APPROVED COURSE STRUCTURE AND SYLLABUS

FOR

4-YEAR B. TECH.
COMPUTER SCIENCE & ENGINEERING

Effective from 2019 Batch

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY (ISM)
DHANBAD- 826 004, JHARKHAND

Course Structure - III Semester – B.Tech (CSE)

III SEMESTER B.TECH- CSE						
Course Type	**Course No.**	**Name of the Courses**	**L**	**T**	**P**	**Credit Hrs.**
DC1	CSC201	Data Structures	3	0	0	**9**
DC2	CSC202	Discrete Mathematics	3	0	0	**9**
DC3	CSC203	Computer Organization	3	0	0	**9**
E/SO1	MCC505	Probability & Statistics	3	0	0	**9**
E/SO2			3	0	0	**9**
DP1	CSC204	Data Structures Lab	0	0	2	**2**
DP2	CSC205	Computer Organization Lab	0	0	2	**2**
Total						**49**
Contact Hrs.			**15**	**0**	**4**	**19**

Course Structure - IV Semester – B.Tech (CSE)

IV SEMESTER B. TECH- CSE						
Course Type	**Course No.**	**Name of the Courses**	**L**	**T**	**P**	**Credit Hrs.**
E/SO3	CSE202	Object Oriented Programming	3	0	0	**9**
DC4	CSC206	Algorithm Design & Analysis	3	0	0	**9**
DC5	CSC207	Computer Architecture	3	0	0	**9**
DC6	CSC208	Theory of Computation	3	0	0	**9**
DC7	CSC209	Operating Systems	3	0	0	**9**
DP3	CSC210	Algorithm Design & Analysis Lab	0	0	2	**2**
DP4	CSC211	Operating Systems Lab	0	0	2	**2**
Total						**49**
Contact Hrs.			**15**	**0**	**4**	**19**

Course Structure - V Semester – B.Tech (CSE)

V SEMESTER B. TECH- CSE						
Course Type	**Course No.**	**Name of the Courses**	**L**	**T**	**P**	**Credit Hrs.**
DC8	CSC301	Database Management Systems	3	0	0	**9**
DC9	CSC302	Compiler Design	3	0	0	**9**
OE1			3	0	0	**9**
HSS1/MS1			3	0	0	**9**
E/SO4			3	0	0	**9**
DP5	CSC303	Database Management Systems Lab	0	0	2	**2**
DP6	CSC304	Compiler Design Lab	0	0	2	**2**
Total						**49**
Contact Hrs.			**15**	**0**	**4**	**19**

Course Structure - VI Semester – B.Tech (CSE)

VI SEMESTER B. TECH - CSE						
Course Type	**Course No.**	**Name of the Courses**	**L**	**T**	**P**	**Credit Hrs.**
DC10	CSC305	Computer Networks	3	0	0	**9**
DC11	CSC306	Software Engineering	3	0	0	**9**
MS2/HSS2			3	0	0	**9**
OE2			3	0	0	**9**
OE3			3	0	0	**9**
DP7	CSC307	Computer Networks Lab	0	0	2	**2**
DP8	CSC308	Software Engineering Lab	0	0	2	**2**
Total						**49**
Contact Hrs.			**15**	**0**	**4**	**19**

Course Structure - VII Semester – B.Tech (CSE)

VII SEMESTER B. TECH - CSE						
Course Type	**Course No.**	**Name of the Courses**	**L**	**T**	**P**	**Credit Hrs.**
DE1			3	0	0	**9**
DE2			3	0	0	**9**
OE4			3	0	0	**9**
OE5			3	0	0	**9**
OE6			3	0	0	**9**
UGP*	CSS401	UG Project - 1	0	0	0	**0**
DC12*	CSS402	Internship	0	0	0	**0**
	Total					**45**
	Contact Hrs.		**15**	**0**	**0**	**15**

Course Structure - VIII Semester – B.Tech (CSE)

VIII SEMESTER B. TECH - CSE						
Course Type	**Course No.**	**Name of the Courses**	**L**	**T**	**P**	**Credit Hrs.**
DE3			3	0	0	**9**
DE4			3	0	0	**9**
OE7			3	0	0	**9**
DC13*	CSS403	UG Project - 2	0	0	0	**0**
Total						**27**
Contact Hrs.			**9**	**0**	**0**	**9**

LIST OF SO/ESO		
	Course No.	**Name**
ESO1	CSE201	Data Structures and Algorithms
ESO2	CSE202	Object Oriented Programming

LIST OF DEPARTMENT ELECTIVE	
Course No.	**Name**
CSD502	**Cloud Computing**
CSD504	**Computer Vision**
CSD508	**Distributed Systems**
CSD510	**Information Retrieval**
CSD511	**Information Theory and Coding**
CSD401	Advanced Algorithms
CSD402	Bioinformatics
CSD403	Combinatorics and Graph Theory
CSD404	Computer Graphics
CSD405	Evolutionary Computation
CSD406	Multimedia Systems
CSD407	Network Security
CSD408	VLSI Designs
CSD409	Wireless and Mobile Computing

LIST OF OPEN ELECTIVE (OE) COURSES	
Course No.	**Name**
CSO301	Database Management Systems
CSO302	Graph Theory
CSO303	Artificial Intelligence
CSO304	Digital Image Processing
CSO401	Machine Learning
CSO402	Soft Computing
CSO403	Internet Technology
CSO404	Cryptography
CSO405	Data Mining

COURSE DETAILS OF B. TECH (CSE)

Course Type	Course Code	Name of Course	L	T	P	Credit
DC1	CSC201	Data Structures	3	0	0	9

Course Objective
The course will provide the basic and fundamental knowledge on various data structures concepts for solving different problems in Computer Science.
Learning Outcomes
Enhance the ability to understand different data structures approaches for organizing data in a computer so that it can be used effectively.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Course: Basic concepts; Mathematical Background, Algorithms, Complexity Analysis; Arrays: one dimensional, multi-dimensional, Sparse Matrix, Elementary Operations	4	Basic overview and understanding about the subject
2	Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching; Queues: Simple queue, circular queue, dequeue, elementary operations and applications	6	Familiarity with Stack, queue and similar terminologies with basic operations
3	Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation	6	Basic understanding dynamic allocation strategies and manipulations for the same.
4	Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree, tries, B-tree, other operations and applications of trees	8	Basic understanding of non-linear data structures and its operations such as various trees
5	Graphs: representation, Adjacency list, graph traversal, path matrix, connected components, DAG, topological sort, Spanning tree;	6	Basic understanding of non-linear data structures and its operations such as graphs
6	Sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, Radix sort; Searching: linear and binary search; Hashing: hash tables, hash functions, and open addressing.	9	Basic understanding of Arranging numbers and hashing

Text Books:

1. J. P. Tremblay and P. G. Sorenson, "An Introduction to Data Structures with Application", TMH
2. Ellis Horowitz and SartajSahni, "Fundamentals of Data Structures"
3. Seymour Lipschutz, "Data Structures with C (Schaum's Outline Series)"

Reference Books:

1. Cormen, Leiserson, Rivest and Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2010.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC2	CSC202	Discrete Mathematics	3	0	0	9

Course Objective
The course will provide the basic and fundamental knowledge on Discrete Mathematics along with various applications based techniques to solve problems in Computer Science.
Learning Outcomes
Upon successful completion of this course, students will: ● Have a broad understanding of Discrete Mathematics course. ● Understand and construct mathematical arguments ● Develop recursive algorithms based on mathematical induction ● Know basic properties of relations ● Know essential concepts in graph theory and related algorithms ● Apply knowledge about discrete mathematics in problem solving

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Set Theory: Introduction, Different types of Set: Index and Indexed Sets, Partitions of Sets; Different Operations on set: Union, Intersection, Compliment, Symmetric Difference; De Morgan's Laws, Computer representation of Sets, Fuzzy Set and its related operations	3	Comprehensive study of Set Theory with application of De Morgan's Laws, and to recognize fuzzy logic membership function
2	Mathematical Logic: Introduction, Types of Logic: Proposition and Predicate Logic; Propositional & Predicate Calculus, Basic Logical Operations: Conjunction, Disjunction, Negation; Tautology and Rule of Inferences, Different types of Normal Form: Conjunctive and Disjunctive	4	Usefulness mathematical logic in reasoning and its application to Artificial Intelligence.
3	Function and Relation: Introduction, Different types of functions and relations; Principle of Mathematical Induction	3	Basic idea of Function and Relations and usefulness of induction in proving problems
4	Algebraic Structures: Introduction, Binary Operation and its various properties; Group: Definition and its properties, Different types of Group: Finite & Infinite, Abelian, Permutation, Cyclic; Ring: Definition and its properties, Types of Ring, Integral Domain, Field	8	Basics of Group and Ring Theory and its application to information security.
5	Congruence Arithmetic: Some elementary properties, Solution of Linear Congruence equation, Chinese Remainder Theorem	3	Understanding the application of congruence to solve equations in one and two variables.
6	Boolean Algebra: Introduction, Basic Theorems on Boolean Algebra, Duality Principle, Boolean functions	4	Relate Boolean expressions to truth tables and logic diagrams and apply Duality Principle
7	Recurrence Relations and Generating Functions:	8	Understand how to build recurrence

	Introduction, Characteristics equation of recurrence relation, homogeneous and particular solutions of linear recurrence relations with constant coefficients, Solution of non-homogeneous recurrence relations using undetermined coefficients and other techniques		relations
8	Combinatorics: Sum and Product Rules, Permutation with repetition of Objects, Circular Permutation, Restricted Permutations; Combinations: Pigeonhole principle, Multinomial Coefficient, Derangements	4	Solve counting problems by applying elementary counting techniques using the product and sum rules, permutations, combinations, the pigeon-hole principle and its application
9	Graph Theory: Introduction of Graph and Tree, Operations on graph, path and cycle, connectivity	3	To understand basics of Graph and Trees

Text Books:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications" McGraw Hill.
2. J.K.Sharma, "Discrete Mathematics" MacMillan India Ltd.

Reference Books:

1. J.P.Tremblay & R. Manohar, "Discrete Mathematical Structure with Applications to Computer Science" McGraw Hill.
2. Kolman, Busby Ross, "Discrete Mathematical Structures", Prentice Hall International.
3. Seymour Lipschutz, M.Lipson, "Discrete Mathematics" Tata McGraw Hill.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC3	CSC203	Computer Organization	3	0	0	9

Course Objective
The objective of the course is to present an understanding of the basic principles on which computers work. To know about the various components and their organization.
Learning Outcomes
Upon successful completion of this course, students will: ● understand the structure, function and characteristics of computer systems. ● Understand the design of the various functional units and components of computers. ● identify the elements of modern instructions sets and their impact on processor design. ● understand the function of each element of a memory hierarchy, ● Identify and compare different methods for computer I/O. ● Be able to write assembly language code.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Basics of computer, Von-Neumann Architecture, Generations of Computer, Basic Functional Blocks of a Computer, Instruction Execution, Register Transfer and Micro operations, Digital Circuits.	4	Understanding of Computer, its components and its working.
2	Data representation: Signed number representation, fixed and floating point representations, character representation.	4	This unit will help student in understanding the number system and its importance.
3	Computer Arithmetic: Integer Addition and Subtraction, Ripple carry adder, carry look-ahead adder, etc. Multiplication - Shift-and-Add, Booth Multiplier, Carry save multiplier, etc. Division - Non-restoring and restoring techniques. Floating point arithmetic, Decimal arithmetic-Operations, BCD Adder, BCD Subtraction.	7	This will help in understanding performing the arithmetic operations. This will create the foundation for designing ALU.
4	Organization of a Computer: Central Processing Unit (CPU) - Hardwired and micro-programmed		One can understand the design and working of CPU and its components.

	design approaches, ALU organization, Instruction formats, Three-, two-, one- and zero-address instructions, Addressing modes- Immediate, Register direct and indirect, Indexed, Based-indexed	6	Along with this understanding of different instruction format will be provided.
5	Input-Output Organization: Input-output subsystems, I/O transfers- Program controlled, Interrupt driven and DMA, Privileged and non-privileged instructions, Introduction to Peripheral Devices and their Characteristics	6	To understand about the interface designing to interact with the Input Output devices.
6	Memory Organization: Memory hierarchy, Main memory, Auxiliary memory, Cache memory-Organization, Mapping, Replacement, Writing policies, Virtual memory-Page table, Page replacement, Associative memory	6	This will help student in categorizing memory and understanding the processing to storing and fetching data.
7	Programming Basic Computer: Programming Arithmetic and Operations, Assembly Language, Machine Language	6	One can learn about the programming operations and writing assembly language programs.

Text Books:

1. "Computer System Architecture", by M. Morris Mano (PHI)

Reference Books:

1. "Computer Organization and Architecture – Designing for Performance", by William Stallings (Person)
2. "Computer Architecture and Organization", by John P. Hayes (McGraw Hill)
3. "Advanced Computer Architecture", by Kai Hwang and Naresh Jotwani (McGraw Hill)
4. "Computer Organization and Architecture", by P. N. Basu (Vikas Publishing House Pvt. Ltd.)

Course Type	Course Code	Name of Course	L	T	P	Credit
DP1	CSC204	Data Structures Lab	0	0	2	2

Course Objective
To make familiar with Theoretical concept and Practicals together hand to hand on the aspects of Data Structure programming. Representations and operations on various data structures such as array, stacks, queues, trees and graphs. Applications on the above with their application areas should also be explored.
Learning Outcomes
To make familiar with Theoretical concept and Practicals together hand to hand on the aspects of Data Structure programming.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Representations of Arrays: one dimensional, multi-dimensional, Sparse Matrix and various Elementary Operations	6	Basic overview and understanding about the topic
2	Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching; Queues: Simple queue, circular queue, dequeue, elementary operations and applications	6	Familiarity with Stack, queue and similar terminologies with basic operations
3	Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation	6	Basic understanding dynamic allocation strategies and manipulations for the same.
4	Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree, tries, B-tree, other operations and applications of trees	6	Basic understanding of non-linear data structures and its operations such as various trees
5	Graphs: representation, Adjacency list, graph	6	Basic understanding of non-linear data

	traversal, path matrix, connected components, DAG, topological sort, Spanning tree;		structures and its operations such as graphs
6	Sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, Radix sort; Searching: linear and binary search; Hashing: hash tables, hash functions, open addressing.	6	Basic understanding of Arranging numbers and hashing

Text Books:

1. Let Us C 16TH EDITION Paperback – 2017, Yashavant Kanetkar.

Reference Books:

1. An introduction to data structures with applications McGraw-Hill computer science series
2. SartajSahni, 2000, Data structures, Algorithms and Applications in C++, McGraw Hill International Edition

Course Type	Course Code	Name of Course	L	T	P	Credit
DP2	CSC205	Computer Organization Lab	0	0	2	2

Course Objective
The objective of the course is to present an understanding of the working of various components of computer systems.
Learning Outcomes
Upon successful completion of this course, students will: ● Understand the design of combination circuits. ● Understand the design of sequential circuits. ● Know about writing assembly language code.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Design of Combinational & Sequential Circuits: Half & Full Adder, Half & Full Subtractor, Comparators, Code Converters, Counters, Decoder, Encoder, ALU etc.	20	Understanding of working of digital Gates and how that can be used for designing combinational and sequential circuits.
2	Assembly Language Programming	06	This unit will help students in understanding the instructions sets of 8085 and writing Assembly Language Code.

Text Books:

1. "Computer System Architecture", by M. Morris Mano (PHI)

Reference Books:

2. "8085 Microprocessor and Its Applications", by A N Kani (TMH)

Course Type	Course Code	Name of Course	L	T	P	Credit
DC4	CSC206	Algorithm Design and Analysis	3	0	0	9

Course Objective
To provide fundamental knowledge about algorithms, algorithm paradigms, and measurement of space and time complexity.
Learning Outcomes
Enhance the ability to understand different algorithm design paradigms and their respective space and time complexity analysis.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Notions of Algorithms, Algorithm Paradigms, Complexity Analysis, Asymptotic	6	Understanding of algorithm design techniques, validation of algorithms, and

	Notations, Practical Complexities.		space and time complexity measurement of algorithms.
2	Divide-and Conquer Paradigm: Recurrence Relations, Order Statistics, Strassen's Matrix Multiplication.	6	To understand fundamentals of divide-and-conquer strategy.
3	Greedy Algorithms: Knapsack Problem, Tree Vertex Splitting, Job Sequencing with Deadlines, Activity Selection Problem, Minimum Cost Spanning Trees, Optimal Storage on Tapes, Optimal Merge Patterns, Single-Source Shortest Paths.	8	Understanding of different problems solved by greedy method.
4	Dynamic Programming: Multistage Graphs, Matrix Chain Multiplication, Single-Source and All-Pairs Shortest Paths, Traveling Salesperson Problem, Longest Common Subsequence.	7	Understanding of different problems solved by dynamic programming.
5	Back Tracking: 8-Queens Problem, Graph Coloring, Hamiltonian Cycles.	5	To understand fundamentals of back tracking technique.
6	Branch-and-Bound: Least Cost Search, 15-Puzzle Problem.	3	Understanding of different problems solved by branch-and-bound technique.
7	NP-Hard and NP Complete Problems, Introduction to Approximation Algorithms.	4	To understand the basic principles of deterministic and non-deterministic algorithms.

Text Books:

1. Cormen, Leiserson, Rivest and Stein, Introduction to Algorithms, Prentice Hall of India.
2. E. Horowitz, S. Sahni, and S. Rajasekaran, Fundamentals of Computer Algorithms, Universities Press.

Reference Books:

1. J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education.
2. M. T. Goodrich and R. Tamassia, Algorithm Design, Wiley Student Edition.
3. S. Dasgupta, C. Papadimitriou, and U. Vazirani, Algorithms, McGraw Hill Education (India) Pvt. Ltd.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC5	CSC207	Computer Architecture	3	0	0	9

Course Objective
To provide fundamental knowledge about computer architecture which includes ILP, TLP, DLP and Memory design.
Learning Outcomes
Enhance the ability to understand different techniques in computer architecture.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Fundamentals of Quantitative Design and Analysis: Introduction, Classes of Computers, Defining Computer Architecture, Trends in Technology, Power, Energy and Cost, Measuring, Reporting, and Summarizing Performance, Quantitative Principles of Computer Design.	6	Understanding the importance of Computer architecture and other quantitate parameters
2	Instruction set Architecture: Introduction, Classifying Instruction Set Architectures, Memory Addressing, Type and Size of Operands, Operations in the Instruction, Instructions for Control Flow, Encoding an Instruction Set, CISC and RISC processors.	3	Understanding basics of instruction set architectures and related topics
3	Pipelining: Introduction, Pipeline Hazards, Pipelining	7	Learning pipelining techniques and

	Implemented and hardness Pipeline for floating-point operations, its hazards and minimization		methods to overcome pipeline hazards.
4	Instruction-Level Parallelism (ILP): Concepts and Challenges, Basic Compiler Techniques for Exposing ILP Advanced Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling, Dynamic Scheduling: Examples and the Algorithm, Hardware-Based Speculation, Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation, Limitations, Multithreading.	8	Learning advanced topics in instruction level parallelism like dynamic techniques.
5	Thread-Level Parallelism, Introduction Centralized Shared-Memory Architectures. Memory Coherence, Synchronization, Models of Memory Consistency.	5	Learning topic like coherence problem and memory consistency
6	Data-Level Parallelism: Introduction, Vector Architecture, GPU.	4	Learning vector and GPU architectures
7	Memory Hierarchy: Introduction, Advanced Optimizations of Cache Performance, Memory Technology and Optimizations, Virtual Memory and Virtual Machines.	5	Understanding importance of memory hierarchy in computer architecture and cache optimization techniques.

Text Books:

John L. Hennessy and David A Patterson, Computer Architecture, Morgan Kauffnman, 5th Edition, 2012

Reference Books:

1. William Stallings, Computer Organization and Architecture, Prentice Hall of India, 9th Edition, 2012.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC6	CSC208	Theory of Computation	3	0	0	9

Course Objective
The objective of the course is to provide fundamental knowledge about how to solve various computational problems using Automaton.
Learning Outcomes
Upon successful completion of this course, students will have a broad understanding ofTheory of Computation course.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction, Languages	2	Comprehensive introduction about the course content will be delivered.
2	Deterministic Finite Automata (DFA) and Non-Deterministic Finite Automata (NFA) Equivalence of DFA and NFA, State Minimization of DFA, Finite Automata with Epsilon-Transitions.	6	To understand the working procedure of DFA and NFA.
3	Regular Expression and their relation to Regular Language, Pumping Lemma for Regular Languages	5	To learn how to describe finite automata through Regular Language.
4	Context-Free Grammars (CFG), Parse Trees, Ambiguity in CFG, Normal forms for CFG: CNF and GNF.	8	To understand Context-Free Grammars (CFG) and their different forms of representation.
5	Pumping Lemma for CFG, Pushdown Automata (PDA), Equivalence of PDA's and CFG's.	6	This unit will help students to understand PDA.

6	Tuning Machines (TM), Multitrack TM, Multitape TM.	6	To understand the more powerful type of automaton i.e. Tuning Machine.
7	Decidability and Undecidability, Computational Complexity, NP Completeness Problems	6	This unit will help students to understand Decidability and Undecidability problems.

Text Books:

1. John E. Hopcroft, Rajeev Motwani, and Jeffrey D Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson, 3rd Edition, 2008
2. Peter Linz, An Introduction to Formal Languages and Automata, 6th Edition, Market Paperback, 2016

Reference Books:

1. Harry Lewis, and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson, 2nd Edition, 2015

Course Type	Course Code	Name of Course	L	T	P	Credit
DC7	CSC209	Operating Systems	3	0	0	9

Course Objective

This syllabus is designed in such a manner that it will provide the basic and fundamental knowledge on Operating Systems. The proposed syllabus is designed to cover Operating Systems in detail to provide better research and industry oriented understanding for UG students.

Learning Outcomes

On successful completion of this unit students will be able to:

- Identify the basic concept and describe the main responsibilities of a contemporary operating system (OS) and to explain the history leading to their current form.
- recognize and give examples of conflicting goals and compromises necessary in implementing an OS and configuring its run-time parameters
- identify and list application scenarios in which it is useful to use multiple threads of execution (including the fundamental need for multitasking in an OS)
- explain the concept of a process and the process control block (PCB) in a typical OS; recognize a PCB upon seeing the C code of such, and assess whether such a data structure contains everything that is necessary to handle the main tasks of a modern OS
- Provide a useful definition for a real-time system; give examples of actual real-time systems
- Understand how we can apply operating system concepts in industry

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction, Categories of Operating Systems, Computer System Architecture, Interrupts, Storage Structure, Hardware Protection; OS Structures: OS Components;	4	Recognize and give examples of conflicting goals and compromises necessary in implementing an OS and configuring its run-time parameters
2	System Calls, System Structures, Virtual Machines, System Design Goal, SYSGEN	3	know and identify (from content description or C code), the most common data structures required in an OS implementation
3	Process Management: Process Concept, Process Sate, PCB, Process Scheduling, Schedulers, Process Creation, Process Termination, Co-operating Process, Producer Consumer Problem, Inter-process Communication, Client Server Communication, Threads, Process Synchronization, Critical Section Problem, Bakery Algorithms, Semaphores, Reader's Writer's Problem, Dining Philosopher's Problem;	5	Remember the most elementary challenges in concurrent programming (i.e., situations requiring mutual exclusion and synchronization) and solve them using semaphores (as defined by the POSIX threading interface). verify whether a given C (or similar pseudocode) program correctly solves the producer-consumer problem using multi-valued semaphores
4	CPU Scheduling: CPU Scheduler,	6	List and explain simple scheduling algorithms

	Scheduling Criteria, Scheduling Algorithms: FCFS, SJF, Priority Scheduling, Round Robin Scheduling, Multilevel Queue Scheduling, Multilevel Feedback Queue Scheduling;		and give examples of applications in which each scheduler could be more beneficial than the others; likewise, choose the most suitable scheduling algorithm from a number of given choices, given an application scenario
5	Deadlock: Introduction, Deadlock Prevention, Deadlock Avoidance, Resource Allocation Graph Algorithms, Deadlock Detection, Prevention and Recovery;	5	Provide a concrete example (in C or in some pseudocode) of code that can lead to deadlock or data corruption due to a race; likewise, the student is able to tell whether a given code example (in C or similar pseudocode) has a bug that makes deadlock or data corruption likely to occur
6	Memory Management: Memory Hierarchy, Memory Types, Main Memory Architecture, Cache Memory, Address Binding, Dynamic Loading, Linking, Overlays, Logical vs Physical Addresses, Swapping, Contiguous Memory allocation, Fragmentation, Segmentation;	6	Know what the principle of locality stands for, how it is used in a typical memory system, and how the principle can be used in applications other than computer technology and OSs. translate a virtual memory address into a physical address, given a page table (of a given simple "toy" computer with very tiny address space); understand and explain how a shared memory area can be implemented using VM addresses in different processes
7	Virtual Memory, Paging, Demand Paging, Page Replacement Algorithms, Thrashing;	4	Describe how the page fault exception is handled when the reason for fault is a reference to an existing but swapped-out page, and the LRU page replacement algorithm is selected
8	Secondary Storage Structure: Disk Structure, Disk Scheduling, Disk Management; Case study: Unix and DOS;	4	Understand and explain how a shared memory area can be implemented using VM addresses in different processes

Text Books:

1.Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 9th Edition, Wiley Global Education, 2012.

Reference Books:

1. William Stallings, Operating Systems: Internals and Design Principles, GOAL Series, Pearson international edition, 2009.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP3	CSC210	Algorithm Design & Analysis Lab	0	0	2	2

Course Objective
To provide practical knowledge about algorithms, algorithm paradigms, and measurement of space and time complexity.
Learning Outcomes
Enhance the ability to implement different algorithm design paradigms and their respective space and time complexity analysis.

Unit No.	Topics to be Covered	Lab Hours	Learning Outcome
1	Fundamentals of Algorithms and Complexity Analysis.	2	Develop the ability to design the algorithm for unseen problems. Ability to write the algorithms in easy to code manner. Students will learn to develop algorithms which are efficient in terms of time and

			space.
2	Divide-and Conquer Paradigm: Problems on Recurrence Relations, Order Statistics, and Strassen's Matrix Multiplication.	4	Develop the ability to solve different divide-and-conquer problems.
3	Greedy Algorithms: Problems on Knapsack Problem, Tree Vertex Splitting, Job Sequencing with Deadlines, Activity Selection Problem, Minimum Cost Spanning Trees, Optimal Storage on Tapes, Optimal Merge Patterns, and Single-Source Shortest Paths.	5	Enhance the ability to solve different problems solved by greedy method.
4	Dynamic Programming: Problems on Multistage Graphs, Matrix Chain Multiplication, Single-Source and All-Pairs Shortest Paths, Traveling Salesperson Problem, and Longest Common Subsequence.	5	Develop the ability to solve dynamic programming problems and its advantage over divide-and-conquer strategy.
5	Back Tracking: Problems on 8-Queens Problem, Graph Coloring, and Hamiltonian Cycles.	2	Enhance the ability to solve different problems solved by backtracking method.
6	Branch-and-Bound: Problems on Least Cost Search, and 15-Puzzle Problem.	2	Develop the ability to solve different branch-and-bound problems.
7	Problems on Approximation Algorithms.	2	Enhance the ability to understand how to solve approximation problems.

Text Books:

1. Cormen, Leiserson, Rivest and Stein, Introduction to Algorithms, Prentice Hall of India.
2. E. Horowitz, S. Sahni, and S. Rajasekaran, Fundamentals of Computer Algorithms, Universities Press.

Reference Books:

1. J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education.
2. M. T. Goodrich and R. Tamassia, Algorithm Design, Wiley Student Edition.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP4	CSC211	Operating Systems Lab	0	0	2	2

Course Objective
Practical experiments will be set based on the topics covered in the theory subject, operating system. It includes programming assignments for practicing and designing on different algorithms used in operating system.
Learning Outcomes
Enhance the ability to implement different algorithms or techniques in the operating system domain.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Basic Unix commands and shell programming	2	Learn the Unix basics and advanced commands and shell programming which is required for unix based OS programming
2	Implementation of CPU Scheduling algorithm	6	Simulate the results of various algorithms of CPU scheduling and can compare how good various algorithms under different conditions
3	Implementation of Process synchronization methods	2	Simulate the results of various algorithms of Process synchronization and handling various difficult situations.
4	Implementation of Deadlock handling methods	6	Simulate the results of various algorithms

			of Deadlock detection, avoidance and recovery.
5	Implementation of Disk scheduling algorithms	4	Simulate the results of various algorithms of Disk scheduling.
6	Project Implementation	4	Live tasks of industry or research topics in operating as a project for implementation as well as testing.

Text Books:

1.Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 9th Edition, Wiley Global Education, 2012.

Reference Books:

1. William Stallings, Operating Systems: Internals and Design Principles, GOAL Series, Pearson international edition, 2009.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC08	CSC301	Database Management Systems	3	0	0	9

Course Objective
The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.
Learning Outcomes
Upon successful completion of this course, students will: ● have a broad understanding of database concepts and database management system software. ● have a high-level understanding of major DBMS components and their function. ● be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model. ● be able to write SQL commands to create tables and indexes, insert/update/delete data, and query data in a relational DBMS.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Introduction and Overview of a DBMS – Purpose of Database Systems, View of Data, Data Models, DDL, DML, Transaction Management, Storage Management, Database Administrator, Database Users, Overall System Structure.	5	Understanding of DBMS and what it provides. You know when to use files and when to use a DBMS. It provides idea of DBMS Architecture.
2	Entity-Relationship Model: Basic Concepts, Design Issues, Mapping Constraints, Keys, ER-Diagram, Weak Entity Sets, Extended ER-Diagram, Reduction of ER-Schema to Tables Relational Model.	5	This unit will help student in understanding the steps to prepare a data model based on user requirements.
3	Concepts: Structure of Relational Databases, Relational Algebra, Tuple Relational Calculus, Domain Relational Calculus, Extended Relational-Algebra Operations, Modification of the Database, Views.	6	This will help is designing the relation model, which will conceptualize data using the relational model. You can also express queries using relational algebra.
4	Structured Query Language	5	You can express queries using SQL.
5	Integrity Constraints: Domain Constraints, Referential Integrity, Assertions, Triggers, Functional Dependencies.	5	To understand what constraints and triggers are for and how to use them.
6	Relational Database Design: Decomposition, Normalization, Transactions.	4	This will help student in further refining the relational database for efficient management & outcome.

7	Concurrency Control: Transaction Concepts, Transaction State, Concurrent Executions, Serializability, Recoverability, Lock-Based Protocols, Timestamp-Based Protocols, Deadlock Handling Basics of Database.	5	To know all about the transactions and handling concurrent transactions in databases.
8	File Organization & Query Processing: File Organization, Organization of Records in Files, Data Dictionary Storage, Steps in Query Processing.	3	Help in understanding the organization of files for keeping databases and how to optimize the database queries for fast response.

Text Books:

1. Korth, Slberchatz,Sudarshan, :"Database SystemConcepts", 6th Edition, McGraw –Hill

Reference Books:

1. Elmasri and Navathe, "Fundamentals of Database Systems", 5thEdition, PEARSON Education.
2. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
3. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC09	CSC302	Compiler Design	3	0	0	9

Course Objective
The main objective of this course is to make the students understand various phases of a compiler with the associated techniques and algorithms to impart knowledge about designing a new compiler.
Learning Outcomes
Upon successful completion of this course, students will: ● Have a broad understanding of language translator and their need. ● Have a detailed understanding of various phases of a compiler and their design techniques. ● Be able to design a complier for new high level language.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Need of compilers; Cousins of compilers; Compiler writing tools, compiler phases.	2	The students will be introduced with the language translator, their need and various phases of a compiler.
2	Lexical analysis: Tokens, regular expressions, transition diagrams, Design of lexical analyzer generator.	5	Students will be familiar with various elements of a scanner (lexical analyzer). They will also learn how to use transition diagram or finite automata for designing a new lexical analyzer
3	Syntax analysis: Context free grammars, ambiguity, top down parsing, bottom up parsing, operator precedence parsing, LR parsers (SLR, LALR, LR).	10	This will help the students in understanding various parsing techniques, basic as well as advanced level. They will also gain knowledge of using a specific parsing technique for a new language construct.
4	Syntax Directed Translation (SDT): Scheme, Implementation of SDT, postfix notation, SDT to postfix code; Intermediate code generation.	6	This unit will help the students to understand intermediate code generator. They will learn how to use Syntax Directed Translation for its design.
5	Error Detection and Recovery: Lexical-phase errors, Syntactic-phase errors.	3	The students will familiarize with various kinds of compiler errors and they will learn how to design error handler associated with various parsing techniques.
6	Code optimization: Sources, optimization of basic blocks, loops in flow graphs, loop optimization.	5	This unit will help the students to understand importance of code optimization. They will also learn various code optimization techniques with

			a special emphasis on loop optimization.
7	Code generation: Issues, target machine, runtime storage management, basic block and flow graphs, next use information, a simple code generator, register allocation, DAG representation of basic blocks, peephole optimization, code generation from DAGs.	7	Here the students will know how to use DAGs for optimization of a basic block of code. They will also learn about the analysis of flow graph and their use for generating final code.

Text Books:

1. Aho, Ullman, Sethi, *Compiler Principles, Techniques and Tools,* Addison-Wesley, 2004.

Reference Books:

2. Alfred Aho and Jeffrey Ullman, *Principles of Compiler Design*, Narosa, 2002.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP5	CSC303	Database Management Systems Lab	0	0	2	2

Course Objective

Students will have the ability to:

- Keep abreast of current developments to continue their own professional development.
- To engage themselves in lifelong learning of Database management systems theories and technologies this enables them to pursue higher studies.
- To interact professionally with colleagues or clients located abroad and the ability to overcome challenges that arise from geographic distance, cultural differences, and multiple languages in the context of computing.
- Develop team spirit, effective work habits, and professional attitude in written and oral forms, towards the development of database applications

Learning Outcomes

Students will be able to demonstrate their skills In drawing the ER, EER, and UML Diagrams. In analyzing the business requirements and producing a viable model for the implementation of the database.
In converting the entity-relationship diagrams into relational tables. To develop appropriate Databases to a given problem that integrates ethical, social, legal, and economic concerns.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction SQL-SQL*Plus	2	Students will learn about SQL
2	E-R Diagrams, Tables	2	Requirement gathering in terms of ER
3	My SQL Installation, DDL and DML Commands with Examples	2	Students will learn basic commands
4	Key Constraints,, Aggregate functions	2	Students will learn how to apply integrity constraints
5	Joins, Views, Indexing	2	Students will learn to perform indexing and joins
6	Pl/SQL	2	Students will learn about Pl/SQL
7	Triggers	2	Applying triggers
8	Cursors, Subprograms-procedure PL/ SQL	2	Programming with cursors and sub-programs
9	Functions of PL/ SQL	2	
10	Mini Project and extra programs	2	

Text Books:

1. Korth, Slberchatz,Sudarshan, :"Database SystemConcepts", 6th Edition, McGraw –Hill

Reference Books:

1. Elmasri and Navathe, "Fundamentals of Database Systems", 5thEdition, PEARSON Education.

2. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
3. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP6	CSC304	Compiler Design Lab	0	0	2	2

Course Objective
Practical Implementation of different phases of a compiler with the aim to design and implement a new compiler
Learning Outcomes
The students will be able to learn the implementation of the following ● Lexical Analyzers ● Parser using both top-down and bottom-up approach ● Error handler ● Code optimizer ● Code generator

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Lexical Analyzer(LA) using state diagram	3	Implementation of LA using state diagram
2	Finite Automata for LA	4	Implementation of LA using Finite Automata
3	Operator Precedence parsing	3	Implementation of Operator Precedence parser
4	Predictive Parsing	3	Implementation of Predictive Parser
5	SLR, LR and LALR parsing	7	Implementation of LR parsers
6	Code optimization	2	Implementation of Code optimizer
7	Error handler	2	Implementation of Error handler

Text Books:

1. Aho, Ullman, Sethi, *Compiler Principles, Techniques and Tools,* Addison-Wesley, 2004.

Reference Books:

1. Alfred Aho and Jeffrey Ullman, *Principles of Compiler Design,* Narosa, 2002.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC10	CSC305	Computer Networks	3	0	0	9

Course Objective
This syllabus is designed in such a manner that it will provide the basic and fundamental knowledge on Computer Networks. The proposed syllabus is designed to cover Computer Networks in detail to provide better research and industry oriented understanding for UG students.
Learning Outcomes
On successful completion of this unit students will be able to: ● Identify the basic concept and understand the state-of-the-art in protocols, architectures and applications of computer networks. ● Compare, contrast and analyse networks. ● Understand how networking research is done. ● Understand how we can apply networking concepts in industry.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Overview of Data Communication and Networking: OSI Reference Model, TCP/IP Protocol Suite; Network Architecture and Physical Topology.	3	Comprehensive introduction about the course content will be delivered.

2	Physical Layer: Analog and Digital Signals, Transmission Impairment, Data Rate Limits, Performance Analysis of a Network; Representation and Synchronization of Bits, Analog and Digital Transmission; Multiplexing and Spreading Techniques; Guided Transmission Media; Circuit, Packet and Virtual Circuit Switching.	9	To understand working procedure of Physical layer.
3	Data Link Layer: Framing, Flow and Error Control (Noiseless and Noisy Channels Protocols), Point-To-Point Protocol; Random Access protocols (Pure/slotted ALOHA, CSMA/CD, CSMA/CA), Controlled Access Protocol (Bit-Map, Polling and Token Passing), Channelization (TDMA, FDMA, CDMA); Physical Addressing and Ethernet; Connecting LANs and Virtual LANs.	9	To understand the Data Link layer for computer networks.
4	Network Layer: Internet Protocol version 4 and 6; Address Mapping (ARP, RARP, BOOTP and DHCP), ICMP and IGMP, Routing Algorithms.	6	This unit will help students to understand some popular Ipv4, Ipv6 packet formatting and Routing protocols. In addition, they will learn the important address mapping techniques.
5	Transport Layer: UDP, TCP; Congestion Control and QoS; Client-Server Model and Socket Interface.	6	The students learn the TCP and UDP protocols of the Transport layer. In addition, they will learn the important concepts of QoS.
6	Application Layer: DNS, Remote Logging, Electronic Mail (SMTP, POP), FTP, Introduction to WWW and HTTP.	3	To understand basic properties of application layer and to get an overview of different application layer protocols and techniques. The students also learn the basic concepts of Internet Technologies.

Text Books:

1. B. Forouzan, “Data Communication and Network”, McGraw-Hill Publications. 4th ed.
2. A. S. Tanenbaum., “Computer Networks”, Pearson Education Asia. 5th ed.

References:

1. W. Stalling, “Data and Computer Communication”, PHI (EEE). 8th ed.
2. A. L. Garcia and I. Widjaja, “Communication Networks: Fundamental Concepts and Key Architectures”, Tata McGraw-Hill. 2nd ed.
3. S. Sharma, “A course in Computer Networks”, Kataria. 3rd ed.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC11	CSC306	Software Engineering	3	0	0	9

Course Objective
Develop methods and procedures that can be used to consistently produce high-quality software at low cost. How to use available resources to develop software, reduce cost of software and how to maintain quality of software. Methods and tools of testing and maintenance of software.
Learning Outcomes
Upon successful completion of this course, students will study and learn the following aspects of software engineering: ● Different Life cycle models for different software applications. ● Cost estimation techniques ● Understand the techniques and concepts of software project management. ● Learn UML diagrams. ● Testing a software products

- Quality control mechanism

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Objectives and Scope of SE, Introduction to System, Software Definition, and Characteristics of software.	2	Comprehensive introduction about the course content will be delivered. Difference between software and hardware.
2	Software Development Methodologies	2	This section encompasses all phases of software development that are considered crucial to the success of software projects.
3	Software Project Management.	4	Brief discussion on requirements analysis and specification, software metrics, cost estimation methods, efficient way project scheduling.
4	Software Design: Function oriented design	4	Learn some important facets of software design, the methodology of Structured Analysis/Structured Design (SA/SD) in relation to traditional function-oriented design.
5	Object oriented design: UML diagramme, Use Case Model, Class Diagrams, Interaction Diagram, Activity Diagram, State Chart Diagram.	6	Study object oriented design using UML.
6	Introduction to Software Testing: Fundamentals of Verification and Testing. Review of software development models, Test Metrics, Software Testing Principles.	3	Learn coding and unit testing techniques. Integration and system testing techniques are elaborately discussed in this module.
7	Whit Box Testing, Structured examination, Control flow & Data flow.	4	Elaborate discussion on different types of White box testing.
	Black Box Testing, Gray Box Testing, Intuitive and Experience Based Testing.	4	Elaborate discussion on different types of Black box testing.
9	Software Quality Assurance and Quality control, Quality factors, Quality standards – TQM, ISO, SEI CMM, PCMM, Six sigma.	4	Module is exclusively devoted to software quality assurance aspects, ISO 9000 and software reliability models, as these are considered necessary to expose students to basic quality concepts as part of a software engineering course.

Text Books:

1. Rajib Mall, Fundamentals of Software Engineering.
2. Pankaj Jalote, An integrated approach to Software Engineering

Reference Books:

1. Ian Sommerville, Software Engineering,
2. Roger S. Pressman, Software Engineering: A Practitioner's App

Course Type	Course Code	Name of Course	L	T	P	Credit
DP7	CSC307	Computer Networks Lab	0	0	2	2

Course Objective
This syllabus is designed in such a manner that it will provide the basic and fundamental practical knowledge on Computer Networks. The proposed syllabus is designed to cover Computer Networks to provide better research and industry oriented understanding for UG students.
Learning Outcomes

On successful completion of this unit students will be able to:

- Identify the basic concept and understand the state-of-the-art in protocols, architectures and applications of computer networks.
- Compare, contrast and analyse networks.
- Understand how networking research is done.
- Understand how we can apply networking concepts in industry.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Socket Programming	8	The students can understand how Transport Layer works
2	NS-3 Programming	8	To understand the basics of network architecture and throughput of the network.
3	Cisco Packet Tracer	2	The students can understand how we can configure networks through simulation.
4	FTP and TELNET, Different Networking tools like Wireshark, Filezilla etc.	4	The students can understand how application layer works.

Text Books:

1. B. Forouzan, "Data Communication and Network", McGraw-Hill Publications. 4th ed.
2. A. S. Tanenbaum., "Computer Networks", Pearson Education Asia. 5th ed.

References:

1. W. Stalling, "Data and Computer Communication", PHI (EEE). 8th ed.
2. A. L. Garcia and I. Widjaja, "Communication Networks: Fundamental Concepts and Key Architectures", Tata McGraw-Hill. 2nd ed.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP8	CSC308	Software Engineering Lab	0	0	2	2

Course Objective

Develop methods and procedures that can be used to consistently produce high-quality software at low cost. How to use available resources to develop software, reduce cost of software and how to maintain quality of software. Methods and tools of testing and maintenance of software.

Learning Outcomes

Upon successful completion of this course, students will study and learn the following aspects of software engineering:

- Different Life cycle models for different software applications.
- Cost estimation technique
- Understand the techniques and concepts of software project management.
- Learn UML diagrams.
- Testing a software products
- Quality control mechanism

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Process and Models	4	Comprehensive introduction about the course content will be delivered. Difference between software and hardware.
2	Software Development Methodologies	4	This section encompasses all phases of software development that are considered crucial to the success of software projects.
3	Software Project Management.	4	Brief discussion on requirements analysis and specification, software metrics, cost estimation

			methods, efficient way project scheduling.
4	Software Design: Function oriented design	4	Learn some important facets of software design, the methodology of Structured Analysis/Structured Design (SA/SD) in relation to traditional function-oriented design.
5	Object oriented design: UML diagram, Use Case Model, Class Diagrams, Interaction Diagram, Activity Diagram, State Chart Diagram, Architectural design, Component design, User interface design	7	Study object oriented design using UML.
6	Whit Box Testing, Black-Box Testing	6	Learn coding and unit testing techniques. Integration and system testing techniques are elaborately discussed in this module.

Text Books:

1. Rajib Mall, Fundamentals of Software Engineering.
2. Pankaj Jalote, An integrated approach to Software Engineering

Reference Books:

1. Ian Sommerville, Software Engineering,
2. Roger S. Pressman, Software Engineering: A Practitioner's App

Course Type	Course Code	Name of Course	L	T	P	Credit
ESO1	CSE201	Data Structures & Algorithms	3	0	0	9

Course Objective
Understanding towards how the choice of data structures and algorithm design methods impacts the performance of the program.
Learning Outcomes
Ability for the following. ● Choose the appropriate data structure and algorithm design method for a specified application. ● Write programs using object-oriented design principles. ● Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, Minimum Spanning Tree, Single-source shortest path computation, topological sorting, , string matching algorithms and graphs and writing programs for these solutions. ● Solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, and writing programs for these solutions.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Objectives of time analysis of algorithms; Big Oh and Theta notations	3	Learning towards algorithm performance analysis in terms of time and space complexity
2	Elementary data-structures: arrays, linked lists, queues, stacks and their applications.	6	Understanding of elementary data structures with some applications
3	Binary search algorithm, binary trees, binary-search-tree data-structure, Balanced binary-search-tree: Red-Black trees,	7	Learning of efficient searching solution using binary tree and their variations
4	Bubble,Insertion,Merge,Heapand quicksort Sorting algorithms	6	Understanding of various sorting algorithms with varying complexity
5	Greedy paradigm with examples, Divide and conquer paradigm with examples, Dynamic-programming paradigm with examples	6	learning of various algorithm paradigms with application in example problems

6	Definition of graphs, paths, trees, cycles. Data structures for graphs: adjacency lists, adjacency matrix.Graph algorithms: Depth First Search, Breadth First Search, Minimum Spanning tree, Dijkstra's, Bellman ford and Floyd Warshell's shortest path algorithms	7	Understanding of graph data structure with their representation, traversal methods.Learning of shortest path problem and various standard shortest path algorithms
7	Naive, Automata based, KMP String matching algorithms	4	Understanding of various string matching algorithms with varying complexity
8	Hashing techniques	2	Understanding of efficient searching solution using hash table

Text Books:

1. Cormen, Leiserson, Rivest and Stein, *Introduction to Algorithms*, Prentice Hall of India, 3rd Edition, 2010.
2. AV Aho, J Hopcroft, JD Ullman, Data Structures and Algorithms, Addison- Wesley, 1983.
3. MT Goodrich, R Tamassia, DM Mount, Data Structures and Algorithms in Java, 5th Ed., Wiley, 2010. (Equivalent book in C also exists.)

Reference Books:

1. Cormen, Leiserson, Rivest and Stein, *Introduction to Algorithms*, Prentice Hall of India, 3rd Edition, 2010.
2. An Introduction to Data Structures with Application, J .P . Tremblay and P. G . Sorenson, TMH

Course Type	Course Code	Name of Course	L	T	P	Credit
ESO2	CSE202	Object Oriented Programming	3	0	0	9

Course Objective
This syllabus is designed in such a manner that it will provide theObject Oriented concepts that is Classes & Objects, Inheritance, and Polymorphism, Templates and C++ language.
Learning Outcomes
● Learn the principles of object oriented programming. ● Able to understand object oriented programming concept, and C++ language features.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Object Oriented Programming and languages: fundamentals, necessity and advantages, Objects and Classes, Encapsulation. Data and method binding, access specification: private, protected and public.	4	Student will learn object oriented principles
2	Inheritance: passing knowledge down. single versus multiple inheritance, sub and super classes. Code reuse, inheritance and subtyping.	4	Student will learn inheritance
3	Polymorphism: Simple (or static) polymorphism (in C++), method overloading, subtype polymorphism (extending a class) through method overriding, 'virtual' methods (in C++) and distinction with non-virtual ones, abstraction through polymorphism, 'abstract' classes and methods, 'pure' virtual functions in C++.	8	Understand polymorphism
4	Interfaces: OOPLs allowing interfaces (like Java),	8	Student will learn interface

	interfaces versus multiple inheritance. Exception Handling: the 'try-catch-throw-finally' paradigm, catching and throwing errors, ensuring cleaning up using 'finally', exception classes and their hierarchy, error handling as a built-in feature (as in Java), exception specification, the 'throws' keyword and compiler behavior.		
5	Templates: Introduction, simple generic classes & generic function, simple example programs.STL-List, Vector, Array.	6	Understand template

Text Books:

1. Herbert Schildt**, The complete Reference C++.**

Reference Books:

1. E.Balagurusamy, **OBJECT ORIENTED PROGRAMMING WITH C++**.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD502	**Cloud Computing**	3	0	0	9

Course Objective
Students will try to learn: 1. Basics of cloud computing. 2. Key concepts of virtualization. 3. Different Cloud Computing services 4. Cloud Implementation, Programming and Mobile cloud computing 5. Key components of Amazon Web Services 6. Cloud Backup and solutions
Learning Outcomes
To learn how to use Cloud Services. To implement Virtualization To implement Task Scheduling algorithms. Apply Map-Reduce concept to applications. To build Private Cloud. Broadly educate to know the impact of engineering on legal and societal issues involved

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Overview of Distributed Computing Cloud introduction and overview Different types of cloud services Deployment models Advantages and Disadvantages, Companies in the Cloud	5	This section provides a brief introduction about cloud methodologies.
2	**Infrastructure as a Service (IaaS):** Introduction, CPU Virtualization - Hyper Storage Virtualization – SAN, ISCSI, Network Virtualization - VLAN	6	The section encompasses the structure of Infrastructure required for cloud computing
3	**Platform/Software as a Service (PaaS / SaaS):** From IaaS to PaaS, Introduction PaaS properties and Characteristics PaaS Techniques: File System GFS, HDFS	6	The section encompasses the structure of platform required for cloud computing
4	PaaS: Programming Model – Map Reduce Storage System , BigTable, HBase	6	This section supports the computing paradigms required for PaaS

5	Software as a Service (**SaaS):** Web Service, Applications and Web Portal	5	The section encompasses the structure of software services required for cloud computing
6	**Security in Cloud Environment:** Cloud Computing Threats, Security for Cloud Computing	5	This section briefs about security paradigms required for cloud environment.
7	Case Studies: Amazon EC2, Google App Engine, IBM Clouds, Microsoft's Windows Azure	3	This will discuss about case studies with suitable architectures

Text Books:

1. Raj Kumar Buyya, "Cloud Computing: Principles and Paradigms", Wiley Press.
2. Barrie Sosinsky, "Cloud Computing Bible", Wiley India.
3. Borko Furht and Armando Escalante, "Hand Book of Cloud Computing", Springer.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD504	Computer Vision	3	0	0	9

Course Objective
To meet the requirement of the current trends in the industry and academic fields pertaining to machine vision
Learning Outcomes
• The students are expected to acquire knowledge and develop expertise

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction, challenges	2	The students would learn about the need, scopes, application areas, role and importance of the subject
2	images and imaging operations in low level vision, edge detection, corner, interest point and invariant feature detection	7	The basic input for the subject comes from the images and the students would acquire the basics of image processing operations with objectives
3	texture analysis, binary shape analysis, boundary pattern analysis,	5	The students will pick up concepts of handling the texture features, shape

			features, pattern analysis which are basic cues to machine vision related tasks
4	detection of linear, circular and elliptic structures, the generalised Hough transform, pattern matching techniques	5	The students will learn concepts related to detection of linear and curvilinear structures from a scene which constitute the complex structures in natural objects and scenes and need proper interpretation in machine vision tasks
5	object segmentation and shape models, basic classification concepts	8	The students would learn the most difficult task of object detection via segmentation - a mid level processing highly essential for recognition in machine vision
6	the three-dimensional world, invariants and perspective, image transformations and camera calibration and motion	6	The students would learn to handle more practical and more difficult and realistic problems encountered by machine vision in real 3D world
7	real time vision systems, face detection and recognition, surveillance in-vehicle vision systems,	5	In continuation with module 6 the students would learn to deal with more complex systems with more practical problems in vision
8	machine learning and deep learning concepts in vision	4	The students would learn the modern trend in vision related task with the concepts of intelligent processing

Text Books: **Text Books:**

1. Computer vision by Dana H. Ballard, Christopher M. Brown, Prentice Hall

Reference Books:

1. 3D computer vision: efficient methods and applications by Christian Wohler, Springer Berlin Heidelberg

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD508	Distributed Systems	3	0	0	9

Course Objective
This Subject provides students with an in-depth knowledge about the distributed operating system. It covers distributed operating system in detail, including communication process, file system and memory management synchronization and so on but this time in the context of distributed systems. The students will able to understand the desirable features along with associated issues to design the best distributed operating system.
Learning Outcomes
Knowledge and understanding: Outline the potential benefits of distributed systems. Summarize the major issues associated with distributed systems along with the range of techniques available for increasing system transparency. Apply standard design principles in the construction of these systems. Select appropriate approaches for building a range of distributed systems, including some that employ middleware

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to Distributed Systems: Introduction to Distributed Computing System Models, Distributed Operating System, Difference between Network and Distributed System, Goals of Distributed System, Hardware Concept.	4	Learning various features and goals of distributed system
2	Message Passing: Desirable features, Issues in IPC, Synchronization, Buffering, Encoding and Decoding, Process Addressing, Failure Handling,	4	Learning various features I IPC, group communication.

	Group Communication.		
3	Remote Procedure Calls: RPC Model, Transparency of RPC, Implementation of RPC Mechanism, RPC Messages, Marshalling, Server Management (Stateful and Stateless Server), Parameter-Passing Semantics (Call-by-Value, Call-byReference), Call-Semantics, Communication Protocols for RPCs, Client-Server Binding, Special Types of RPCs.	4	Learning various features and mechanisms in RPC.
4	Distributed Shared Memory: General Architecture of DSM Systems, Design and Implementation Issues of DSM, Structure of Shared-Memory Space, Consistency Models, Replacement Strategy, Thrashing, Advantages of DSM.	6	Learning various features and techniques in distributed systems.
5	Synchronization: Clock Synchronization, Event Ordering, Mutual Exclusion, Deadlock, Election Algorithms.	6	Learning various clock synchronization mechanisms and other issues.
6	Resource Management: Task Assignment Approach, Load-Balancing Approach, Load-Sharing Approach.	4	Learning various resource management techniques
7	Process Management: Process Migration, Threads.	6	Learning various process management techniques
8	Distributed File Systems: File Models, File-Accessing Models, FileSharing Semantics, File-Caching Schemes, and File Replication.	4	Learning various features and issues in distributed file system
9	Security: Potential Attacks to Computer Systems, Cryptography, Authentication, Access Control, Digital Signatures.	2	Learning various security issues in distributed system.

Text Books:
1. “Distributed Operating Systems – Concepts and Design”, by Pradeep K. Sinha (PMH)

Reference Books:
1. “Distributed Systems – Principles and Paradigms”, by Andrew S. Tanenbaum and Maarten Van Steen (PHI)
2. “Distributed Systems – Concepts and Design”, by G. Coulouris, J Dollimore and T. Kindberg (Pearson Education)

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD510	Information Retrieval	3	0	0	9

Course Objective
This Subject provides students with an in-depth knowledge about the Information Retrieval. The students will be able to understand the various Retrieval Models, Link Analysis, Social Search techniques and related applications.
Learning Outcomes
• Knowledge and understanding: Outline the potential benefits Information Retrieval

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Basic IR system structure	2	Gives Basic understand the need of IR and its Structure
2	Retrieval techniques: Boolean retrieval, term-vocabulary, postings-lists, Dictionaries and tolerant	4	Describe various retrieval techniques and understanding Dictionaries

	retrieval: Wildcard queries, Spelling correction, Phonetic correction;		
3	Inverted indices: Preprocessing steps, tokenization, stemming, stopword removal, term weighting;	4	Understanding how inverted indices are done.
4	Models: vector space model, probabilistic model, language models;	5	Understanding different models to analyze data.
5	Evaluation: standard test collection, concept of relevance, precision-recall based metrics, reciprocal rank;	4	Understanding Evaluation methods
6	Relevance feedback and query expansion: Rocchio algorithm;	4	Understanding Different expansion methods
7	Text classification: Naïve Bayes; Text clustering: Flat Clustering, Hierarchical Clustering;	8	Understanding Text classification
8	XML Retrieval: Basic concepts, Challenges, Evaluation; Web search: Structure of Web, web graph, Hidden Web, User intent, Web crawl.	4	Understanding XML Retrieval, Web search
9	Link Analysis: Web as a graph, PageRank, Hubs and Authorities; Social search: Community-based search activities, Question Answering, Collaborative Searching.	4	

Text Books:

1. An Introduction to Information Retrieval, By Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press.

Reference Books:

1. Information Retrieval: Algorithms and Heuristics, By David A. Grossman, Ophir Frieder

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD511	Information Theory and Coding	3	0	0	9

Course Objective
The objective of the course is to give an insight into Information Theory, Source Coding, and Error Control Coding.
Learning Outcomes
Upon successful completion of this course, students will: ● Have a broad understanding of Information Theory, Source Coding, and Error Control Coding. ● Have a high-level understanding of different approaches so that digital data can be reliably transmitted over a noisy channel.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to Information Theory, Uncertainty and Information, Information Measure, Entropy of Markov Sources, Extensions of Sources; Channel Models, Channel Capacity, Information Capacity Theorem.	6	Comprehensive introduction about the course content will be delivered.
2	Source Coding: Instantaneous Codes, Kraft Inequality, Source Coding Theorem, Shannon Codes, Shannon-Fano Codes, Huffman Codes, Arithmetic Codes.	4	To learn the need of source coding and to get an overview of different categories of source codes.

3	Fundamentals of Channel Coding: Decoding Rules, Definition of Block code, Single parity check codes, Product code, Hamming codes, Error-detection and error-correction capabilities of block codes. Bounds on the size of codes.	6	To understand the need for channel coding in a communication system and to learn some special class of Block codes and their encoding-decoding procedures.
4	Definition of linear codes, Parity Check Matrix, Decoding of Linear Block code.	4	This unit will help students to understand another class error control codes like Linear Code and its encoding-decoding mechanism.
5	Definition of Cyclic codes, Encoding and Decoding of Cyclic codes, LFSR based Cyclic code Encoding-decoding.	8	To understand encoding-decoding mechanism of cyclic codes and to realize encoding-decoding of cyclic codes using LFSR.
6	Definition of BCH codes, Encoding and Decoding of BCH codes, PGZ Decoder, Reed-Solomon codes.	6	To learn BCH and Reed-Solomon codes.
7	Convolution codes: Encoding, State diagram, Trellis diagram, Viterbi Decoder, Turbo codes.	6	To understand encoding-decoding of Convolution codes and Turbo codes

Text Books:

1. R. Togneri and C. J. S. deSilva, Fundamentals of Information Theory and Coding Design, CRC Press
2. S. Gravano, Introduction to Error Control Codes, Oxford

Reference Books:

1. K. Sayood, Introduction to Data Compression, Morgan Kaufmann
2. S. Lin and D. J. Costello, Error Control Coding, Prentice Hall
3. Todd K. Moon, Error Correction Coding, Wiley-Interscience

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD401	Advanced Algorithms	3	0	0	9

Course Objective:

The main objective of this course is to make the students understand advanced level algorithms with their design and analysis. It will also make them familiar with some advanced data structures.

Learning Outcomes

- To impart knowledge of advanced algorithms
- To familiar with some advanced data structures
- To know the areas of such algorithms and data structures

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Methods of Amortized Analysis of Algorithms such as Aggregate Analysis, Accounting Method And Potential Method	3	To understand various methods of Amortized Analysis with some examples
2	Topological Sorting, Strongly Connected Components, Single Source Shortest Paths In DAG, Johnson's Algorithm	6	To familiar with advanced level graph algorithms with their applications
3	Polynomials and the FFT architecture and algorithms	4	To impart knowledge about DFT computation and FFT
4	String Matching Algorithms such as Naïve	6	Students will learn various string matching

	Approach, Finite Automata Approach, Rabin-Karp And Knuth-Morris-Pratt		algorithms.
5	Computational Geometric Algorithms: Point location Algorithms, Plane sweep techniques for Segment Intersection Problems	4	To familiar with some geometric algorithms and their real applications
6	Matrix Algorithms: LU Decomposition, LUP Decomposition, Linear System of Equations Solver, Matrix Inversion	5	Students will be exposed to how to use matrix methods to solve linear system of equations and how to obtain inverse of a high dimensional matrix.
7	kd-Tree, Binomial and Fibonacci Heaps: Definition, properties, Searching, construction and deletion algorithms	8	Students will learn how to design algorithms for various operations on these advanced level data structures.
8	Approximation Algorithms: Vertex Cover Problem, Travelling Salesman Problem, Set Cover Problem	2	To understand how to develop approximation algorithms for some NP complete/NP hard problems

Text Books:

1. Cormen, Leiserson, Rivest and Stein, Introduction to Algorithms, Prentice Hall of India, 3rd Edition, 2010.

Reference Books:

1. Sartaj Sahni and Sanguthevar Rajasekaran Ellis Horowitz, Fundamentals of Computer Algorithms, Universities Press.
2. Mark De Berg et al., Computational geometry: Algorithms and Application, 3rd edition, Springer, 2008.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD402	Bioinformatics	3	0	0	9

Course Objective
The objective of the course is to give an insight into Basics of bioinformatics and application of various computational methods to deal with biology, medical problems.
Learning Outcomes
Upon successful completion of this course, students will: ● Have a broad understanding of Basics and understanding of various tasks of bioinformatics that uses computational methods. ● Helps us to interdisciplinary work and in biology with the help of computational tools and techniques, approaches.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to bioinformatics, biological sequence/structure, Central dogma of Molecular Biology, Genome Projects, Pattern recognition and prediction, Folding problem, Sequence Analysis, Homology and analogy.	5	All basics of the subjects will be known and also learn the scope of the bioinformatics course.
2	Classical algorithms in pattern matching and bioinformatics, exact matching problem, suffix trees, dynamic programming	5	Able to know all the classical approaches in various methods of bioinformatics
3	Pairwise alignment, scoring model, dynamic programming algorithms, Hidden Markov Models, Multiple sequence alignment	5	Understand Alignment methods and its applications.
4	Motif finding, Secondary database searching, Advanced topics in phylogenetic tree, Biological databases, Primary sequence databases, Protein classification databases. DNA databases	5	Able to understand Motif finding in the sequence and its applications
5	Specialized Genomic Resources, Importance of	6	Able to know Preparation Specialized

	DNA analysis, Gene structure and DNA sequences, protein sequence and structure		Genomic Resources.
6	Gene expression analysis using microarray data	5	able to understand Microarray data preparation and processing for its analysis
7	Application of Computational techniques on gene expression data, EST searches.	5	Expressed sequenced tags will be able to understand
8	Case studies	4	Able to understand the Solving various real time or research papers related in bioinformatics

Text Books:

1. Dan Gusfield, *Algorithms on STRINGS, TREES, AND SEQUENCES, Cambridge University Press, 2007*.

Reference Books:

1. T.K Attwood, *Introduction to bioinformatics, Pearson Education India,*, 1999.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD403	Combinatorics and Graph Theory	3	0	0	9

Course Objective
The successful students are expected to know the definitions of relevant terminologies from graph theory and combinatorics, and know how to apply the concepts in different related areas
Learning Outcomes
The students will learn the basic concepts and formulate & solve problems in related areas.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
I	Graph Theory		
1	Graphs and their relatives	3	This introductory topics help students pick up the basic knowledge and concepts to start with the subject, to proceed with the more complex concepts
2	trees, matrix tree theorem; connectivity	3	students will pick up concepts about the special subgraphs with many applications in related problems
3	Eulerian tours, , de Bruijn sequences, Hamiltonian cycle	3	the students will learn about special cycle and tours in graphs and will learn how to detect them if they exist in a graph
4	Matching, covering	4	Matching covering have extensive applications in problems that can be handled under the framework of graph theory and the students will learn them
5	Independent set, edge coloring, vertex coloring, critical graphs	3	These are continued topics of items in 4 and the students will learn them
6	Planar graphs, directed graphs	2	planar graphs and related concepts are very important in various problems like VLSI and many others and the students will learn them
7	counting flows, spectral methods in graph theory, algebraic techniques in graph theory.	2	The students will pick up concepts to analyze graphs from a different perspective which is more inclined to algorithmic treatments
II	Combinatorics		
1	Essential problems in combinatorics, binomial coefficients, multinomial coefficients,	2	The students would learn the role and importance of combinatorics, the

			applications of combinatorics, start with basic problems of combinatorics
2	Pigeonhole principle, inclusion/exclusion	2	students will learn about the most widely used principles in combintorics, will learn how to apply this principle in solving problems, will learn enumeration/counting using principle of inclusion exclusion
3	generating Functions, double decks, counting with repetitions, Fibonacci numbers,Recurrence Relations, difference sequence, catalan Numbers integer partitions, Bell numbers	10	students will learn counting methods by framing the problem employing recursive relation, employing generating functions, difference sequence and will get familiarized with some selected well known problems involving special numbers like catalan number. They will also learn some special techniques like integer partition.
4	Permutation groups, Burnside theorem, Polya's theorem of counting	6	students will learn more difficult problems involving permutation groups and solid objects with their geometrical transformation, enumeration on them and some special counting techniques

Text Books:

1. Graph Theory with Applications : J.A. Bondy & U.S.R. Murty, Elsevier
2. Introductory Combinatorics, Richard A. Brualdi, Publisher: Prentice-Hall

Reference Books:

1. Introduction to Graph Theory - Douglas B West, Publisher: Pearson
2. Combinatorics and Graph Theory: John Harris, Jeffry L. Hirst and Michael Mossinghoff , Springer-Verlag New York

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD404	Computer Graphics	3	0	0	9

Course Objective
The course content will cover salient topics of Computer Graphics with a blend of theory and applications with an objective to enable the students to learn the subject and to apply wheresoever required.
Learning Outcomes
The successful students are expected to conceptualize the subject and feel comfortable to implement them as per requirement

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction, application areas, graphics systems, devices	4	The students will learn the basic purpose, application areas and basic devices related

			to graphics
2	Object representation techniques, curve and surface interpolation techniques,	8	The students will learn the techniques to generate the basic graphics primitives
3	Modeling transformation, viewing, clipping, graphics rendering, scan conversion,	6	The students will learn the basic techniques of object and scene representation in a realistic way
4	Illumination and shading models, color models	5	The students will learn to work with color light and surface shading
5	Hidden surface removal	8	The students will pick up techniques to depict visible surface hiding the obscured surfaces of the objects in dynamically changing scenes
6	Animation. texture mapping and other discrete techniques	3	the students will learn more pratical concepts of animation and texture mapping for more realistic graphics applications
7	Hierarchical modeling, fractal geometry	2	The students will learn more advanced topics
8	Input and interaction, graphics programming	3	The students will learn concepts related to interactive graphics programming

Text Books:

1. Computer Graphics: Donald Baker and M. Pauline Hearn, Prentice Hall
2. Computer Graphics: Principles and Practice - James D. Foley, Andries Van Dam, John F. Hughes, Steven K. Feiner, Addison_Wesley

Reference Books:

1. Fundamentals of Computer Graphics, 4th Edition: Peter Shirley, Steve Marschner Publisher: A K Peters/CRC Press

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD405	Evolutionary Computation	3	0	0	9

Course Objective

This syllabus is designed in such a manner that it will provide the basic and fundamental knowledge on evolutionary algorithms. The proposed syllabus is designed to cover evolutionary computingin detail to provide better research and industry oriented understanding for UG students.

Learning Outcomes

- Describe the basic phenomena of evolutionary algorithms and its applications
- Basic components of evolutionary algorithms
- Describe with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations
- Develop some familiarity with current research problems and research methods in evolutionary approaches

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to Machine learning and evolutionary computation, Schema /Schemata theorem	3	Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications

2	Components of evolutionary algorithms, Various representations, Selection methods, initialization/ termination. Fitness function, population models.	4	Basic Step of evolutionary algorithms, general view of evolutionary approaches.
3	Variation operators, Mutation techniques and Crossover techniques for various representations.	3	Genetic algorithms working principle and understand various internal details of evolutionary algorithms
4	Genetic programming and biology, formalism, Fundamental of genetic programming, Application of genetic programming,	6	Describe with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations
5	Evolutionary Structure, representation of ES and modifications in the parameter values and methods.	3	Evolutionary Algorithm Parameters and their respective setting.
6	Evolutionary Programming representation of EP and modifications in the parameter values and methods.	4	Evolutionary Algorithm Parameter Effect
7	Evolutionary neural networks, Learning classifier systems. application in natural language processing	8	To understand the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms, applications and theirlimitations
8	Development of evolutionary systems for application in Industry and Medicine, Case studies.	4	Develop some familiarity with current research problems and research methods in Soft Computing Techniques.
9	Application of evolutionary algorithm various in domain	3	Application of Evolutionary approaches possibilities in engineering and real time problems

Text Books:

1.A.E.Eiben, J.E.Smith, Introduction to Evolutionary Computing, Natural Computing Series, 2nd Edition, 2015.
2.Simon Haykin, "ArtificialNeutral Networks"

Reference Books:

1. David E Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Pearson Edition, 2013.
2. Jack M. Zurada, "Introduction to Artificial Neural Systems", PWS Publishing Co., Boston, 2002.
3. Dan W. Patterson, Introduction to AI and Expert System, PHI, 2009.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD406	Multimedia Systems	3	0	0	9

Course Objective
To provide fundamental knowledge related to Multimedia Systems.
Learning Outcomes
● Enhance the ability to understand different Multimedia related applications.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome

1	Multimedia Fundamentals and Representation: Introduction to Multimedia, Multimedia Data Representation Classification of Multimedia Systems, Image Representation and Enhancement, Color Models.	9	To provide the course outline.
2	Fundamental Concepts in Video, Basics of Digital Audio.	6	To give some view of different multimedia formats
3	Multimedia Coding Techniques: Lossless Compression Algorithms: Run-Length Coding, Variable-Length Coding (Huffman Coding, Adaptive Huffman Coding), Arithmetic Coding, Adaptive Arithmetic Coding, Dictionary-Based Coding, Context-based Coding, CALIC, Lossy Compression Algorithms: Standard Image Compression Techniques (JPEG, JPEG 2000), Video Compression Technique (MPEG), Audio Coding.	12	to understand effective multimedia representation approaches
4	Multimedia Communication: Fundamentals of data communication and networking, Bandwidth requirements of different media, Real time constraints: latency, video data rate, multimedia over LAN and WAN, Multimedia conferencing, video-on-demand broadcasting issues.	8	To focus on multimedia communication techniques
5	Multimedia Retrieval: Content Based Image Retrieval, Issues	4	To learn multimedia retrieval process

Text Books:

1. Ze-Nian Li, and Mark S. Drew, "Fundamentals of Multimedia", PHI Learning.
2. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards", Pearson.

Reference Books:

1. Khalid Sayood, "Introduction to Data Compression", Elsevier Publication.
2. Asit Dan and Dinkar Sitaram Multimedia Servers Elsevier, 2006.
3. Latest publications in multimedia related conferences and journals.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD407	Network Security	3	0	0	9

Course Objective
To understand the basics of Network vulnerability and Security Protection.
Learning Outcomes
To understand various protocols for network security to protect against the threats in the networks.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to Network Security	2	To provide a brief introduction.
2	Application Layer Security: Pretty Good Privacy (PGP) and S/MIME (Secure/ Multipurpose Internet Mail Extension)	8	To discuss how PGP and S/MIME can provide security services for e-mail.
3	Transport layer Security- SSL (Secure Socket Layer): Architecture, Message Formats, TLS (Transport Layer Security)	10	To discuss general architectures of SSL and TLS.
4	Network Layer Security(IPSec): Authentication Header(AH) and Encapsulation Security Payload(ESP), Security Association, IKE (Internet Key Exchange Protocol), ISAKMP (Header	10	To discuss how IPSec can be used to provide both confidentiality and authentication. To explain how Security association is

	Formats and Payloads),		implemented for IPSec To explain how IKE is used by IPSec
5	Firewall: Need and Characteristics, Types, Firewall Basing, Firewall Location and Configurations	8	To understand how firewalls provide the protection of data on the network
6	SET (Secure Electronic Transaction)	4	To understand the basic principles of cryptographic protocols for secure electronic transaction

Text Books:

1. William Stallings, Cryptography and Network Security:Principles and Practice, Prentice Hall, India
2. B.A. Forouzan, Cryptography and Network Security, Tata McGraw-Hill, India

Reference Books:

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD408	VLSI Design	3	0	0	9

Course Objective

- In this course, the MOS circuit realization of the various building blocks that is common to any microprocessor or digital VLSI circuit is studied.
- Architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology are discussed.
- The main focus in this course is on the transistor circuit level design and realization for digital operation and the issues involved as well as the topics covered are quite distinct from those encountered in courses on CMOS Analog IC design.

Learning Outcomes

- Student will learn the basic CMOS circuits and the CMOS process technology.
- Discuss the techniques of chip design using programmable devices.
- Digital system using Hardware Description Language (VHDL and Verilog).

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Mos Transistor Principle:** NMOS and PMOS transistors, Process parameters for MOS and CMOS, Electrical properties of CMOS circuits and device modeling, Scaling principles and fundamental limits, CMOS inverter scaling, propagation delays, Stick diagram, Layout diagrams.	7	Student will learn basics of MOS technology
2	**Combinational Logic Circuits:** Examples of Combinational Logic Design, Pass transistor Logic, Transmission gates, static and dynamic CMOS design, Power dissipation – Low power design principles	6	Combinationallogic circuits and power issues will beDiscussed.
3	**Sequential Logic Circuits:** Static and Dynamic Latches and Registers, Timing issues, pipelines, Memory architecture and memory control circuits, Low power memory circuits, Synchronous and Asynchronous design.	7	Sequential logic and power issues will be discussed.

4	**Designing Arithmetic Building Blocks:** Data path circuits, Architectures for ripple carry adders, carry look ahead adders, Multipliers, dividers, Barrel shifters, and speed and area tradeoff.	7	Student will learn the design of basic Arithmetic building blocks
5	**Implementation Strategies:** Full custom and Semi-custom design, Standard cell design and cell libraries, FPGA building block architectures,	6	Students will learn Standard cell design and cell libraries

Text Books:

A.Pucknell, Kamran Eshraghian, "BASIC VLSI Design", Third Edition, Prentice Hall of India, 2007.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE	CSD409	Wireless & Mobile Computing	3	0	0	9

Course Objective

At the end of the course, the students will be able to:

- To study the evolving wireless technologies and standards
- To understand the protocols, architectures and applications of various wireless networks.
- To gain expertise in some specific areas of wireless networking.

Learning Outcomes

On successful completion of this unit students will be able to:

- Identify the basic concept and understand the state-of-the-art in protocols, architectures and
- Applications of wireless networks.
- Compare, contrast and analyse wireless networks;
- Classify and also develop new protocols in ad hoc networks.
- Understand how wireless networking research is done.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to Wireless Networks: Issues and Challenges.	1	Comprehensive introduction about the course content will be delivered and basics of Wireless Networks.
2	Radio wave propagation: Antennas; Propagation Modes; LOS Transmission; Fading in the wireless Environment; Energy consumption and Delay.	6	To understand the working procedure of Physical layer and Radio wave propagation.
3	MAC Layer: Noisy channels and its protocols; Multiple Access Techniques; Control Access Mechanisms; Channelization methods - TDMA, FDMA, Spread Spectrum, CDMA, OFDMA.	6	To understand the MAC layer for Wireless networks.
4	Mobility Management and GSM: Cellular Architecture, Cell splitting and sectoring concept; Frequency allocation and interference issues; Handoff techniques; Hierarchical Scheme; Mobile IP; Mobile TCP.	8	This unit will help students to understand GSM architecture and working principle of Cell phones.
5	Wireless LANs: Wireless LAN technologies, Wireless standards (IEEE 802.11, 802.15, 802.16 etc.), WiFi, Bluetooth and WiMAX.	3	Students learn the different types of wireless LANs.
6	Ad-hoc Networks and Sensor Networks: Introduction, Challenges and Issues, AODV, DSR, DSDV Routing protocols; Architecture and factors influencing the sensor network design; Concept of MANET and VANET.	8	To understand basic properties of Ad-hoc Networks and to get an overview of different routing techniques.
7	Wireless Application Protocol (WAP) and WML.	2	Students learn WAP and WML.
8	File system support for mobility and storage manager for mobility support. Models for mobile	2	This unit will help students to understand basic concepts of Distributed file systems

	transaction, Kangaroo and Joey transactions.		and Distributed transactions.

Text Books:

1. Wireless Communications and Networks by William Stallings, PHI
2. Wireless Networks by Clint Smith and Daniel Collins, McGrawHill
3. Mobile Communications by Jochen Schiller, Pearson Education

Reference Books:

1. Computer Networks by Andrew S. Tanenbaum, Pearson Education
2. Computer Networking by James F. Kurose and Keith W. Ross, Pearson Education
3. Data and Computer Communications by William Stallings, PHI
4. Communication Networks Fundamental concepts and key architecture by Alberto Leon-Garcia and Indra Widjaja, Tata McGrawHill
5. Data Communications and Networking by Behrouz A. Forouzan, Tata McGrawHill
6. Wireless Communications Principles and Practice by Theodore E. Rapaport, PHI

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO301	Database Management Systems	3	0	0	9

Course Objective

The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.

Learning Outcomes

Upon successful completion of this course, students will:

- Have a broad understanding of database concepts and database management system software.
- Have a high-level understanding of major DBMS components and their function.
- Be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.
- Be able to write SQL commands to create tables and indexes, insert/update/delete data, and query data in a relational DBMS.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Introduction:** Introduction and Overview of a DBMS – Purpose of Database Systems, View of Data, Data Models, DDL, DML, Transaction Management, Storage Management, Database Administrator, Database Users, Overall System Structure.	5	Understanding of DBMS and what it provides. You know when to use files and when to use a DBMS. It provides idea of DBMS Architecture.
2	**Entity-Relationship Model**: Basic Concepts, Design Issues, Mapping Constraints, Keys, ER-Diagram, Weak Entity Sets, Extended ER-Diagram, Reduction of ER-Schema to Tables Relational Model.	5	This unit will help student in understanding the steps to prepare a data model based on user requirements.
3	**Concepts:** Structure of Relational Databases, Relational Algebra, Tuple Relational Calculus, Domain Relational Calculus, Extended Relational-Algebra Operations, Modification of the Database, Views.	6	This will help is designing the relation model, which will conceptualize data using the relational model. You can also express queries using relational algebra.
4	Structured Query Language	5	You can express queries using SQL.
5	**Integrity Constraints:** Domain Constraints, Referential Integrity, Assertions, Triggers, Functional Dependencies.	5	To understand what constraints and triggers are for and how to use them.
6	**Relational Database Design**: Decomposition, Normalization, Transactions.	4	This will help student in further refining the relational database for efficient management & outcome.
7	**Concurrency Control**: Transaction Concepts, Transaction State, Concurrent Executions,	5	To know all about the transactions and handling concurrent transactions in

	Serializability, Recoverability, Lock-Based Protocols, Timestamp-Based Protocols, Deadlock Handling Basics of Database.		databases.
8	**File Organization & Query Processing:** File Organization, Organization of Records in Files, Data Dictionary Storage, Steps in Query Processing.	3	Help in understanding the organization of files for keeping databases and how to optimize the database queries for fast response.

Text Books:

1. Korth, Slberchatz,Sudarshan, :"Database SystemConcepts", 6th Edition, McGraw –Hill

Reference Books:

1. Elmasri and Navathe, "Fundamentals of Database Systems", 5thEdition, PEARSON Education.
2. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition.
3. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH.

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO302	Graph Theory	3	0	0	9

Course Objective
To create interest, to familiarize the students with the important concepts, to develop their skills in the subject
Learning Outcomes
The students are expected to be able to deal with problems and challenges in the related fields both in academics and industries

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Basic graph theoretical concepts, definitions, representation, related theorems, different types of graphs	5	This introductory topics help students pick up the basic knowledge and concepts to start with the subject, to proceed with the more complex concepts
2	trees, spanning trees, Euler's theorem, vertex and edge connectivity, blocks,	4	students will pick up concepts about the special subgraphs with many applications in related problems
3	Hamiltonian and Euler graphs	5	the students will learn about special cycle and tours in graphs and will learn how to detect them if they exist in a graph
4	Matching, covering, related theorem, SDR, Edge coloring	7	Matching covering have extensive applications in problems that can be handled under the framework of graph theory and the students will learn them
5	Independent set, clique, Ramsey theorem, vertex coloring, critical graphs	5	These are related and extended concepts of topics in item 4 which the students will learn
6	Planar graphs, planarity testing, Directed graphs	4	planar graphs and related concepts are very important in various problems like VLSI and many others and the students will learn them
7	Strongly regular graphs, line graphs and eigen values, Laplacian of graphs, cuts and flows, rank polynomial	6	The students will pick up concepts to analyze graphs from a different perspective which is more inclined to algorithmic treatments
8	Random and infinite graphs, Applications in biology and social sciences	4	The students will learn the application parts of the graph theory

Text Books:

1. Graph theory with applications by J.A. Bondy and U.S.R. Murty, Elsevier
2. Algebraic graph theory by Chris Godsil and Gordon Royle, Springer

Reference Books:

1. Modern Graph Theory by Bela Bollobas, Springer
2. Introduction to Graph Theory by Douglas B West, PHI

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO303	Artificial Intelligence	3	0	0	9

Course Objective
Course will introduce the basic principles in artificial intelligence, which covers blind and heuristic search strategies, simple knowledge representation schemes, introduction to CSP problems and use for general purpose heuristic for constraint propagation, genetic algorithm, rule based system, Introduction to probabilistic reasoning, planning and learning neural network models, Areas of application, natural language processing, will be explored. The PROLOG programming language will also be introduced.
Learning Outcomes
Understanding of the following:Problem as Search - Converting real world problems into AI search problems and explain important search concepts, such as the difference between informed and uninformed search, the definitions of admissible and consistent heuristics and completeness and optimality. Understanding of various heuristic search techniques, MiniMax search for game playing.Constraint Satisfaction - Formulation of real world problem as CSP problem and solution for CSP using general purpose heuristics, Genetic Algorithm for optimization. Knowledge representation using First order logic, proofs in first order using techniques such as resolution, unification. Rule based system and logic programming using Prolog programming language, Planning techniques, Bayesian network and reasoningFundamentals of learning using neural net, decision tree, naïve- Bayes, nearest neighbour,inductive learning, Fundamentals of NLP.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Artificial Intelligence Introduction, Brief history, Problem solving by search: state space, Search and Knowledge representation. Uninformed search : Breadth First Search, Depth First Search, Depth First with Iterative Deepening and Uniform Cost Search,	5	Learning various Informed and Uninformed search techniques.
2	Heuristic Search: Hill climbing, Simulated Annealing, A*, problem reduction, Algorithm, Minimax search	6	Learning heuristic search
3	Binary and Higher order CSP, Constraint Satisfaction Graph, MRV, Degree,Least Constraining, Forward Checking and Arc Consistency General purpose heuristics for CSP	6	Learning various techniques constraint satisfaction problems.
4	Introduction to genetic algorithm, operations : selection,crossover,mutation examples	4	Learning various techniques in the context of AI.
5	Logic based representations (PL, FoL) and inference, Logic Programming: Prolog. Rule based representations, forward and backward chaining, matching algorithms.	5	Learning various logic representation techniques includes forward and backward chaining.
6	Planning Techniques: Goal Stack Planning, Constraint posting	4	Learning various planning techniques in the context of AI.
7	Probabilistic Reasoning: Bayesian Network and reasoning.	3	Learning various probabilistic techniques includes Bayesian network and reasoning.
8	Learning: Neural Network models, Statistical methods: Naive-Bayes, Nearest Neighbor, Decision trees, Inductive Learning	5	Learning various techniques in NN, Decision tree and learning methods.

9	Introduction to Natural Language Processing	2	Learning various techniques in NLP.

Text Books:

1. Artificial Intelligence Modern Approach Third Edition by S. Russell. Norvig,PHI

Reference Books:

1. Artificial Intelligence Third Edition byKevin Knight (Author),Elaine Rich (Author),
2. Artificial Intelligence, Structures and Strategies for Complex Problem Solving George F Luger, Sixth Edition, Pearson
3. Machine Learning by Mitchell, Tom M. Indian Edition

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO304	Digital Image Processing	3	0	0	9

Course Objective
To provide basic and fundamental knowledge on different phases of digital image processing. The proposed syllabus is designed to cover image analysis part in detail to provide better practical and research understanding for students.
Learning Outcomes
Enhance the ability to understand different phases of digital image processing and also to provide better understanding about their uses in real world applications.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Image Sampling and Quantization; Image Representation; Image Formats; Pixel Geometry; Mathematical Operators used in Image Processing.	5	Understanding of the fundamentals of digital image processing and pixel geometry.
2	Image Enhancement: Contrast Enhancement, Histogram Processing, Point Processing, Spatial Domain Filtering, Frequency Domain Filtering.	5	To understand image enhancement techniques used in spatial and frequency domain.
3	Image Restoration: Noise Models, Image Restoration Filtering, Image Estimation, Geometric Transformation.	4	To understand fundamental knowledge about image restoration techniques used in digital image processing.
4	Multiresolution Analysis and Wavelet: Pyramidal Coding; Subband Coding; Application of Wavelets.	4	Understanding the effect of multiresolution analysis and its different techniques used in digital image processing.
5	Image Compression: Error Criterion; Lossless Compression: Run-length Coding; Shannon-Fano Coding; Huffman Coding; Arithmetic Coding; Lossy Compression: Block Truncation Compression; Vector Quantization Compression.	6	To understand basic of image compression and different lossy and lossless compression techniques.
6	Image Morphology: Fundamental Operations; Morphological Algorithms; Mathematical Examples.	3	Understanding of different operations used in image morphology and corresponding mathematical examples.
7	Image Segmentation: Pixel-based Segmentation, Multilevel and Adaptive Thresholding, Optimal Thresholding, Region-based Segmentation, Point, Line, and Edge detection; Hough Transform.	8	To understand the basic principle of image segmentation, different types of segmentation methods and their used in real applications..
8	Image Representation and Description: Freeman Chain Coding; Binary Tree and Quad Tree Coding; Boundary Extraction; Medial Axis Generation & Thinning; Boundary Descriptors; Regional Descriptors; Topological Descriptors; Relational Descriptors.	4	Understanding of different techniques used for image representation as well as description.

Text Books:

Digital Image Processing, R. C. Gonzalez and R. E. woods, Pearson Education.

Reference Books:

3. Digital Image Processing and Analysis, B. Chanda and D. Dutta Mazumdar, PHI.
4. Digital Image Processing, W. K. Pratt, Wiley-Interscience.
5. Fundamentals of Digital Image Processing, A. K. Jain, Pearson India Education.

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO401	Machine Learning	3	0	0	9

Course Objective: To make familiarize with Fundamentals of Machine Learning
Learning Outcomes
• To make familiarize with Fundamentals of Machine Learning so that learner may start working for machine learning applications

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction: Well Defined Learning Problems, Designing A Learning System, Issues In Machine Learning. Learning Tasks: General-To-Specific Ordering Of Hypotheses, Candidate Elimination Algorithm, Inductive Bias.	6	To make familiarize with basics of Machine learning
2	Decision Tree Learning: Decision Tree Learning Algorithm-Inductive Bias- Issues In Decision Tree Learning. Evaluating Hypotheses – Estimating Hypotheses Accuracy Basics Of Sampling Theory, Comparing Learning Algorithms, Bayesian Learning – Bayes Theorem, Concept Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, EM Algorithm,	8	To make familiarize with decision tree based learning and statistical learning
3	Computational Learning Theory – Sample Complexity For Finite Hypothesis Spaces. Artificial Neural Networks: Perceptron, Gradient Descent And The Delta Rule, Adaline, Multilayer Networks, Derivation Of Backpropagation Rule backpropagation Algorithm.	6	To make familiarize with Artificial Neural Networks
4	Generalization. Genetic Algorithms – An Illustrative Example, Hypothesis Space Search, Genetic Programming, Models Of Evolution And Learning;	6	To make familiarize with Meta-heuric techniques
5	Reinforcement Learning 13 - The Learning Task, Q Learning, Instance-Based Learning – K-Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Function Networks, Case-Based Learning	8	To make familiarize with Reinforcement Learning

Text Books:

1. Artificial Neural Networks 1998 B. Yegnanarayana, PHI
2. Neural Networks: Algorithms, Applications, and Programming Techniques, 1e – 2002, James FREEMAN and David Skapura, Pearson

Reference Books:

1. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms Paperback – 2010, Wiley
2. GENETIC ALGORITHMS: in search, optimization and machine learning 1 Dec 2008, D. E. GOLDBERG,

Course	Course	Name of Course	L	T	P	Credit

Type	Code					
OE	CSO402	Soft Computing	3	0	0	9

Course Objective: To make familiarize with Fundamentals of Soft Computing
Learning Outcomes
• To make familiarize with Fundamentals of Soft Computing so that learner may start working for Soft Computing applications

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Artificial Neural Networks (ANN): Basics Characteristics of artificial neural networks, Comparison with biological neural networks, Advantages and disadvantages of ANNs,Synaptic dynamics, Applications of ANNs, Basic Models: Mc-Culloch Pitt's model,Single Layer and Multilayer Perceptron model of neural networks, Hebb's model,	8	To make familiarize with basics and models of Artificial neurons
2	Learning Laws; Learning: Supervised, unsupervised, Reinforcement Law of learning;Differences among learning laws; LMS and Delta Learning, Gradient descent method,Multilayer Perceptron Model (MLP), Back propagation algorithm for weight updates,classification problem using MLP; Architecture for complex pattern recognition tasks;	6	To make familiarize with various learning paradigms with few ANN models
3	Genetic Algorithm: working Principle, Cross-over mutation, roulette wheel selection,tournament selection, population, binary encoding and decoding for any optimizationproblem, Multi objective Gas, Concepts on Non-domination, tournament selection, crowding distance operator, ranking,	6	To make familiarize with working principles of various meta-heuristic algorithms for search and optimizations
4	Fuzzy Logic: Fuzzy sets, basic operations, membership functions, Fuzzy Relations, Fuzzification, Fuzzy Inference, Fuzzy Rule Based System, Defuzzification;	6	To make familiarize with Fuzzy concepts
5	Rough Sets: basic operations, lower and upper, approximations, discernibility matrix, distinction table; Accuracy of Approximations.	6	To make familiarize with Rough Sets Theory
6	Hybridization of Soft Computing tools like Neuro-fuzzy, Rough fuzzy, Rough-Fuzzy-GA etc.boundary region. Applications	6	To make familiarize with Hybridizing the components for various applications

Text Books:

1. Principles of Soft Computing, 2ed (WILEY) 2011, S.N. Deepa S.N. Sivanandam

Reference Books:

2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms Paperback – 2010, Wiley
3. GENETIC ALGORITHMS: in search, optimization and machine learning 1 Dec 2008, D. E. GOLDBERG, P
4. Artificial Neural Networks 1998 B. Yegnanarayana, PHI
5. Neural Networks: Algorithms, Applications, and Programming Techniques, 1e – 2002, James FREEMAN and David Skapura, Pearson

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO403	Internet Technology	3	0	0	9

Course Objective
This Subject provides students with an in-depth knowledge about the Internet Technology. The students will be able to understand the various protocols like RIP, OSPF, BGP and Related Protocols.
Learning Outcomes
Knowledge and understanding: Outline the potential benefits of Internet Technology.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to Internet - Internet Architecture, Evolution and Internet Network Architecture, OSI Reference Model, TCP/IP Model	2	Basic introduction
2	Internet Protocols, Introduction to IPv4 and IPv6, Need of Internet Protocols, Addressing Schemes	4	Understanding Internet Protocols
3	Internet Routing Protocols - RIP, OSPF, BGP	4	Understanding Internet routing Protocols
4	Other Protocols - ICMP ARP, RARP, BOOTP, DHCP, DNS	4	Understanding other Protocols
5	Transport Layer Protocol - TCP, UDP	4	Understanding Transport Protocols
6	Mail Server & E-mail Protocol - SMTP, MIME, POP	4	Understanding Mail Protocols
7	Introduction to HTTP, HTTP Transaction, HTTP Request and Response Message.	4	Understanding HTTP Protocols
8	Introduction to WWW, Browser Architecture, HTML Page Creation (Static and Dynamic)	4	Understanding Internet
10	Voice & Multimedia over IP, Introduction to Real Time Traffic, VoIP	4	Understanding Voice and Multimedia Protocols
11	Mobile IP - Introduction and Need of MIP, Agent Discovery, Registration, Data Transfer, Inefficiency in MIP.	6	

Text Books and Reference Book

IBM/RedBook - TCP/IP Tutorial and Technical Overview

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO404	Cryptography	3	0	0	9

Course Objective
The objective of the course is to present an introduction to Cryptography, with an emphasis on how to protect the information security from unauthorized users.
Learning Outcomes
Upon successful completion of this course, students will: ● Have a broad understanding of Cryptography course. ● Have a high-level understanding of cryptographic based different applications and their functionality. ● Be able to model secure applications based on the knowledge of cryptography.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Introduction to Cryptography and Its Applications, Mathematical Tools for Cryptography	3	Comprehensive introduction about the course content will be delivered.
2	Classical Cryptosystems, Cryptanalysis of Classical Ciphers	3	To understand the working procedure of cryptography through the example of Classical Cryptosystems and their cryptanalysis process.

3	Private-Key Cryptosystems: Feistel Cipher, DES, Differential Cryptanalysis	4	To understand the internal structure Feistel networks. This will help students to understand the design process of DES, which is very helpful for understanding the evolution of modern cryptography. The students also learn the security analysis on DES algorithm.
4	AES, IDEA, CAST, RC4, RC5, Blowfish; Mode of operations;	6	This unit will help students to understand some popular private key cryptosystems. In addition, they will learn the most important modes of operation for block ciphers in practice.
5	Public Key Cryptosystems: Knapsack cryptosystems, RSA; Attacks on RSA, Diffie-Hellman Key Exchange, Discrete Logarithm problem, ElGamal cryptosystems, Elliptic Curve cryptosystems;	12	To understand the need of Public Key Cryptosystems. Practical aspects of different Public key cryptosystems. Protocols that can be realized with Public key cryptosystems.
6	Cryptographic Hash functions: MD5, SHA-1, SHA-512, Birthday Attack	4	To understand important properties of hash functions and to get an overview of different families of hash functions. The students also learn the security threat on this particular topics.
7	Message Authentication Codes, HMAC	2	To understand the principles of Message Authentication Codes
8	Digital Signatures: RSA Signatures, ElGamal Signature, DSA, Blind Signatures	3	To understand the principle of digital signatures and their different variants.
9	Key Establishment: Kerberos, X.509 Certificates.	2	The students will learn several mechanisms for establishing keys between remote parties.

Text Books:

1. W. Trappe and L. Washington, "Introduction to Cryptography with Coding Theory", Pearson Prentice Hall.

Reference Books:

1. B. Forouzan and D. Mukhopadhyay, "Cryptography and Network Security", McGraw Hill Education.
2. D. Stinson, "Cryptography: Theory and Practice", Chapman and Hall/CRC.

Course Type	Course Code	Name of Course	L	T	P	Credit
OE	CSO405	Data Mining	3	0	0	9

Course Objective

Course Objective:

This Subject provides students with an in-depth knowledge about the Data Mining. The students will be able to understand the various Techniques like Associations, Classification and Clustering and related applications.

Learning Outcomes

Knowledge and understanding: Outline the potential benefits of Data Mining.

Unit	Topics to be Covered	Lecture	Learning Outcome

No.		Hours	
1	Introduction: Data mining functionalities, classification and integration, major issues in data mining	4	Understanding introduction concepts
2	Data preprocessing: data summarization, data cleaning, data integration and transformation and data reduction;	4	Understanding Preprocessing techniques
3	Data warehouse and OLAP Technology: a multidimensional data model, data warehouse architecture;	3	Understanding Data warehouse and OLAP
4	Mining Frequent Patterns; Associations and correlations: efficient and scalable frequent item-set mining methods, mining various kinds of association rules, constraints based association mining;	6	Understanding Associations rules and related topics
5	Classification: Basic concepts and advanced Methods, Prediction, Accuracy and Error Measures, Evaluating the accuracy of a classifier or Predictor, Ensemble Methods,	7	Understanding classifications techniques
6	Clustering: Partitioning Methods, Hierarchical Methods, Density-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data.	8	Understanding clustering techniques
7	Outlier Detection, Mining Stream.	8	Understanding Outlier detection Stream Mining
8	Time-Series, and Sequence Data, Text Mining	4	Understanding Time Series
9	Applications and Trends in Data Mining	5	

Text Books:

1. Data Mining: Concepts and Techniques, By Jiawei Han, Jian Pei, Micheline Kamber, Elsevier.

Reference Books:

2. Data Mining: The Textbook, By Charu C. Aggarwal, Springer International.