent, Specifying task environment, Properties of task environment; measuring problem-solving performance

UNIT - II

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

UNIT - III

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

UNIT - IV

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

UNIT - V

Propositional Logic: Inference, Equivalence, Validity and satisfiability, Resolution, Forward and Backward Chaining, First Order Logic: Syntax and Semantics of FOL, Inference in FOL, Unification algorithm, Forward Chaining, Backward Chaining, and Resolution.

UNIT - VI

Uncertainty Knowledge and Reasoning: Probability and Baye's Theorem, Statistical reasoning: Bayesian networks, Bayes optimal classifier, Naïve bayes algorithm, Fuzzy Logic, Introduction to expert system

Course Outcomes

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

1. Represent given problem using state space representation and apply uninformed and informed search techniques on it.
2. Solve the fully informed two player games using different AI techniques.
3. Solve the AI problems by using logic programming
4. Apply uncertainty theory based on techniques such as probability theory and fuzzy logic.

Text Book

Stuart Russel and Peter Norvig; Artificial Intelligence: A Modern Approach; Third Edition; Pearson Education, 2009.

Reference Books

1. E. Rich, K. Knight, S. B. Nair; Artificial Intelligence; 3rd Edition; Tata McGraw Hill, 2014.
2. Denis Rothman; Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases; Kindle Edition, Packt Publishing Ltd, 2018

Syllabus for Semester IV, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAP206 Course : Artificial Intelligence Principles and Techniques

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

Course Outcomes

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

1. Implement different AI toy problems by using search techniques.
2. Design two player games using min-max algorithm with Alpha-Beta pruning.
3. Simulate AI problems using logic programming.
4. Implement probabilistic based methods to solve classification problems. PRACTICALS BASED ON CAP206

SYLLABUS

Reference Books

1. Stuart Russel and Peter Norvig; Artificial Intelligence: A Modern Approach; Third Edition; Pearson Education, 2009.
2. E. Rich, K. Knight, S. B. Nair; Artificial Intelligence; 3rd Edition; Tata McGraw Hill, 2014.
3. Denis Rothman; Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases; Kindle Edition, Packt Publishing Ltd, 2018

Syllabus for Semester IV, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAT207 Course : Theory Computation

L: 3Hrs, T: 1Hr, P: 0Hr, Per Week Total Credits : 04

Course Objectives

1. To provide students an understanding of basic concepts in the theory of computation.
2. To teach formal languages and various models of computation.
3. To exhibit fundamental concepts related with computability theory.

SYLLABUS

UNIT I

Basics of Sets and Relation, Countability and Diagonalisation, 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.

UNIT VI

Undecidability: Church-Turing thesis, Universal Turing machine, Undecidable problems about languages, Recursive Function Theory.

Course Outcome

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

1. Describe the formal relationships among machines, languages and grammars.
2. Design and Optimize finite automata for given regular language.

3. Design Push Down Automata, Turing Machine for given languages.
4. Demonstrate use of computability, decidability, recursive function theory through Problem solving.

Text Books

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. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAT208 Course : Design and Analysis of Algorithms

L: 3Hrs, T: 1Hr, P: 0Hr, Per Week Total Credits : 04

Course Objectives

1. Students should learn techniques for effective problem solving in computing.
2. Students should analyze different paradigms of problem solving to solve a given problem in efficient way.

SYLLABUS

UNIT - I : Mathematical foundations for arithmetic and geometric series, 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 it's applications.

UNIT - II : Divide and Conquer- basic strategy, Binary Search, Quick sort, Merge sort, Strassen's matrix multiplication, Maximum sub-array problem, Closest pair of points problem, Convex hull problem.

UNIT - III : Greedy method – basic strategy, fractional knapsack problem, Minimum cost spanning trees, Huffman Coding , activity selection problem ,Find maximum sum possible equal to sum of three stacks, K Centers Problem.

UNIT - IV : Dynamic Programming -basic strategy, Bellmen ford algorithm, all pairs shortest path, multistage graphs, optimal binary search trees, traveling salesman problem, String Editing, Longest Common Subsequence problem and its variations.

UNIT - V : Basic Traversal and Search Techniques, breadth first search and depth first search, connected components. Backtracking basic strategy, 8-Queen's problem, graph coloring, Hamiltonian cycles, sum of subset problem, Introduction to Approximation algorithm.

UNIT - VI : 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

Course Outcomes

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

1. Understand mathematical formulation, complexity analysis and methodologies to solve the recurrence relations for algorithms.
2. Design Greedy and Divide and Conquer algorithms and their usage in real life examples.
3. Design Dynamic programming and Backtracking Paradigms to solve the real life problems.
4. Understand NP class problems and formulate solutions using standard approaches.

Text Books

1. Thomas H. Cormen et.al; “Introduction to Algorithms”; 3 Edition; Prentice Hall, 2009.
2. Horowitz, Sahani and Rajasekaram; “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 Johnsonbaugh, “Algorithms”, Pearson Publication, 2003.

Syllabus for Semester IV, B. E. Computer Science & Engineering

(Artificial Intelligence and Machine Learning)

Course Code : CAP209 Course : Software Lab - 1

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

Course Objective

The course introduces processes, tools, and methodologies to balance needs throughout the software development life cycle, from coding and deployment, to maintenance and updates.

Course Prerequisite

Basic understanding of Linux and operating system fundamentals, Web Development fundamentals and Java and programming fundamentals.

Course Contents

- Introduction to Dev Ops.
- Version Control System (Git and Git Hub).
- Integration, Deployment and Building (Jenkins).
- Resource Management and Configuration (Puppet and Chef).
- Containerization (Docker).
- Working with Nagios Monitoring Tool.
- Cloud services and DevOps.

Course Outcome

On Successful completion of course student will be able to:

1. Understand Processes, Tools, and Methodologies in Software Development Lifecycle.
2. Implement Agile Software Development Life Cycle.
3. Integrate Software Development and its Operations.
4. Use Cloud Environment and its Services

Reference Books

1. The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations by by Gene Kim, Patrick Debois, John Willis , Jez Humble.
2. Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale by Jennifer Davis.
3. Python for DevOps: Learn Ruthlessly Effective Automation by Noah Gift , Kennedy Behrman, Alfredo Deza, Grig Gheorghiu.
4. Building Microservices: Designing Fine-Grained Systems by Sam Newman.
5. Effective DevOps with AWS: Ship faster, scale better, and deliver incredible productivity by Nathaniel Felsen

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

Course Code : CHT252 Course : Environmental Science

L: 2Hrs, T: 0Hr, P: 0Hr, Per Week Total Credits : Nil (Audit Course)

SYLLABUS

Principle of contaminant behaviour and recent trends in environmental pollution control.

UNIT - I

Air pollution and its control techniques: (4 lectures)

Contaminant behaviour in the environment, Air pollution due to SOx, NOx, photochemical smog, Indoor air pollution Natural pathways for degradation: Carbon cycle, Sulphur cycle, Nitrogen cycle, Oxygen cycle Factors responsible for altering the composition of atmosphere (deforestation, burning of fossil fuels, industrial and vehicular emissions, CFCs). Techniques to control Air pollution, ambient air quality and continuous air quality monitoring, Control measures at source, Kyoto Protocol, Carbon Credits.

UNIT - II

Noise pollution and its control techniques: (2 lectures)

Introduction to noise pollution and its causes. Noise pollution control: Recent advances in noise pollution control and benefits.

UNIT - III

Soil pollution and its control techniques: (5 lectures)

Soil pollution: Soil around us, Soil water characteristics, soil pollution.

Solid waste management: Composting, vermiculture, landfills, hazardous waste treatment, bioremediation technologies, conventional techniques (land farming, constructed wetlands),and phytoremediation. Degradation of xenobiotics in environment: Petroleum hydrocarbons, pesticides, heavy metals

UNIT - IV

Water pollution and its control techniques: (8 lectures)

Major sources of water pollution: Eutrophication, acid mine drains, pesticides and fertilizers, dyeing and tanning, marine pollution, microplastics Techniques to control water pollution: Conventional waste water treatment-types of sewage, ewerage system, alternative systems, primary, secondary and tertiary processes including aerobic and anaerobic techniques, safe disposal. Case studies: Treatment schemes for waste water from dairy, textile, power plants, pharmaceutical industries, and agro based industries such as rice mills.

UNIT - V

E-wastes (2 lectures)

Introduction, types of e-wastes, environmental impact, e-waste recycling, e-waste management rules.

Unit - VI

Environmental Sustainability: Role of Green technology (5 lectures)

Concept of green technologies, categories, goals and significance, sustainability Green energy, green chemistry, challenges to green technology, advantage and disadvantages of green processes, Eco mark certification- its importance and implementation VII- Different government initiatives (2 lectures) National ambient air quality standard 2009, Swacch Bharat Abhiyan, National afforestation program and Act-2016, National river conservation plan, Formation of National Green Tribunal

Course Outcomes

On successful completion of the course, students

1. Will get sufficient knowledge regarding different types of environmental pollutions, their causes, detrimental effects on environment and effective control measures.
2. Will realize the need to change an individual's outlook, so as to perceive our Environmental issues correctly, using practical approach based on observations and self-learning.
3. Will become conversant with recent waste management techniques such as E-wastes, its recycling and management.
4. Will gain knowledge about the modes for sustainable development, importance of green energy and processes.
5. Will be able to identify and analyze environmental problems as well as risks associated with these problems and greener efforts to be adopted, to protect the environment from getting polluted.

Suggested Books

1. Benny Joseph, Environmental Studies, Mc Graw Hill Education (India) Private Limited
2. B. K. Sharma, Environmental Chemistry, Goel Publishing House, Meerut
3. P Aarne Vesilind, J. Jeffrey Peirce and Ruth F. Weiner, Environmental Pollution and Control, Butterworth - Heinemann
4. D. D. Mishra, S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, S. Chand & Company Ltd. Sultan Chand & Company
5. Shree Nath Singh, Microbial Degradation of Xenobiotics, Springer-Verlag Berlin Heidelberg
6. P.T. Anastas & J.C. Warner, Green Chemistry: Theory & practice, Oxford University Press
7. P. Thangavel & Sridevi, Environmental Sustainability: Role of Green technologies, Springer publications.

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

Course Code:	**CAT301**	**Course:**	**Database Management Systems**
L:3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**3**

Course Objectives

The objective of this course is:
To understand the role of a database management system in an organization.
To construct simple and advanced database queries using a data language.
To understand and apply logical database design principles and database normalization.
To recognize the need for transaction management and query processing.

Syllabus

Unit 1: Database - Fundamentals 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. Introduction to NoSQL databases and In-Memory databases.

Unit 2: Relational 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 3: 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 4: 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 5: 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 6: 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:

After successful completion of this course, the student will be able to:
1. Model data requirements for an application using conceptual modeling tools.
2. Design database schemas by applying normalization techniques.
3. Execute efficient data storage and retrieval queries using SQL.
4. Use concurrency control and database recovery in transaction management.

Text Books:

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

Wesley 2011.

Reference Books:

Raghu Ramakrishnan and Johannes Gehrke; “Database Management Systems”; Third Edition; Tata McGraw Hill Publication, 2003.
Rini Chakrabarti and Shilbhadra Dasgupta; “Advanced Database Management System”; Dreamtech Press India Pvt. Ltd (Wiley India); 2014.

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

Course Code: CAP301 Course: Database Management Systems Lab

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

Course Objectives

The objective of this Lab is:

To enable students to use DDL, DML and DCL.

To prepare students to conceptualize and realize database objects (tables, indexes, views and sequences) and execute SQL queries.

To encourage students to design and execute PL/SQL blocks and triggers.

P**RACTICALS BASED ON CAT301 SYLLABUS**

Experiments covering CAT301 syllabus in Oracle 11g or12c | MySQL.

[Added experiments to be conducted to demonstrate handling of databases on cloud and demonstrating use of NoSQL]

Course Outcomes:

After successful completion of this course, the student should be able to:

Demonstrate database user administration and authorizations.

Execute simple, nested, multiple table, and advanced queries for data retrieval.

Construct PL-SQL block structure and Trigger for specific application.

Implement various integrity constraints, views, sequences, indices and synonym on database.

Reference Books

James Groff, Paul Weinberg and Andy Oppel, SQL - The Complete Reference, 3rd Edition, McGraw Hill, 2017

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

Course Code:	**CAT302**	**Course:**	**Machine Learning**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Pre-requisite
Artificial Intelligence, Mathematics for machine learning

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

Syllabus:
Unit-1
Foundations for ML: ML Techniques overview, Validation Techniques (Cross-Validations), Over-fitting and under-fitting, Data Normalization, Hypothesis Evaluation, Feature Reduction/Dimensionality reduction, Linear and Logistic regression

Unit-2
Discriminative Methods: K-nearest neighbor, Linear Discriminant Functions, Decision Tree, Random Forest algorithm, Bagging and Boosting

Unit -3
Artificial Neural Network: Linear threshold units, Perceptron, Multilayer networks, Feature extraction, Feature selection techniques: Filter Method, Wrapper Method, Dimensionality Reduction techniques: Introduction to PCA, LDA.

Unit-4
Parameter Estimation: Maximum Likelihood and Bayesian Parameter Estimation
Kernel Machines: SVMs (primal and dual forms), Kernel Tricks, Radial Basis function

Unit-5
Bayes Decision Theory: Bayes decision rule, Minimum error rate classification, Normal density and discriminant functions, Naïve Bayes Classifiers, probably approximately correct (PAC) learning

Unit-6
Unsupervised Learning: Clustering (K means, Fuzzy-c means), Hidden Markov Models, Gaussian Mixture Modeling, EM-algorithms

Course Outcomes
On successful completion of the course, students will be able to:
1. Apply various preprocessing techniques before solving the problems
2. Use supervised machine learning techniques to solve different problems.
3. Apply probability based models to solve different problems.
4. Apply un-supervised machine learning techniques to solve different problems.

Text Books

Shalev-Shwartz,S., Ben-David,S., (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press
Christopher Bishop, Pattern Recognition and machine learning; Springer Verlag, 2006.

Reference Books

1. Tom Mitchell; Machine Learning- an Artificial Intelligence Approach, Volume-II; Morgan Kaufmann, 1986.
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 and Machine Learning)

Course Code:	**CAP302**	**Course:**	**Machine Learning Lab**
L: 0Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

Course Prerequisite:
Python programming

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

Course Syllabus
Experiments based on CAT 302(Machine Learning) Syllabus. Technology: Python.

Course Outcomes
On successful completion of the course, students will be able to:
1. Apply various preprocessing techniques before solving the problems
2. Use supervised machine learning techniques to solve different problems.
3. Apply probability based models to solve different problems.
4. Apply un-supervised machine learning techniques to solve different problems.

Text Books
Shalev-Shwartz,S., Ben-David,S., (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press
Christopher Bishop, Pattern Recognition and machine learning; Springer Verlag, 2006.

Reference Books
1. Tom Mitchell; Machine Learning- an Artificial Intelligence Approach, Volume-II; Morgan Kaufmann, 1986.
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 and Machine Learning)

Course Code: CAT303 Course: Microcontroller Design

L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week Total Credits: 03

Course Pre-requisite
Fundamentals of Digital Electronics

Course Objectives
Understand the architecture of microcontroller.
Acquire the knowledge, techniques and skill to interface external peripheral devices with microcontroller.
Design microcontroller-based system to solve the real world problem.
To make students aware of evolution of microcontrollers and their advancement in recent time

Syllabus:
Unit-1
Introduction to Computer, Microprocessor and Microcontroller
Introduction to components of computer, microprocessor and microcontroller, family of microcontrollers, architecture of 8051, functional pin diagram and its description, Internal program and data memory,
organization of internal RAM, ROM and register banks, Special function registers, oscillator and clock circuit, Reset circuit, I/O Port, Memory organization,.
Unit-2
Addressing Modes, Instruction Sets and Assembly Language programming
Instruction Syntax, Data types, Subroutines, addressing modes (register, direct, indirect, Immediate) Instruction set of 8051, Data transfer Instruction, Assembly language programming, assembler directives, concepts with examples for various software routines.
Unit-3
Hardware Interfacing using I/O ports
Basic I/O concepts, data transfer techniques, Input/output technique, Port structures and operation, Interfacing commonly used peripherals like switches, matrix keypads and seven segment LEDs, matrix keyboard and Alphanumeric LCD, Interfacing A/D and D/A converter using parallel ports, Interfacing serial A/D converter, Interfacing Stepper Motor and DC motor.
Unit-4
Interrupts, Timer and Counter
Basics of timers, 8051 timers/counters, Timer/counter operation modes, Programming timers/counter, Basics of interrupts, 8051 interrupts, response time, interrupt control registers, example of interrupts applications with programming
Unit-5
ARM Processor Fundamentals
ARM Processor architecture: Register Set, Modes of operation, data processing and data transfer Instructions, control flow instructions, ARM instructions set, ARM organization, 3-stage pipeline, 5-stage pipelines, ARM memory interface, Arm Processor Families.
Unit-6
ARM Applications
Basic Concepts of RTOS, Hard and Soft Real Time Systems, Tasks –periodic and aperiodic tasks, Timing parameters –release time, execution time, deadline, period, Basic real time Task Scheduling Algorithms, Resource Contention, Deadlocks, Priority Inversion, Basics of Re-entrancy and Thread

Safety in Embedded Software Development.

Course Outcome:
At the end of the course, the students should be able to:
Implement Assembly language programming for microcontroller.
Develop interfacing of peripherals like, I/O, A/D, D/A, timer etc.
Design microcontroller based system using Timer & interrupts.
Learn RISC processors and design ARM microcontroller based systems

Text Books:

1. The 8051 Microcontroller and Embedded Systems Using Assembly and C; Muhammad Ali Mazidi, 2nd Edition, Pearson.
2. 8051 Microcontroller Hardware, Software and Applications; V. Udayashankara and M. Mallikarjunaswamy, McGraw-Hill.

3. Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000

Reference Books:

1. Real Time Systems – Design for distributed Embedded Applications: Herma K.Kluwer Academic.
2. Operating Systems – A Design Oriented approach: Charles Crowley, McGraw Hill.

3. The 8051 Microcontroller – Architecture, Programming and Applications – Kenneth J. Ayala, West Publishing Company.

4. ARM Architecture Reference Manual, David Seal, Adison Wesley Publication

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

Course Code: CAP303 Course: Microcontroller Design Lab

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

Course Pre-requisite
Fundamentals of Digital Electronics

Course Outcome:
At the end of the course, the students should be able to:
Implement Assembly language programming for microcontroller.
Develop interfacing of peripherals like, I/O, A/D, D/A, timer etc.
Design microcontroller based system using Timer & interrupts.
Design ARM microcontroller based systems by applying RISC concepts.

Syllabus:
Experiments based on CAT303 Syllabus in assembly language and embedded C.

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

Course Code: CAT304 Course: Compiler Design

L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week Total Credits: 03

Course Pre-requisite
Theory of Computation

Course Objectives
To understand the theory & practice of Compiler implementation.
To explore the principles, algorithms, and data structures involved in the design and construction of compilers.
To understand various phases of compiler and their working.

Syllabus:
Unit-1
Introduction to Compilers- Introduction to Compilers, Phases of compiler design, Relating Compilation Phases with Formal Systems.
Lexical Analysis- Lexical analysis, tokens, pattern and lexemes, Design of Lexical analyzer, Regular Expression, transition diagram, recognition of tokens, Lexical Errors.
Unit-2
Syntax Analysis- Specification of syntax of programming languages using CFG, Top-down parser, design of LL (1) parser, bottom-up parsing techniques, LR parsing, Design of SLR, CLR, LALR parsers, Parser Conflicts.
Unit-3
Syntax directed translation- Study of syntax directed definitions & syntax directed translation schemes, Type and Type Checking, implementation of SDTS, intermediate notations- postfix, syntax tree, TAC, translation of Assignment Statement, expressions, controls structures, Array reference.
Unit-4
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, Elimination of Common sub expression, and Machine-dependent optimisation techniques.
Unit-5
Code generation – Problems in code generation, Simple code generator, code generation using labelling algorithm, Code Generation by Dynamic Programming.
Unit-6
Storage allocation & Error Handling- Run time storage administration stack allocation, Activation of Procedures, Storage Allocation Strategies, symbol table management, Error detection and recovery- lexical, syntactic and semantic.

Course Outcome:
At the end of the course, the students should be able to:
Implement lexical analyzer from language specification.
Realize bottom up and top down parsers incorporating error handling.
Demonstrate syntax directed translation schemes, their implementation for different programming language constructs.
Implement different code optimization and code generation techniques using standard data structures.

Text Books:

Aho, Sethi, and Ullman; Compilers Principles Techniques and Tools; Second Edition, Pearson education, 2008.
Alfred V. Aho and Jeffery D. Ullman; Principles of Compiler Design; Narosa Pub.House, 1977.
Manoj B Chandak, Khushboo P Khurana; Compiler Design; Universities Press, 2018.

Reference Books:

Vinu V. Das; Compiler Design using Flex and Yacc; PHI Publication, 2008.
V. Raghavan; Principles of Compiler Design, McGraw Hill Education (India), 2010.

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

Course Code: CAP304 Course: Compiler Design Lab

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

Course Pre-requisite
Course on Formal Language & Automata Theory, Programming

Course Objectives
The laboratory course is intended to make the students experiment on the basic techniques of compiler construction and use of various tools for implementation. The course will provide deeper insights into the aspects of programming languages and various phases of compiler.

Syllabus:
Experiments based on syllabus of Complier Design (CAT 304).

Course Outcome:
At the end of the course, the students should be able to:
Use Open-Source tools to create a lexical analyzer and parser.
Implement different types of Parsing techniques.
Implement various syntax directed translation schemes to generate intermediate code.
Implement various code optimization techniques to improve performance of a program segment and code generation.

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

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

Course Code: CAP305 Course: Mini Project-1

L:0 Hrs, T: 0 Hr, P: 4 Hrs, 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 completion of the mini-project, the student 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
5. 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 V, B. Tech. Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code: HUT353 Course: Indian Traditional Knowledge

L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week Total Credits:02

Course Pre-requisite

NIL

Course Objectives

The course is designed with the objective of developing understanding of the students about the essence of Indian traditional knowledge in terms of its scientific approach, legality, role in natural resource protection, as well as its contribution to philosophy and art.

Syllabus:

Unit 1: Basic Structure of Indian Traditional Knowledge: Vedas, Upavedas, Vedang, Upadang, scientific approach

Unit 2: Ecology and Indian Traditional Knowledge: Meaning, role, case studies

Unit 3: Intellectual Property Rights and Indian traditional Knowledge: Meaning, role in protection of Indian traditional knowledge, cases studies

Unit 4: Indian Philosophical traditions: Nyay, Sankaya, Yog, Mimansa, Jainism, Buddhism, Sikhism, and other approaches

Unit 5: Indian Artistic Traditions: Chitrakala, Murtikala, Vastukala, Sangeet, Sthpatya, Nritya evam Sahitya, case studies.

Unit 6: Knowledge of traditional Indian Science and Technology

Course Outcomes

On successful completion of the course, students will have increased ability to understand the importance and application of:

1. Indian Knowledge system and its scientific approach.
2. Traditional knowledge and protection of nature.
3. The legality and its importance for the protection of Indian traditional knowledge.
4. Indian philosophical tradition.
5. Indian artistic tradition

Reference Books/Material.

1. Amit Jha (2009), Traditional Knowledge System in India, Atlantic Publishers and Distributors.
2. RR Gaur, Rajeev Sangal, GP Bagaria, Human Values and Professional Ethics (Excel Books, New Delhi, 2010)
3. V. Sivaramakrishanan (ed.), Cultural Heritage of India – Course material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
4. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan
5. Swami Jitatmanand, Holistic Science and Vedant, Bharatiya Vidya Bhavan
6. S.C. Chatterjee and D.M. Datta, An introduction to Indian Philosophy, University of Calcutta, 1984
7. Pramod Chandra, Indian Arts, Howard University Press, 1984
8. Krishna Chaitanya, Arts of India, Abhinav Publications, 1987
9.https://www.researchgate.net/publication/299625768_Traditional_Knowledge_systems_in_India_ for_biodiversity_conservation/link

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

Course Code:	**CAT306**	**Course:**	**Deep Learning**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Pre-requisite
Artificial Intelligence, Machine Learning

Course Objectives
To introduce the basic concepts and techniques of deep learning.
To understand major deep learning algorithms.
To identify deep learning techniques suitable for a given problem.

Syllabus:
Unit-1
Introduction to Neural Networks: FeedForward Neural Networks, Backpropagation ,Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam.

Unit-2
Principal Component Analysis: Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis, Principal Component Analysis and its interpretations, Singular Value Decomposition.

Unit -3
Autoencoders: Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders

Unit-4
Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout.

Unit-5
Convolutional Neural Networks: The Convolution Operation, Motivation, Pooling, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation.

Unit-6
Recurrent Neural Networks: Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, LSTMs, GRUs, Attention Mechanism and the Transformer Architecture

Course Outcomes
On successful completion of the course, students will be able to:
Solve various deep learning problems
Apply autoencoders for unsupervised learning problems
Implement Convolutional Neural Networks to image classification problems
Apply recurrent neural network to sequence Learning Problem.

Text Books

Neural Networks and Deep Learning A Textbook, Charu C. Aggarwal, Springer
Deep Learning from Scratch ,Building with Python from First Principles, Seth Weidman, O'Reilly

Reference Books.

1. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville MIT press.

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

Course Code:	**CAP306**	**Course:**	**Deep Learning Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

Course Prerequisite:
Python programming, Machine Learning

Course Syllabus
Experiments based on CAT 306(Deep Learning) Syllabus.
Technology: Python, Tensorflow, Keras

Course Outcomes
On successful completion of the course, students will be able to:
Solve various deep learning problems
Apply autoencoders for unsupervised learning problems
Implement Convolutional Neural Networks to image classification problems
Apply recurrent neural network to sequence Learning Problem.

Text Books

Neural Networks and Deep Learning A Textbook, Charu C. Aggarwal, Springer
Deep Learning from Scratch ,Building with Python from First Principles, Seth Weidman, O'Reilly

Reference Books.
1. Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville MIT press.

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

Course Code:	**CAT307**	**Course:**	**Data Warehousing and Mining**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits: 03**	

Course Pre-requisite
Database Management Systems

Course Objectives
Methods and theory for development of data warehouses and data analysis using data mining.
Data quality and methods and techniques for preprocessing of data.
Modeling and design of data warehouses.
Algorithms for classification, clustering and association rule analysis.

Syllabus:
Unit-1
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

Unit-2
Data Cube, Data Cube Computation methods, Advanced SQL support for OLAP, Data Preprocessing Data Cleaning methods, Descriptive Data Summarization, Data Reduction, Data Discretization and Concept hierarchy generation

Unit-3
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, Data partitions.

Unit-4
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.

Unit-5
Classification and Prediction:- Classification by decision tree induction, Bayesian Classification, Rulebased Classification, Associative Classification.

Unit-6
Clustering: Measuring Data Similarity and Dissimilarity Partition based Clustering, Hierarchical based clustering, Density based clustering.

Course Outcome:
At the end of the course, the students should be able to:
Use the fundamental theories and concepts of data warehousing in real life application.
Apply multi-dimensional modeling techniques in designing data warehouses.
Use the principles of data mining for designing data mining applications.

Apply different methods and techniques involved in data mining.

Text Books:

Jaiwei Han and Micheline Kamber; Data Mining Concepts and Techniques; 2 edition; Morgan Kaufmann Publishers, 2006.

Reference Books:

Tang and MacLennan, Data Mining with SQL Server 2005, Wiley Publishing, 2005

Data Warehousing and Fundamentals by Paulraj Ponniah, A Wiley-Interscience Publication

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

Course Code: CAP307 Course: Data Warehousing and Mining Lab

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

Course Pre-requisite
Database Management Systems

Course Objectives
Methods and theory for development of data warehouses and data analysis using data mining.
Data quality and methods and techniques for preprocessing of data.
Modeling and design of data warehouses.
Algorithms for classification, clustering and association rule analysis.

Syllabus:
Experiments based on CAT307 syllabus.

Course Outcome:
At the end of the course, the students should be able to:
Use the fundamental theories and concepts of data warehousing in real life application.
Apply multi-dimensional modeling techniques in designing data warehouses.
Use the principles of data mining for designing data mining applications.
Apply different methods and techniques involved in data mining.

Text Books:
Jaiwei Han and Micheline Kamber; Data Mining Concepts and Techniques; 2 edition; Morgan Kaufmann Publishers, 2006.
Reference Books:
Tang and MacLennan, Data Mining with SQL Server 2005, Wiley Publishing, 2005
Data Warehousing and Fundamentals by Paulraj Ponniah, A Wiley-Interscience Publication

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

Course Code:	**CAT308**	**Course:**	**Natural Language Processing**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits: 03**	

Course Pre-requisite
Theory of Computation, Compiler

Course Objectives
To familiarize the concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS.
To relate mathematical foundations, Probability theory with Linguistic essentials such as syntactic and semantic analysis of text.
To apply the Statistical learning methods and cutting-edge research models to solve NLP problems

Syllabus:
UNIT 1: Introduction to NLP, Morphology
Introduction to NLP, Stages of NLP, Ambiguity, Information Theory Essentials , Linguistic Essentials : Parts of Speech and Morphology, Morphological analysis and generation using Finite State Automata and Finite State transducer.

UNIT 2: Markov Model and POS Tagging
Markov Model: Hidden Markov model, Fundamentals, Probability of properties, Parameter estimation, Variants, Multiple input observation. The Information Sources in Tagging: Markov model taggers, Viterbi algorithm, Applying HMMs to POS tagging, Applications of Tagging

UNIT 3: Syntax and Semantics
Shallow Parsing and Chunking, Shallow Parsing with Conditional Random Fields (CRF), Lexical Semantics, WordNet, Thematic Roles, Semantic Role Labelling with CRFs.

UNIT 4: Language Modelling
Corpus based work, Statistical Inference: n -gram Models over Sparse Data, Methodological Preliminaries, Supervised Disambiguation: Bayesian classification, An information- theoretic approach, Dictionary-Based Disambiguation: Disambiguation based on sense, Thesaurus-based disambiguation, Disambiguation based on translations in a second-language corpus.

UNIT 5: Probabilistic Parsing and Disambiguation
Probabilistic Context Free Grammars and Probabilistic parsing The Probability of a String, Problems with the Inside-Outside Algorithm, Parsing for disambiguation, Treebanks, Parsing models vs. language models, Phrase structure grammars and dependency, Lexicalized models using derivational histories, Dependency-based models.

UNIT 6: NLP Applications
Statistical Alignment and Machine Translation, Text alignment, Word alignment, Information extraction, Text mining, Information Retrieval, NL interfaces, Sentimental Analysis, Question Answering Systems, Social network analysis.

Course Outcome:

At the end of the course, the students should be able to:
Apply the Principles and Process of Human Languages using computers.
Demonstrate the state-of-the-art algorithms and techniques for text-based processing of natural languages with respect to morphology.
Perform POS tagging for a given natural language
Create Linguistics CORPUS based on Text Corpus method
Realize semantics and pragmatics of natural languages for text processing
Develop a Statistical Methods for Real World NLP Applications.

Text Books:

Christopher D. Manning and Hinrich Schutze, "Foundations of Natural Language Processing" , 6th Edition, The MIT Press Cambridge, Massachusetts London, England, 2003
Daniel Jurafsky and James H. Martin "Speech and Language Processing", 3rd edition, Prentice Hall, 2009.

Reference Books:

James Allen "Natural Language Understanding", Pearson Publication 8th Edition. 2012.

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

Course Code:	**CAP308**	**Course:**	**Natural Language Processing Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits: 01**	

Course Pre-requisite
Database Management Systems

Course Objectives
To familiarize the concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS.
To relate mathematical foundations, Probability theory with Linguistic essentials such as syntactic and semantic analysis of text.
To apply the Statistical learning methods and cutting-edge research models to solve NLP problems

Syllabus:
Experiments based on CAT308 syllabus.

Course Outcome:
At the end of the course, the students should be able to:
Apply the Principles and Process of Human Languages using computers.
Demonstrate the state-of-the-art algorithms and techniques for text-based processing of natural languages with respect to morphology.
Perform POS tagging for a given natural language
Create Linguistics CORPUS based on Text Corpus method
Realize semantics and pragmatics of natural languages for text processing
Develop a Statistical Methods for Real World NLP Applications.

Text Books:
Natural Language Processing with Python by Steven Bird, Ewan Klein and Edward Loper , Oreily Publications

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

Course Code: CAT309 **Course: Fundamentals of Digital Image and Video Processing**

L:3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week **Total Credits: 03**

Course Prerequisite:
Design and Analysis of Algorithms, Fundamentals of Discrete Mathematics, Fourier Transform, Probability and Statistics is desired.

Course Objectives:
This course offers fundamentals of digital image and video processing. Through this course, students will get a clear understanding of the breadth and practical scope of digital image and video processing. A brief view of basic enhancement techniques, different models and various algorithms used for digital image and video processing are discussed in the course. This course introduces the students with real time applications and its implementation using various techniques and algorithms, which will enable them to undertake further study, research and/or implementation work in this area.

Syllabus:

UNIT-I
Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system, Digital Image Formation and Camera Geometry, sampling and quantization of an Image, Basic relationship between pixels, Image representation, types of images (binary, grayscale, color, indexed), and Mathematical operations.

UNIT-II
Image Enhancement: Spatial Domain methods- Intensity transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters.
Frequency Domain methods- Basics of filtering in frequency domain, The Fourier transform- 2D Discrete Fourier Transform and its inverse, properties of DFT, image smoothing, image sharpening, Homomorphic filtering, selective filtering.

UNIT-III
Morphological Image Processing: Erosion, Dilation, Opening, Closing, Hit or Miss Transformation, Boundary Extraction, Hole Filing, Extraction of Connected components.
Image Segmentation: Point, Line, edge detection, boundary detection, Thresholding, region based segmentation

UNIT-IV
Image Compression: Image compression fundamentals, coding Redundancy. Compression models- Huffmann coding, run length coding, Bit Plane coding, and JPEG standards
Image restoration: Types of Noise and removal methods – Mean filter, Median, Min, Max, Midpoint, Adaptive filters etc.

UNIT-V
Introduction to Video Processing: Digital Video, Time varying Image Formation models: 3D

motion models, Geometric Image formation, Motion Estimation- Optical flow, general methodologies, background subtraction and modelling, pixel based motion estimation, Lucas-Kanade algorithm, Kalman filter.

UNIT-VI

Video Segmentation, Object detection in videos: Basics of background modeling and foreground detection, connected component labelling, etc., Object recognition in images and videos, Viola Jones algorithm for face detection, Case study of applications like automated video surveillance.

Course Outcomes:

After successful completion of the course students will be able to:

1. Describe basic methods of image processing, video processing and their applications.
2. Performing image processing by application of various techniques like image enhancement, morphological processing, image Segmentation, compression, etc.
3. Interpret image and video processing algorithms.
4. Select, apply and use various algorithms in image and video processing applications.

Text Books:

R. C. Gonzalez, R. E. Woods. Digital Image Processing. Pearson Education, 3rd ed.
Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India. 2nd edition 2004
John Willam, K. Pratt, Digital Image Processing. Willey & Sons (3rd Edition).
D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach. Prentice Hall, 2011.

Reference Books:

Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson, 2009.
E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012
Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012
Richard Szeliski, Computer Vision: Algorithms and Applications. Springer, 2010.

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

Course Code: CAP309 **Course: Fundamentals of Digital Image and Video Processing Lab**

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

Course Objectives:

This laboratory course is intended to make the students experiment with various algorithms and techniques of image and video processing techniques, to gain deeper insights of visual representations.

This course will introduce the students to working of real world applications and enhance the problem solving skills to solve the real world problems.

Syllabus:

Experiments based on syllabus of Fundamentals of Digital Image and Video Processing Lab (CAP309).

Course Outcomes:

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

1. Implement and test fundamental image and video processing algorithms.
2. Perform various image processing tasks like morphological operations, image enhancement, image segmentation, image compression, etc.
3. Implement various video processing tasks, and perform motion computation.

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

Course Code: CAP310 Course: Mini Project-2

L:0 Hrs, T: 0 Hr, P: 4 Hrs, 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 completion of the mini-project, the student 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 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 VI, B. Tech. Computer Science & Engineering
(Artificial Intelligence and Machine Learning)

Course Code:	**CAP311**	**Course:**	**Comprehensive Viva**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits: 01**	

Course Objectives

To assess the overall knowledge of the student in Computer Science and Engineering .
To assess preparedness of the student for placements and entrance examinations for higher learning through the examination like GATE, GRE, CAT.
To facilitate the students in selecting appropriate career track for themselves.

Syllabus:

The Comprehensive Viva will cover the contents from the courses, both the theory and the lab practice which the student learnt during third thru sixth semester of the undergraduate programme.

Course Outcome:

At the end of the course, the students should be able to:
Respond to the queries and issues covering various computing domain
Exhibit oral presentation skills and inter-personal skills
Prepare the students to face interview both in the academic and the industrial sector

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

Course Code: CAT299 Course: Statistical Computing with R (Open Elective)

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

Course Objectives

The objective of this course is:
To understand the use of R for effective data analysis
To understand the statistical tests

Syllabus

Unit 1: Introduction to R programming, Data structures, variables, and data types
Unit 2: R packages and scripts, Descriptive statistics in R
Unit 3: Statistical graphs: Scatter Plots, Box Plots, Histograms, Working with messy data
Unit 4: Conditional statements, Iterations, Writing functions Reporting
Unit 5: Data exploration and visualization
Unit 6: Data querying: SQL and R, Interactive reporting with Rmarkdown

Course Outcomes:

After successful completion of this course, the student will be able to:
Access online resources for R and import new function packages into the R workspace
Import, review, manipulate and summarize data-sets in R
Perform appropriate statistical tests using R
Create and edit visualizations with R

Text book:

Wickham, H. & Grolemund, G. (2018). R for Data Science. O'Reilly: New York.

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

Course Code:	**CAT398**	**Course:**	**Machine Learning – Tools and Techniques (Open Elective)**
L:3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**3**

Course Objectives

The objective of this course is:
To understand machine learning concepts
To understand the concepts of libraries and tools for solving machine learning problems.

Syllabus

Unit 1: Machine Learning Basics: Types of ML, Data preprocessing, Over fitting and under fitting; Introduction to IPython
Unit 2: Introduction to NumPy ; Data Manipulation with Python
Unit 3: Visualization with Matplotlib & Scipy; Sci-kit Learn
Unit 4: Tensorflow, Pytorch
Unit 5: Keras, Rapid Minor
Unit 6: Colab, Shogun, Weka

Course Outcomes:

After successful completion of this course, the student will be able to:
Apply python to solve machine learning problems
Use different data manipulation methods of python for solving machine learning problems
Use different ML libraries for solving ML problems.

Text book:

Jake Vanderplas , Python Data Science Handbook: Essential Tools for Working with Data , O'Reilly: New York.
Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras and Tensor Flow: Concepts, Tools and Techniques to Build Intelligent Systems (2019), O'Reilly: New York.

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

Course Code: CAT399 Course: Data Analytics (Open Elective)

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

Course Objectives

To understand of data analysis techniques in business decision making.
To understand data analysis techniques for solving real world problems.
To understand concepts of time series analysis

Syllabus:

Unit 1: Data Definitions and Analysis Techniques:

Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing

Unit 2: Descriptive Statistics:

Measures of central tendency, Measures of location of dispersions

Unit 3: Basic Analysis Techniques:

Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance,Correlation analysis,Maximum likelihood test

Unit 4: Data analysis techniques

Regression analysis,Classification techniques,Clustering,Association rules analysis

Unit 5 : Time Series Analysis

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 6: Creating Stories with Data

Why Planning?, Creating Interesting Stories with Data – Reader-driven Narratives, Author-driven Narratives; Perceptions and Presentation Methods

Course Outcomes

On successful completion of the course, students will be able to:
Demonstrate understanding of data analysis techniques in business decision making.
Apply data analysis techniques for solving real world problems.
Apply time series analysis on different problems

Text Books

David Dietrich, Barry Heller and Beibel Yang, - Data Science and Big Data Analytics –Discovering, Analyzing, Visualizing, and Presenting Data||, John Wiley and Sons [EMCEducation Services], 2015.
Python: Data Analytics and Visualization, Packt Publishing, 2017
Probability & Statistics for Engineers & Scientists (9th Edn.), Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall Inc.
Data Mining and Analysis, Mohammed J. Zaki, Wagner Meira, Cambridge, 2012

Reference Books.

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

The Elements of Statistical Learning, Data Mining, Inference, and Prediction (2nd Edn.), Trevor Hastie Robert Tibshirani Jerome Friedman, Springer, 2014

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

Course Code: CAT401 Course: Data Analytics and Visualization
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week Total Credits: 03

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: Importance of analytics and visualization, data preprocessing, Data categorization, Levels of Measurement, Data management and indexing, Descriptive statistics , Data Analytics Lifecycle, and different Phases

UNIT-II: Basic Analysis Techniques : Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test.

UNIT-III: Basic concepts of probability, random variables, probability distributions, sampling and estimation, statistical inference.

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

UNIT VI : 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 completion of the course the student 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. Design 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. Probability & Statistics for Engineers & Scientists (9th Edn.), Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall Inc.
3. Claus O. Wilke, "Fundamentals of Data Visualization – A Primer on Making Informative and Compelling Figures", O'Reilly, 2019.

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 and Engineering)
(Artificial Intelligence & Machine Learning)

Course Code: CAP 401 **Course: Data Analytics and Visualization Lab**

L: 0 Hr, T: 0 Hr, P: 2 Hr, 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 CAT401 syllabus

Course Outcomes:

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

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

Reference Books:

1. Python: Data Analytics and Visualization, Packt Publishing, 2017.
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 and Engineering)
(Artificial Intelligence & Machine Learning)

Course Code:	**IDT453**	**Course:**	**Bio-informatics**
L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**02**

Course Objectives

1. Provide an introduction to the field of Bioinformatics.
2. Describe how bioinformatics data is stored and organized.
3. Provide an approach to build search query and sequence alignment.
4. Provide methods for genome analysis.

Syllabus

UNIT-I

Introduction to Bioinformatics: Genome Sequences ORFs, Genes, Introns, Exons, Splice Variants DNA/RNA Secondary Structure, Retrieval methods for DNA sequence, protein sequence and protein structure information.

UNIT-II

Biological Databases: Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence and structure databases; Organism specific databases, Data retrieval tools – Entrez, DBGET and SRS, Submission of (new and revised) data.

UNIT-III

Sequence Analysis: Local versus global, Distance metrics, Similarity and homology, scoring matrices, PAM, BLOSUM, PSSM, Dot Plot.

UNIT-IV

Dynamic programming algorithms: Needleman-wunsch and Smith-waterman, Heuristic Methods of sequence alignment, FASTA, BLAST and PSI BLAST.

UNIT-V

Multiple Sequence Alignment: Software tools for pair wise and multiple sequence alignment, Clustal W algorithm - Feng Doolittle algorithm, Phylogenetic Analysis: Methods of phylogenetic analysis, UPGMA, WPGMA, neighbour joining method.

UNIT-VI

Genome Analysis: Genomic data and databases, Genomic data analysis strategies, existing software tools, Gene Prediction, NGS data analysis

Course Outcomes:

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

1. Understand the basics of Biological Data acquisition.
2. Implement format, access and retrieval of Biological data.
3. Identify sequence structure, alignment and search query.
4. Apply genome data and analysis.

Text Books

1. Bioinformatics: Databases and Systems, by Stanley I. Letovsky
2. Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC Mathematical Biology & Medicine), by Sorin Draghici
3. Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
4. Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang

Reference Books

1. D. Baxevanis and F. Oulette, (2002) "Bioinformatics : A practical guide to the analysis of genes and proteins", Wiley Indian Edition
2. Cynthia Gibas and Per Jambeck (2001), "Developing Bioinformatics Computer Skills". O'Reilly press, Shorff Publishers and Distributors Pvt. Ltd., Mumbai.
3. Bryan Bergeron MD (2003), "Bioinformatics Computing". Prentice Hall India(Economy Edition)

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

Course Code: CAT402-1 **Course: Cloud Computing**

L: 3 Hrs, T: 0 Hr, P: 2 Hr, Per Week **Total Credits: 03**

Pre-requisites

Operating Systems, Computer Networks

Course Objectives

The objective of this course is to impart necessary and practical knowledge of components of Cloud computing and develop skills required to design real-life cloud based projects by:

1. Learning basics of cloud and challenges in implementation.
2. Identifying areas where cloud computing can be applied.
3. Understanding the cloud environment and its security issues.
4. Understanding the various cloud programming and software environments.

Syllabus

UNIT I

Evolution of Cloud Computing –Underlying Principles of Parallel and Distributed Computing, Cloud Fundamentals: Definition, Evolution, Architecture, Cloud Characteristics, deployment models - Public, Private and Hybrid Clouds, and service models Cloud Computing Stack , Reference Architecture.

UNIT II

Virtualization: Definition, Understanding and Benefits of Virtualization. Implementation Level of Virtualization, Virtualization Structure/Tools and Mechanisms, virtualization issues, technologies and architectures, introduction to virtual machine monitors/Hypervisors and types, Types of virtualization- hardware, operating system, server, storage- Features of virtualization- Advantages and disadvantages of different types of virtualization, Data centers, virtualization of data centers.

UNIT III

Resource Management and Load Balancing: Virtual Infrastructures , Dynamic provisioning and resource management, Resource Optimization, Resource dynamic reconfiguration, Load Balancing, types of load balancing algorithms, various load balancing techniques, auto-scaling.

UNIT IV

Interoperability, Migration and Fault Tolerance: Issues with interoperability, Interoperability approaches, Broad Aspects of Migration into Cloud, Type of migration , Migration of virtual Machines and techniques, live virtual machine migration- types.Fault Tolerance Mechanisms in cloud computing.

UNIT V

Security: Vulnerability Issues and Security Threats, Data level Security, and Virtual Machine level Security, Virtualization based security and Multi-tenancy Issues. Cloud storage: Introduction to Storage Systems, Cloud Storage Concepts, Data in the cloud- Cloud file systems.

UNIT VI

Cloud Programming and Software Environments: Parallel and Distributed Programming paradigms, Programming on real cloud platforms, Implementation and application requirements in the cloud using open source tools.

Course Outcomes

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

1. Articulate the concepts of cloud computing, its various deployment and service models.
2. Implement the concept of virtualization and resource management.
3. Apply the measures to be taken for handling fault tolerance and security.
4. Identify cloud computing solutions and recommendations for cloud programming and software environments based applications.

Text Books:

1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, "Distributed and cloud computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier – 2012
2. "Cloud Computing Principles and Paradigms", Rajkumar Buyya, JamesBroberg, AndrzejGoscinski, Wiley Publishers.2011.

Reference Books:

1. Barrie Sosinsky, " Cloud Computing Bible" John Wiley & Sons, 2010
2. Tim Mather, SubraKumaraswamy, and ShahedLatif, "Cloud Security and Privacy An Enterprise Perspective on Risks and Compliance", O'Reilly 2009
3. Cloud Computing : A Practical Approach, Toby Velte, Anthony TVelte, Robert Elsenpeter, McGraw Hill,2009
4. Research papers based on recent trends in cloud computing.

Syllabus for Semester VI, B. Tech (Computer Science and Engineering)

(Artificial Intelligence & Machine Learning)

Course Code: CAP402-1 **Course: Cloud Computing Lab**

L: 3 Hrs, T: 0 Hr, P: 2 Hr, Per Week **Total Credits: 01 (Program Elective-I)**

Course Objectives

The objective of this course is to impart necessary and practical knowledge of components of Cloud computing and develop skills required to build real-life cloud based projects by:

1. Studying various cloud environments.
2. Implementing various cloud programming concepts.
3. Designing and developing processes involved in creation of a cloud based application.

Syllabus:

Practicals based on CAT402-1 syllabus.

Course Outcomes

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

1. Configure various virtualization tools.
2. Design an application in a cloud environment.
3. Demonstrate the use of cloud environment to access cloud storage.
4. Implement concepts of migration and load balancing.

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

Course Code: CAT402-2 **Course: Social Network Analysis**

L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week **Total Credits: 03**

Course Objectives

1. To make students familiar with social networks and their applications.
2. To familiarize students with different models and representations of social networks.
3. To enable students to design solutions to query and evaluate the social networks.

SYLLABUS

UNIT – I: Networks and Society

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

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

UNIT – II: Network Measures

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

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

UNIT – III: Network Growth Models

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

UNIT – IV: Link Analysis and Network Cohesion

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

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

UNIT – V: Link Predictions and Community Detection

Application of Link Prediction; Link Prediction Methods and Metrics; Evaluating Link

Prediction Methods; Heuristic Models; Probabilistic Models.

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

UNIT – VI: Ego Networks and Information Diffusion

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

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

Case Studies in Online Social Networks.

Course Outcomes:

On completion of the course the student will be able to

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

Text Books:

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

References:

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

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

Course Code: CAP402-2 Course: Social Network Analysis Lab

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

Course Objectives

1.To familiarize students with conceptualizations and models for analyzing social networks.

2.To enable students to apply concepts to realize social network interactions.

3.To expose students to software tools for processing social network data.

Syllabus

Experiments based on CST403-4 Syllabus using Python.

Course Outcomes:

On completion of the course the student will be able to

1. Evaluate different network measures and metrics over network data.
2. Demonstrate approaches to link analysis and link prediction.
3. Apply graph based approaches and algorithms on ego networks.
4. Implement specific applications for social networks.

Reference Books:

1. Mohd. Gouse Galety, et. al.; Social Network Analysis: Theory and Applications; Wiley Global; 2022.
2. Krishna Raj P. M., Ankith Mohan and K. G. Srinivasa; Practical Social Network Analysis with Python; Springer; 2018.
3. Mohd. Zuhair Al-Taie and Saifedine Kadry; Python for Graph and Network Analysis; Springer; 2017.

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

Course Code:	**CAT402-3**	**Course:**	**Distributed Systems**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Objectives

This course introduces principles, design and implementation of distributed system. The course focus primarily on the principles and design of distributed systems and cover communication, distributed storage, naming, synchronization, scheduling, fault tolerance and recovery.

Syllabus

Unit I

Introduction to Distributed systems: Examples of distributed systems, challenges, architectural models, issues in distributed operating systems, communication primitives, Theoretical Foundations - inherent limitations of a distributed system, Lamports logical clocks, vector clocks, casual ordering of messages, global state, cuts of a distributed computation, termination detection.

Unit II

Distributed Mutual Exclusion: Introduction, classification of mutual exclusion and associated algorithms (token based and non-token based approach), a comparative performance analysis.

Unit III

Distributed Deadlock Detection: Introduction, deadlock handling strategies in distributed systems, issues in deadlock detection and resolution, control organizations for distributed deadlock detection, centralized and distributed deadlock detection algorithms, hierarchical deadlock detection algorithms.

Agreement protocols: introduction, the system model, a classification of agreement problems, solutions to the Byzantine agreement problem

Unit IV

Distributed File system: Introduction to DFS , design issues , File service architecture , **Distributed shared memory:** design issues, Architecture, algorithms for implementing DSM, memory coherence and protocols

Unit V

Distributed Scheduling: Introduction, issues in load distributing, components of a load distributing algorithm, load distributing algorithms, performance comparison, selecting a suitable load sharing algorithm, requirements for load distributing, task migration and associated issues.

Unit VI

Failure Recovery: introduction, basic concepts, classification of failures recovery in concurrent systems, consistent set of check points, synchronous and asynchronous check pointing and recovery.

Fault Tolerance: Introduction, Atomic Actions and committing, Commit protocols, Voting Protocols

Course Outcomes:

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

1. Apply knowledge of basic distributed system techniques and concepts.
2. Comprehend issues in mutual exclusion, deadlock detection, and agreement protocols in the context of distributed systems.
3. Realize design issues for distributed file system, distributed shared memory and distributed scheduling.
4. Recognize the importance of fault tolerance and failure recovery in a distributed environment.

Text Books

1. Advanced concepts in Operating Systems – Singhal and Shivratri; McGraw Hill Coulouris, Dollimore, Kindleberg;
2. Distributed Systems Concepts and Design, Fourth Edition, Pearson education, 2009.
3. Distributed Systems An Algorithmic Approach, Second Edition, Sukumar Ghosh, CRC Press.

Reference Books

1. Andrew S. Tanenbaum; Distributed Operating System; Pearson education; 2003.
2. Pradeep K. Sinha, "Distributed Operating System-Concepts and Design", PHI, 2003

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

Course Code:	**CAP402-3**	**Course:**	**Distributed Systems Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

Course Objectives

The course will help students to learn the basic principles and concepts of distributed systems including various distributed algorithms, mutual exclusion, commit protocols, Remote procedure calls.

Syllabus:

Experiments based on Syllabus of CAT402-3

Course Outcomes:

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

1. Implement timing and event relation in distributed environment. 2.
2. Apply basic concepts of remote procedure call, RMI, and mutual exclusion.
3. Employ a solution for a given distributed computing protocol.

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

Course Code: CAT402-4 **Course:** Computer Vision

L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week **Total Credits: 03**

Course Objectives

1.To review image processing techniques for computer vision.
2.To understand shape and region analysis.
3.To understand three-dimensional image analysis techniques and motion analysis.
4.To introduce methods and concepts which will enable the student to implement computer vision systems with emphasis on applications and problem solving.

Syllabus

Unit I

CAMERAS: Pinhole Cameras, **Geometric Camera Models:** Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations, **Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, An Application: Mobile Robot Localization

Unit II

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

Unit III

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

Unit IV

The Geometry of Multiple Views: Two Views, Stereopsis: Reconstruction, Human Stereposis, Binocular Fusion, Using More Cameras, Segmentation by Clustering: segmentation, Human Vision: Grouping and Getstalt, Applications: Shot Boundary Detection and Background

Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering

Unit V

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

Unit VI

Model- Based Vision: Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Application: Registration In Medical Imaging Systems, Curved Surfaces and Alignment.

Course Outcomes:

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

1. Implement fundamental image processing techniques required for computer vision.
2. Perform shape analysis and to implement boundary tracking techniques.
3. Apply chain codes and other region descriptors
4. Apply motion related techniques.
5. Develop applications using computer vision techniques

Text Books

1. D Forsyth and J Ponce, Computer Vision - A modern approach, Prentice Hall of India, 2002.
2. Ballard And Brown, “Computer Vision”, Prentice Hall Publication.

Reference Books

1. E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.
2. R. Szeliski, Computer Vision: Algorithms and Applications, Springer 2011.
3. Simon J D Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.

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

Course Code:	**CAP402-4**	**Course:**	**Computer Vision Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

Course Pre-requisite:

Fundamental of Digital Image and Video Processing

Course Objectives:

This laboratory course is intended to make the students experiment with Computer Vision techniques, to gain deeper insights of visual representations.
This course will introduce the students to working of real-world applications and enhance the problem-solving skills to solve the real-world problems.

Syllabus:

Experiments based on the syllabus of CAP309-Computer Vision Lab.

Course Outcomes:

On successful completion of the course, students will be able to:
1. Implement and test fundamental of Image processing and computer vision.
2. Perform various image processing tasks like image formation, color image processing and feature extraction, etc.
3. Apply chain codes and other region descriptors
4. Implement motion related techniques.
5. Develop applications using computer vision techniques

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

Course Code:	**CAT403-1**	**Course:**	**Financial Analytics**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Objectives

Students will be able to build their competencies in financial analysis and decision making, apply quantitative methods of financial analysis in their regular businesses, analyse real-life proposals for financial investment in a meaningful manner, to be industry-ready through application of analytical tool.

Syllabus

UNIT I

Introduction to Financial Analytics: Introduction to Financial Analytics, Definition, relevance and scope , recent trends in financial analytics, Analytical thinking, Role of a Financial Analyst, Data Driven Financial Decision, Decision making under uncertainty financial analytics, Financial Accounting - concepts and conventions, classification of accounts, Rules and principles governing Double Entry Book-keeping system, Meaning, Preparation of Journal, Ledger , Cash book & Trial balance.

UNIT II

Introduction to Analysis of Financial Data Using Statistical Tools: Statistical concepts; Probability, Normal, Lognormal, distribution properties, multi variate returns, Data visualization, Understanding data in finance, cleaning and pre-processing of data, Application of software on different forms of financial data set- Time Series and Cross Sectional Data.

UNIT III

Financial Modelling: Introduction to Basic Financial Functions in Excel, Discounted Cash flows, Annuity, PMT, PV, NPV, IRR, Financial modelling using Ratios, An overview of

Discounted Cash Flow, NPV, IRR, Sensitivity and Simulation analysis, What if Analysis. income statement and financial statements using Excel.

UNIT IV

Application of Data Science across Financial Services: Learn about Financial Data Analytics with respect to Data Science in Financial Services, Artificial Intelligence and Machine Learning in Financial Services, Usage of AI in Algorithmic Stock Trading, Automated Robo-Advisors, Fraud Detection and Prevention.

UNIT V

Optimal Portfolio Allocation: Capital Allocation Line (CAL) and Optimal Portfolio, Lending and Borrowing on the CAL, analysis using indifference curves. CAPM- Features of Markowitz analysis, expected returns from historical averages, efficient frontier.

UNIT VI

Risk-Return Trade-off & Quadratic Utility: Investments and trade consumption across time, trade-off between risk and return, decision making under uncertainty, indifference curves, quadratic utility function, etc.

Course Outcomes:

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

1.Explain the concept of advanced financial management and risk analysis

2.Demonstrate an understanding on analysis of financial data using different statistical tools

3.Apply knowledge of data science across financial services

4.Assess the financial services on the basis of machine learning and artificial intelligence

Text Books

1. M. J., & Hugen, D. L . Financial analytics with R: building a laptop laboratory for data science Bennett, Cambridge University Press.

2. Hilpisch, Y. " O'Reilly Python for Finance: Analyze big financial data, Media, Inc.".

3. Consoli, S., Reforgiato Recupero, D., & S. Data Science for Economics and Finance. Methodologies and Applications, Springer Nature.

Reference Books

1. 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 VII, B. TECH. (Computer Science and Engineering)
(Artificial Intelligence & Machine Learning)

Course Code:	**CAP403-1**	**Course:**	**Financial Analytics Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

Course Objectives

1. Apply quantitative methods of financial analysis in their regular businesses,
2. Analyse real-life proposals for financial investment in a meaningful manner,
3. To be industry-ready through application of analytical tool.

Syllabus:

Syllabus based on CAT 404-1.

Course Outcomes:

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

1. Explain the concept of advanced financial management and risk analysis
2. Demonstrate an understanding on analysis of financial data using different statistical tools
3. Apply knowledge of data science across financial services
4. Assess the financial services on the basis of machine learning and artificial intelligence

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

Course Code: CAT403-2 **Course: Customer Relationship Management**

L: 3 Hrs, T: 0 Hr, P: 0 Hr, 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 e-CRM and e-CRM technologies.
3. To enable the students understand the technological and human issues relating to implementation of Customer Relationship Management in the organizations

Syllabus:

Unit 1: Introduction to CRM

Overview of CRM, Introduction to Salesforce, Salesforce terminology: Orgs/Profiles/Users/ Permission Set/Account/Contact/Roles/Platform License/User License/sObjects/Custom Object/Managed Package/Unmanaged Package, Type of Orgs, Sales Cloud, Service Cloud, Marketing Cloud, Importance of CRM for businesses.

Unit 2: Database Essentials

Objects, fields, relationships, SOQL, SOSL, creating custom objects, Organization wide settings, Object-Level security, Field-level security, Record-level security, triggers.

Unit 3: Apex Fundamentals

Introduction, loops, arrays, collections, exception handling, asynchronous execution, Governer limits, CRUD in Apex, triggers, object oriented apex, Invoking Apex.

Unit 4: Lightning Web Components

Introduction, component, data binding, CSS, conditional rendering, reactive and non-reactive properties, decorators, lifecycle hooks, events, LDS adapters, deployment via sfdx/vs code, lightning design system.

Unit 5: Integration with CRM

API: Rest/Soap/Bulk/Streaming/Metadata/Pub-Sub, Integration patterns, Integration and Apex Utilities, pattern selection, Salesforce connect.

No-Code/Low-Code Development

Flow builder, schema builder, OmniStudio Introduction, Flexcards, OmniScripts, DataRaptors, Integration Procedures, deployment.

Unit 6: Reports and Dashboards

Reports Introduction, types of reports, report builder, formatting reports, formula, dashboard introduction, dashboard generation, charts in dashboards, limitations of Salesforce reports.

Course Outcomes:

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

1. Understand the basic concepts of Salesforce and its role in the modern business world
2. Build and customize in Salesforce to meet the needs of a business
3. Manage data in Salesforce, including importing and exporting data
4. Automate business processes using Salesforce workflows and process builder
5. Apply the importance of security and access control in Salesforce

Text Books:

1. Jason Ouellette; Development with the Force.com Platform, Second Edn, Addison Wesley, 2011.
2. Mohith Shrivastava; Salesforce Lightning Application Development, 2018.

Reference Books:

1. Judith W .Kincaid , Customer Relationship Management Getting it Right, Pearson Education

2. H.Peeru Mohamed , A Sagadevan, Custmer Relationship Management, A Step by Step Approach, Vikas Publishing House

3. Customer Centricity –Focus on right customer for strategic advantage, by Peter Fader, Wharton Digital Press, 2012

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

Course Code:	**CAP403-2**	**Course:**	**Customer Relationship Management Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

Course Objectives

1. Apply quantitative methods of financial analysis in their regular businesses,
2. Analyse real-life proposals for financial investment in a meaningful manner,
3. To be industry-ready through application of analytical tool.

Syllabus:

Syllabus based on CAT 403-2.

Course Outcomes:

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

1. Implement basic concepts of Salesforce and its role in the modern business world
2. Build and customize in Salesforce to meet the needs of a business
3. Manage data in Salesforce, including importing and exporting data
4. Automate business processes using Salesforce workflows and process builder
5. Apply the importance of security and access control in Salesforce

Syllabus for Semester VII, B. Tech. (Computer Science & Engineering)

(Artificial Intelligence and Machine Learning)

Course Code:	**CAT403-3**	**Course:**	**Blockchain Technology**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

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, Permisionless 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 Wallet, Desktop Wallet, App based Wallet, Browser based wallet, Metamask, Creating a 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

Unit VI

Use Cases:

Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Block chain, Blockchain in energy sector, Blockchain in governance

Course Outcomes:

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

1. Realize importance of blockchain technology and consensus mechanism
2. Identify 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.

Text Books

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 ArvindNarayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder

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

Course Code:	**CAP403-3**	**Course:**	**Blockchain Technology Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

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:

Syllabus based on CAP 403-3

Course Outcomes:

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

1. Apply importance of blockchain technology and consensus mechanism
2. Analyze 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.

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

Course Code:	**CAT 403-4**	**Course:**	**Information Security**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Objectives

1. To understand the basics of Information Security
2. To know the legal, ethical and professional issues in Information Security
3. To know the aspects of risk management
4. To become aware of various standards in this area
5. To know the technological aspects of Information Security

Syllabus

Unit I

INTRODUCTION:

History, What is Information Security?, Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access, The SDLC, The Security SDLC

Unit II

SECURITY INVESTIGATION: Need for Security, Business Needs, Threats, Attacks, Legal, Ethical and Professional Issues - An Overview of Computer Security - Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies

Unit III

SECURITY ANALYSIS: Risk Management: Identifying and Assessing Risk, Assessing and Controlling Risk - Systems: Access Control Mechanisms, Information Flow and Confinement Problem

Unit IV

LOGICAL DESIGN: Blueprint for Security, Information Security Policy, Standards and Practices, ISO 17799/BS 7799, NIST Models, VISA International Security Model, Design of

Security Architecture, Planning for Continuity

Unit V

PHYSICAL DESIGN: Security Technology, IDS, Scanning and Analysis Tools, Cryptography, Access Control Devices, Physical Security, Security and Personnel

UNIT-VI

Web security: Web security considerations, Secure Socket Layer and Transport Layer Security, SHTTP. Security systems: Intruders, Intrusion detection, Firewalls design principles, Trusted systems, Virtual private networks

Course Outcomes:

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

1. Discuss the basics of information security
2. Illustrate the legal, ethical and professional issues in information security
3. Demonstrate the aspects of risk management.
4. Understand various standards in the Information Security System
5. Design and implement various Security Techniques.

Text Books

1. Michael E Whitman and Herbert J Mattord, —Principles of Information Security||, Vikas Publishing House, New Delhi, 2003

Reference Books

1. Micki Krause, Harold F. Tipton, — Handbook of Information Security Management||, Vol 1-3 CRC Press LLC, 2004.
2. Stuart McClure, Joel Scrambray, George Kurtz, —Hacking Exposed||, Tata McGraw-Hill, 2003
3. Matt Bishop, — Computer Security Art and Science||, Pearson/PHI, 2002.

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

Course Code:	**CAP 403-4**	**Course:**	**Information Security Lab**
L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week		**Total Credits:**	**01**

Course Objectives

1. To understand the basics of Information Security
2. To know the legal, ethical and professional issues in Information Security
3. To know the aspects of risk management
4. To become aware of various standards in this area
5. To know the technological aspects of Information Security

Syllabus

Experiments based on CAT403-4 syllabus

Course Outcomes:

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

1. Apply the basics of information security
2. Illustrate the legal, ethical and professional issues in information security
3. Demonstrate the aspects of risk management.
4. Apply various standards in the Information Security System
5. Design and implement various Security Techniques.

Syllabus for Semester VII, B. Tech. (Computer Science & Engineering)

(Artificial Intelligence and Machine Learning)

Course Code:	**CAP 404**	**Course:**	**Project Phase-I**
L: 0 Hrs, T: 0 Hr, P: 12 Hr, Per Week		**Total Credits: 06**	

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 completion of the Project-phase I, the student 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 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 VIII, B. Tech. (Computer Science & Engineering)
(Artificial Intelligence and Machine Learning)

Course Code:	**CAT405-1**	**Course: Introduction to GAN [Generative Adversarial Networks]**	
L: 3 Hrs,	**T: 0 Hr,**	**P: 0 Hr,**	**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

Introduction to Deep Learning Evolution of deep learning: Sigmoid activation, Rectified Linear Unit (ReLU), Exponential Linear Unit (ELU), Stochastic Gradient Descent (SGD), Learning rate, tuning Regularization, Shared weights and pooling, Local receptive field, Convolutional network (ConvNet), Deconvolution or transpose: convolution Recurrent Neural Networks and LSTM, Deep neural networks, Discriminative versus generative models Summary.

Unit-II

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.

Unit-III

Transfer Image Style Across Various Domains, Bridging the gap between supervised and unsupervised learning, Introduction to Conditional GAN, Generating a fashion wardrobe

with CGAN, 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-IV

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-V

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-VI

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

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 and Machine Learning)

Course Code:	**CAT405-2**	**Course:**	**Reinforcement learning**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Pre-requisite

- Python Programming, Foundations of Machine Learning

Course Objectives

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. 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 Programing: Overiew of dynamic programing 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: Overiew 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.

Unit 5

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 and their variants.

Unit 6

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, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

Course Outcomes

After the completion of the course the 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 Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", Second Edition, MIT Press, 2018

Reference Books.

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

Syllabus for Semester VIII, B. E. (Computer Science & Engineering-AIML)

Course Code:	**CAT405-3**	**Course:**	**Human Computer Interaction**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

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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.

Syllabus

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.

Unit VI

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 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 and Machine Learning)

Course Code:	**CAT405-4**	**Course:**	**Game Theory**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Objectives

1. Course provides an introduction to Game Theory, a mathematical framework which makes possible the analysis of the decision making process of interdependent subjects.
2. Course aims at explaining and predicting how individuals behave in a specific strategic situation to improve decision making.

Syllabus

Unit I: Introduction to Game Theory

Game Theory Introduction, Classification of Games, Self-Interested Agents and Utility Theory, Defining Games, Examples of Games, Theory of rational choice, interacting decision makers.

Unit II : Strategic Games and Nash Equilibrium

Strategic Reasoning, Strategic games: examples, Nash Equilibrium Introduction, concept and examples, Best response functions, Nash Equilibrium of Example Games Dominant Strategies, Dominated Actions, Symmetric games and symmetric equilibrium.

Unit III: Illustrations of Nash Equilibrium

Cournot's model of duopoly market, Bertrand's model of duopoly market, Electoral Competition, War of Attrition, Auctions, Accident Laws.

Unit IV: Mixed Strategy Nash Equilibrium

Introduction, Strategic games with randomization, Mixed strategy Nash equilibrium: concept and

examples, Computing Mixed Nash Equilibrium, Dominated Actions, Formation of Players' beliefs, Alternate solution concepts.

Unit V: Extensive Games and Nash Equilibrium

Introduction to extensive games, Strategies and outcomes, Subgame perfect Nash equilibrium, Backward induction.

Unit VI: Advanced Topics

Repeated games, finite and infinite repeated games, stochastic games and learning, Bayesian Games: Definition, Analyzing Bayesian Games, and Coalitional Game Theory: Definitions, The Shapley Value, The Core, Comparing the Core and Shapley value.

Course Outcomes:

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

1. Distinguish a game as decision problem and understand concepts of players, strategies, payoffs, rationality, and equilibrium.
2. Establish dominant strategy equilibrium, pure and mixed strategy Nash equilibrium.
3. Create sequential games using game trees, and to use the backward induction to design solutions.
4. Analyze repeated games and Bayesian Games.

Text Books

1. Osborne, M.J., An Introduction to Game Theory, Oxford University Press, 2004
2. Gibbons, R. A , Primer in Game Theory, Pearson Education, 1992
3. Fudenberg, Drew, and Jean Tirole, Game Theory. MIT Press, 1991. ISBN: 9780262061414.

Reference Books

1. Vijay Krishna, Auction Theory, Academic Press.
2. PrajitDutta, Strategies and Games, MIT Press
3. Mas-Colell, A., M.D. Whinston and J.R. Green Microeconomic Theory, Oxford University Press, 1995

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

Course Code:	**CAT405-5**	**Course:**	**Information Retrieval**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits:**	**03**

Course Objectives

The objective of the course is to prepare the students:

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.

Syllabus

UNIT - I

Boolean retrieval, term vocabulary and postings lists, dictionaries and tolerant retrieval, index construction, index compression.

UNIT - II

Scoring, term weighting and the vector space model computing scores in a complete search system.

UNIT - III

Evaluation in information retrieval, relevance feedback and query expansion.

UNIT - IV

Probabilistic information retrieval, language models for information retrieval.

UNIT - V

Text classification and Naive Bayes, Vector space classification, Support vector machines and machine learning on documents.

UNIT - VI

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, Hinrich Schütze, The MIT Press.
3. 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 and Machine Learning)

Course Code:	**CAT406-1**	**Course:**	**Robotics**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits: 03**	

Course Objectives

1.Identify robots and its peripherals for satisfactory operation

2.Control of robots for industrial and non-industrial applications.

3.Develop skills necessary to design, build and operate robotic systems.

Syllabus

Unit I: Robot Basics

Robot-Basic concepts, need, Law, history, anatomy, specifications. Robot configurations-Cartesian, cylinder, polar and articulate, robot wrist mechanism, precision and accuracy of robot.

Unit II : Robot Elements

End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.

Unit III: Robot Kinematics and Control

Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control, Robot programming

Unit IV: Robot Sensors

Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.

Unit V: **Robot Vision and Perception**

Image processing for robot vision, Stereo vision, optical flow, and range sensing, Object recognition and tracking, 3D perception and reconstruction

Unit VI: Robot Applications

Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications.

Course Outcomes:

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

1.List and explain the basic elements of industrial robots

2.Analyse robot kinematics and its control methods.

3.Classify the various sensors used in robots for better performance.

4.Summarize various industrial and non-industrial applications of robots.

Text Books:

1. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, "Industrial Robotics Technology, Programming and Applications", Tata –McGraw Hill Pub. Co., 2008.
2. Klafter.R.D, Chmielewski.T.A, and Noggin's., "Robot Engineering: An Integrated Approach"', Prentice Hall of India Pvt. Ltd., 1994.
3. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, "Robotics control, sensing, vision and intelligence", Tata-McGraw Hill Pub. Co., 2008
4. Yu. "Industrial Robotics", MIR Publishers Moscow, 1985.

Reference Books:

1. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.

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

Course Code:	**CAT406-2**	**Course:**	**Cyber Security Intelligence**
L: 3 Hrs,	**T: 0 Hr, P: 0 Hr, Per Week**	**Total Credits:**	**03**

Course Objectives

1. To learn basic fundamentals of cyber threat intelligence.
2. To demonstrate how cyber has changed the nature of intelligence collection.
3. To analyze the cyber threats at different levels.
4. To learn how to collect cyber threat data.
5. To validate and prioritize risks involved

Syllabus

Unit I

Defining Cyber Security Intelligence: The Need for Cyber Security Intelligence: The menace of targeted attacks, The monitor-and-respond strategy, Why the strategy is failing, Cyber Security Intelligence Defined, Key Characteristics: Adversary based, Risk focused, Process oriented, Tailored for diverse Consumers, The Benefits of Cyber Security Intelligence.

Unit II

Developing Cyber Security Intelligence Requirements: Assets That Must Be Prioritized: Personal information, Intellectual property, Confidential business information, Credentials and IT systems information, Operational systems.

Adversaries: Cybercriminals, Competitors and cyber espionage agents, Hacktivists. Intelligence Consumers: Tactical users, Operational users, Strategic users.

Unit III

Collecting Cyber Security Information: Level 1: Threat Indicators, File hashes and reputation data, Technical sources: honeypots and scanners, Industry sources: malware and reputation feeds. Level 2: Threat Data Feeds, Cyber security statistics, reports, and surveys, Malware analysis. Level 3: Strategic Cyber Security Intelligence, Monitoring the underground,

Motivation and intentions, Tactics, techniques, and procedures.

Unit IV

Analyzing and Disseminating Cyber Security Intelligence: Information versus Intelligence, Validation and Prioritization: Risk scores, Tags for context, Human assessment. Interpretation and Analysis: Reports, Analyst skills, Intelligence platform, Customization. Dissemination: Automated feeds and APIs, Searchable knowledge base, Tailored reports.

Unit V

Selecting the Right Cyber Security Intelligence Partner: Types of Partners: Providers of security indicators, Providers of security data feeds, Providers of comprehensive cyber security intelligence

Course Outcomes:

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

1. Examine the history and development of cyber intelligence operations and how those operations can integrate with other intelligence collection.
2. Study the technique to Develop Cyber Security Intelligence Requirements.
3. Evaluate the benefits and risks of the current cyber intelligence structure.
4. Use the attributes of computer network exploitation, defense and attack within the intelligence context.
5. Examine the intelligence challenge of attribution in cyber-attacks.

Text Books

1. Friedman, J., & Bouchard, M. (2015). Definitive Guide to Cyber Threat Intelligence: Using Knowledge about Adversaries to Win the War against Targeted Attacks. CyberEdge Group.
2. Dalziel, H. (2014). How to define and build an effective cyber threat intelligence capability. Syngress.

Reference Books

1. Thomas Calabres and Tom Calabrese, “Information Security Intelligence: Cryptographic Principles & Application”, Thomson Delmar Learning, 2004.

Syllabus for Semester VIII, B. Tech. (Computer Science & Engineering)

(Artificial Intelligence and Machine Learning)

Course Code: CAT406-3 **Course: Time Series Analysis**

L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week **Total Credits: 03**

Course Objectives

1. To understand Time Series Analysis.
2. To introduce the tools and Models for basic concepts of Time Series Analysis.
3. To apply the Time Series Model Selection research models to solve problems.

Syllabus

Unit I

TIME SERIES DATA: EXAMPLES AND BASIC CONCEPTS: Introduction, Examples of Time Series Data, Understanding Autocorrelation, The Wold Decomposition, The Impulse Response Function, Superposition Principle ,Parsimonious Model.

Unit II

VISUALIZING TIME SERIES DATA STRUCTURES: GRAPHICAL TOOLS: Introduction, Graphical Analysis of Time Series, Graph Terminology, Graphical Perception, Principles of Graph Construction, Aspect Ratio, Time Series Plots, Bad Graphics.

Unit III

STATIONARY MODELS: Basics of Stationary Time Series Models, Autoregressive Moving Average (ARMA) Models, Stationarity and Invertibility of ARMA Models, Checking for Stationarity using Variogram, Transformation of Data.

Unit IV

NONSTATIONARY MODELS: Introduction, Detecting Nonstationarity , Autoregressive Integrated Moving Average (ARIMA) Models, Forecasting using ARIMA Models, Concentration Measurements from a Chemical Process, The EWMA Forecast.

Unit V

SEASONAL MODELS: Seasonal Data, Seasonal ARIMA Models, Forecasting using Seasonal ARIMA Models.

Unit VI

TIME SERIES MODEL SELECTION: Introduction, Finding the "BEST" Model, Internet Users Data, Model Selection Criteria, Impulse Response Function to Study the Differences in Models, Comparing Impulse Response Functions for Competing Models.

Course Outcomes:

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

1. Get acquainted with the main concepts of **Time Series** theory and methods of **analysis**.
2. Use traditional methods of **Time Series analysis**, intended mainly for working with **time series** data.
3. Differentiate the underlying concepts in the time series and frequency domains
4. Demonstrate advanced understanding of the concepts of time series and their application.

Text Books

Murat Kulahci Technical University of DenmarkA JOHN WILEY & SONS, INC., PUBLICATION "TIME SERIES ANALYSISAND FORECASTINGBY EXAMPLE".

Reference Books

George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Freta M. Ljung "Time Seies Analysis Forecasting and Control".

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

Course Code:	**CAT406-4**	**Course: Introduction to IOT**
L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week		**Total Credits: 03**

Course Objectives

1.To introduce the terminology, technology, and its applications

2.To introduce the concept of M2M (machine to machine) with necessary protocols

3.To introduce the Python Scripting Language which is used in many IoT devices

4. To introduce the Raspberry PI platform, which is widely used in IoT applications

5.To introduce the implementation of web-based services on IoT devices

Syllabus

Unit I: Introduction to IoT:

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs. IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates.

Unit II: IoT & M2M :

Machine to Machine, Difference between IoT and M2M, Software define Network.

Network function virtualization, the difference between SDN and NFV for IoT, Basics of IoT System Management with NETCONF, YANG- NETCONF, YANG, SNMP, NETOPEER

Unit III: Network & Communication aspects:

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.

IoT Physical Devices and Endpoints- Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C)

Unit IV: Challenges in IoT

Design challenges, Development challenges, Security challenges, other challenges.

Unit V: Domain-specific applications of IoT

Home automation, City, Environment, Energy, Agriculture, Industry applications, Surveillance applications, and Other IoT applications

Unit VI: Developing IoTs

Introduction to Python, Introduction to different IoT tools, Developing applications through

IoT tools, Developing sensor-based applications through embedded system platform, Implementing IoT concepts with python.

Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors.

Course Outcomes:

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

1. Understand the concepts of Internet of Things
2. Analyze basic protocols in wireless sensor network
3. Design IoT applications in different domain and be able to analyze their performance
4. Implement basic IoT applications on embedded platform

Text Books

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

Reference Books

1. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

2. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

3. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014

Course Code:	**CAT406-5**	**Course:**	**Big Data Analytics using Hadoop**
L: 3 Hrs,	**T: 0 Hr, P: 0 Hr, Per Week**	**Total Credits: 03 (Program Elective-IV)**	

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 explore the ecosystem of Hadoop.

Syllabus

UNIT - I

Introduction to Big Data : Evolution of Big Data, What is Big Data, its types and characteristics, Traditional BI versus Big Data, Data warehouse versus Big data and their co-existence, Consistency Availability Partition Tolerance (CAP), Basically Available Soft State Eventual Consistency (BASE).

Technology Landscape: NoSQL databases: why, advantages, Hadoop: Features, advantages, Hadoop1.0-Hadoop2.0, overview of Hadoop ecosystems.

UNIT - II

Introduction to Hadoop and MongoDB : Hadoop Distributed File System (HDFS), HBase, Hadoop Map-Reduce, Map-reduce way of designing solutions with examples.

NoSQL Databases : NoSQL vs. Relational Database MongoDB: Create Database, Create Collection, Document operations like Insert, update, query, delete, Using JSON, creating and generating a unique key, support for dynamic queries, Data types in MongoDB, CRUD (Create, Read, Update,Delete), Aggregation, Indexing, Sharding, Map-Reduce functions.

UNIT - III

Cassandra : Architecture, Data Replication in Cassandra, Data model: cluster, keyspace, column family, Cassandra Keyspace Operations: Create, Alter, drop, Table Operations:

create, alter, drop, truncate, index, CURD Operations, Cassandra CQL: data types, collections.

UNIT - IV

Introduction to Hive: Introducing Hadoop Hive, architecture of Hive, Working with Hive Query Language, Creation of a database, table, group by and other clauses, Hive partitioning, and Buckets.

Introduction to Pig- Pig : Data Model, Reading and storing data, Diagnostic Operators, Grouping & Joining, Combining & Splitting, Filtering, Built-In Functions,Pig Vs Hive.

Jasper Report using Jasper soft: Jasper Studio: Jasper Reports, Jaspersoft Studio, connecting to mongo DB.

UNIT – V

Introduction to Zoo Keeper : what is Zoo Keeper , Architecture of Zoo Keeper, Nodes in a Zoo Keeper, Zoo Keeper Command Line Interface (CLI), Basics of Zoo Keeper API.

Flume, Sqoop and HBase: Apache Sqoop introduction, Importing and exporting data, Performance improvement with Sqoop, Sqoop limitations, introduction to Flume and understanding the architecture of Flume, introduction to HBase and its concepts.

UNIT - VI

Machine learning with Big Data : Introduction to Machine Learning with MLlib, Estimating the relationships, Outliers, Variances, Probability Distributions, and Correlations, Regression analysis, Finding Similar Items, Similarity of Sets and Collaborative Filtering, Frequent Itemsets and Association Rule Mining.

Linear and logistic regression, classification and clustering with Big Data tool like Spark.

Text, Web Content, Link, and Social Network Analytics: Introduction, Text mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and analyzing a Web Graph, Social Network as Graphs and Social Network Analytics.

Course Outcomes:

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

1.Understand fundamentals, applications and approaches to data management with Big Data Analytics.

2.Solve distributed computing challenges with the help of Hadoop Map-Reduce method.

3.Use NoSql Databases for analyzing large data sets.

4.Perform various machine learning tasks and mining using Big data tools.

Text Books

1. Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman; Big Data for Dummies; Wiley India, 2015.
2. Tom White; Hadoop: The Definitive Guide, 4th Edition, O'Reilly, 2015.
3. Hien Luu; Beginning Apache Spark 2: With Resilient Distributed Datasets, Spark SQL, Structured Streaming And Spark Machine Learning Library, Apress, 2018.
4. Raj Kamal and Preeti Saxena, “Big Data Analytics Introduction to Hadoop, Spark, and MachineLearning”, McGraw Hill Education, 2018 ISBN: 9789353164966, 9353164966.

Reference Books

1. P. Simon, Too Big to Ignore: The Business Case for Big Data; Wiley, 2015.
2. Douglas Eadline, "Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1st Edition, Pearson Education, 2016. ISBN13: 9789332570351.
3. Arshdeep Bahga, Vijay Madisetti, "Big Data Analytics: A Hands-On Approach", 1st Edition, VPT Publications, 2018. ISBN-13: 978-0996025577.

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

Course Code:	**CAP407**	**Course:**	**Project Phase-II**
L: 0 Hrs, T: 0 Hr, P: 12 Hrs, Per Week		**Total Credits:**	**06**

Course Objectives

1. The objective of the project phase-II is to enhance the students' knowledge and skills in solving problem through structured project research in order to produce a competent and productive engineer.

Course Outcome

Upon completion of Project Phase -II, student should 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 VIII, B. Tech. (Computer Science & Engineering)
(Artificial Intelligence and Machine Learning)

Course Code:	**CAP408**	**Course:**	**Industry Internship**
L: 0 Hrs, T: 0 Hr, P: 24 Hr, 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 manufacturing industry.

Objectives of industrial training are:

To provide students the opportunity to test their interest in a particular career before permanent commitments are made.

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

OPEN ELECTIVE

Syllabus for Semester VII, B. E. (Artificial Intelligence and Machine Learning))

Course Code:	**CAT498**	**Course:**	**Software Engineering**
L:3 Hrs, T: 0 Hr, P: Hr, Per Week		**Total Credits:**	**3**

Course Objectives

The objective of this course is to familiarize the prospective engineers with:

1. To make students successful professionals in the field with solid fundamental knowledge of software engineering
2. To prepare students with strong communication and interpersonal skills, as well as professional and ethical principles when functioning as members and leaders of multi-disciplinary teams
3. To teach students how to apply their foundations in software engineering to adapt to readily changing environments using the appropriate theory, principles and processes

Syllabus

Unit 1:

Introduction to Software Engineering, Software engineering principles, Software Myths, Software Engineering- A Layered Technology, Software Process Framework, Requirements Engineering Tasks, Requirement Engineering Process, Eliciting Requirement: Software Requirements Specification.

Software Process Models, The Waterfall Model, Incremental Process Models, Evolutionary Process Models.

Unit 2:

Agile Process Models, Agile metrics, Extreme Programming (XP), Scrum. An overview, Requirements Analysis, Analysis Modeling Approaches, Data Modeling, Object-Oriented Analysis, Scenario-Based Modeling, Flow-Oriented Modeling, Class-based Modeling, Behavioral Model. Design Engineering Concepts, Design Model, Unified Modelling Language: Star UML.

Unit 3:

Basic concepts of testing, Testing Life Cycle, Structural Testing, Functional Technique, Static testing, Dynamic testing, Unit Testing, Integration Testing, Validation Testing, System Testing, Debugging. Black-Box Testing, White-Box Testing, Web Testing, Automated Testing, Selenium, JUnit.

Unit 4:

Software Project management. Project Evaluation, Cost-benefit evaluation technique, Project Planning-stepwise project Planning, Software Effort Estimation- Albrecht Function Point Analysis, COSMIC Function Point, Cost Estimation, Project Scheduling, Gantt Chart creation tool.

Unit 5:

An overview, 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, metrics for software quality, metrics for small organization, managing people in software environment.

Unit 6:

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

Course Outcomes:

After successful completion of this course, the student should able to:

1. Implement software engineering practices and various models.
2. Apply software engineering processes to modeling and solving real-world problems.
3. Analyze impact of different software testing strategies.
4. Apply approaches to assessment of software quality and management.

Text books and Reference books:

1. Roger Pressman; Software Engineering-A Practitioner's Approach; Sixth Edition, MaGraw Hill, 2010
2. Project Management by Clifford F. Gray, Erik W. Larson, McGraw Hill
3. Ian Somerville; Software Engineering; Seventh Edition; Pearson Education. 2008.
4. Ethics in Information Technology, George W. Reynalds, 4th Edition, Cengage Leraning Publication
5. David Gustafsan, Software Engineering;Schaum's Series,Tata McGraw Hill,2002
6. Sanjay Mohapatra; Software Project Management, First Edition, Cengage Learning, 2011.
7. Rajib Mall, Software Project Management, 5th Edition, McGrawHill