DAYANANDA SAGAR UNIVERSITY

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS
FOR
BACHELOR OF TECHNOLOGY (B.Tech.) – 2020

COMPUTER SCIENCE & ENGINEERING

(CSE)

(WITH EFFECT FROM 2020-21)

SCHEME - B.TECH – 2020-21 ONWARDS

III SEM - COMPUTER SCIENCE & ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	103	20CS2301	DISCRETE MATHEMATICAL STRUCTURES	CR	3	-	-	-	3	*	***
2	103	20CS2302	DATA STRUCTURES	CR	3	-	-	-	3	I/II	20EN1103
3	103	20CS2303	DIGITAL ELECTRONICS & LOGIC DESIGN	CR	3	-	-	2	4	*	***
4	103	20CS2304	DATABASE MANAGEMENT SYSTEMS	CR	3	-	-	-	3	*	***
5	103	20CS2305	COMPUTATIONAL THINKING WITH PYTHON	CR	3	-	-	-	3	*	***
6	103	20CS2306	AGILE SOFTWARE ENGINEERING	CR	2	-	-	2	3	*	***
7	103	20CS2307	DATA STRUCTURES LAB	CR	-	-	2	-	1	*	***
8	103	20CS2308	DATABASE MANAGEMENT SYSTEMS LAB	CR	-	-	2	-	1	*	***
9	103	20CS2309	MANAGEMENT AND ENTREPRENEURSHIP	CR	2	-	-	-	2	*	***
10	103	20CS2310	LIBERAL STUDIES – I	CR	1	-	-	-	1	*	***
					20	**-**	**04**	**04**	**24**		

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SCHEME - B.TECH – 2020-21 ONWARDS

IV SEM - COMPUTER SCIENCE & ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	103	20CS2401	PROBABILITY AND STATISTICS	CR	3	-	-	-	3	*	***
2	103	20CS2402	OBJECT ORIENTED DESIGN AND PROGRAMMING	CR	3	-	-	-	3	*	***
3	103	20CS2403	PRINCIPLES OF MICROPROCESSORS AND COMPUTER ORGANIZATION	CR	4	-	-	-	4	*	***
4	103	20CS2404	FINITE AUTOMATA & FORMAL LANGUAGES	CR	3	-	-	2	4	*	***
5	103	20CS2405	INTRODUCTION TO NETWORKS & CYBERSECURITY	CR	3	-	-	-	3	*	***
6	103	20CS2406	FULL STACK DEVELOPMENT	CR	2	-	-	2	3	*	***
7	103	20CS2407	OBJECT ORIENTED PROGRAMMING LAB	CR	-	-	2	-	1	*	***
8	103	20CS2408	MICROPROCESSORS LABORATORY	CR	-	-	2	-	1	*	***
9	103	20CS2409	SPECIAL TOPICS - I	CR	-	-	-	4	2	*	***
10	103	20CS2410	LIBERAL STUDIES – II	CR	1	-	-	-	1	*	***
					19	**-**	**04**	**08**	**25**		

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SCHEME - B.TECH – 2020-21 ONWARDS
V SEM - COMPUTER SCIENCE & ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	103	20CS3501	COMPUTER NETWORKS	CR	3	-	2	-	4	*	***
2	103	20CS3502	DESIGN AND ANALYSIS OF ALGORITHMS	CR	3	-	-	-	3	*	***
3	103	20CS3503	OPERATING SYSTEMS	CR	3	1	-	-	4	*	***
4	103	20CS3504	MACHINE LEARNING	CR	3	-	2	-	4	*	***
5	103	20CS35XX	PROFESSIONAL ELECTIVE-1	CR	3	-	-	-	3	*	
6	103	20OE00XX	OPEN ELECTIVE-1	CR	3	-	-	-	3	*	***
7	103	20CS3505	DESIGN AND ANALYSIS OF ALGORITHMS LAB	CR	-	-	2	-	1	*	***
8	103	20CS3506	OPERATING SYSTEMS LAB	CR	-	-	2	-	1	*	***
	103	20CS3507	SPECIAL TOPICS -II	CR		-	-	4	2	*	***
					18	1	8	4	25		

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SCHEME - B.TECH – 2020-21 ONWARDS
V SEM-PROFESSIONAL ELECTIVE – I

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20CS3508	RANDOMIZED AND APPROXIMATE ALGORITHMS	03	_	_	_	03	_	**
2	20CS3509	GRAPH THEORY	03	_	_	_	03	_	**
3	20CS3510	MICROCONTROLLERS AND EMBEDDED SYSTEMS	03	_	_	_	03	_	**
4	20CS3511	VLSI DESIGN	03	_	_	_	03	_	**
5	20CS3512	INTERNET OF THINGS	03	_	_	_	03	_	**
6	20CS3513	ARTIFICIAL INTELLIGENCE	03	_	_	_	03	_	**
7	20CS3514	DATA WAREHOUSE AND DATA MINING	03	_	_	_	03	_	**
8	20CS3515	CLOUD COMPUTING	03	_	_	_	03	_	**
9	20CS3516	BIOLOGICAL FOUNDATIONS OF AI AND ML	03	_	_	_	03	_	**
10	20CS3517	QUANTUM MECHANICS	03	_	_	_	03	_	**

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SCHEME - B. TECH – 2020-21 ONWARDS

VI SEM - COMPUTER SCIENCE & ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	103	20CS3601	COMPILER DESIGN AND SYSTEM SOFTWARE	CR	3	1	-	-	4	*	***
2	103	20CS3602	SECURE PROGRAMMING	CR	2	-	2	-	3	I/II	20EN1103
3	103	20CS3603	CLOUD APPLICATION DEVELOPMENT	CR	3	-	-	-	3	*	***
4	103	20CS36XX	PROFESSIONAL ELECTIVE-2	CR	3	-	-	-	3	*	***
5	103	20CS36XX	PROFESSIONAL ELECTIVE-3	CR	3	-	-	-	3	*	***
6	103	20OE00XX	OPEN ELECTIVE-2	CR	3	-	-	-	3	*	***
7	103	20CS3604	COMPILER DESIGN AND SYSTEM SOFTWARE LAB	CR	-	-	2	-	1	*	***
8	103	20CS3605	CLOUD APPLICATION DEVELOPMENT LAB	CR	-	-	2	-	1	*	***
					17	01	06	-	21		

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VI SEM-PROFESSIONAL ELECTIVE – II & III

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20CS3606	SOFT COMPUTING	3	–	–	–	03	*	***
2	20CS3607	EDGE COMPUTING	3	–	–	–	03	*	***
3	20CS3608	DISTRIBUTED COMPUTING	3	–	–	–	03	*	***
4	20CS3609	COMPUTER ARCHITECTURE	3	–	–	–	03	*	***
5	20CS3610	BLOCK CHAIN AND DISTRIBUTED LEDGER	3	–	–	–	03	*	***
6	20CS3611	MOBILE COMPUTING AND APPS DEVELOPMENT	3	–	–	–	03	*	***
7	20CS3612	SOFTWARE DEFINED NETWORKS	3	–	–	–	03	*	***
8	20CS3613	MACHINE LEARNING FOR HEALTHCARE	3	–	–	–	03	*	***
9	20CS3614	DEEP LEARNING	3	–	–	–	03	*	***
10	20CS3615	DIGITAL IMAGE PROCESSING	3	–	–	–	03	*	***
11	20CS3616	HUMAN COMPUTER INTERFACE	3	–	–	–	03	*	***
12	20CS3617	UG RESEARCH PROJECT-I/PRODUCT DEVELOPMENT FOUNDATION-I	–	–	–	06	03	*	***
13	20CS3618	COMPUTATIONAL GEOMETRY	3	–	–	–	03	*	***
14	20CS3619	GAME THEORY	3	–	–	–	03	*	***
15	20CS3620	DATA SCIENCE	3	–	–	–	03	*	***
16	20CS3621	BIG DATA ANALYTICS	3	–	–	–	03	*	***
17	20CS3622	SEMANTIC WEB	3	–	–	–	03	*	***
18	20CS3623	COMPUTATIONAL METHODS IN NEUROSCIENCE	3	–	–	–	03	*	***
19	20CS3624	QUANTUM COMPUTATION	3	–	–	–	03	*	***
20	20CS3625	MOOC COURSE	3	–	–	–	03	*	***

SCHEME - B. TECH – 2020-21 ONWARDS
VII SEM - COMPUTER SCIENCE & ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	103	20CS47XX	PROFESSIONAL ELECTIVE – 4	CR	3	-	-	-	3	AS INDICATED IN ELECTIVE LIST	
2	103	20CS47XX	PROFESSIONAL ELECTIVE – 5/MOOC	CR	3	-	-	-	3		
3	103	20OEXXXX	OPEN ELECTIVE-3	CR	3	-	-	-	3	*	***
4	103	20CS4701	PROJECT PHASE – I	CR	-	-	-	6	3	*	***
					09	-	-	06	12		

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SCHEME - B. TECH – 2020-21 ONWARDS
VIII SEM - COMPUTER SCIENCE & ENGINEERING

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	103	20CS48XX	PROFESSIONAL ELECTIVE – 6	CR	3	-	-	-	3	AS INDICATED IN ELECTIVE LIST	
2	103	20CS4801	PROJECT PHASE – II	CR	-	-	-	12	6		
3	103	20CS4802	INTERNSHIP	CR	-	-	-	6	3	*	***
					03	**-**	**-**	**18**	**12**		

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VII SEM-PROFESSIONAL ELECTIVE – 4 & 5

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20CS4702	ADVANCED DRIVING ASSISTANCE SYSTEMS	03	–	–	–	03	*	***
2	20CS4703	WIRELESS NETWORKS	03	–	–	–	03	*	***
3	20CS4704	CRYPTOGRAPHY	03	–	–	–	03	*	***
4	20CS4705	NATURAL LANGUAGE PROCESSING	03	–	–	–	03	*	***
5	20CS4706	PATTERN RECOGNITION	03	–	–	–	03	*	***
6	20CS4707	SEQUENCE NETWORKS AND GAN	03	–	–	–	03	*	***
7	20CS4708	UG RESEARCH PROJECT-II/PRODUCT DEVELOPMENT FOUNDATION-II	–	–	–	06	03	*	***
8	20CS4709	AWS WEB SERVICES	03	–	–	–	03	*	***
9	20CS4710	AUGMENTED REALITY AND VIRTUAL REALITY	03	–	–	–	03	*	***
10	20CS4711	MOOC	03	–	–	–	03	*	***

VIII SEM-PROFESSIONAL ELECTIVE – 6

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20CS4803	PARALLEL COMPUTING	3	–	–	–	3	*	***
2	20CS4804	SOCIAL NETWORKS AND ANALYTICS	3	–	–	–	3	*	***
3	20CS4805	COMPUTER VISION	3	–	–	–	3	*	***
	20CS4806	CLOUD INFRASTRUCTURE MANAGEMENT	3	–	–	–	3	*	***
4	20CS4807	MOOC	3	–	–	–	3	*	***

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2301**					
TITLE OF THE COURSE	**DISCRETE MATHEMATICAL STRUCTURES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Solve problems using relations and generating functions.
- Understand and Construct mathematical arguments.
- Use propositional and predicate logic in knowledge representation and program verification.
- Develop recursive algorithms based on mathematical induction.
- Know essential concepts in graph theory and related algorithms.
- Apply knowledge of discrete mathematics in Elementary Number Theory and problem solving.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Classify functions, basic set theory relations.	L4
CO2	Demonstrate the correctness of an argument using propositional and predicate logic, laws and truth tables.	L2
CO3	Compare and differentiate graphs in different geometries related to edges.	L4
CO4	Apply mathematical induction, counting principles, recursion, elementary number theory.	L3
CO5	Apply and solve Euclidean Division Algorithm and Chinese Remainder Theorem.	L3

COURSE CONTENT:	
MODULE 1	**9Hrs**
RELATIONS AND FUNCTIONS: Relation and Types of relations, Closure Properties, Equivalence Relations, Partial Ordering Relations, n-ary relations, Functions: one-to-one, onto and invertible functions, sequences, indexed classes of sets, recursively defined functions, cardinality Counting Principles: Permutation, combination, the pigeon hole principle,inclusion-exclusion principle Self – Learning Component: Set theory definition and Properties	
MODULE 2	**8Hrs**
LOGIC: Propositions and truth tables, tautologies and contradictions, logical equivalence, algebra of propositions, logical implications, predicate logic, theory of inference for propositional logic and predicate logic. Introduction to Predicate Calculus.	
MODULE 3	**9Hrs**
NUMBER THEORY : Properties of Integers: Introduction, order and inequalities, absolute value, mathematical induction, division algorithm, divisibility, primes, greatest common divisor, Euclidean algorithm, fundamental theorem of arithmetic, congruence relation, congruence equations and Chinese Reminder Theorem (CRT).	
MODULE 4	**7Hrs**
GRAPH THEORY: Graphs and multi-graphs, sub-graphs, isomorphic and homomorphic graphs, paths, connectivity, Euler and Hamilton paths, labelled and weighted graphs, complete, regular and bipartite graphs, planar graphs.	
MODULE 5	**9Hrs**
TREES AND GRAPH COLORING: Trees: Definitions-properties - fundamental theorems of trees-rooted trees-binary trees-spanning trees- Kruskal's Algorithm- Prims Algorithm- Cut-Set, BFS and DFS. Coloring of planar graphs, Chromatic Number- Chromatic partitioning- The four Color Problem-Five-color and Four-color theorem- Thickness and crossing.	

TEXT BOOKS :

1. K. H. Rosen, Discrete Mathematics & its Applications, 7th Ed., Tata McGraw-Hill, 2007.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall India (PHI).

REFERENCES:

1. M.Huth and M. Ryan, Logic in Computer Science, Cambridge University N.Press, 2004.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2302**					
TITLE OF THE COURSE	**DATA STRUCTURES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/II	20EN1103	FUNDAMENTALS OF PROGRAMMING

COURSE OBJECTIVES :

- To introduce the concept of data structure and its applications
- To introduce C language concepts required for data structures
- To design data structure operations to solve problems
- To introduce applications of data structures
- To introduce non-primitive data structures
- To analyse the complexity of a data structure
- To introduce static and dynamic memory allocation using C language
- To explain linear data structures – stack, queue, linked list
- To explain non-linear data structures – trees and graphs
- To train students to design an application as part of the course mini- project using their choice of data structure using C language.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Outline basic C program design for data structures	L2
CO2	Iimplement stack & queue data structure and their applications	L3
CO3	Apply concepts of dynamic memory allocation to real-time Problems	L3
CO4	Implement tree data structure and its applications	L3
CO5	Implement graph data structure and its applications	L3
CO6	Outline the concepts of file structures	L2

COURSE CONTENT:

MODULE 1	8Hrs
INTRODUCTION TO DATA STRUCTURES: Definition, Types, Algorithm Design, C Pointers, C Structure, Array Definition, Representation of Linear Array in Memory, Array Operations (Insertion, Deletion, Search and Traversal), Single Dimensional Arrays, Two Dimensional Arrays, Function Associated with Arrays, Arrays as Parameters, Recursive Functions.	
MODULE 2	**9Hrs**
INTRODUCTION TO STACK AND QUEUE: **Stack:** Definition, Array Representation of Stack, Operations Associated with Stacks- Push & Pop, Applications of Stack: Recursion, Polish expressions, Conversion of Infix to Postfix, Infix to Prefix, Postfix Expression Evaluation, Tower of Hanoi. **Queue:** Definition, Representation of Queues, Operations of Queues- QInsert, QDelete, Priority Queues, Circular Queue.	
MODULE 3	**9Hrs**
DYNAMIC DATA STRUCTURE: **Linked List:** Types, Introduction to Singly Linked lists: Representation of Linked Lists in Memory, Traversing, Searching, Insertion & Deletion from Linked List. Doubly Linked List, Operations on Doubly Linked List (Insertion, Deletion, Traversal). Applications: Polynomial Representation & Basic Operations, Stack & Queue Implementation using Linked Lists.	
MODULE 4	**9Hrs**
TREES & GRAPHS: **Trees:** Basic Terminology, Binary Trees and their Representation, Complete Binary Trees, Binary Search Trees, Operations on Binary Trees (Insertion, Deletion, Search & Traversal), Application: Expression Evaluation. **Graphs:** Terminology and Representations, Graphs & Multigraphs, Directed Graphs, Sequential Representation of Graphs, Adjacency Matrices, Graph Transversal, Connected Components and Spanning Trees.	
MODULE 5	**7Hrs**
FILE STRUCTURES: Physical storage media, File Organization, Linked Organization of File, Inverted File, Organization Records into Blocks, Sequential Blocks, Indexing & Hashing, Multilevel Indexing, Tree Index, Random File, Primary Indices, Secondary Indices.	

TEXT BOOKS :

1. A M Tannenbaum, Y Langsam, M J Augentien "Data Structures using C", Pearson, 2013
2. R.L. Kruse, B.P. Leary, C.L. Tondo, "Data Structure and Program Design in C" PHI

REFERENCES :

1. Horowitz Anderson-Freed, and Sahni, "Fundamentals of Data structures in C", 2nd Edition, Orient Longman, 2008
2. Data Structures and Algorithm analysis in C by Mark Allen Weiss, Published by Addison Wesley (3rd Indian Reprint 2000).
3. D E Knuth, The Art of Computer Programming, Volume 1, Addison-Wesley Publishing, 2013

SEMESTER	**III**
YEAR	**II**
COURSE CODE	**20CS2303**
TITLE OF THE COURSE	**DIGITAL ELECTRONICS & LOGIC DESIGN**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**2**	**42**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- To understand various number systems and conversion from one to other number systems
- To introduce basic postulates of Boolean algebra
- To manipulate expressions into POS or SOP form.
- To introduce the methods for simplifying Boolean expressions like K-Map and Quine Mclusky
- To understand the concept of don't care conditions and how they can be used to further optimize the logical functions
- To design simple combinational circuits such as multiplexers, decoders, encoders
- To understand the differences between combinational and sequential Logic circuits
- To familiar with basic sequential logic component-SR Latch
- To understand the basics of various types of memories.
- To present the working of various Flip- Flops (T flip-flop, D flip-flop, R-S flip-flop, JK flip-flop)
- To get familiarized with State Diagram, State Table, State Assignment
- To design combinational circuits using programmable logic devices.
- To design sequential circuits such as different types of Counters, Shift Registers

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate the knowledge of binary number systems, logic families, Boolean algebra and logic gates	L2
CO2	Analyze different methods used for simplification of Boolean expressions	L4
CO3	Design combinational logic circuits using combinational logic elements	L3
CO4	Design combinational circuits using Programmable Logic Devices	L3
CO5	Analyze sequential logic elements in the design of synchronous and asynchronous systems	L4
CO6	Design sequential systems composed of standard sequential modules, such as counters and registers	L3

COURSE CONTENT:	
MODULE 1	**9Hrs**
NUMBER SYSTEMS: BCD number representation, Unsigned and signed number representation, Binary arithmetic. **BOOLEAN ALGEBRA AND SIMPLIFICATION:**	

Laws of Boolean algebra, Theorems of Boolean algebra, Boolean/Switching functions and their implementation. **SIMPLIFICATION OF BOOLEAN EXPRESSIONS AND FUNCTIONS:** Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs Quads, and Octets,Karnaugh Simplifications, Don't-care Conditions. Product-of-sums Method, Product-of-sums simplifications, Simplification by Quine-McClusky Method.	
MODULE 2	**8Hrs**
DESIGN OF COMBINATIONAL LOGIC CIRCUITS: Modular combinational logic elements- Multiplexers and Demultiplexers, Decoders,Magnitude comparator, BCD converter, Encoders, Priority encoders.	
MODULE3	**7Hrs**
PROGRAMMABLE LOGIC: Programmable Logic Arrays, Design of Combinational Circuits using Programmable Logic Devices (PLDs): Programmable Read Only Memories (PROMs), Programmable Logic Arrays (PLAs), Programmable Array Logic (PAL) devices.	
MODULE 4	**9Hrs**
INTRODUCTION TO SEQUENTIAL CIRCUITS : Introduction to Sequential Circuits. Combinational Vs sequential circuits, Clock, Clock Triggering, Memory elements and their excitation functions – Latches, T flip-flop, D flip-flop, R-S flip-flop. JK flip-flop and their excitation requirements, State diagram,state table and state equation, Design of synchronous sequential circuits like Sequence Detectors and binary counters**.**	
MODULE 5	**9Hrs**
APPLICATION OF LOGIC CIRCUITS SEQUENTIAL CIRCUITS (REGISTERS AND COUNTERS): Registers-Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In - Serial Out, Parallel In -Parallel Out, Universal Shift Register, Applications of Shift Registers, Asynchronous and Synchronous Counters	

TEXT BOOKS :

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 6th Edition,N.Pearson Education, 2018
2. Donald.P. Leach, Albert Paul Malvino & Goutam Saha: Digital Principles and Applications, 8th Edition, Tata McGraw Hill, 2015

REFERENCES :

1. D Sudhaker Samuel: Illustrative Approach to Logic Design, Sanguine-Pearson, 2010.
2. Charles H. Roth: Fundamentals of Logic Design, Jr., 7th Edition, Cengage Learning, 2014
3. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2304**					
TITLE OF THE COURSE	**DATABASE MANAGEMENT SYSTEMS**					
	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

SCHEME OF Instruction	**3**	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- To learn data models, conceptualize and depict a database system using ER diagram
- To understand the internal storage structures in a physical DB design
- To know the fundamental concepts of transaction processing techniques

COURSE OUTCOMES

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate the basic elements of a relational database management system	L2
CO2	Identify the data models for relevant problems	L2
CO3	Apply normalization for the development of application software's	L3
CO4	Use Structured Query Language (SQL) for database manipulation.	L3
CO5	Understand transactions and their properties (ACID)	L2
CO6	Design and develop a large database with optimal query processing	L6

COURSE CONTENT:	
MODULE 1	**8Hrs**
Introduction: Purpose of Database System-–Views of data–data models, database management system, three-schema architecture of DBMS, components of DBMS. E/R Model - Conceptual data modeling - motivation, entities, entity types, attributes relationships, relationship types, E/R diagram notation, examples.	
MODULE 2	**9Hrs**
Relational Model: Relational Data Model - Concept of relations, schema-instance distinction, keys, referential integrity and foreign keys, relational algebra operators, SQL -Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors. Querying in SQL, notion of aggregation, aggregation functions group by and having clauses. .	
MODULE 3	**9Hrs**
Database Design: Dependencies and Normal forms, dependency theory –functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, 4NF, and 5NF	

MODULE 4	9Hrs
Transactions: Transaction processing and Error recovery - concepts of transaction processing, ACID properties, concurrency control, locking based protocols for CC, error recovery and logging, undo, redo, undo-redo logging and recovery methods.	
MODULE 5	**7Hrs**
Embedded SQL: triggers, procedures and database connectivity. Introduction to NoSQL	

TEXT BOOKS :

1. Silberschatz, Henry F. Korth, and S. Sudharshan, "Database System Concepts", 5thEd, Tata McGraw Hill, 2006.
2. J. Date, A. Kannan and S. Swamynathan, "An Introduction to Database Systems", 8thed, Pearson Education, 2006.

REFERENCES :

1. Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Fourth Edition, Pearson/Addision Wesley, 2007
2. Raghu Ramakrishnan, "Database Management Systems", Third Edition, McGraw Hill, 2003
3. S. K. Singh, "Database Systems Concepts, Design and Applications", First T. Edition, Pearson Education, 2006

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2305**					
TITLE OF THE COURSE	**COMPUTATIONAL THINKING WITH PYTHON**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- To understand basic concepts of computational thinking.
- To introduce python programming for problem solving.
- To introduce different debugging and unit testing tools.
- To solve real world problems using python data structures.
- Learn to handle files and exception handling in python.
- To explore Python's object-oriented features.
- To build Web services and Networked programs in python.
- To train students to design an application as part of the course mini- project using computational thinking with python.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand basic concepts of computational thinking.	L2
CO2	Outline basic python programming for problem solving.	L2
CO3	Apply computational thinking to solve real world programs using Python	L3
CO4	Build python programs using core data structures like list, dictionaries and tuples	L3
CO5	Implement object oriented concepts using python	L3
CO6	Design applications related to web services and network Programming.	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
INTRODUCTION TO COMPUTATIONAL THINKING AND PYTHON: Introduction to computational thinking: Stages of Computational thinking, Design using Flowcharts, Implementation, Testing Python Basics: Values, expressions and statements, Conditional execution, Functions Iterations	
MODULE 2	**9Hrs**
PYTHON ENVIRONMENT AND DATA STRUCTURES : Python Environment: Usage of Debugging and Unit Testing tools in python, Introduction to Github, Executing the python programs using Jupyter notebooks, Python Data Structures: Strings, Arrays, Lists, Tuples, Sets and Dictionaries	
MODULE 3	**9Hrs**
PYTHON FILES AND EXCEPTION HANDLING: Files: File types, modes, File functions, File attributes, File positions, Looping over file, Exception Handling: Try-Except, Exception syntax, examples, Types of exception with except, multiple exceptions with except, Try-Finally, Raise exceptions with arguments, Python built-in exceptions, User-defined exceptions, Assertions	

MODULE 4	**9Hrs**
PYTHON OBJECTS : Classes and Objects: Creating classes, Using Objects, Accessing attributes, Classes as Types, Introduction to Multiple Instances, Inheritance.	
MODULE 5	**7Hrs**
Applications of Python Applications: Networked Programs, Using web services	

TEXT BOOKS :

1. "Python for Everybody-Exploring Data Using Python 3", Dr. Charles R. Severance,
2. "Introduction to Computing & Problem Solving with Python",Jeeva Jose,P.Sojan Lal, Khanna Book Publishing; First edition (2019).

REFERENCES :

1. "Computer Science Using Python: A Computational Problem- Solving Focus", Charles Dierbach, Introduction John Wiley, 2012.
2. "Introduction to Computation and Programming Using Python", John V Guttag,Prentice Hall of India, 2015.
3. "How to think like a Computer Scientist, Learning with Python", Allen Downey,Jeffrey Elkner and Chris Meyers, Green Tea Press, 2014.
4. "Learning to Program with Python", Richard L. Halterman, 2011.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2306**					
TITLE OF THE COURSE	**AGILE SOFTWARE ENGINEERING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**2**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Agile methodology, Scrums, Sprints.
- Agile testing, test automation, DevOps.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Compare and contrast the differences between Agile and other project management methodologies	L4
CO2	Interpret and apply various principles, phases and activities of the Scrum methodology	L3

CO3	Define the benefits of using an Agile approach to managing projects	L2
CO4	Understand Agile Testing principles for real life situations and learn the basics of SAFe for scaled agile	L2
CO5	Identify and use various tools for Agile development and DevOps principles for CI/CD	L3

COURSE CONTENT:	
MODULE 1	**9Hrs**
INTRODUCTION TO AGILE : Introduction to Software engineering, SDLC, Software process models- waterfall, V model, Iterative model, Spiral model; Introduction to Agile: Agile versus traditional method comparisons and process tailoring; Introduction to Agile, Various Agile methodologies -Scrum, XP, Lean, and Kanban, Agile Manifesto.	
MODULE 2	**9Hrs**
SCRUM AND SPRINT: Scrum: Scrum process, roles - Product Owner, Scrum Master, Team, Release manager, Project Manager, product manager, architect, events, and artifacts; Product Inception: Product vision, stakeholders, initial backlog creation; Agile Requirements – User personas, story mapping, user stories, 3Cs, INVEST, acceptance criteria, sprints, requirements, product backlog and backlog grooming; Test First Development; Pair Programming and Code reviews;	
MODULE 3	9**Hrs**
AGILE PROJECT MANAGEMENT: Sprint Planning, Sprint Reviews, Sprint Retrospectives, Sprint Planning - Agile release and iteration (sprint) planning, Develop Epics and Stories, Estimating Stories, Prioritizing Stories (WSJF technique from SAFe), Iterations/Sprints Overview. Velocity Determination, Iteration Planning Meeting, Iteration, Planning Guidelines, Development, Testing, Daily Stand-up Meetings, Progress Tracking, Velocity Tracking, Monitoring and Controlling: Burn down Charts, Inspect & Adapt (Fishbone Model), Agile Release Train	
MODULE 4	**7Hrs**
AGILE TESTING : Testing: Functionality Testing, UI Testing(Junit, Sonar), Performance Testing, Security Testing, A/B testing; Agile Testing: Principles of agile testers; The agile testing quadrants, Agile automation, Test automation pyramid; Test Automation Tools - Selenium, Traceability matrix;	
MODULE 5	**8Hrs**
DEVOPS: DevOps: Continuous Integration and Continuous Delivery; CI/CD: Jenkins, Git/Github Creating pipelines, Setting up runners Containers and container orchestration (Dockers and Kubernetes) for application development and deployment; Build tools - maven; Checking build status; Configuration management - puppet, chef, ansible; Fully Automated Deployment; CM - Continuous monitoring with Nagios; Introduction to DevOps on Cloud	

List of Laboratory/Practical Experiments activities to be conducted :
1. Setting up Devops Environment
2. Writing Requirements Document, Requirement Analysis (user stories)
3. Estimation and Scrum Planning

4. Implementation and Testing Using Iterative Sprint Model
5. Test Automation using Selenium
6. Unit Testing using Junit or Sonar or Python Test framework
7. CI/CD using Jenkins as Orchestrion platform
8. Containerzation using Docker or Kubernetes

TEXT BOOKS :

1. Essential Scrum: A Practical Guide to the Most Popular Agile Process Kenneth S.Rubin 2012, published by Addison-Wesley Professional
2. Agile Software Development: The Cooperative Game Alistair Cockburn 2nd Edition, 2006, Addison-Wesley Professional

REFERENCES :

1 Scrum and XP from the Trenches Henrik Kniberg 2nd Edition, 2015, Published by C4Media, publisher of InfoQ.com
2. Agile Project Management: Creating Innovative Products, Second Edition By Jim Highsmith, Addison-Wesley Professional, 2009
3. Agile Project Management: Managing for Success, By James A. Crowder, Shelli Friess,Springer 2014
4. Learning Agile: Understanding Scrum, XP, Lean, and Kanban, By Andrew Stellman, Jennifer Greene, 2015, O Reilly
5. DevOps: Continuous Delivery, Integration, and Deployment with DevOps: Dive ... By Sricharan Vadapalli, Packt, 2018
6. Agile Testing: A Practical Guide For Testers And Agile Teams, Lisa Crispin, Janet Gregory, Pearson, 2010
7. More Agile Testing: Learning Journeys for the Whole Team By Janet Gregory, Lisa Crispin, Addison Wesley, 2015
8. DevOps: Puppet, Docker, and Kubernetes By Thomas Uphill, John Arundel, Neependra Khare, Hideto Saito, Hui-Chuan Chloe Lee, Ke-Jou Carol Hsu, Packt, 2017

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2309**					
TITLE OF THE COURSE	**MANAGEMENT & ENTREPRENEURSHIP**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**30**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Identify and analyze the factors that contribute to the process of successfully launching an entrepreneurial venture and managing a new business.
- Learn the entrepreneurial process from idea generation to implementation.
- Acquaint with special problems of starting new ventures, finding products and services, which can support new enterprises, and raising capital.
- Discuss how to start own business and also to work in or with small business or are involved with entrepreneurship.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate knowledge of the key elements of the entrepreneurial process	L2
CO2	Employ strategies to generate new ideas for startups	L2
CO3	Outline how to protect IP legally	L2
CO4	Examine different ways of generating funding	L2
CO5	Explain organizing managing people, finance and customers	L2

COURSE CONTENT:

MODULE 1	**6Hrs**

OVERVIEW OF ENTREPRENEURSHIP: THE ENTREPRENEURIAL PERSPECTIVE :

Nature and Development of Entrepreneurship. Defining Manager, Entrepreneur, Entrepreneurship and Entrepreneurship. Key Elements of Entrepreneurship. Personality Characteristics of Successful Entrepreneurs. Common Myths about Entrepreneurs. Ethics and Social Responsibility of Entrepreneurs. Types of Start-Up Firms. Process of New Venture Creation. Role of Entrepreneurship in Economic Development. Emerging Trends and Issues in Entrepreneurship.

Case Study: Successful Entrepreneurs Narayana Murthy Infosys

MODULE 2	**6Hrs**

THE ENTREPRENEURIAL AND ENTREPRENEURIAL MIND:

The Entrepreneurial Process: Identify and Evaluate the Opportunity, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise. Managerial Versus Entrepreneurial Decision Making: Strategic Orientation, Commitment to Opportunity, Commitment of Resources, Control of Resources, Management Structure, Entrepreneurial Venturing inside a Corporation, Causes for Interest in Entrepreneurship, Climate for Entrepreneurship, Entrepreneurial Leadership Characteristics.

Case study: How to develop effective Business Plan

MODULE 3	**6Hrs**

CREATIVITY AND BUSINESS IDEA :

Identify and Recognizing Opportunities: Observing Trends and Solving Problems. Creativity: Concept, Components and Types of Creativity, Stages of Creative Process. Sources of New Venture Ideas. Techniques for Generating Ideas. Stages of Analyzing and Selecting the Best Ideas. Protecting the Idea: Intellectual Property Rights and its Components. Linking Creativity, Innovation and Entrepreneurship.

Case study : Application of Design Thinking in New business ideas generation in particular sector (Health care, Water Saving, Energy saving)

MODULE 4	**6Hrs**

PREPARING THE PROPER ETHICAL AND LEGAL FOUNDATION:

Initial Ethical and Legal Issues Facing a New Firm, Establishing a Strong Ethical Culture, Choosing an attorney (Lawyer), Drafting a founder's agreement, Avoiding legal disputes, Choosing a form of business organization, Obtaining business licenses and permits, Choosing a Form of Business Ownership (Sole, Proprietorship, Partnership, Corporation & Limited Liability Company)

Case study: Startup Law A to Z IP

https://techcrunch.com/2019/02/25/startup-law-a-to-z-intellectual-property/

MODULE 5	**6Hrs**

MANAGING EARLY GROWTH AND CHALLENGES

Recruiting and Selecting Key Employees. Lenders and Investors. Funding Requirements: Sources of Personal Financing. Venture Capital. Commercial Banks. Sources of Debt Financing. Key Marketing Issues for New Ventures. Why marketing is critical for Entrepreneurs. Entrepreneurs face unique Marketing Challenges. Guerrilla Marketing. Business Growth: Nature of Business Growth, Planning for Growth, Reasons for Growth. Managing Growth: Knowing and Managing the Stages of Growth, Challenges of Growing a Firm. Strategies for Firms Growth: Internal and External Growth Strategies. Implications of Growth for the Firm and Entrepreneur. Entrepreneurial Skills and Strategies to Overcome Pressures On: Financial Resources (Financial Control, Managing Inventory and Maintaining Good Records). Human Resources, Management of Employees, Time Management.

Case study: 9 ways to get startups funded

https://www.quicksprout.com/how-to-get-your-startup-funded/

TEXT BOOKS :

1. Barringer, Ireland, “Entrepreneurship: Successfully Learning New Ventures”, Pearson, Latest Edition.
2. Hisrich, Peters, Shepherd, “Entrepreneurship”, Mc Graw Hill, Sixth Edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2307**					
TITLE OF THE COURSE	**DATA STRUCTURES LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**30**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

- To introduce C language concepts required for data structures
- To design data structure operations to solve problems
- To introduce applications of data structures
- To implement linear data structures – stack, queue, linked list
- To implement non-linear data structures – trees and graphs

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Design and develop the programs in C to understand the different concepts of data structures.	L3
CO2	Implement stack & queue data structure and their applications, Analyse the output based on the given input data.	L3
CO3	Implement Conversions of Polish and reverse polish expressions and Record Experimental process and results	L4
CO4	Apply and implement concepts of dynamic memory allocation	L3
CO5	Use the concepts of file structures and communicate results effectively	L3

List of Laboratory/Practical Experiments activities to be conducted

Writing C programs:

1. To perform arithmetic storage/operations using arrays
2. To Implement C programs with concepts of pointers, structures
3. To implement multidimensional array Matrix Multiplication
4. To search element(s) in a multidimensional array
5. To search elements in data structure with different search methods
6. To implement stack , queue and their variations using arrays
7. To implement stack, queue and their variations using linked lists
8. To Implement Linked Lists and variations and use them to store data.
9. To implement graph & binary tree traversal techniques

10. To evaluate/convert infix/prefix/postfix expressions
11. To perform basic file operations

Open-Ended Experiments

1. A man in an automobile search for another man who is located at some point of a certain road. He starts at a given point and knows in advance the probability that the second man is at any given point of the road. Since the man being sought might be in either direction from the starting point, the searcher will, in general, must turn around many times before finding his target. How does he search to minimize the expected distance travelled? When can this minimum expectation be achieved?

2. The computing resources of a cloud are pooled and allocated according to customer demand. This has led to increased use of energy on the part of the service providers due to the need to maintain the computing infrastructure. What data structure will you use for allocating resources which addresses the issue of energy saving? Why? Design the solution.

3. Mini-Project on applying suitable data structure to a given real-world problem

Textbooks

1. A M Tannenbaum, Y Langsam, M J Augentien "Data Structures using C", Pearson, 2013
2. R.L. Kruse, B.P. Leary, C.L. Tondo, "Data Structure and Program Design in C" PHI

Reference Books

1. Horowitz Anderson-Freed, and Sahni, "Fundamentals of Data structures in C", 2nd Edition, Orient Longman, 2008
2. Data Structures and Algorithm analysis in C by Mark Allen Weiss, Published by Addison Wesley (3rd Indian Reprint 2000).
3. D E Knuth, The Art of Computer Programming, Volume 1, Addison-Wesley Publishing, 2013

SEMESTER	**III**
YEAR	**II**
COURSE CODE	**20CS2308**

TITLE OF THE COURSE	DATABASE MANAGEMENT SYSTEMS LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	**2**	-	**30**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES :

- Understand the fundamental concepts of database management. These concepts include aspects of database design, database languages, and database-system implementation.
- To provide a strong formal foundation in database concepts, recent technologies and best industry practices.
- To give systematic database design approaches covering conceptual design, logical design and an overview of physical design.
- To learn the SQL and NoSQL database system.
- To learn and understand various Database Architectures and its use for application development.
- To programme PL/SQL including stored procedures, stored functions, cursors and packages

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Install and configure database systems.	L3
CO2	Analyze database models & entity relationship models.	L3
CO3	Design and implement a database schema for a given problem-domain	L3
CO4	Understand the relational and document type database systems.	L2
CO5	Populate and query a database using SQL DML/DDL commands.	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Design any database with at least 3 entities and relationships between them. Apply DCL and DDL commands. Draw suitable ER/EER diagram for the system.
2. Design and implement a database and apply at least 10 different DML queries for the following task. For a given input string display only those records which match the given pattern or a phrase in the search string. Make use of wild characters and LIKE operator for the same. Make use of Boolean and arithmetic operators wherever necessary.
3. Execute the aggregate functions like count, sum, avg etc. on the suitable database. Make use of built in functions according to the need of the database chosen.

Retrieve the data from the database based on time and date functions like now (), date (), day (), time () etc. Use group by and having clauses.
4. Implement nested sub queries. Perform a test for set membership (in, not in), set comparison (<some, >=some, <all etc.) and set cardinality (unique, not unique).
5. Write and execute suitable database triggers .Consider row level and statement level triggers.
6. Write and execute PL/SQL stored procedure and function to perform a suitable task on the database. Demonstrate its use.
7. Write a PL/SQL block to implement all types of cursor.
8. Execute DDL statements which demonstrate the use of views. Try to update the base table using its corresponding view. Also consider restrictions on updatable views and perform view creation from multiple tables.
9. Mini project.

TEXT BOOKS :

1. Ramon A. Mata-Toledo, Pauline Cushman, Database management systems, TMGH, ISBN: IS978-0-07-063456-5, 5th Edition.

REFERENCES :

1. Dr. P. S. Deshpande, SQL and PL/SQL for Oracle 10g Black Book, DreamTech.
2. Ivan Bayross, SQL, PL/SQL: The Programming Language of Oracle, BPB Publication.
3. Dalton Patrik, SQL Server – Black Book, DreamTech Press.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2401**					
TITLE OF THE COURSE	**PROBABILITY AND STATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Understand probability, random variable and random process concepts and their importance in Computer Engineering course.
- Calculate statistics related to Random variables and process such as mean, variance, etc.
- Evaluate standard distribution functions such as Poisson's, Normal distributions
- Apply functions of random variables such as characteristic function, moment generating function to calculate statistics.
- Understand probability, random variable and random process concepts and their importance in Computer Engineering course.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Compute and interpret descriptive statistics using numerical and graphical techniques.	L4
CO2	Understand the basic concepts of random variables and find an appropriate distribution for analyzing data specific to an experiment.	L2
CO3	Extend the concepts to multiple random variables and apply them to analyze practical problems.	L2
CO4	Make appropriate decisions using statistical inference that is the central to experimental research.	L4

COURSE CONTENT:	
MODULE 1	**6 Hrs**
INTRODUCTION TO PROBABILITY THEORY : Basic Notions of Probability, Axiomatic definition, properties, Conditional Probability and Independence – Baye's Theorem.	
MODULE 2	**7 Hrs**
DISCRETE PROBABILITY DISTRIBUTIONS: Discrete random variables and its properties - Bernoulli trials – Binomial Distribution and its properties – Poisson Distribution and its properties.	
MODULE 3	**10 Hrs**
CONTINUOUS PROBABILITY DISTRIBUTIONS Continuous random variables and its properties - Gamma Distribution and its properties – Exponential Distribution and its properties - Normal Distribution and its properties. **BIVARIATE DISTRIBUTIONS:** Bivariate random variables – Joint – Marginal - Conditional distribution**.**	
MODULE 4	**9 Hrs**
RANDOM PROCESS AND QUEUING THEORY Classification – Stationary process – Markov process – Markov chain – Poisson process – Random telegraph process.	

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties. Queuing Models, Methods for generating random variables and Validation of random numbers
MODULE 5 **10 Hrs**
TESTING OF HYPOTHESIS Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis- Large sample tests- Z test for Single Proportion - Difference of Proportion, mean and difference of mean - Small sample tests- Student's t-test, F-test-chi-square test- goodness of fit - independence of attributes.

TEXT BOOKS :

1. A First Course in Probability, S. Ross, Pearson International Edition, 9th Edition.
2. Fundamentals of Mathematical Statistics, S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons, 11th Edition.

REFERENCES :

1. K. S. Trivedi, Probability and Statistics with Reliability, Queuing, and L.Computer Science Applications, 2nd Ed., Wiley, 2001.
2. Robert V. Hogg, J.W. McKean, and Allen T. Craig: Introduction to Mathematical Statistics, Seventh Edition, Pearson Education, Asia.
3. Rohatgi, V K. and Saleh , A. K. Md. Ehsanes, "An Introduction to Probability and Statistics", (John Wiley and Sons) , (2nd edition) (2000)
4. Higher Engineering Mathematics by B S Grewal, 42 nd Edition, Khanna Publishers.
5. Probability and Statistics for engineers and scientists, R.,E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
6. An Introduction to Probability Theory and its Applications, W. Feller , Vol. 1, 3rd Ed., Wiley, 1968

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2402**					
TITLE OF THE COURSE	**OBJECT ORIENTED DESIGN AND PROGRAMMING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

***	***	***	***

COURSE OBJECTIVES:

- Understand the basic concepts of object-oriented design techniques.
- Understand the fundamentals of object-oriented programming with Java.
- Draw UML diagrams for the software system.
- Impart basics of multi-threading and database connectivity.
- Develop GUI using event handling techniques in Java.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Apply the concepts of object-oriented programming in software design process.	L3
CO2	Develop Java programs using Java libraries and construct to solve real-time problems.	L3
CO3	Understand, develop and apply various object-oriented features using Java to solve computational problems	L2
CO4	Implement exception handling and JDBC connectivity in Java.	L3
CO5	Build an event-oriented GUI (graphical user interface).	L6

COURSE CONTENT:	
MODULE 1	**09 Hrs**
An Overview of Object-Oriented Systems Development: Introduction; Two Orthogonal Views of the Software; Object-Oriented Systems Development Methodology; Why an Object-Oriented? Overview of the Unified Approach. **Object Basics**: Introduction; An Object-Oriented Philosophy; Objects; Objects are Grouped in Classes; **Attributes**: Object State and Properties; Object behaviour and Methods; Object Respond to Messages; Encapsulation and Information Hiding; **Class Hierarchy:** Inheritance; Multiple Inheritance; **Polymorphism**; Object Relationships and Associations: Consumer-Producer Association; Aggregation and Object Containment; **Case Study** - A Payroll Program; **Object-Oriented Systems Development Life Cycle**: Introduction; Software Development Process; Building High-Quality Software; Object-Oriented Systems Development: A Use Case Driven Approach; Reusability.	
MODULE 2	**08 Hrs**
Unified Modelling Language :Introduction; Static and Dynamic models; Why Modeling? Introduction to the UML; UML Diagrams; UML Class Diagram; Use-Case Diagram. **Introduction to Java**: Java's Magic: The Bytecode; JVM; Object-Oriented Programming; Simple Java programs; Two Control Statements; Lexical Issues; **Data Types; Variables, Arrays and String constructors**; **Operators; Control Statements; Introducing Classes:** Class Fundamentals; objects; methods; constructors; this Keyword; Garbage Collection; finalize() method; Parameter Passing; Overloading; Access Control Keywords. Inheritance basics;	

method overriding; abstract classes; Packages and interfaces. Exception handling fundamentals; multiple catch; nested try statements.	
MODULE 3	**09 Hrs**
Multi-Threaded Programming :Multi-Threaded Programming: Java Thread Model; The main Thread; Creating a thread and multiple threads; Extending threads; Implementing Runnable; Synchronization; Inter Thread Communication; producer consumer problem. **Input/Output**: I/O Basic; Reading console input Writing Console output.	
MODULE 4	**08 Hrs**
Event and GUI Programming:Introducing Swing; The Origins of Swing; Swing Is Built on the AWT; Two Key Swing Features; The MVC Connection; Components and Containers; The Swing Packages; A Simple Swing Application; Event Handling; JLabel; JTextField; JButton	
MODULE 5	**08 Hrs**
Database Access: The Concept of JDBC; JDBC Driver Types; JDBC Packages; A Brief Overview of the JDBC process; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; ResultSet.	

TEXT BOOK:

1. Bahrami A.; Object Oriented Systems Development using the Unified Modeling Language; McGraw Hill; 1999.
2. Schildt; Herbert. Java The Complete Reference; 8th Edition. US: McGraw-Hill Osborne Media; 2011.
3. Jim Keogh; J2EE: The Complete Reference; McGraw Hill Education in 2002.

REFERENCES:

1. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.

2.Y. Daniel Liang, Introduction to Java Programming, 7th edition, Pearson, 2013.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2403**					
TITLE OF THE COURSE	**PRINCIPLES OF MICROPROCESSORS & COMPUTER ORGANIZATION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- To introduce the architecture of 8086
- To understand the importance and function of each pin of 8086 Microprocessor
- To familiarize with the architecture of 8086 microprocessor and its operation
- To understand the various addressing modes required for assembly language
- Programming and to calculate the physical address.
- To learn the 8086 instruction set and write 8086 Assembly level programs
- To understand the importance of different peripheral devices and their interfacing to 8086
- Understand the concepts of Hardwired control and micro programmed control.
- To explain the current state of art in memory system design
- Discuss the concept of memory organization.
- Summarize the types of memory.
- Learn about various I/O devices and the I/O interface.
- Learn the different types of serial communication techniques.
- To understand DMA technique
- To provide the knowledge on Instruction Level Parallelism
- To understand the concepts of pipelining techniques.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Identify the basic building blocks of 8086 microprocessor and use the addressing modes for executing programs efficiently	L2
CO2	Develop 8086 assembly language programs using modern assembler tools	L3
CO3	Discuss the computer arithmetic and design algorithms for various Arithmetic operations.	L2
CO4	Design data part and control part of a processor	L3
CO5	Analyze the performance of various classes of Memories	L4
CO6	Understand pipeline & parallel processing	L2
COURSE CONTENT:		

MODULE 1	8 Hrs
Introduction to Microprocessor & its Architecture: Introduction-Evolution of Microprocessor, The Microprocessor-Based Personal Computer Systems, Internal Microprocessor Architecture, Real mode memory addressing, Memory paging, 8086 pin diagram, Internal Architecture of 8086,Registers, Addressing Modes-Immediate addressing, Register addressing, direct addressing, indirect addressing, relative addressing, Instruction formats	
MODULE 2	**12 Hrs**
Programming 8086: Assembler directives, Data Movement Instructions, String Data Transfers, Miscellaneous Data Transfer Instructions, Arithmetic and Logic Instructions, BCD and ASCII Arithmetic, Basic Logic Instructions, Shift and Rotate, String Comparisons. Program Control Instructions: The Jump Group, Assembly language programming with 8086, macros, procedures	
MODULE 3	**10 Hrs**
Processor Organization: Basic organization of computers, Block level description of the functional units as related to the execution of a program; Fetch, decode and execute cycle. Execution cycle in terms machine instructions. Information representation, Floating point representation (IEEE754), computer arithmetic and their implementation; **Data Part Design:** Fixed-Point Arithmetic-Addition, Subtraction, Multiplication and Division, Arithmetic Logic Units control and data path, data path components, design of ALU and data-path, **Control Part Design:** Control unit design; Hardwired and Micro programmed Control unit. Discussions about RISC versus CISC architectures.	
MODULE 4	**12 Hrs**
Memory Technology: Memory hierarchy, static and dynamic memory, RAM and ROM chips, Memory address map, Auxiliary Memory, Associative Memory, Cache Memory and organization. **Input/Output Organization:** Peripheral devices, Input-Output Interface; I/O Bus and Interface Modules, Isolated versus Memory-Mapped I/O, Example of an l/0 interface unit, keyboard interface, Modes of Transfer; Programmed I/O, Interrupt-initiated I/O, Direct memory access (DMA)	
MODULE 5	**10 Hrs**
Pipelining: Basic Concepts, Arithmetic Pipeline, Instruction Pipeline; Four-Segment Instruction Pipeline, Pipeline hazards and their resolution, **Parallel Processing;** Flynn's classification, Multicore architectures, Introduction to Graphics Processing Units, Example: NVIDIA GPU Architecture	

TEXT BOOK:

1. Barry B Brey: The Intel Microprocessors, 8th Edition, Pearson Education, 2009
2. Mano, Morris M. Computer system architecture. Dorling Kindesley Pearson, 2005.

REFERENCES:

1. Krishna Kant, "MICROPROCESSORS AND MICROCONTROLLERS Architecture, programming and system design using 8085, 8086, 8051 and 8096". PHI 2007.

2. Douglas V Hall, “MICROPROCESSORS AND INTERFACING, PROGRAMMING AND HARDWARE” TMH, 2006.
3. Kenneth J. Ayala, “The 8086 Microprocessor: Programming & Interfacing The PC”, Delmar Publishers, 2007
4. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Danny Causey, The x86 PC Assembly Language Design and Interfacing, 5th Edition, Pearson, 2013.
5. V. Carl Hamacher, Safwat G. Zaky and Zvonko G. Vranesic , Computer Organization ,McGraw-Hill series 2002
6. Hayes, J.P , Computer Architecture and Organization, McGraw-Hill, 1998
7. Vincent P. Heuring and Harry F. Jordan , Computer Systems Design and Architecture (2nd Edition), Dec, 2003
8. David Patterson and John Hennessey , Computer Organization and Design, Elsevier. 2008
9. Comer, Douglas. Essentials of computer architecture. Chapman and Hall/CRC, 2017.
10. Hord, R. Michael. Parallel supercomputing in MIMD architectures. CRC press, 2018.
11. Tanenbaum, Andrew S. Structured computer organization. Pearson Education India, 2016.
12. William Stallings-Computer Organization and Architecture, Seventh Edition, Pearson Education

SEMESTER	**IV**
YEAR	**II**
COURSE CODE	**20CS2404**
TITLE OF THE COURSE	**FINITE AUTOMATA AND FORMAL LANGUAGES**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**2**	**50**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES :

- To learn general theory of automata, properties of regular sets and regular expressions.
- To understand basics of formal languages.
- To know push-down automata, context- free languages, Turing machines.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the concept of Automata	L1
CO2	Explain the concept of Regular Expression, languages and abstract machines to recognize them	L2
CO3	Know the generalized computation model and different types Computation	L2

COURSE CONTENT:	
MODULE 1	**9Hrs**
Introduction to Finite Automata: Study and Central concepts of automata theory, An informal picture of finite automata, deterministic and non-deterministic finite automata, applications of finite automata, finite automata with epsilon – transitions.	
MODULE 2	**12Hrs**
Regular expression and languages: Regular expressions, finite automata and regular expressions, algebraic laws of regular expressions. applications of regular expressions such as Grep, and Lex etc.. Properties of Regular Languages: closure properties of regular languages, Pumping Lemma, equivalence and minimization of automata .	

MODULE 3	10Hrs
Context – free Grammars and Languages: Context free grammars, Context-free languages, Parse trees, Ambiguity in grammars and languages Pushdown Automata: Pushdown automation (PDA), the language of PDA, equivalence of PDA's and CFG's, Deterministic Pushdown Automata	
MODULE 4	**9Hrs**
Properties of Context – Free Languages: Normal forms of context free grammars, pumping lemma for context free languages, closure properties of context free languages. Applications of CFG - such as spec of programming languages, parsing techniques, and Yacc	
MODULE 5	**10Hrs**
Introduction to Turing Machine- The Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine, restricted Turing Machines, Turing Machines and Computers. Chomsky hierarchy	

TEXT BOOKS :

1. Daniel I. A. Cohen, Introduction to Computer Theory, 2nd Edition, Wiley India Student Edition, 2008.
2. J.E. Hopcroft , R. Motwani, and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, 3rd Edn. Pearson Education , New Delhi 2008

REFERENCES :

1. K.L.P. Misra and N. Chandrashekaran. Theory of Computer Science- Automata, Languages and Computation, 3rd Edn. PHI, New Delhi, 2007

2. C. Martin - Introduction to Languages and the Theory of Computation 2ndEdn, TMH, New Delhi, 2000.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2405**					
TITLE OF THE COURSE	**INTRODUCTION TO NETWORKS AND CYBERSECURITY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To introduce the fundamental aspects of various types of computer networks.
- To demonstrate the TCP/IP and OSI models with merits and demerits.
- Understand the basic concepts of cyber security, how it has evolved, and some key techniques used today.
- Have an insight view of Security, Cryptography, Malware, IDS, Secure Programming etc
- Explore the subject through prescribed book, case studies, seminars and Assignments.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Understand and explore the basics of Computer Networks and working principles.	L2
CO2	Understand the concepts of Network security corresponding to various Internet Layers.	L2
CO3	Determine appropriate mechanisms for protecting the Network.	L2

COURSE CONTENT:	
MODULE 1	**9Hrs**
Overview of the Internet: Protocol, Layering Scenario, TCP/IP Protocol Suite: The OSI Model, Internet Architecture; Comparison of the OSI and TCP/IP reference model. Top-down approach **Cybersecurity:** Basics of Cyber Security-Attacks, Vulnerabilities and Threats. Need for Network Security, Data Security and physical security.	
MODULE 2	**9 Hrs**
Application Layer- Introduction, providing services, Applications layer paradigms, Client server model, Standard client-server application-HTTP, DNS, SSH. Malware Detection System, Types of	

Malware, Viruses & Counter Measures, Worms, Bots. **E-mail Security:** PGP, S/MIME. Secure socket programming using UDP and TCP.	
MODULE 3	**9 Hrs**
Transport Level Security: Functionality and services, TCP and UDP basics, Principles of Cryptography, Web Security Considerations, Secure Sockets Layer (SSL), Transport Layer Security, Data/Message Integrity and Digital Signatures.	
MODULE 4	**9 Hrs**
Network Layer Security: Network Security and Services, IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Internet Key Exchange. Virtual Private Network (VPN), Wireless Networks Security.	
MODULE 5	**9 Hrs**
Data Link Layer: LLC and MAC Sublayer services, Error detection and correction Techniques. **Physical Layer:** Introduction to Guided transmission media and wireless transmission media. Transmission mode, Classification of networks. Firewall, Intrusion Detection System (IDS)	

TEXT BOOK:

1. Computer Networking- A top-down approach- James F Kurose and Keith W Ross,6th Edition, Pearson Education.
2. Computer Security- Principles and Practice, William Stalling, Laurie Brown 4th Edition, Pearson

REFERENCES:

1. Behrouz A. Forouzan, Data Communications and Networking -, Fifth Edition TMH, 2013.
2. Computer Networks - Andrew S Tanenbaum, 4th Edition, Pearson Education.
3. James Graham, Richard Howard, Ryan Olson- Cyber Security Essentials CRC Press.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2406**					
TITLE OF THE COURSE	**FULL STACK DEVELOPMENT**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**2**	**42**	**3**

Prerequisite Courses # Sem/Year Course Code Title of the Course

COURSE OBJECTIVES:

1. Understand the major areas and challenges of web programming..
2. To create websites using HTML5, CSS3, JavaScript
3. Front end framework for developing Interactive WebApp using ReactJS
4. Understand server-side scripting language-Node.JS
5. Latest Framework for fast API development using GraphQL

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know the fundamentals of front end web technologies like HTML5 and CSS3.	L2
CO2	Use of ReactJS a javascript library to build UI components	L3
CO3	Building real world application using Node.Js,Express	L3
CO4	Develop a fully functioning website and deploy on a web server.	L5

COURSE CONTENT:	
MODULE 1	**8 Hrs**
Markup Language (HTML5), CSS3 Introduction to HTML and HTML5 - Formatting and Fonts -Commenting Code – Anchors – Backgrounds – Images – Hyperlinks – Lists – Tables – HTML Forms, Video & Audio tag CSS3: Levels of style sheets; Style specification formats; Selector forms; Property value forms; Font properties; List properties; Color; Alignment of text; Background images, Conflict Resolution, CSS box model,CSS3 features: Box Shadow, Opacity, Rounded corners, Attribute selector	
MODULE 2	**9 Hrs**
Client-Side Scripting: JavaScript , JSON JavaScript Basics –Arrays- Functions - JavaScript objects – HTML DOM - DOM methods – Events- Regular Expressions , JSON	
MODULE 3	**9 Hrs**

Node JS Introduction to Node JS, Setup Dev Environment, Node JS Modules, Node Package Manager, File System, Debugging Node JS Application, Events, Express.JS, Database Connectivity, MVC Architecture In Node Js Applications	
MODULE 4	**10 Hrs**
React JS React.JS: Introducing React ,Main Principles of React, Building your first react app, Components in React, Transferring properties, Dealing with State, The Component life cycle, Virtual DOM, JSX	
MODULE 5	**9 Hrs**
GraphQL Introduction to GraphQL, GraphQL Vs. REST, GraphQL Vs. SQL, Your First GraphQL Query, Complex Types – Unions, Fragments, Interfaces, Graph Nodes, GraphQL with JavaScript, GraphQL with React, GraphQL Server-Exercise Problems	

Text Books:

1. Robert W. Sebesta, Programming the World Wide Web ,7th Edition, Pearson Education, 2008.
2. Basarat Ali Syed - Beginning Node.js-Apress ,2014.
3. Anthony Accomazzo, Ari Lerner, Clay Allsopp, David Guttman, Tyler Mcginnis, Nate Murray, FullStack React – The Complete Guide to ReactJS & Friends, Fullstack.io, 2017

References:

1. Lionel Lopez,React Quickstart Step-by-Step Guide to Learning React Javascript Library
2. Kirupa Chinnathambi, JavaScript Absolute Beginner's Guide, 1st Edition, 2017.
3. Robert W Sebesta, Pearson, Programming the World Wide Web, 7th Edition, 2013.
4. Kirupa Chinnathambi, Learning React, 1 Edition, Addison-Wesley Professional
5. Mark Pilgrim,HTML5Up and Running,O'Reilly, 1st Edition, 2012.
- https://reacthandbook.com/

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2407**					
TITLE OF THE COURSE	**OBJECT ORIENTED PROGRAMMING LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**30**	**1**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES :

- To learn an object oriented way of solving problems using java.
- To write Java programs using multithreading concepts and handle exceptions
- To write Java programs that connects to a database and be able to perform various operations.
- To create the Graphical User Interface using AWT Components & Swing Components.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Develop simple java programs that make use of classes and objects	L3
CO2	Write Java application programs using OOP principles and proper program structuring.	L3
CO3	Make use of inheritance and interfaces to develop java application	L3
CO4	Model exception handling, multi threading concepts in java	L3
CO5	Create the Graphical User Interface based application programs by utilizing event handling features and Swing in Java	L3
CO6	Develop Java program that connects to a database and be able to perform various operations.	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Basic programs using data types, operators, and control statements in Java.
2. Basic programs using Arrays, , Strings in java
3. Object Oriented Programming Concepts: Problem on the use of constructors, inheritance, method overloading & overriding, polymorphism and garbage collection
4. Programs involving: Exception handling, Multi-threading in Java
5. Programs involving: Packages, Interfaces in Java
6. Programs involving: Input and Output in Java
7. GUI Programming in Java
8. Programs involving : Database connectivity in Java
9. Mini Project

TEXT BOOKS :

1. Bahrami A.; Object Oriented Systems Development using the Unified Modeling Language; McGraw Hill; 1999.
2. Schildt; Herbert. Java The Complete Reference; 8th Edition. US: McGraw-Hill Osborne Media; 2011.
3. Jim Keogh; J2EE: The Complete Reference; McGraw Hill Education in 2002.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2408**					
TITLE OF THE COURSE	**MICROPROCESSORS LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**30**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES :

- To develop and execute variety of assembly language programs of Intel 8086 including arithmetic and logical, sorting, searching, and string manipulation operations

- To develop and execute the assembly language programs for interfacing Intel 8086 with peripheral devices.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Implement 8086 assembly language programs for microprocessor application using 8086 training boards	L3
CO2	Implement 8086 assembly language programs for microprocessor application using assembler and debuggers	L3
CO3	Design interfacing of various peripherals with 8086 microprocessor for simple applications	L3
CO4	Use Macros and Procedures in 8086 Programs	L3
CO5	Use assembly language and debugging tools when writing programs for a microprocessor	L3
CO6	Communicate effectively on the work done in the laboratory using formal report	L3

List of Laboratory/Practical Experiments activities to be conducted
Part-A: Software Programs Using Microprocessor Trainer Kit i) Programs involving : arithmetic operations, sorting ii) Programs on : code conversion (BCD TO HEX, Binary to ASCII, Binary to Gray) iii) Programs involving - Bit manipulation like checking: 1. Whether given data is positive or negative 2. Whether given data is odd or even 3. Logical 1‟s and 0‟s in a given data
Part- B: Software Programs Using MASM/TASM software i) Programs on : searching and sorting ii) Programs on : palindrome, string comparison iii) Programs on : current time display, Decimal up-counter display
Part-C: Hardware Programs to interface microprocessor with various peripherals Using Microprocessor Trainer Kit i) DC Motor Interface ii) Stepper Motor Interface iii) Matrix Keypad Interface iv) 7 Segment Display Interface

TEXT BOOKS :

1. Microprocessor and Interfacing - Douglas V Hall, SSSP Rao, 3rd edition TMH, 2012.
2. The Intel Microprocessor, Architecture, Programming and Interfacing - Barry B. Brey, 6e, Pearson Education / PHI, 2003.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3501**					
TITLE OF THE COURSE	**COMPUTER NETWORKS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	2	-	39+26	4

Perquisite Courses (if any)			
#	Sem /Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To introduce the fundamental aspects of various types of computer networks.
- To demonstrate the TCP/IP and OSI models with merits and demerits.
- To Understand the working principle of layering structure and basic network components
- To explore the features of each layer by various approach and methods

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand and explore the basics of Computer Networks and physical layer	L2
CO2	Understand about data link layer and its protocols	L2
CO3	Understand about routing mechanisms and different routing protocols	L2
CO4	Identify the issues of Transport layer to analyse the congestion control mechanism	L2
CO5	Explain principles of application layer protocols	L2

COURSE CONTENT	
MODULE 1: Overview of Networks	**9 Hrs**
Network Components- Network Physical Structure, Classification of networks (LAN-MAN-WAN), Protocols and Standards, Data representation and data flow, Layered Architecture – Comparison of the OSI and TCP/IP reference model. Physical Layer: Introduction to wired and wireless transmission media. Transmission mode (Serial/Parallel signals, Analog/Digital Signals and Periodic/Aperiodic Signals), Line coding Schemes.	

MODULE 2: Data Link Layer	9 **Hrs**
Data Link Layer – MAC (Media Access Control) and LLC (Logical Link Control) sublayer Functionalities– Design Issues: Framing – Flow control (Simplest protocol, Stop and wait, sliding window) – Error control (CRC, Hamming code) — Ethernet Basics-Multi Access Protocols: ALOHA, CSMA/CD, Connecting Devices: Hubs, Bridges, Switches, Routers, and Gateways	
MODULE 3: Network Layer	**8 Hrs**
Network Layer Design issues, Routing Protocol Basics, Routing Algorithm (Distance Vector Routing, Link State Routing and Hierarchical Routing). IP addressing, IP Packet format IPV4, IPV6 and IP Tunneling. Congestion control algorithms, QoS (Traffic Shaping, Packet Scheduling).	
MODULE 4: Transport Layer	7 **Hrs**
Transport Layer functions- Multiplexing and Demultiplexing. Introduction to TCP and UDP, The TCP Service Model, The TCP Segment Header, The TCP Connection Management, TCP Flow Control- Sliding Window, TCP Congestion Control, User Datagram Protocol	
MODULE 5: Application Layer	6 **Hrs**
Principles of Network Applications, WEB and HTTP, FTP, E-MAIL(SMTP, POP3), TELNET, DNS, SNMP	

List of Laboratory/Practical Experiments activities to be conducted

PART A

1. Implement three nodes point – to – point network with duplex links between them. Set the queue size, vary the bandwidth and find the number of packets dropped.
2. Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
3. Implement an Ethernet LAN using n nodes and set multiple traffic nodes and plot congestion window for different source / destination.
4. Implement simple ESS and with transmitting nodes in wire-less LAN by simulation and determine the performance with respect to transmission of packets.
5. Implement and study the performance of GSM on NS2/NS3 (Using MAC layer) or equivalent Environment.
6. Implement and study the performance of CDMA on NS2/NS3 (Using stack called Call net) or equivalent environment.

PART B

Implement the following in Java:

7. Write a program for error detecting code using CRC.
8. Write a program to find the shortest path between vertices using bellman-ford algorithm.
9. Using TCP/IP sockets, write a client – server program to make the client send the

file name and to make the server send back the contents of the requested file if present. Implement the above program using as message queues or FIFOs as IPC channels.

10. Write a program on datagram socket for client/server to display the messages on client side, typed at the server side.
11. Write a program for simple RSA algorithm to encrypt and decrypt the data.
12. Write a program for congestion control using a leaky bucket algorithm.

TEXT BOOKS:

1. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition TMH, 2013.
2. Computer Networks - Andrew S Tanenbaum, 5th Edition, Pearson Education.

REFERENCES:

1. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach", Seventh Edition, Pearson Education, 2017.
2. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.
3. William Stallings, "Data and Computer Communications", Tenth Edition, Pearson Education, 2014.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3502**					
TITLE OF THE COURSE	**DESIGN AND ANALYSIS OF ALGORITHMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	39	3

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	***	***

COURSE OBJECTIVES:

- To introduce and implement various techniques for designing algorithms and advanced data structures
- To learn space and time complexity analysis of algorithms.
- To understand the Divide and conquer design strategy and the Greedy Technique
- To understand the concepts of Dynamic Programming Applications
- Synthesize efficient algorithms in common engineering design situations

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Outline the overview of Data structures and Algorithms	L1
CO2	Understand the different Algorithmic Design strategies	L2
CO3	Apply the Design principles and concepts to Algorithmic design	L3
CO4	Describe the DAA paradigms and when an Algorithmic Design situation calls for it.	L6
CO5	Analyse the efficiency of Algorithms using Time and Space complexity theory	L4
CO6	Implement an existing algorithm to improve the run time efficiency	L3

COURSE CONTENT:	
MODULE 1: INTRODUCTION	**8 Hrs**
The role of Algorithms in Computing, Running time analysis -- recall of asymptotic notation, big-oh, theta, big-omega, and introduce little-oh and little-omega. Worst case and average case complexity	
MODULE 2: DIVIDE AND CONQUER	**9 Hrs**
Recursive algorithms, Divide-and-Conquer recurrences, Methods for solving recurrences:	

substitution method, recursion tree method and the Master method. Examples-Binary search, Quick sort, Merge sort, Strassen's Matrix Multiplication. GREEDY METHOD Minimum cost spanning tree, Knapsack problem, Fractional knapsack	
MODULE 3: DYNAMIC PROGRAMMING	**9 Hrs**
Integral knapsack (contrasted with the fractional variant: 0/1 knapsack), longest increasing subsequence, All pair shortest path in graph, Matrix chain multiplication, Travelling salesman Problem	
MODULE 4: APPLICATION OF GRAPH TRAVERSAL TECHNIQUES	**7 Hrs**
Recall representation of graphs, BFS, DFS, connected components, Strongly-connected components of DAGs, Kosaraju's algorithm 1 and 2, Applications.	
MODULE 5: REASONING ABOUT ALGORITHMS	**6 Hrs**
Complexity Analysis (Polynomial vs Non-Polynomial time complexity), P, NP-hard and NP-Completeness, Reductions.	

TEXT BOOK:

1. T. H. Cormen, Leiserson, Rivest and Stein, "Introduction of Computer algorithm," , 3rd Edition, The MIT Press, 2015

REFERENCES:

1. Anany Levitin, ―Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012
2. Sara Basse, A. V. Gelder, "Computer Algorithms : Introduction Design & Analysis", 3rd Edition, Addison Wesley.
3. J.E Hopcroft, J.D Ullman, "Design and analysis of Computer algorithms", PearsonEducation, 2009.
4. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer, 2008

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3503**					
TITLE OF THE COURSE	**OPERATING SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	1	-	-	52	4

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	***	***	****

COURSE OBJECTIVES:

- To understand the basic concepts and functions of operating systems.
- To understand Processes and Threads
- To analyze Scheduling algorithms.
- To understand the concept of Deadlocks.
- To analyze various Memory and Virtual memory management, File system and storage techniques.
- To discuss the goals and principles of protection in a modern computer system.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Demonstrate need for OS and different types of OS	L2
CO 2	Analyze the performance of scheduling algorithms for the given problems	L4
CO 3	Demonstrate Process Coordination and synchronization techniques.	L2
CO4	Apply the deadlock handling mechanisms to solve the given problem	L3
CO 5	Apply suitable techniques for management of different Resources	L3
CO 6	Understand the principles of protection and security Mechanisms	L2

COURSE CONTENT:	
MODULE 1: OS Overview and System Structure	**10 Hrs**
Introduction to operating systems, System structures: What operating systems do; Computer System organization; Computer System architecture; Operating System structure; Operating System operations; Process management; Memory management; Storage management;	

Protection and Security; Distributed system; Computing environments. Operating System Services: User - Operating System interface; System calls; Types of system calls; System programs; Operating system design and implementation; Operating System structure; Virtual machines;	
MODULE 2: Process Management	**12 Hrs**
Process Management: Process concept; Process scheduling; Operations on processes. Multi-threaded Programming: Overview; Multithreading models; Threading issues. Process Scheduling: Basic concepts; Scheduling Criteria; Scheduling Algorithms.	
MODULE 3: Process Coordination	**10 Hrs**
Process Synchronization: The critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors Deadlocks: Deadlocks; System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.	
MODULE 4: Memory Management	**10Hrs**
Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. Virtual Memory Management: Background; Demand paging; Copy-on-write; Page replacement; Allocation of frames; Thrashing.	
MODULE 5: File System and Secondary Storage Structure	**10 Hrs**
File System, Implementation of File System**:** File system: File concept; Access methods; Directory structure; File system mounting; File sharing. Protection: Implementing File system: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management. Mass storage structures; Disk structure; Disk attachment; Disk scheduling; Disk management; Swap space management. Protection and Security: Protection: Goals of protection, Principles of protection, System Security: The Security Problem, Program Threats, System and Network Threats.	

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 8th edition, Wiley-India, 2010

REFERENCES:

1. Operating Systems-Internals and Design Principles, William Stallings, 6th Edition, Pearson Education, 2009.
2. Operating Systems: A Modern Perspective, Gary J. Nutt, Addison-Wesley, 1997

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3504**					
TITLE OF THE COURSE	**MACHINE LEARNING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	-	2	-	39+26	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES:

- Define machine learning and understand the basic theory underlying machine learning.
- To understand the working principle of Machine Learning Algorithms
- To apply various techniques of Machine Learning Algorithms
- Perform statistical analysis of machine learning techniques.

COURSE OUTCOMES:

CO No.	Outcomes	Taxonomy Level
CO1	Describe the basic concepts and different types of Machine Learning	L2
CO2	Explore and analyse the mathematics behind Machine Learning algorithms	L2
CO3	Apply the design principles and concepts of Machine Learning Algorithms	L3
CO4	Apply effectively Unsupervised Machine Learning algorithms and various learning techniques for appropriate applications.	L3
CO5	Explore, analyse and validate the different Machine Learning algorithms	L3

COURSE CONTENT:	
MODULE 1: Introduction to Machine Learning	**7Hrs**

Well posed learning problems, Designing a Learning system. Introduction to AI, Machine learning and Deep learning with applications. Types of learning: supervised, unsupervised and reinforcement learning. Perspective and Issues in Machine Learning.
Classical paradigm of solving learning problems, The learning problems--classes and types of learning, fundamental of statistical learning and its framework. Introduction to feature representation and extraction.
MODULE 2: Mathematics for Machine Learning **8Hrs**
Introduction to Statics Probability (joint probability, conditional probability, Bayes theorem, different distributions, univariate and multivariate Gaussian distribution, PDF, MLE, Motivation, estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypothesis, Comparing learning algorithms.
MODULE 3: Supervised Learning **9Hrs**
Introduction to Supervised Learning, Introduction to Perceptron model and its adaptive learning algorithms (gradient Decent and Stochastic Gradient Decent), Introduction to classification, Naive Bayes classification Binary and multi class Classification, decision trees and random forest, Regression (methods of function estimation) --Linear regression and Non-linear regression, logistic regression, Introduction To Kernel Based Methods of machine learning: K-Nearest neighbourhood , kernel functions, SVM, Introduction to ensemble based learning methods
MODULE 4: Unsupervised Learning **8 Hrs**
Introduction to Unsupervised Learning, Clustering (hard and soft clustering) Hierarchal clustering: K-means, Fuzzy C-Means (FCM) algorithm, Gaussian mixture models (GMM), Expectation Maximization algorithm, feature Engineering in Machine Learning, Dimensionality reduction, Linear Discriminant Analysis and Principle Component Analysis.
MODULE 5: Model Selection **7Hrs**
Machine Learning model validation - Confusion Matrix, Accuracy, Precision, F score, Cost function, Machine Learning Optimization algorithms: Gradient descent, stochastic GD. Regularization: Normalization and Standardization overfitting, underfitting, optimal fit, bias, variance, cross-validation.

List of Laboratory/Practical Experiments activities to be conducted
1. Implementation of linear and logistic regression 2. Implementation of SVM, KNN, Naïve Bayes ML algorithms 3. Implementation of Decision trees, Random Forest classifiers 4. Implement ensemble algorithms. 5. Implementation of different clustering algorithms and PCA Implementation of different neural networks Capstone project in specific domains (Health care, Transportation, Telecom etc.)

TEXT BOOKS;

1. Thomas M. Mitchell, Machine Learning, McGraw- Hill, Inc. New York, ISBN: 0070428077 9780070428072.

2. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press

book in preparation. (2015).

REFERENCE BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning series), The MIT Press; second edition, 2009.
2. V. N. Vapnik " The Nature of statistical Learning"

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3505**					
TITLE OF THE COURSE	**DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	2	-	26	1

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	****	****	****

COURSE OBJECTIVES:

- To learn mathematical background for analysis of algorithm
- To understand the concept of designing an algorithm.
- To analyze the algorithms using space and time complexity.
- To learn dynamic programming and greedy method.
- To acquire knowledge of various applied algorithms.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Design and develop the Algorithms to understand the different concepts.	L3
CO2	Apply the Design principles and concepts to Algorithmic design	L3
CO3	Describe the DAA paradigms and when an Algorithmic Design situation calls for it.	L6
CO4	Analyse worst-case and best – case running times of algorithms using asymptotic analysis.	L4
CO5	Implement an existing algorithm to improve the run time efficiency	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Design a C program to solve the Tower of Hanoi. Compute the time complexity.
2. Apply divide and conquer method and Design a C program to search an element in a

given array and Compute the time complexity. Binary search - recursive method

3. Apply Divide and Conquer method Design a C program to sort an array using Merge sort algorithm and compute its time complexity
4. Apply Divide and Conquer method Design a C program to sort an array using Quick sort algorithm and compute its time complexity.
5. Apply Greedy method and Design a C program to find the minimum cost spanning tree using Prim's and Kruskal's Algorithm and compute its complexity
6. Apply Dynamic Programming Technique and Design a C program to find the all pairs shortest path using Dijkstra's Algorithm and computes its complexity
7. Design a C program to find the optimal solution of 0-1 knapsack problem using dynamic programming and Compute the time complexity
8. Design a C program to solve the Travelling Salesman Problem using dynamic programming and compute its time complexity.
9. Design a C program to find the longest common subsequence using dynamic programming and compute its time complexity
10. Mini project proposal should be submitted and Implementation should be done based on the problem stated in the proposal

TEXT BOOK:

1. Levitin A, "Introduction to the Design And Analysis of Algorithms", Pearson Education, 2008.
2. T. H. Cormen, Leiserson, Rivest and Stein, "Introduction of Computer algorithm," , 3rd Edition, The MIT Press, 2015

REFERENCES:

1. E. Horowitz, S. Sahni, and S. Rajsekaran, "Fundamentals of Computer Algorithms," Galgotia Publication, 2015.
2. Goodrich M.T., R Tomassia, "Algorithm Design foundations Analysis and Internet Examples", John Wiley and Sons, 2006.
3. Sara Basse, A. V. Gelder, "Computer Algorithms : Introduction Design & Analysis", 3rd Edition, Addison Wesley.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3506**					
TITLE OF THE COURSE	**OPERATING SYSTEMS LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	2	-	26	1

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	***	****

COURSE OBJECTIVES:

- To learn creating process and Threads
- To implement various CPU Scheduling Algorithms
- To implement Process Creation and Inter Process Communication.
- To implement Deadlock Avoidance and Deadlock Detection Algorithms
- To implement Page Replacement Algorithms
- To implement File Organization and File Allocation Strategies

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Implement System Calls	L2
CO2	Compare the performance of various CPU Scheduling Algorithms	L3
CO3	Analyze Deadlock avoidance and Detection Algorithms	L3
CO4	Implement Semaphores	L2
CO5	Analyze the performance of the various Page Replacement Algorithms	L3
CO6	Implement File Organization and File Allocation Strategies	L2

List of Laboratory/Practical Experiments activities to be conducted		
Exp. No	Division of Experiments	List of Experiments
1	System Calls	Write a C program to create a new process that exec a new program using system calls fork(), execlp() & wait()
2		Write a C program to display PID and PPID using system calls getpid () & getppid ()
3		Write a C program using I/O system calls open(), read() & write() to copy contents of one file to another file
4	Process Management	Write a C program to implement multithreaded program using pthreads
5		Write C program to simulate the following CPU scheduling algorithms a) FCFS b) SJF c) Priority d) Round Robin
6	Process synchronization	Write a C program to simulate producer-consumer problem using semaphores
7	Deadlock	Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.
8		Write a C program to simulate deadlock detection.
9	Memory Management	Write a C program to simulate paging technique of memory management
10		Write a C program to simulate page replacement algorithms a) FIFO b) LRU c) LFU
11	I/O System	Write a C program to simulate the following file organization techniques a) Single level directory b) Two level directory
12		Write a C program to simulate the following file allocation strategies. a) Sequential b) Indexed

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 8th edition, Wiley-India, 2010

REFERENCES:

1. Operating Systems-Internals and Design Principles, William Stallings, 6th Edition, Pearson Education, 2009.

2. **Operating Systems: A Modern Perspective, Gary J. Nutt, Addison-Wesley, 1997**

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3508**					
TITLE OF THE COURSE	**RANDOMIZED & APPROXIMATE ALGORITHMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	***	***

COURSE OBJECTIVES:

- To introduce the concept of randomized algorithms
- **To apply the concepts of probabilistic analysis of algorithms**

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Apply basics of probability theory in the analysis of algorithms	L3
CO2	Comprehend randomized algorithms and its advantages to traditional algorithm	L4
CO3	Design and implement randomized techniques in solving real world problems	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
Elements of probability theory, Verification of polynomial identities, matrix multiplication. Las Vegas and Monte Carlo algorithms, Random Variables and Expectations	
MODULE 2	**8Hrs**
Jensen's Inequality, Bernoulli and Binomial RV, Conditional Expectation, Geometric distribution, Coupon collector's problem.	
MODULE 3	**8Hrs**
Game Tree evaluation, The Minimax Principle, Randomness and Non Uniformity, Markov's Inequality, Variance and Moments of a RV, Chebyshev's inequality.	
MODULE 4	**7Hrs**
Randomized Quick Sort, Coupon Collector's problem and Randomized Median Finding.	
MODULE 5	**8 Hrs**
Sum of Poisson Trials, Coin flips, Set balancing, Packet Routing in Sparse Networks, Bucket Sort, Hashing, Hamiltonian Cycles in Random Graphs, Finding a large cut, Maximum satisfiability, Graphs with large girth.	

TEXT BOOK:

1. M. Mitzenmacher and E. Upfal, "Probability and computing: Randomized algorithms and Probabilistic analysis", Cambridge, 2005
2. **D. Dubhashi and A. Panconesi, "Concentration of measure for the analysis ofrandomized algorithms", Cambridge, 2009.**
3. R. Motwani and P. Raghavan, "Randomized Algorithms", Cambridge Press, 1995.

REFERENCES:

1. J. Hromkovic, "Design and analysis of randomized algorithms", Springer Verlag,2005.
2. **K. Mulmuley, "Computational Geometry, an introduction through randomized algorithms", Prentice Hall, 1994.**

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**GRAPH THEORY**					
TITLE OF THE COURSE	**20CS3509**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	***	****

COURSE OBJECTIVES:

- To Understand and explain the basic concepts of graph theory.
- To understand the concept of digraphs, Euler digraphs and Hamiltonian digraphs.
- To develop the under-standing of Geometric duals in Planar Graphs.
- To introduce the idea of coloring in graphs

.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy**

		Level
CO1	Appreciate the definition and basics of graphs along with types and their examples	L2
CO2	Understand the definition of a tree and learn its applications to fundamental circuits.	L2
CO3	Know the applications of graph theory to network flows.	L2
CO4	Understand the notion of planarity and coloring of a graph.	L2
CO5	Relate graph theory to real-world problems.	L3

COURSE CONTENT:	
MODULE 1: Paths, Circuits and Graph Isomorphisms	**8Hrs**
Definition and examples of a graph, Subgraph, Walks, Paths and circuits; Connected graphs, disconnected graphs and components of a graph; Euler and Hamiltonian graphs, Graph isomorphisms, Adjacency matrix and incidence matrix of a graph, Directed graphs and their elementary properties	
MODULE 2: Trees and Fundamental Circuits	**8Hrs**
Definition and properties of trees, Rooted and binary trees, Cayley's theorem on a counting tree, Spanning tree, Fundamental circuits, Minimal spanning trees in a connected graph.	
MODULE 3: Cut-Sets and Cut-Vertices	**8 Hrs**
Cut-set of a graph and its properties, Fundamental circuits and cut-sets, Cut-vertices, Connectivity and separability, Network flows, 1- isomorphism and 2- isomorphism	
MODULE 4: Planar Graphs	**7Hrs**
Planar graph, Euler theorem for a planar graph, Various representations of a planar graph, Dual of a planar graph, Detection of planarity, Kuratowski's theorem.	
MODULE 5: Graph Coloring	**8Hrs**
Chromatic number of a graph, Chromatic partition, Chromatic polynomial, Matching and coverings, Four color problem	

TEXT BOOK:

1. R. Balakrishnan & K. Ranganathan (2012). A Textbook of Graph Theory. Springer.
2. Narsingh Deo (2016). Graph Theory with Applications to Engineering and Computer Science. Dover Publications.

REFERENCES:

1. Reinhard Diestel (2017). Graph Theory (5th edition). Springer.
2. Edgar G. Goodaire & Michael M. Parmenter (2018). Discrete Mathematics with Graph Theory (3rd edition). Pearson.
3. Douglas West (2017). Introduction to Graph Theory (2nd edition). Pearson.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3510**					
TITLE OF THE COURSE	**MICROCONTROLLERS AND EMBEDDED SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	***	***

COURSE OBJECTIVES:

- Explain the architectural features and instructions of 32 bit microcontroller -ARM Cortex M3.
- Develop Programs using the various instructions of ARM Cortex M3 and C language for different applications.
- Identify and understand the unique characteristics and components of embedded systems

- Understand how can we interfacing different input and output devices/components to cortex M3 microcontroller
- Understanding of how Arduino Uno & Raspberry Pi work

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Describe the architectural features and instructions of 32 bit microcontroller ARM Cortex M3.	**L2**
CO2	Apply the knowledge gained for Programming ARM Cortex M3 for different applications	**L3**
CO3	Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.	**L2**
CO4	Develop an embedded application with Cortex M3 architecture	**L3**
CO5	Design embedded systems using Arduino board and RasberryPi	**L3**

COURSE CONTENT:	
MODULE 1: ARM-32 bit Microcontroller	**8Hrs**
Microprocessors versus Microcontrollers, Different Microcontroller Architectures (CISC, RISC, ARISC), Microcontroller Types: PIC, AVR, ARM, Background of ARM and ARM Architecture: A Brief History, Architecture Versions, The Thumb-2 Technology and Instruction Set Architecture, Cortex-M3 Processor Applications, Overview of the Cortex-M3: What Is the ARM Cortex-M3 Processor, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, Exceptions and Interrupts	
MODULE 2: ARM Cortex M3 Instruction Sets and Programming:	**8Hrs**
Assembly basics, Instruction List, Instruction Descriptions: Moving Data, LDR and ADR Pseudo-Instructions, Processing Data, Call and Unconditional Branch, Decisions and Conditional Branches, Combined Compare and Conditional Branch, Conditional Execution Using IT Instructions, Instruction Barrier and Memory Barrier Instructions, MSR and MRS, More on the IF-THEN Instruction Block, SDIV and UDIV, REV, REVH, and REVSH, Reverse Bit, SXTB, SXTH, UXTB, and UXTH.	
MODULE 3: Cortex-M3 Programming	**8Hrs**
A Typical Development Flow, Using C, CMSIS: Background of CMSIS, Organization of CMSIS, Using CMSIS, Using Assembly: The Interface between Assembly and C, The First Step in Assembly Programming, Producing Outputs, The "Hello World" Example, Using Data Memory, Simple programming exercises	
MODULE 4: Embedded System Design Concepts	**8Hrs**

Introduction: Definition of Embedded System, Embedded Systems Vs General Computing Systems, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems, Core of the Embedded System: General Purpose and Domain Specific Processors, Embedded system architecture.	
MODULE 5: Embedded System Design using Raspberry Pi	**7 Hrs**
Introduction to RaspberryPi, About the Raspberry Pi board and programming (on Linux) Hardware Layout, Operating systems on RaspberryPi, Configuring raspberry Pi, Programming raspberry Pi with Python libraries.	

TEXT BOOK:

1. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", 2nd Edition, Newnes, (Elsevier),2010.
2. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2nd Edition.

REFERENCES:

1. Muhammad Tahir, Kashif Javed, ARM Microprocessor Systems: Cortex-M Architecture, CRC Press 2017
2. Richard Blum, "Arduino Programming in 24 Hours", Sams Teach Yourself, Pearson Education, 2017.
3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2016
4. Srinivasa K G, Internet of Things,CENGAGE Leaning India, 2017

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3511**					
TITLE OF THE COURSE	**VLSI DESIGN**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

1. Study VLSI design methodology and need of CAD tools
2. Study of algorithms used in design-automation tools.
3. Study of algorithms used in automation tools for verification and testing

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.	L3
CO2	Draw the basic gates using the stick and layout diagrams with the knowledge of physical design aspects.	L4
CO3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements	L2
CO4	Interpret Memory elements along with timing considerations	L5

COURSE CONTENT:	
MODULE 1	**8Hrs**
Introduction: A Brief History, MOS Transistors, CMOS Logic MOS Transistor Theory: Introduction, Long-channel I-V Characteristics, Non-ideal I-V Effects, DC Transfer Characteristics	
MODULE 2	**8Hrs**
Fabrication: CMOS Fabrication and Layout, VLSI Design Flow, Introduction, CMOS Technologies, Layout Design Rules, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitances	
MODULE 3	**7Hrs**

Delay: Introduction, Transient Response, RC Delay Model, Linear Delay Model, Logical Efforts of Paths, Combinational Circuit Design: Introduction, Circuit families	
MODULE 4	**8Hrs**
Sequential Circuit Design: Introduction, Circuit Design for Latches and Flip Flops Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Synchronous Dynamic Circuit Techniques.	
MODULE 5	**8Hrs**
Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM) and Static Random Access Memory (SRAM)	

TEXT BOOK:

1. "CMOS Digital Integrated Circuits: Analysis and Design" - Sung Mo Kang & Yosuf Leblebici, Third Edition, Tata McGraw-Hill.
2. "CMOS VLSI Design- A Circuits and Systems Perspective"- Neil H. E. Weste and David Money Harris, 4th Edition, Pearson Education.
3. Computational Aspects of VLSI (Principles of Computer Science Series)- J D Ullman – January 1, 1984

REFERENCES:

1. Adel Sedra and K. C. Smith, "Microelectronics Circuits Theory and Applications", 6th or 7th Edition, Oxford University Press, International Version, 2009.
2. Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design", PHI 3rd Edition, (original Edition- 1994).
3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", TMH, 2007

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3512**					
TITLE OF THE COURSE	**INTERNET OF THINGS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To learn the building blocks of the Internet of Things (IoT) and their characteristics.
- To introduce the students to the programming aspects of the Internet of Things with a view toward rapid prototyping of IoT applications.
- To learn communication protocol for IoT.
- To learn Reference architectures for different levels of IoT applications.
- To learn IoT data analytics and Tools for IoT.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
)1	Identify various protocols for IoT and Secure the elements of an IoT device	L1
)2	Understand the building blocks of the Internet of Things and the application areas of IoT	L2
)3	Apply IoT technologies in practical domains of society	L3
)4	Analyze a suitable IoT data analytics and a tool for IoT	L4
)5	Design an IoT device to work with a Cloud Computing infrastructure and program IoT devices	L6

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO IOT	**8 Hrs**
Introduction: Concepts behind the Internet of Things, Definition, Characteristics of IoT, IoT Conceptual framework, Physical design of IoT, Logical design of IoT, Application of IoT, IoT and M2M, IoT System Management with NETCONF-YANG.	
MODULE 2: IOT ARCHITECTURE AND SECURITY	**8 Hrs**
M2M high-level ETSI architecture, IETF architecture for IoT, IoT reference model, IoT 3 Tier, and 5 tier architecture	

IoT Security: IoT and cyber-physical systems, IoT security (vulnerabilities, attacks, and countermeasures), Security engineering for IoT development, IoT security lifecycle	
MODULE 3 : IOT PROTOCOLS	**7 Hrs**
IoT Access Technologies: Physical and MAC layers, Web Communication Protocols for connected devices, SOAP, REST, HTTP Restful, and Web Sockets. Internet Connectivity Principles: Internet Connectivity, Internet-based communication, Network Layer: IP versions, IP addressing in IoT, Zigbee,6LoWPAN, Routing over Low Power and Lossy Networks.	
MODULE 4 : HARDWARE AND DEVELOPMENT TOOLS FOR IOT	**8 Hrs**
Sensors, actuators, radio frequency identification (RFID) technology, wireless sensor networks, and participatory sensing technology. Embedded Platforms for IoT: Embedded computing basics, Overview of IoT supported Hardware platforms such as Arduino, Raspberry Pi, NodeMCU, Programming with Arduino, NodeMCU, and Raspberry Pi	
MODULE 5 : CASE STUDY AND REAL-WORLD APPLICATION	**8 Hrs**
Case Studies: Smart Agriculture, IoMT, Smart Cities (Smart Parking, Smart Lighting, Smart Road, Health and Lifestyle), Data Analytics for IoT, Cloud Storage Models & Communication APIs, Cloud for IoT, Amazon Web Services for IoT	

TEXT BOOK:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things - A Hands-On Approach
2. Rajkamal," Internet of Things", Tata McGraw Hill publication

REFERENCES:

1. Hakima Chaouchi "The Internet of Things: Connecting Objects", Wiley publication.
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, by David Hanes, Gonzalo Salgueiro , Patrick Grossetete , Robert Barton, Jerome Henry by CISCO
3. Donald Norris "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone Black", McGraw Hill publication

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3513**					
TITLE OF THE COURSE	**ARTIFICIAL INTELLIGENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	***	***	***

COURSE OBJECTIVES:

- To explore introductory survey of concepts and techniques in artificial intelligence.
- To learn about with methods for search, classification, reasoning, and machine learning.
- Familiar with applications including core AI (games, planning), robotics, computer vision,
  and natural language understanding.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Demonstrate fundamental understanding of artificial intelligence (AI) especially the notion of problem solving using AI techniques, current scope and limitations thereof.	**L2**
CO2	Apply basic principles of AI in solutions that require problem solving, knowledgerepresentation, and learning	**L3**
CO3	Demonstrate awareness and a fundamental understanding of applying AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.	**L2**

COURSE CONTENT:	
MODULE 1: Introduction	**7Hrs**
What is AI? Foundations of artificial intelligence (AI). History of AI; The State of the Art. Agents and Environments, Good Behavior, The Nature of Environments, The Structure of Agents, Problem-solving agents, Example problems, searching for solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions	

MODULE 2: Robotics and Classical Planning	**8Hrs**
Classical Planning: Definition, Algorithms for Planning as State-Space Search, Planning Graphs, Other Classical Planning Approaches, Analysis of Planning Approaches, Robotics: Introduction, Robot Hardware, Robotic Perception, planning to move, Planning Uncertain Movements.	
MODULE 3: Uncertainty, Naive Bayes and Probabilistic Reasoning	**8Hrs**
Acting Under Uncertainty, Review of Basic Probability, Bayes Theorem, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks,Exact Inference in Bayesian Networks, Time and Uncertainty, Inference in Temporal Models	
MODULE 4: Learning	**8Hrs**
Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and Choosing the Best Hypothesis, Regression and Classification with Linear Models, Artificial Neural Networks. Reinforcement Learning	
MODULE 5: Applications	**8Hrs**
Natural Language Processing: Language Models, Text Classification, Information Retrieval, Information Extraction, Computer Vision: Image Formation, Early Image-Processing Operations, Object Recognition by Appearance, Reconstructing the 3D World, Object Recognition from Structural Information, Using Vision.	

TEXT BOOK:

1. Stuart Russell and Peter Norvig. Artificial Intelligence – A Modern Approach, Pearson Education Press, 3rd or 4th Editions.

REFERENCES:

1 Artificial Intelligence, Pallab Das Gupta and Partha Pratim.C

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3514**					
TITLE OF THE COURSE	**DATA WARE HOUSE AND DATA MINING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- To extract knowledge from data repository for data analysis,
- Apply preprocessing statistical methods for any given raw data.

- Characterize the kinds of patterns that can be discovered by association rule mining, classification and clustering.
- Master data mining techniques in various applications like social, scientific and environmental context.
- Develop skill in selecting the appropriate data mining algorithm for solving practical problems.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Understand** warehousing architectures and tools for systematically organizing large Database and use their data to make strategic decisions	L2
CO2	**Explain** the analysing techniques of various data	L2
CO3	**Apply** the association rules for mining the data	L3
CO4	**Design** and deploy appropriate classification techniques	L6
CO5	**Describing** and demonstrating basic data mining algorithms, methods, and tools	L3
CO6	**Evaluate** various mining techniques on complex data objects	L5

COURSE CONTENT:	
MODULE 1: DATA WAREHOUSING	**7Hrs**
Data Warehouse, Data warehousing Components –Building a Data warehouse - Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, Transformation and loading, Tools, Metadata.	
MODULE 2: BUSINESS ANALYSIS	**7Hrs**
Reporting and Query tools and Applications – Tool Categories – The Need for Applications – Cognos Impromptu – Online Analytical Processing (OLAP) – OLAP Guidelines – Multidimensional Data Model - Multidimensional versus Multi-relational OLAP – OLAP Tools and the Internet. Case study: Data Warehouse tools in cloud (MS Azure, AWS)	
MODULE 3: DATA MINING	**9 Hrs**
Introduction to Data – Types of Data – Types of Data-attributes and measurements - types of data sets, Data Quality - Data Mining Functionalities – Interestingness of Patterns – Classification of Data Mining Systems, Data Mining Task Primitives – Integration of a Data Mining System with a Data Warehouse – Issues in DM, KDD process. Data Preprocessing.	
MODULE 4: CLUSTERING AND TRENDS IN DATA MINING	**8Hrs**
Cluster Analysis, Categorization of Major Clustering Methods - Partitioning Methods: K-means clustering. Hierarchical Methods: Agglomerative Methods and Divisive Methods,	

Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data, Constraint Based Cluster Analysis, Outlier Analysis, Data Mining Applications.
MODULE 5: ASSOCIATION RULE MINING AND CLASSIFICATION **8 Hrs**
Frequent Item Set Generation, The APRIORI Principle, Support and Confidence Measures, Association Rule Generation, APRIORI Algorithm, Correlation Analysis. Classification and Prediction: General Approaches to solving a classification problem, Evaluation of Classifiers, Classification techniques

TEXT BOOK:

1. Alex Berson and Stephen J Smith, "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint, 2007
2. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Second Edition, Elsevier, 2007

REFERENCES:

1. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Person Education, 2007.
2. K.P. Soman, Shyam Diwakar and V. Ajay ", Insight into Data mining Theory and Practice", Easter Economy, Edition, Prentice Hall of India, 2006.
3. G. K. Gupta, "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006
4. Daniel T. Larose, "Data Mining Methods and Models", Wile-Interscience, 2006

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3515**					
TITLE OF THE COURSE	**CLOUD COMPUTING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Understand various basic concepts related to cloud computing technologies

- Understand the architecture and concept of different cloud models: IaaS, PaaS, SaaS
- Understand the applications of Cloud Computing
- Get exposure to Microsoft Azure, Google Cloud Platform, Amazon Web Services

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Define Cloud computing and characteristics	L1
CO2	Describe benefits and drawbacks of Cloud computing	L2
CO3	Explain various types of virtualization and capacity planning metrics	L2
CO4	Discuss various types of cloud services	L2
CO5	Discuss Cloud Security and various challenges	L2

COURSE CONTENT:	
MODULE 1: INTRODUCTION	**8Hrs**
Basics of cloud computing, Cloud Computing Models (Paas, Saas, Iaas), Understanding Public Clouds, Private Clouds, Community Cloud and Hybrid Clouds, Cloud Computing Benefits and risks, Cloud Computing Challenges, Cloud Computing Architecture and Virtualization	
MODULE 2: CLOUD Technologies	**7 Hrs**
Overview of Cloud Computing techniques (Grid Computing,Cloud Computing, Utility Computing, Fog Computing, Edge computing), Introduction to Cloud security.	
MODULE 3: CLOUD VIRTUALIZATION TECHNOLOGY	**8Hrs**
Introduction, why virtualization, virtualization benefits, Types of Virtualization- Storage, Application & Network Virtualization, implementing virtualization, Hypervisor.	
MODULE 4: ACCESSING THE CLOUD AND MIGRATING TO THE CLOUD	**8Hrs**
Accessing the Cloud: Cloud Web access technologies (SOAP, REST), Platforms, Web applications framework, web hosting service, web APIs, web browsers. Migrating to the Cloud: Broad approaches to migrating into the cloud, the seven-stepmodel of migration in to a cloud.	
MODULE 5: CLOUD APPLICATIONS	**8Hrs**
Cloud Platforms in Industry: Amazon Web Services, Google Cloud Platform, Microsoft Azure. Cloud Applications: Scientific Applications (Healthcare: ECG Analysis in the Cloud) and Business and Consumer Applications (Social Networking, Smart Grids)	

TEXT BOOK:

1. **Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi Mastering Cloud. Computing McGraw Hill Education**
2. **Cloud Computing, Dr. Kumar Saurabh, Wiley Publications, 2012**

REFERENCES:

1. Guide to Cloud Computing, Richard hill, Springer Publications, 2013
2. **Cloud Computing A Practical Approach, Anthony T Velte et.al, MC Graw Hillpublications, 2014**
3. Cloud Computing Principles and Paradigms, Rajkumar Buyya et.al, WileyPublications, 2015
4. **Cloud Computing Technologies and Strategies of the Ubiquitous data center, Brain J.S et.al, CRC Press, 2014**

SEMESTER	**V**
YEAR	**III**
COURSE CODE	**20CS3516**
TITLE OF THE COURSE	**BIOLOGICAL FOUNDATIONS OF AI AND ML**

SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand the fundamentals of the nervous system
- To analyze the signals generated by neurons
- To understand synaptic transmission
- To evaluate the role of sub-cellular processes in neural communication

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Apply basic CSE and EE understanding to the nervous system	L3
CO2	Analyze the signals generated by neurons	L4
CO3	Understand synaptic transmission	L2
CO4	Evaluate the role of sub-cellular processes in information transmission	L5

COURSE CONTENT:	
MODULE 1: HUMAN AND ANIMAL NERVOUS SYSTEMS	**8 Hrs**

Overview – Genetics, Genomics, and the Brain – The Cellular Components of the Nervous System – Neurons – Neuroglial Cells – Cellular Diversity in the Nervous System – Neural Circuits – Organization of the Human Nervous System – Neuroanatomical Terminology – Subdivisions of the CNS	
MODULE 2 : ELECTRICAL SIGNALS OF NERVE CELLS	**8 Hrs**
Overview – Electrical Potentials Across Nerve Cell Membranes – Ions and Signals – Membrane Potentials – Electrochemical Equilibrium – Resting Membrane Potential – Ionic Basis of Action Potentials	
MODULE 3: VOLTAGE-DEPENDENT MEMBRANE PERMEABILITY	**8 Hrs**
Overview – Ionic Currents Across Membranes – Voltage-Dependent Ionic Currents Voltage-Dependent Membrane Conductances – Reconstruction of the Action Potential – Long-Distance Signaling – Refractory Period – Increased Conduction Velocity Due to Myelination	
MODULE 4: CHANNELS AND TRANSPORTERS	**7 Hrs**
Overview – Ion Channels Underlying Action Potentials – The Diversity of Ion Channels – Voltage-Gated Ion Channels – Stretch- and Heat-Activated Channels – Molecular Structure – Active Transporters -- Pumps	
MODULE 5: SYNAPTIC TRANSMISSION	**8 Hrs**
Overview – Electrical Synapses – Chemical Synapses – Neurotransmitter Properties – Quantal Release – Synaptic Vesicles and Their Recycling – Calcium's Role – Mechanisms of Transmitter Secretion – Transmitter Reception – Permeability and Synaptic Transmission – Postsynaptic Potentials – Postsynaptic Receptors	

TEXT BOOK:

1. Dale Purves et. al. Neuroscience. Sinauer Associates. 2004.

SEMESTER	**V**
YEAR	**III**
COURSE CODE	**20CS3517**

TITLE OF THE COURSE	QUANTUM MECHANICS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	39	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand the fundamentals of the wave function and the Schrodinger equation
- To identify various problem settings in quantum mechanics and be able to solve them
- To apply the formalism of quantum mechanics to simple problems
- To understand the path integral approach and its applications

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the fundamentals of the wave function and the Schrodinger equation	L2
CO2	Identify various problem settings in quantum mechanics and be able to solve them	L3
CO3	Apply the Dirac formalism of quantum mechanics to simple problems	L3
CO4	Understand the path integral approach and its applications	L2

COURSE CONTENT:	
MODULE 1: THE WAVE FUNCTION	**8Hrs**

The Schrodinger Equation, The Statistical Interpretation, Probability, Normalization, Momentum, Uncertainty	
MODULE 2: SCHRODINGER EQUATION	**8Hrs**
Stationary States, Infinite Square Well, Harmonic Oscillator, Free Particle, Delta-function Potential, Finite Square Well; Scattering Matrix	
MODULE 3: FORMALISM	**7Hrs**
Linear Algebra, Function Spaces, Generalized Statistical Interpretation, Uncertainty Principle	
MODULE 4: IN-DEPTH CONCEPTS AND THE LAW OF MOTION	**8Hrs**
Probability in Quantum Mechanics, The Uncertainty Principle, Interfering Alternatives, Classical Action, Quantum Amplitude, Classical Limit, Sum Over Paths, Events Occurring in Succession	
MODULE 5: SPECIAL EXAMPLES	**8Hrs**
The Free Particle, Diffraction Through a Slit, Sharp-edged Slit, Wave Function, Gaussian Integrals, Motion in a Potential Field	

TEXT BOOKS:

1. Griffiths, D. J., & Schroeter, D. F. (2018). Introduction to quantum mechanics. Cambridge university press.
2. Feynman, R. P., Hibbs, A. R., & Styer, D. F. (2010). Quantum mechanics and path integrals. Courier Corporation.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4601**					
TITLE OF THE COURSE	**COMPILER DESIGN AND SYSTEMS SOFTWARE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

1. To explain the basic system software components such as assembler, loader, linkers, compilers.
2. Provide an understanding of the fundamental principles in compiler design
3. To discuss the techniques of scanning, parsing & semantic elaboration well enough to build or modify front end.
4. To illustrate the various optimization techniques for designing various optimizing compilers.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the architecture of a hypothetical machine, structure and design of assembler.	L2
CO2	Analyse how linker and loader create an executable program from an object module created by assembler	L4
CO3	Describe the major phases of compilation and to apply the knowledge of Lex tool & YAAC tool	L2
CO4	Explain the syntax analysis phase and identify the similarities and differences among various parsing techniques and grammar transformation methods	L2
CO5	Use formal attributed grammars for specifying the syntax and semantics of programming languages.	L3
CO6	Summarize various optimization techniques used for dataflow analysis and generate machine code from the source code of a novel language.	L2

COURSE CONTENT:	
MODULE 1: Introduction to System Software, ASSEMBLERS	**10Hrs**
Introduction to System Software, Machine Architecture of SIC and SIC/XE.	

ASSEMBLERS: Basic assembler functions: A simple assembler, Assembler algorithm and data structures, Machine dependent assembler features: Instruction formats and addressing modes – Program relocation, Machine independent assembler features: Literals, Symbol-defining statements, Expressions, Program blocks	
MODULE 2 : LOADERS AND LINKERS:	**9Hrs**
Basic loader functions: Design of an Absolute Loader, A Simple Bootstrap Loader, Machine dependent loader features: Relocation, Program Linking, Algorithm and Data Structures for Linking Loader, Machine-independent loader features: Automatic Library Search, Loader Options, Loader design options: Linkage Editors, Dynamic Linking	
MODULE 3: COMPILERS	**11Hrs**
Introduction: Language Processors, Structure of compiler, The science of building a compiler, Applications of compiler technology. LEXICAL AND SYNTAX ANALYSIS: Role of lexical Analyzer, Specification of Tokens, Lexical Analyzer generator Lex. SYNTAX ANALYSIS I: Role of Parser, Syntax error handling, Error recovery strategies, Writing a grammar: Lexical vs Syntactic Analysis, Eliminating ambiguity, Left recursion, Left factoring.	
MODULE 4: SYNTAX ANALYSIS II	**12Hrs**
Top down parsing: Recursive Descent Parsing, First and follow, LL (1), –Bottom up parsing: Shift Reduce Parsing, Introduction to LR parsing Simple LR: Why LR Parsers, Items and LR0 Automaton, The LR Parsing Algorithm. SYNTAX-DIRECTED TRANSLATION: Syntax-Directed Definitions: Inherited and Synthesized Attributes, Evaluation orders for SDDs: Dependency graphs, Ordering the evaluation of Attributes, S-Attributed Definition, L-Attributed Definition, Application: Construction of Syntax Trees.	
MODULE 5: INTERMEDIATE CODE GENERATION	**10Hrs**
Three Address Code: Addresses and Instructions, Quadruples, Triples, indirect triples. CODE GENERATION: Issues in the design of code generator, Basic Blocks, Optimization of Basic Blocks, The Code Generation Algorithm, Peephole optimization. MACHINE INDEPENDENT OPTIMIZATION: The Principal Sources of Optimization	

TEXT BOOKS:

1. Leland L. Beck, "System Software – An Introduction to Systems Programming", 3rd Edition, Pearson Education Asia, 2006.
2. Alfred V Aho, Monica S. Lam, Ravi Sethi and Jeffrey D Ullman, "Compilers – Principles, Techniques and Tools", 2nd Edition, Pearson Education, 2007.

REFERENCES:

1. V. Raghavan, Principles of Compiler Design‖, Tata McGraw Hill Education Publishers, 2010.
2. Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers Elsevier Science, 2004.
3. D.M.Dhamdhere, Systems Programming and operating systems, Second Revised edition, Tata McGraw Hill.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4602**					
TITLE OF THE COURSE	**SECURE PROGRAMMING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	2	-	26+26	3

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
1	I,II/I	20EN1103	FUNDAMENTALS OF PROGRAMMING

COURSE OBJECTIVES:

- To enhance and understand student competence on basic concepts of cyber security and code protection.
- To understand and analyze the importance of Secure Programming Design Principles.
- To develop competence in Robust secure programming concepts.
- To gain insights to maintain a secure repository.
- To develop competence in cryptography algorithms to be used to protect the data.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the Basic concepts of Secure Programming	L1
CO2	Understand and Demonstrate Secure Programming Principles	L2
CO3	Apply concepts of secure programming concepts for Software Development	L3
CO4	Analyze and conclude requirements, importance, and need of secure programming.	L4
CO5	Develop secure crypto systems for Data base Management	L5

COURSE CONTENT:	
MODULE 1: Introduction to Secure Programming	**8 Hrs**
Fundamentals of secure programming in C. Various security vulnerabilities (e.g., buffer overflows) in C. Introduction; Definitions (policy, mechanism, enforcement, property), Definitions (safety, liveness, and CIA properties); Best practices (e.g., coding standards). Unenforceability; Threats;	

Tradeoffs; Secure design; Access control; Authentication; Authorization; Memory segmentation; Buffer overflows;	
MODULE 2: Secure Programming Design Principles	**4Hrs**
Secure Programming Design Principles Overview; Principle of Least Privilege; Fail-Safe Defaults; Principle of Economy of Mechanism;	
MODULE 3: Robust Programming	**5Hrs**
Robust Programming Overview; Robust Programming Basic Principles; An Example of Fragile Code; Error Handling; Cohesion, New Interfaces	
MODULE 4: Databases	**5Hrs**
Client-state manipulation, Databases; Information management; SQL queries, SQL injection attacks, Code injections; XSS;	
MODULE 5: Cryptography	**4Hrs**
Symmetric cryptography Asymmetric cryptography; Diffie-Hellman; RSA; Signatures; MACs; Password management	

List of Laboratory/Practical Experiments activities to be conducted
C programs on: 1. Memory segmentation, buffer over flows, authentication etc 2. Fail safe defaults principles 3. Robust programming; fragile code, error handling etc 4. SQL queries, injection attacks, code injections etc 5. Various Cryptography algorithms (DH, RSA); Password management etc.

TEXT BOOKS:

1. Foundations of Security: Neil Daswani, Christoph Kern, and Anita Kesavan. Apress, 2007 (1st ed). ISBN-10: 1590597842; ISBN-13: 978-1590597842
2. Secure Coding: Principles and Practices: Mark Graff and Kenneth Wyk

REFERENCES:

1. The C Programming Language: Brian Kernighan and Dennis Ritchie., 2nd Edition.
2. Computer Systems: A Programmer's Perspective: Randy Bryant's and David R. O'Halloran. 2nd Edition.
3. Hacking: The Art of Exploitation: Jon Erickson., 2nd Edition.
4. Secure Coding in C and C++: Robert Seacord., 1st Edition.
5. Programming. A Modern Approach: K. N. King, Published by W. W. Norton & Company.
6. Building Secure and Reliable Systems: Heather Adkins, Betsy Beyer, Paul Blankinship and 3 more published by O'Reilly
7. Fundamentals of Information Security Systems: David Kim and Michael Solomon

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4603**					
TITLE OF THE COURSE	**CLOUD APPLICATION DEVELOPMENT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	39	3

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To give insights into the Cloud computing Technology, Service Oriented Architecture (SOA) and Virtualization.
- To recognize the basic programming for building the Cloud Application and to be familiar with version control tool.
- To understand the design and development framework for Cloud Applications.
- To deploy the cloud infrastructure using different methods from the scratch.
- To apply and map theoretical knowledge to practical through case studies and tutorials.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain the cloud architecture, different cloud delivery and deployment models and the idea of Virtualization	L2
CO2	Construct the Cloud Application and work with the version control tool.	L3
CO3	Select the appropriate cloud framework for the development of cloud applications.	L5
CO4	Implement cloud-based application by exploring real time methods and tools.	L6
CO5	Examine the cloud services offered by various vendors and emerging technologies.	L4

COURSE CONTENT:	
MODULE 1: Introduction	**8Hrs**
Introduction- Cloud Computing Architecture – The Cloud Reference Model – Cloud Characteristics –Cloud Deployment Models: Public, Private, Community, Hybrid Clouds- Cloud Delivery Models: IaaS, PaaS, SaaS **Virtualization**: Introduction, Characteristics of Virtualized Environments, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Paravirtualization, Full Virtualization	
MODULE 2: Understanding Cloud Programming	**8Hrs**
Introduction to Cloud development using HTML5-Tag and Structural elements, Input elements and Data Attributes, Management and support and scripting. CSS3-Styling HTML, JavaScript-Variables and control statement, functions and API's Client side Javascript	
MODULE 3: Design and Developing cloud Application	**9 Hrs**
Building Native Cloud Application: REST APIs and JSON - Using RESTAPI's with WatsonAI Services. JSON Data types-Arrays, objects, Parse, Server and HTML **Developing Cloud Applications with Node.js and React:** Create server-side applications using Node.js and develop the front-end using React.	
MODULE 4: Deploying Cloud Applications and services	**7 Hrs**
Cloud Application deployment models: **Amazon Web Services**- Compute Services, Storage Services, Communication Services, **Google AppEngine**- Architecture and Core Concepts, Application Life-Cycle, Cost Model, Observations. **Microsoft Azure**- Azure Core Concepts	
MODULE 5: CASE Study	**7 Hrs**
Introduction to Emerging technologies supported by Cloud: AI, IoT, Blockchain, Analytics. **Cloud Infrastructure:** -Dockers and Containers. **Cloud Storage**: Direct Attached-File Storage-Block Storage-Object Storage-Content Delivery Networks (CDN). **Cloud Native and Emergent Cloud Trends:** Hybrid Multicloud-Serverless-Microservices-Cloud Native-DevOps-Application Modernization. Need for Cloud Security.	

TEXTBOOKS:

1. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi Mastering Cloud Computing McGraw Hill Education
2. Deitel, Deitel and Neito, "Internet and World Wide Web – How to program", Pearson Education Asia, 5th Edition, 2011

REFERENCES:

1. Tom Marrs, "JSON at Work - Practical Data Integration for the Web", O'REILLY, First edition, 2017
2. Guo Ning Liu, Qiang Guo Tong, Harm Sluiman, Alex Amies, "Developing and Hosting Applications on the Cloud", IBM Press (2012)

3. Dan Marinescu, “Cloud Computing: Theory and Practice”, M K Publishers, 1st Edition, 2013
4. A.Srinivasan, J.Suresh, ”Cloud Computing, A practical approach for learning and implementation”, Pearson,2014

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4604**					
TITLE OF THE COURSE	**COMPILER DESIGN AND SYSTEM SOFTWARE LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	2	-	26	1

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Experiment on the basic techniques of compiler construction and tools that can used to perform syntax-directed translation of a high-level programming language into an executable code.
- Know the implementation of assemblers, loaders and various parsing techniques.
- Learn how to optimize and effectively generate machine codes.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Identify patterns, tokens & regular expressions for lexical analysis.	L2
CO2	Develop LEX and YACC programs for lexical and syntax analysis phases of Compiler.	L3
CO3	Implement the pass 1 of two pass assembler and absolute loader algorithm	L3
CO4	Analyze and Implement the bottom up parsing technique	L4
CO5	Implement front end of the compiler by means of generating intermediate codes.	L3

List of Laboratory/Practical Experiments activities to be conducted
1a. Program to count the number of characters, words, spaces and lines in a given input file.
1b. Program to recognize and count the number of identifiers in a file.
2a. Program to count the numbers of comment lines in a given C program. Also eliminate them and copy the resulting program into separate file.
2b. Program to recognize whether a given sentence is simple or compound.

3a. Program to count no of: i.+ve and –ve integers ii. +ve and –ve fractions
3b. Program to count the no of „scanf‟ and „printf‟ statements in a C program. Replace them with “readf‟ and “writef‟ statements respectively.
4.Program to evaluate arithmetic expression involving operators +,-,*,/
5. Program to recognize a valid variable which starts with a letter, followed by any number of letters or digits.
6. Program to recognize the strings using the grammar ($a^n b^n$;n>=0)
7. C Program to implement Pass1 of Assembler
8. C Program to implement Absolute Loader
9. C program to find the FIRST in context free grammar.
10.C Program to implement Shift Reduce Parser for the given grammar E →E+E E→E*E E→(E) E → id
11. C Program to implement intermediate code generation for simple expression

TEXT BOOKS:

1. Leland L. Beck, “System Software – An Introduction to Systems Programming”, 3rd Edition, Pearson Education Asia, 2006.
2. Alfred V Aho, Monica S. Lam, Ravi Sethi and Jeffrey D Ullman, “Compilers – Principles, Techniques and Tools”, 2nd Edition, Pearson Education, 2007.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4605**					
TITLE OF THE COURSE	**CLOUD APPLICATION DEVELOPMENT LABORATORY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	2	-	26	1

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To Demonstrate operation of cloud and to develop simple cloud-based applications
- To design and deploy cloud-based applications using various tools and to explain command usage and sequence.
- To Handle virtualization environment, technology and familiarize in efficient cloud-based application development.
- To implement version control system commands and work with Docker containers

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
)1	Understand the installation of Virtual box and VMware, installation of gcc C-compiler and the ping command to test the communication between the guest OS and Host OS.	L2
)2	Understand and establish an AWS account. Use the AWS Management Console to launch an EC2 instance and connect to it and the usage of Google App Engine in Eclipse.	L2
)3	Understanding of Windows Azure environment and Containerization using Docker.	L2
)4	Practice several commands of version control system and deploy application in Dockers.	L3

List of Laboratory/Practical Experiments activities to be conducted

1. Install Oracle Virtual box and create two VMs on your laptop/Desktop.
2. Test ping command to test the communication between the guest OS and Host OS
3. Use gcc to compile c-programs. Split the programs to different modules and create an application using make command
4. Find a procedure to transfer the files from one virtual machine to another virtual machine.
5. Establish an AWS account. Use the AWS Management Console to launch an EC2 instance and connect to it.
6. Develop a Hello World application using Google App Engine in Eclipse.
7. Use version control systems command to clone, commit, push, fetch, pull, checkout, reset, and delete repositories
8. Develop a Windows Azure Hello World application.
9. Install Google App Engine. Create hello world app and other simple web applications using python/java. Use GAE launcher to launch the web applications
10. Launch GUI applications inside Docker Container & access them from the Docker Host system.

TEXTBOOKS:

1. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi Mastering Cloud Computing McGraw Hill Education
2. Deitel, Deitel and Neito, "Internet and World Wide Web – How to program", Pearson Education Asia, 5th Edition, 2011

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4606**					
TITLE OF THE COURSE	**SOFT COMPUTING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand the scope of soft computing
- To analyze various components of soft computing
- To implement few algorithms in Fuzzy, Artificial neural networks, genetic algorithm.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Understand various soft computing techniques	L2
CO2	Use application in various areas	L4
CO3	Analyze Architecture, training algorithm, back propagation, and radial basis functions	L3

COURSE CONTENT:	
MODULE 1: Introduction	**7 Hrs**
Scope of soft computing, various components, description of Artificial neural networks, overview fuzzy logic, theory of genetic algorithms, theory of hybrid systems.	
MODULE 2: Neural network	**8 Hrs**
Fundamentals of neural network, basic models of ANN, learning and activation functions, basic fundamental McCulloch- Pitts neuron model	
MODULE 3: Learning Models	**8 Hrs**
Supervised learning networks, Adaline, Back propagation, Unsupervised learning network, Korhonen self-organizing feature maps networks.	
MODULE 4: Fuzzy Logic	**8 Hrs**
Introduction to fuzzy logic, classical sets and Fuzzy sets, Classical relations and Fuzzy	

relations, Membership functions, Fuzzy arithmetic and Fuzzy measures, fuzzy decision making.	
MODULE 5: Genetic Algorithms	**8 Hrs**
Introduction, Search space and optimization techniques, encoding, selection crossover, mutation. Application on either MATLAB environment or Python programming - Neural network algorithm, Fuzzy algorithm, Genetic algorithm	

TEXT BOOK:

1. Principles of Soft computing 2nd Edition S N Sivanandan, S N Deepa. Wiley India

SEMESTER	**VI SEM**
YEAR	**III**

COURSE CODE	20CS4607					
TITLE OF THE COURSE	EDGE COMPUTING					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

1. Study VLSI design methodology and need of CAD tools
2. Study of algorithms used in design-automation tools.
3. Study of algorithms used in automation tools for verification and testing

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.	L3
CO2	Draw the basic gates using the stick and layout diagrams with the knowledge of physical design aspects.	L4
CO3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements	L2
CO4	Interpret Memory elements along with timing considerations	L5

COURSE CONTENT:	
MODULE 1: Introduction to Edge Computing	**8 Hrs**
What Is Edge Computing, Why Do We Need Edge Computing, Key Techniques that Enable Edge Computing, Edge Computing Definition, Edge Computing Benefits, Edge Computing Systems.	
MODULE 2: Computing Paradigms	**8 Hrs**
Introduction to Computing Paradigms, The Major Impacts of Computing, Parallel Computing, Distributed Computing, Cluster Computing, Utility Computing, Grid Computing, Cloud Computing	
MODULE 3: Edge Analytics	**8 Hrs**
Types of Data, Data Analytics, Goals of Data Analytics, Domains Benefiting from Big Data Analytics, Real-Time Applications of Data Analytics, Phases of Data Analytics, Data Collection and Pre-Processing, Machine Learning-Model Building, Performance Evaluation	

MODULE 4: Edge Data Storage and Security	**9 Hrs**
Data Security, Data Confidentiality, Identity-Based Encryption, Attribute-Based Encryption, Proxy Re-encryption Functional Encryption, Honey Encryption Searchable Encryption, Homomorphic Encryption, Types of Homomorphic Encryption, Basic Functions of Homomorphic Encryption, Authentication, Single-Domain Authentication, Cross-Domain Authentication, Handover Authentication, Privacy-Preserving Schemes, Data Privacy, Location Privacy, Identity Privacy	
MODULE 5: Challenges and Opportunities in Edge Computing	**6 Hrs**
Programmability, Naming, Data Abstraction, Service Management, Privacy and Security, Application, Distribution Scheduling Strategies, Business Model, Optimization Metrics	

TEXT BOOK:

1. "EDGE COMPUTING Fundamentals, Advances and Applications"- Anitha Kumari G. Sudha Sadasivam D. Dharani M. Niranjanamurthy CRC Press Taylor and Francis K publication.
2. "Edge Computing: A Primer"- Jie Cao, Quan Zhang ,Weisong Shi, Springer Publications

SEMESTER	**VI**
YEAR	**III**
COURSE CODE	**20CS4608**

TITLE OF THE COURSE	DISTRIBUTED COMPUTING					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	39	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	***	****

COURSE OBJECTIVES:

- To learn the characterization of distributed systems
- To learn issues related to clock Synchronization and the need for global state in distributed systems

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Explain client-server organizations in distributed systems	L2
CO2	Describe the key characteristics and principal concepts of distributed systems	L2
CO3	Describe issues related to clock Synchronization	L2
CO4	Describe the importance of the replication of data in distributed systems	L2
CO5	Identify Security principles for Distributed Systems	L2

COURSE CONTENT:	
MODULE 1: INTRODUCTION	**7Hrs**
Definition of a distributed system, goals, connecting users and resources, transparency, openness, scalability, hardware concepts, software concepts, distributed operating systems, network operating systems, middleware, and the client-server model. Limitation of distributed system.	
MODULE 2: CHARACTERIZATION OF DISTRIBUTED SYSTEMS	**8 Hrs**
Introduction, examples of distributed systems, resource sharing and the web challenges. Architectural models, fundamental models. Communication: layered protocols, remote procedure call, remote object invocation, message oriented, stream-oriented communication, software agents.	

MODULE 3: SYNCHRONIZATION	8 Hrs
Clock synchronization, physical clocks, clock synchronization algorithms, logical clocks, lamport timestamps, vector timestamps, global state, election algorithms, the bully algorithm, ring based algorithm, mutual exclusion, a centralized algorithm, a distributed algorithm, a token ring algorithm, a comparison of the three algorithms. Distributed file systems: Sun network file system, overview of NFS, communication, processes, naming, synchronization, caching and replication, fault tolerance, security, the coda file system	
MODULE 4: REPLICATION	**8 Hrs**
System model and group communication, fault - tolerant services, highly available services, transactions with replicated data. Fault tolerance: Introduction to fault tolerance, basic concepts, failure models, failure masking by redundancy, process resilience, design issues, failure masking and replication, agreement in faulty systems, reliable client-server communication, point-to-point communication, RPC semantics in the presence of failures, reliable group communication, basic reliable multicasting schemes, scalability in reliable multicasting, atomic multicast, distributed commit, recovery, check pointing, message logging.	
MODULE 5: SECURITY	**8Hrs**
Introduction to security, security threats, policies, and mechanisms, design issues, cryptography, secure channels, authentication, message integrity and confidentiality, secure group communication, access control, general issues in access control, firewalls, secure mobile code, security management, key management, secure group management, authorization management, Kerberos, sesame, electronic payment systems.	

TEXT BOOK:

1. Coulouris, dollimore, kindberg, "distributed system: concepts and design", Pearson Education.

2. Andrew S. Tanenbaum, Maarten van Steen, "Distributed Systems: Principles and Paradigms",

2nd edition, Prentice Hall India.

3. Gerald tel, "Introduction to Distributed Algorithms"2nd edition, Cambridge University

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4609**					
TITLE OF THE COURSE	**COMPUTER ARCHITECTURE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	39	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- To understand the micro-architectural design of processors
- **Learn about the various techniques used to obtain performance improvement**
- Learn Power savings in current

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Describe the principles of computer design and classify instructions set architecture	L2
CO2	Describe the operations of performance such as pipelines, dynamic scheduling branch predictions, caches	L2
CO3	Describe the modern architecture such as RISC, Scalar, VLIW Multi core and multi CPU systems	L2
CO4	Describe instruction and thread level parallelism	L2
CO5	Develop the applications for high performance computing systems	L3

COURSE CONTENT:	
MODULE 1: FUNDAMENTALS OF COMPUTER DESIGN	**8Hrs**
Introduction; Classes of computers; Defining computer architecture; Trends in Technology, power in Integrated Circuits and cost; Dependability; Measuring, reporting and summarizing Performance; Quantitative Principles of computer design.	

MODULE 2: PIPELINING	7Hrs
Introduction: Pipeline hazards; Implementation of pipeline; what makes pipelining hard to implement? ILP: Concepts and challenges; Basic Compiler Techniques for exposing ILP; Reducing Branch costs with prediction; Overcoming Data hazards with Dynamic scheduling; Hardware-based speculation.	
MODULE 3: INSTRUCTION –LEVEL PARALLELISM – 2	**8Hrs**
Exploiting ILP using multiple issues and static scheduling; Exploiting ILP using dynamic scheduling, multiple issue and speculation;Advanced Techniques for instruction delivery and Speculation; The Intel Pentium 4 as example	
MODULE 4: MULTIPROCESSORS AND THREAD –LEVEL PARALLELISM	**8Hrs**
Introduction; Symmetric shared-memory architectures; Performance of symmetric shared–memory multiprocessors; Distributed shared memory and directory-based coherence; Basics of synchronization; Models of Memory Consistency.	
MODULE 5: HARDWARE AND SOFTWARE FOR VLIW AND EPIC:	**8Hrs**
Introduction: Exploiting Instruction- Level Parallelism Statically; Detecting and Enhancing Loop-Level Parallelism; Scheduling and Structuring Code for Parallelism; Hardware Support for Exposing Parallelism: Predicated Instructions; Hardware Support for Compiler Speculation; The IntelIA-64 Architecture and Itanium Processor; Conclusions.	

TEXT BOOKS:

1. Computer Architecture, A Quantitative Approach – John L. Hennessey and David A. Patterson 4th Edition, Elsevier, 2007

REFERENCES:

1. Advanced Computer Architecture Parallelism, Scalability-Kai Hwang: Programmability, Tata McGrawhill, 2003.
2. Parallel Computer Architecture, A Hardware / Software Approach – David E. Culler Jaswinder Pal Singh, Anoop Gupta:, Morgan Kaufman, 1999.
3. Computer Organization and Architecture: Designing for performance, W. Stallings 4th Ed. PHI, 1996.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4610**					
TITLE OF THE COURSE	**BLOCKCHAIN AND DISTRIBUTED LEDGER**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-		-	39	3

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
***	***	***	***

COURSE OBJECTIVES:

- Learn the underlying principles and techniques associated with block chain Technologies.
- Understand and describe how blockchain works
- Familiarize with Ethereum, smart contracts and related technologies, and solidity language.
- Understand the application of Blockchain in various domains

COURSE OUTCOMES:

CO No.	Outcomes	Blooms Taxonomy Level
CO1	Describe the basic concepts and technology used for blockchain	L2
CO2	Explore the usage of Merkle tree, cryptography and mining in Blockchain	L2
CO3	Use smart contract in real world applications.	L3
CO4	Implement Ethereum block chain contract.	L3
CO5	Apply hyper ledger platform to implement the Block chain Application	L3
CO6	Apply the learning of solidity and de-centralized apps on Ethereum.	L3

COURSE CONTENT:	
MODULE 1: Introduction to Blockchain	8Hrs
Distributed systems, P2P network Architecture of Blockchain, Generic elements of a blockchain: How blockchain works, Benefits, features, and limitations of blockchain How blockchain accumulates blocks, types of blockchain, Distributed ledger, Consensus mechanisms-Proof of work, Proof of Stake, Proof of Authority, CAP theorem, Decentralization, Disintermediation, Ecosystem - Storage, Communication and Computation	

MODULE 2: Cryptography and Smart Contracts	8Hrs
Symmetric cryptography (DES, AES), Asymmetric cryptography, Public and Private keys, Algorithms - RSA, Hash functions, SHA, SHA-256 Smart contracts - Benefits of Smart contracts, Solidity Programming-Types, Literals, Enums, write basic program using Solidity, Compile, verify and deploy.	
MODULE 3: Ethereum Blockchain	8Hrs
The Ethereum network, Ethereum Virtual Machine Execution Environment, Opcodes and their meaning, Structure of a Block, Genesis Block, Merkle tree, Geth, Transactions, Transaction receipts, Nonce, Gas - gasPrice, gasLimit, Ether, Mining, Wallets, Ethereum network (main net, test net), Metamask	
MODULE 4: Ethereum Development	8Hrs
Infura, Web3.0 for Blockchain, Web3J -Java frontend, Creating Blockchain network and peering, Truffle - build contract, migrate and deploy, Ganache CLI	
MODULE 5: Hyperledger	7Hrs
Projects under Hyperledger, Hyperledger reference architecture, Hyperledger design principles, Hyperledger Fabric, Hyperledger Sawtooth, Case study: Blockchain in IoT	

TEXT BOOKS:

1. Mastering Blockchain, Third Edition, Published by Packt Publishing Ltd, Published 2020, Imran Bashir
2. Solidity Programming Essentials, First Edition, Published by Packt Publishing Ltd, April 2018 Blockchain for Dummies, Manav Gupta, IBM Limited Edition, John Wiley & Sons, Inc. 2017

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4611**					
TITLE OF THE COURSE	**MOBILE COMPUTING AND APPS DEVELOPMENT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	**	***

COURSE OBJECTIVES:

- To understand the basic concepts of mobile computing
- To learn the setup of Android development environment
- To illustrate the interaction of app with the user interface and handling various activities
- To identify the options for saving the persistent application data
- To gain knowledge about different mobile platforms and application development

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Create, test and debug Android application by setting up the Android development environment	L6
CO2	Implement adaptive and responsive user interfaces that work across various devices	L3
CO3	Demonstrate the techniques involved to store, share and retrieve data in Android applications	L2
CO4	Acquire technical competency and skills in developing applications using Android and cross-platform	L2

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO MOBILE COMPUTING	**7Hrs**
Introduction to mobile computing, Architecture of mobile network, Generations of mobile communication, mobile operating systems, Application of mobile communication, Challenges of mobile communication.	
MODULE 2	**8Hrs**
Introduction, trends, platforms, Android Development Setup like, Android Studio, Eclipse,	

Android SDK, tools. Emulator setup. App behavior on the Android Runtime (ART). Platform Architecture. Application framework and basic App Components resources. Hello World program in Android Studio	
MODULE 3: MOBILE APP DEVELOPMENT USING ANDROID	**9Hrs**
MOBILE APP DEVELOPMENT USING ANDROID: Android user Interface – Layouts (Linear, Absolute, Table, Relative, Frame and Scroll), values, asset XML representation, generate R.Java file, Android manifest file.Activities, Intent and UI Design - activities life-cycle. Android Components – layouts,fragments, basic views (Button, Edit Text, Check box, Toggle Button, Radio Button), list views, picker views, adapter views, Spinner views, Menu, Action Bar and Managing data using SQLite database (Database create, Read, Update and delete).	
MODULE 4 : MESSAGING AND LOCATION BASED SERVICES	**8Hrs**
Sending SMS and mail, Google Maps – Displaying Google Maps in Andriod application, Networking – How to connect to Web using HTTP, Publishing Android Applications – how to prepare application for deployment, exporting application as an APK file and signing it with new certificate, how to distribute new android application and publish android application on market place	
MODULE 5: DATA PERSISTENCE AND GOOGLE APIS FOR ANDROID:	**7Hrs**
Introduction of Google APIs for Android. SQLite Databases. CROSS-PLATFORM APP DEVELOPMENT - Introduction to Cross platform App Development - Difference to native apps, Pros and cons, Development tools.	

TEXT BOOKS:

1. Mobile Cloud Computing by Debashis De, CRC Press, Taylor & FrancisGroup
2. **Head First Android Development by Jonathan Simon O'reilly Publications**

REFERENCES:

1. **Learning Android by Marko Gargenta O'reilly Publications**
2. Jochen H. Schller, "Mobile Communications", Second Edition, Pearson Education,New Delhi, 2007.
3. Uwe Hansmann, LotharMerk, Martin S. Nicklons and Thomas Stober, "Principlesof Mobile Computing", Springer, 2003.
4. Erik Hellman, "Android Programming – Pushing the Limits", 1st Edition, WileyIndia Pvt Ltd, 2014
5. J F DiMarzio, "Beginning Android Programming with Android Studio", 4th Edition, Wiley India Pvt Ltd, 2016.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4612**					
TITLE OF THE COURSE	**SOFTWARE DEFINED NETWORKS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	***	**	***

COURSE OBJECTIVES:

- To understands the fundamentals of software defined networks.
- To understand the separation of the data plane and the control plane.
- To study about the SDN Programming and frameworks
- To study about the various real time applications of SDN

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Recognize the fundamentals and characteristics of Software Defined Networks	L1
CO2	Understand the basics of Software Defined Networks Operations and Data flow	L2
CO3	Discriminate different Software Defined Network Operations and Data Flow	L3
CO4	Apply different Software Defined Network Operations in real world problem	L4

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO SDN	**8Hrs**
Understanding the SDN, Understanding the SDN technology, Control Plane, Data Plane, Moving information between planes, separation of the control and data planes, Distributed control planes, Load Balancing, Creating the MPLS Overlay, Centralized control planes	
MODULE 2: Functionality of SDN	**8 Hrs**
Fundamental Characteristics of SDN, SDN Operations, SDN Devices, SDN Controllers, SDN Applications, Alternate SDN methods.	
MODULE 3: OPEN FLOW & SDN CONTROLLERS	**8Hrs**
Open Flow Specification – Drawbacks of Open SDN, SDN via APIs, SDN via Hypervisor Based Overlays – SDN via Opening up the Device – SDN Controllers – General Concepts	
MODULE 4: DATA CENTERS	**7 Hrs**
Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – NVGRE	
MODULE 5: SDN PROGRAMMING & FRAMEWORKS	**8 Hrs**
Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs – Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications. **Frameworks:** Juniper SDN Framework – IETF SDN Framework, Mininet etc	

TEXT BOOKS:

1. Paul Goransson and Chuck Black, Software Defined Networks: A Comprehensive Approach, First Edition, Morgan Kaufmann, 2014.
2. Thomas D. Nadeau, Ken Gray, ―SDN: Software Defined Networks, O'Reilly Media, 2013.

REFERENCE BOOKS:

1. Brian Underdahl and Gary Kinghorn- Software Defined Networking for Dummies brought you by cisco.
2. Siamak Azodolmolky, ―Software Defined Networking with Open Flow, Packet Publishing, 2013.
3. Vivek Tiwari, ―SDN and Open Flow for Beginners‖, Amazon Digital Services, Inc., 2013.
4. Fei Hu, Editor, ―Network Innovation through Open Flow and SDN: Principles and Design, CRC Press, 2014

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4613**					
TITLE OF THE COURSE	**MACHINE LEARNING FOR HEALTHCARE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- To introduce the students to healthcare domain and to make them understandand practice to use machine learning techniques to data in the healthcare domain

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Identify different problems in the healthcare industry that need solution	L4
CO2	Understand and be able to choose appropriate Machine learning technique that is suitable to solve the identified problem	L2
CO3	Build a framework of the solution	L6
CO4	Identify and Apply the Machine learning and deep learning algorithms which are more appropriate for various types of healthcare applications	L4

COURSE CONTENT:	
MODULE 1	**8Hrs**
Knowing Healthcare Industry: Overview of Healthcare & Life science Industry, Introduction to healthcare informatics, Key Components in Health care, Health Level Seven, Medical Standards and Coding Types, GlobalHealthcare Challenges and Trends; Past-Present-Future of AI&ML in Healthcare.	
MODULE 2	**9Hrs**
Advanced Analytics in Health Care: Overview of clinical care, Clinical Data, Data Types;Risk Stratification; Survival Modelling; Disease progression Modelling, Causal Inference, Re-enforcement learning in healthcare applications	
MODULE 3	**8Hrs**

Medical Image Diagnostics and NLP for healthcare: Medical Image modalities and management; ML applications in medical Ology space (cardiology, ophthalmology,dermatology, pathology, oncology, haematology, odontology, osteology, pulmonology); NLP for Healthcare: Payer Analytics – Insurance	
MODULE 4	**8Hrs**
Precision Medicine, Automating clinical workflow, Regulation of AI/ML, the challenge in deploying ML model, Public Health – Government, Provider Analytics, Care Management System, Wearabledevices and Medical Bots.	
MODULE 5	**6Hrs**
Applications of Machine learning models (Linear regression, SVM, Random forest.) and Deep learning models (CNN, RNN….) for the Healthcare area (Case study)	

TEXT BOOKS:

1. Sumeet Dua, U. Rajendra Acharya, Prerna Dua (Editors), Machine Learning in Healthcare Informatics, Intelligent Systems Reference Library 56, Springer,
2. Sergio Consoli, Diego ReforgiatoRecupero, Milan Petkovic (Editors), Data Science for Healthcare Methodologies and Applications

REFERENCES:

1. Thomas M. Deserno, Fundamentals of Bio-Medical Image processing, Biological and Medical Physics, Biomedical Engineering, Springer, ISBN 978-3-642-15816-2, 2011
2. Recent journal publications/white papers from companies
3. Other Video links

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4614**					
TITLE OF THE COURSE	**DEEP LEARNING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand the basic building blocks and general principles that allows one to design Deep learning algorithms
- To become familiar with specific, widely used Deep learning networks
- To introduce building blocks of Convolution neural network architecture
- To learn to use deep learning tools and framework for solving real-life problems

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand Building blocks of deep networks and Neural networks	L2
CO2	Understand the need and significance of mathematical fundamentals in Deep Learning to solve real-time problems.	L2
CO3	Identify and Apply the deep learning algorithms which are moreappropriate for various types of learning tasks in various domains	L3
CO4	Develop deep learning algorithms and solve real-world problems deep learning tools and framework	L6

COURSE CONTENT:	
MODULE 1: Introduction to Deep Learning	**8Hrs**
Introduction to Neural Networks: Single layer and Multilayer NN, training neural networks, activation functions, loss functions, Model Selection. Introduction to Deep Learning, Principles of Deep Networks and Building blocks of deep networks.	
MODULE 2	**7Hrs**
Mathematical background for Deep learning- Data Manipulation and Data Preprocessing, Linear Algebra,Calculus, Probability.	
MODULE 3	8**Hrs**

Forward Propagation, Backward Propagation, and Computational Graphs Layers and Blocks, shallow neural network, deep neural network, Optimization for Training Deep Models.	
MODULE 4	**8 Hrs**
ConvolutionalNeural Networks (CNNs) - Biological inspiration, Mapping of Human Visual System and CNN. Convolution operation, Convolutional Layers, Padding and Stride, Batch normalization and layers, Subsampling, Pooling.	
MODULE 5 Unsupervised Pretrained Networks (UPNs)- Autoencoders, Deep Belief Networks (DBNs) Introduction to Generative Adversarial Networks (GANs), Deep Learning Applications in Healthcare and other areas (Case study)	**8Hrs**

TEXT BOOKS:

1. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, "Dive into Deep Learning", Amazon Science, 2020
2. Josh Patterson and Adan Gibson, "Deep Learning a Practitioners Approach", July, 2018.

REFERENCES:

1 Tom Mitchell, Machine Learning, McGraw-Hill, 1997

2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", The MIT Press, 2016

3. François Chollet, "Deep Learning Python", Manning Publications, 2018

4. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, andTechniques to Build Intelligent Systems", O'Reilly Media; 1 edition (April 9, 2017)

5 "Neural Networks: A Comprehensive Foundation,"S. Haykin, 2ndEd, Prentice Hall of India, 2003.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4615**					
TITLE OF THE COURSE	**DIGITAL IMAGE PROCESSING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand and to become familiar with the fundamentals of Digital Image Processing.
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.	L3
CO2	Operate on images using the techniques of smoothing, sharpening and enhancement	L4
CO3	Understand the restoration concepts and filtering techniques.	L2
CO4	Learn the basics of segmentation, features extraction, compression and recognition methods for images.	L5

COURSE CONTENT:	
MODULE 1 : INTRODUCTION	**8 Hrs**
Overview of Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use Digital Image Processing, Fundamental Steps in Digital Image Processing, Components in Digital Image Processing System. **DIGITAL IMAGE FUNDAMENTALS** Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels.	

MODULE 2 : IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN	8 Hrs
Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering Smoothing (Lowpass) Spatial Filters, Sharpening (High-pass) Spatial Filters, High-pass, Band-reject, and Bandpass Filters from Lowpass Filters, Combining Spatial Enhancement Methods.	
MODULE 3: IMAGE ENHANCEMENT IN THE FREQUENCY DOMAIN	**8 Hrs**
Sampling and the Fourier Transform of Sampled Functions, The Discrete Fourier Transform of One Variable, Some Properties of the 2-D DFT and IDFT, The Basics of Filtering in the Frequency Domain, Image Smoothing Using Low Pass Frequency Domain Filters, Image Sharpening Using High-pass Filters, The Fast Fourier Transform.	
MODULE 4: IMAGE RESTORATION AND MORPHOLOGICAL IMAGE PROCESSING	**7 Hrs**
A Model of the Image Degradation/Restoration process, Noise Models, Restoration in the Presence of Noise Only—Spatial Filtering, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transform**,** Some Basic Morphological Algorithms.	
MODULE 5: IMAGE SEGMENTATION	**8 Hrs**
Point, Line, and Edge Detection, Thresholding, Segmentation by Region Growing and by Region Splitting and Merging, Region Segmentation Using Clustering and Super pixels, Region Segmentation Using Graph Cuts, Segmentation Using Morphological Watersheds, Case Study: The Use of Motion in Segmentation.	

TEXT BOOK:

1. Rafel C Gonzalez and Richard E. Woods, “Digital Image Processing”, 3rd Edition, Pearson Education, 2010.
2. A. K. Jain, “Fundamentals of Digital Image Processing”, Pearson, 2004.

REFERENCES:

1. Scott.E.Umbaugh, “Computer Vision and Image Processing”, Prentice Hall, 1997.
2. Kenneth R. Castleman, _Digital Image Processing‘, Pearson, 2006.
3. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, _Digital Image Processing using MATLAB‘, Pearson Education, Inc., 2011.
4. D,E. Dudgeon and RM. Mersereau, _Multidimensional Digital Signal Processing‘, Prentice Hall Professional Technical Reference, 1990.
5. William K. Pratt, _Digital Image Processing‘, John Wiley, New York, 2002
6. Milan Sonka et al _Image processing, analysis and machine vision‘, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4616**					
TITLE OF THE COURSE	**HUMAN COMPUTER INTERFACE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- Learn the foundations of Human Computer Interface
- Be familiar with the design technologies for individuals and persons with disabilities Be aware of mobile HCI
- Learn the guidelines for user interface

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explore the relationship between HCI, user experience design, human factors engineering, and psychology.	L2
CO2	Analyze the use of HCI in Software Development	L3

CO3	Explore emerging ideas in HCI research, such as context sensitive computing, gesture-based interaction, and social computing.	L3
CO4	Optimize the game development process using HCI	L3

COURSE CONTENT:	
MODULE 1: HCI INTRODUCTION	**7 Hrs**
The Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Historical evolution of HCI; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.	
MODULE 2: SOFTWARE PROCESS, MODELS AND THEORIES	**9 Hrs**
HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Cognitive models –Socio-Organizational issues and stake holder requirements – Communication and collaboration models. Keystroke level model (KLM), GOMS, CASE STUDIES. Shneiderman's eight golden rules; Norman's seven principles; Norman's model of interaction; Neilsen's ten heuristics with example of use.	
MODULE 3: GETTING STARTED WITH GAME DEVELOPMENT	**8 Hrs**
Create Folders- Importing Textures and Meshes- Configuring Meshes - Planning and Configuring Textures**-** Building Sprites - Importing Audio - Create Prefabs - Scene Building Lighting and Lightmapping - Building a Navigation Mesh.	
MODULE 4 : EVENT HANDLING & PLAYER CONTROLLER	**8 Hrs**
Event Handling – Notifications Manager – Send Message and Broadcast Message Character - Controllers and the First Person Controller - Beginning the Universal First Person Controller - Handling Cash Collection - Life and Death: Getting Started**.**	
MODULE 5: CONVERSATIONAL INTERFACE CASE STUDY	**6 Hrs**
Conversational Interfaces, IVR, Chatbot, ALEXIA, MONTANA and similar tools - Case Studies.	

TEXT BOOKS:

1. Alan Dix, Inc, Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, 3rd Edition, Pearson Education, 2004
2. Pro Unity Game Development with C#, Alan Thorn, Apress Berkeley, CA Publisher, ISBN 978-1-4302-6746-1, 2014.
3. Bill Scott and Theresa Neil, “Designing Web Interfaces”, First Edition, O‟Reilly, 2009

REFERENCES:

1. Interaction Design, beyond Human Computer Interaction”, by I Jennifer Preece, Yvonne Rogers, Helen Sharp, John Wiley & Sons.
2. Brian Fling, “Mobile Design and Development”, First Edition ,O‟Reilly Media Inc., 2009.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4617**					
TITLE OF THE COURSE	**UG Research Project-I/Product Development Foundation- I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	6	-	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To identify key research questions within a field to carry out research in a team
- To identify and summarize the literature review of the relevant field
- To demonstrate relevant referencing and inculcate new skills in various aspects of academic writing
- To demonstrate the knowledge and understanding of writing the publication/report
- To showcase the strong evidence on the clarity of the argument,understanding of the selected domain area and presentation of its technical information
- To detail description of the process of carrying out the independent research in written document along with results and conclusions with reference to the existing literature
- To analyze and synthesize the new research findings

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Draft of the Publication or Demonstration of the Proof-of-concept product, Draft of patent application	L6

COURSE CONTENT:

The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further. A degree of industrial input and involvement will be encouraged, and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.

All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from the conception to completion.

The following criteria will be checked by the department chairman to approve for the research proposal:

a. Department staff as course guide

1. Ability to provide research direction to the student in the chosen field of interest
2. Ability to design an appropriate research strategy and methodology tocarry out the research by student
3. Ability to provide and evaluate the strong literature review document forthe chosen research topic
4. Ability to train students on research paper / technical writing skills
5. Conduct reviews in regular time period and submit the evaluation todepartment chairman

b. Student Team

1. To be dedicated and committed to work on a new research topic bylearning new technical skills
2. To have fair knowledge on what is product development or research topic
3. To have constant interaction with allocated guide by providing weekly updates
4. To be committed to complete the project and submitting the technical paperwithin the stipulated time framed by the university

Evaluation:

There will be CIA evaluation as well as the Semester end evaluation of the work done. Itwill be done by a committee of senior researchers of the Department.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4618**					
TITLE OF THE COURSE	**COMPUTATIONAL GEOMETRY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- To understand problems in Computational Geometry and solve them using Randomized Algorithms

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the theory behind computational geometry	L2
CO2	Design and implement randomized techniques in solving real world problems specifically for Computational Geometry	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
Review of Randomized Quick Sort, Introduction to Computational Geometry: Range queries, Arrangements, Trapezoidal decompositions, Convex Polytopes, Voronoi Diagrams, Early deterministic algorithms: planar convex hulls, planar Voronoi diagrams.	
MODULE 2	**8Hrs**
Deterministic vs. Randomized algorithms, Incremental algorithms: Trapezoidal decompositions, Convex polytopes, Voronoi diagrams.	
MODULE 3	**8Hrs**

Dynamic algorithms: Trapezoidal decompositions, Voronoi diagrams, Dynamic Shuffling, Random Sampling: Top down sampling, Bottom up sampling, Dynamic sampling, more dynamic algorithms	
MODULE 4	**7Hrs**
Randomized approximation schemes, The DNF counting problem, Approximating the Permanent, Volume Estimation.	
MODULE 5	**8Hrs**
Delaunay Triangulations Triangulations of Planar Point Sets, The Delaunay Triangulation, Properties of the Delaunay Triangulation, A randomized incremental algorithm for computing the Delaunay Triangulation , Interval Trees, Priority Search Trees, Segment Trees, Interval Trees, Priority Search Trees, Segment Trees	

TEXT BOOKS :

1. K. Mulmuley, “Computational Geometry, an introduction through randomizedalgorithms”, Printice Hall, 1994.

REFERENCES:

1. R. Motwani and P. Raghavan, “Randomized Algorithms”, Cambridge Press, 1995
2. J. Hromkovic, “Design and analysis of randomized algorithms”, Springer Verlag, 2005.
3. M. Mitzenmacher and E. Upfal, “Probability and computing: Randomized algorithms and Probabilistic analysis”, Cambridge, 2005

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4619**					
TITLE OF THE COURSE	**GAME THEORY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	***	****

COURSE OBJECTIVES:

- To provide a foundation of game theory to help students apply game theory to problem solving in a rigorous way.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Understand the fundamental concepts of non-cooperative and co-operative game theory, in particular standard game models and solution concepts.	L2
CO2	Understand a variety of advanced algorithmic techniques and complexity results for computing game-theoretic solution concepts (equilibria).	L2
CO3	Apply solution concepts, algorithms, and complexity results to unseen games that are variants of known examples	L3
CO4	Understand the state of the art in some areas of algorithmic research, including new developments and open problems.	L2

COURSE CONTENT:

MODULE 1: INTRODUCTION	8Hrs
Game Theory, Games and Solutions Game Theory and the Theory of Competitive Equilibrium, Rational Behavior, The Steady State and Deductive Interpretations, Bounded Rationality Terminology and Notation Nash Equilibrium- Strategic Games, Nash Equilibrium Examples Existence of a Nash Equilibrium, Strictly Competitive Games, Bayesian Games: Strategic Games with Imperfect Information	
MODULE 2: MIXED, CORRELATED, AND EVOLUTIONARY EQUILIBRIUM	**8Hrs**
Mixed Strategy Nash Equilibrium Interpretations of Mixed Strategy Nash Equilibrium Correlated Equilibrium Evolutionary Equilibrium Rationalizability and Iterated Elimination of Dominated Actions-Rationalizability Iterated Elimination of Strictly Dominated Actions, Iterated Elimination of Weakly Dominated Actions	
MODULE 3: KNOWLEDGE AND EQUILIBRIUM	**7Hrs**
A Model of Knowledge Common Knowledge, Can People Agree to Disagree, Knowledge and Solution Concepts, The Electronic Mail Game	
MODULE 4: EXTENSIVE GAMES WITH PERFECT INFORMATION	**7Hrs**
Extensive Games with Perfect Information Subgame Perfect Equilibrium Two Extensions of the Definition of a Game the Interpretation of a Strategy, Two Notable Finite Horizon Games Iterated Elimination of Weakly Dominated Strategies Bargaining Games -Bargaining and Game Theory, A Bargaining Game of Alternating Offers Subgame Perfect Equilibrium Variations and Extensions.	
MODULE 5: REPEATED GAMES	**9Hrs**
The Basic Idea Infinitely Repeated Games vs. Finitely Repeated Games Infinitely Repeated Games: Definitions Strategies as Machines Trigger Strategies: Nash Folk Theorems Punishing for a Limited Length of Time: A Perfect Folk Theorem for the Limit of Means Criterion Punishing the Punisher: A Perfect Folk Theorem for the Overtaking Criterion Rewarding Players Who Punish: A Perfect Folk Theorem for the Discounting Criterion The Structure of Subgame Perfect Equilibria Under the Discounting Criterion Finitely Repeated Game.	

TEXT BOOK:

1. Martin J. Osborne, Ariel Rubinstein. A Course in Game Theory. The MIT Press, August 1994.
2. Y. Narahari. Game Theory and Mechanism Design, IISc Press and the World Scientific Publishing Company, March 2014

REFERENCES:

1. Andrés Perea, Epistemic Game Theory: Reasoning and Choice. Cambridge: Cambridge University, July 2012.
2. Michael Maschler, Eilan Solan, and Schmuel Zamir. Game Theory. Cambridge University Press, 2013.
3. Roger B. Myerson. Game Theory: Analysis of Conflict. Harvard University Press, September 1997

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4620**					
TITLE OF THE COURSE	**DATA SCIENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

- To Understand the concept of Data Preprocessing and Transformation
- To use statistical and computational techniques to Discover, Analyze, Visualize andPresent Data
- To analyse the data using visual & summary analytics and common probability distributions
- To acquire the knowledge about building and interpreting regression models and classification with one or more predictors
- To Applying Unsupervised learning approach to the applications

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Apply statistical techniques to preprocess data and perform exploratory data analysis.	L3
CO2	Understand and be able to use appropriate statistical andmachine learning modeling techniques for data analysis and Modeling	L2
CO3	Use data visualization techniques for exploratory dataanalysis and communicating the results	L3
CO4	Evaluate and improve performance of Models	L5
CO5	Use appropriate python libraries for data preprocessing, analysis, modeling and visualization	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**

Overview of the Data Science process. Statistical thinking in the age of big data – Population and Samples, Measures of central tendencies, variability, hypothesistesting, correlation, statistical models and inference. Basic Python constructs and data structures, Jupyter Notebooks	
MODULE 2	**8Hrs**
Data Preprocessing: Data Cleaning - Missing values, Noisy data, Data cleaning process, data Reduction: Principal Components Analysis, Data Transformation: Strategies Overview, Data Transformation by normalization, Discretization by binning. Introduction to Pandas for Data Wrangling.	
MODULE 3	**8Hrs**
Exploratory Data Analysis and Data Visualization with Python: Introduction, Scatter Plots, Histogram, Box Plots, Violin Plot, Heat Map, waffle charts, word clouds, attractive regression plots. Visualizing geospatial data using Folium. choropleth maps. Case Study: Let my dataset change your mindset by Dr HansGosling.	
MODULE 4	**7 Hrs**
Basic Machine Learning Algorithms – Linear Regression, k-nearest neighbors, k- means,decision trees, naïve Bayes	
MODULE 5	**8Hrs**
Model Evaluation: Confusion Matrix, Evaluation Measures. Comparing Classifiers based on cost-benefit and ROC curves. Improving Classifier accuracy: Ensemble Methods, Bagging and Boosting. **Capstone Project**	

TEXT BOOKS:

1. Cathy O'Neil and Rachel Schutt, Doing Data Science, O'reilly Publications,2014
2. Jiawei Han, MichelineKember and Jian Pei, Data Mining Concepts and Techniques, 3rd edition, Elsevier,2012

REFERENCES:

1. Jake VanderPlas, Python Data Science Handbook – Essential tools for working with data, O'Reilly,2016
2. Data Science and Big Data Analytics, Wiley Publications,2015
3. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd edition),Springer,2008

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4621**					
TITLE OF THE COURSE	**BIG DATA ANALYTICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES

- **To optimize business decisions and create competitive advantage with Big Data analytics**
- **To explore the fundamental concepts of big data analytics**
- **To learn to analyze the big data using intelligent techniques**
- **To understand the various search methods and visualization techniques.**
- **To learn to use various techniques for mining data stream**
- **To understand the applications using Map Reduce Concepts**
- **To introduce programming tools PIG & HIVE in Hadoop eco system.**

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Understand big data platform and explore the big data analytics techniques business applications.	L2
CO2	Apply and Build a complete business data analytics solution	L3
CO3	Explore on Big Data applications Using Pig and Hive	L6
CO4	Analyze the HADOOP and Map Reduce technologies associated with big data analytics	L4

COURSE CONTENT:	
MODULE 1: Introduction to big data	**8 Hrs**
Introduction to Big Data Platform – Characteristics of big data-Data in the warehouse and data in Hadoop- Importance of Big data, Challenges of Conventional Systems, Analytic Processes and Tools - Analysis vs reporting, Introduction To Streams Concepts – Stream	

Data Model and Architecture - Stream Computing	
MODULE 2: Hadoop	**7 Hrs**
History of Hadoop, Hadoop Distributed File System (HDFS) , Introducing and Configuring Hadoop cluster (Local, Pseudo-distributed mode, Fully Distributed mode), Configuring XML files. Comparison between Hadoop1 and Hadoop2	
MODULE 3: Pig	**8 Hrs**
Hadoop Programming Made Easier, Admiring the Pig Architecture, Data processing operators in Pig, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Evaluating Local and Distributed Modes of Running Pig Scripts, Checking out the Pig Script Interfaces, Scripting with Pig Latin	
MODULE 4: Hive	**8 Hrs**
Applying Structure to Hadoop Data with Hive: Saying Hello to Hive, Seeing How the Hive is Put Together, Getting Started with Apache Hive, Examining the Hive Clients, Working with Hive Data Types, Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works, HiveQL – Querying Data in Hive	
MODULE 5: HBase	**8 Hrs**
Fundamentals of HBase and ZooKeeper, Predictive Analytics- Simple linear regression- Multiple linear regression- Visualizations - Visual data analysis techniques, IBM InfoSphere BigInsights and Streams	

TEXT BOOK:

1. **Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.**

REFERENCE BOOKS

1. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data:
Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
2. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with
Advanced Analytics", John Wiley& sons, 2012.
3. Pete Warden, "Big Data Glossary", O'Reilly, 2011.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4622**					
TITLE OF THE COURSE	**SEMANTIC WEB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	***	****

COURSE OBJECTIVES:

- To Introduce Semantic Web Vision
- Understanding about XML, RDF, RDFS, OWL
- To learn Querying Ontology
- To explore Ontology Reasoning
- To know the Migration from Document to Data Web

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Discuss semantic web vision and technologies	L2
CO 2	Demonstrate the knowledge of ontology	L3
CO 3	Describe the various query languages	L2
CO 4	Analyze ontology engineering approaches in semantic applications	L 3
CO 5	Demonstrate the knowledge of SPARQL and search optimization for semantic searching on web.	L3

COURSE CONTENT:	
MODULE 1: The Semantic Web Vision and Structured Web Documents in XML	**9 Hrs**
Today's web, from Today's Web to the Semantic web, Semantic Web Technologies, A Layered Approach. **Structured Web Documents in XML**: Introduction, XML, Structuring, Namespaces, Addressing and querying XML document, Processing.	
MODULE 2: Describing Web Resources: RDF	**9 Hrs**

Introduction, RDF: Basic Ideas, RDF: XML-Based Syntax, RDF serialization, RDF Schema: Basic Ideas, RDF Schema: The Language, RDF and RDF Schema in RDF Schema.	
MODULE 3: Web Ontology Language: OWL	**9Hrs**
Introduction, OWL and RDF/RDFS, Three Sublanguages of OWL, Description of the OWL Language, Layering of OWL, Examples, OWL in OWL.	
MODULE 4: Query Languages	**6Hrs**
SPARQL: Query Language for RDF, Conjunctive Queries for OWL DL	
MODULE 5: Applications	**6Hrs**
Introduction, Horizontal information products from Elsevier, Data integration at Boeing (and elsewhere), Skill-finding at Swiss Life, Thinktank portal at EnerSearch, eLearning, Web Services.	

TEXT BOOKS:

1. A Semantic Web Primer by Grigoris Antoniou Frank van Harmelen, The MIT Press Cambridge.
2. Foundation of Semantic Web Technologies, Pascal Hitzler, Markus and Sebastian.

REFERENCES:

1. Michael C. Daconta, Leo J. Obrst, and Kevin T. Smith, "The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Fourth Edition, Wiley Publishing, 2003.
2. John Davies, Rudi Studer, and Paul Warren John, "Semantic Web Technologies: Trends and Research in Ontology-based Systems", Wiley and Son's, 2006.
3. John Davies, Dieter Fensel and Frank Van Harmelen, "Towards the Semantic Web: Ontology-Driven Knowledge Management", John Wiley and Sons, 2003.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS4623**					
TITLE OF THE COURSE	**COMPUTATIONAL METHODS IN NEUROSCIENCE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand encoding and decoding in the neural context
- To analyze the single-compartment model
- To analyze the integrate-and-fire model of a neuron
- To perform basic simulations in MATLAB

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand encoding and decoding in the neural context	L2
CO2	Analyze the single-compartment model	L3

CO3	Analyze the integrate-and-fire model neuron	L3
CO4	Perform basic neural simulations in MATLAB	L5

COURSE CONTENT:	
MODULE 1: NEURAL ENCODING	**8 Hrs**
Introduction – Spike Trains and Firing Rates – What Makes a Neuron Fire? – Spike Train Statistics – The Neural Code	
MODULE 2: NEURAL DECODING	**7 Hrs**
Encoding and Decoding – Discrimination – Population Decoding – Spike-Train Decoding	
MODULE 3: MODEL NEURONS 1: NEUROELECTRONICS	**8 Hrs**
Introduction – Electrical Properties of Neurons – Single-Compartment Models – Integrate and-Fire Models – Voltage-Dependent Conductances – The Hodgkin-Huxley Model – Modeling Channels – Synaptic Conductances – Synapses on Integrate-and-Fire Neurons MATLAB Simulations	
MODULE 4: MODEL NEURONS 2	**8 Hrs**
CONDUCTANCES AND MORPHOLOGY Levels of Neuron Modeling – Conductance-Based Models – The Cable Equation – Multi Compartment Models – MATLAB Simulations	
MODULE 5: NETWORK MODELS	**8 Hrs**
Introduction – Firing-Rate Models – Feedforward Networks – Recurrent Networks – Excitatory-Inhibitory Networks – Stochastic Networks	

TEXT BOOK:

1. Dayan, P., & Abbott, L. F. (2005). Theoretical neuroscience: computational and mathematical modeling of neural systems. MIT press.

SEMESTER	**VI**					
YEAR	**IV**					
COURSE CODE	**20CS4624**					
TITLE OF THE COURSE	**QUANTUM COMPUTATION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To apply techniques of linear algebra to quantum mechanics
- To analyze basic quantum circuits
- To explore the techniques of quantum communication
- To study the protocols of quantum cryptography

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Apply techniques of linear algebra to quantum mechanics problems	L3
CO2	Analyze basic quantum circuits	L4

CO3	Explore the techniques of quantum communication	L2
CO4	Study the protocols of quantum cryptography	L2

COURSE CONTENT:	
MODULE 1: LINEAR ALGEBRA REVIEW	**9 Hrs**
Bases and Linear Independence, Linear Operators and Matrices, Inner Products Eigen Vectors and Eigen Values, Adjoints and Hermitian Operators, Tensor Products, vii. Operator Functions, viii. Commutator and Anti-Commutator	
MODULE 2: QUANTUM MECHANICS	**8 Hrs**
State Space, Evolution, Measurement, Distinguishing Quantum States, Projective Measurements and POVMs	
MODULE 3: QUANTUM GATES AND ALGORITHMS	**7 Hrs**
Universal set of gates, quantum circuits, Solovay-Kitaev theorem, Deutsch-Jozsa algorithm, Shor's factoring, Grover Algorithm and HHL Algorithm	
MODULE 4 : QUANTUM COMMUNICATION	**8 Hrs**
Overview of Quantum Operations, Quantum Noise , Distance Between Quantum States, Accessible Information , Data Compression , Classical Information Over Quantum Channels , Quantum Information Over Quantum Channels , Entanglement as a Physical Resource	
MODULE 5 : QUANTUM CRYPTOGRAPHY	**8 Hrs**
Private Key Cryptography, Privacy Amplification, Quantum Key Distribution, Privacy and Coherent Information, Security of Quantum Key Distribution	

TEXT BOOK:

1. Nielsen, M. A., & Chuang, I. (2002). Quantum computation and quantum information.

REFERENCES:

1. Phillip Kaye, Raymond Laflamme et. al., An introduction to Quantum Computing, Oxford University press, 2007.
2. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press, Cambridge, 2020

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4702**					
TITLE OF THE COURSE	**ADVANCED DRIVING ASSISTANCE SYSTEMS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To apply the concepts, technologies, and components of Advanced Driving Assistance Systems
- To make use of a knowledge of sensors, planning, and control algorithms for autonomous vehicles
- To determine the operating system reliability and security of client systems in ADAS
- To discover the cloud platform architecture and services used with ADAS technology
- To improve the practical experience in developing ADAS components and evaluating their performance

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	**Utilize** the principles and technologies behind autonomous driving and advanced driver assistance systems	L3
CO2	**Develop** a solid understanding of localization, prophecy, and routing algorithms used in autonomous vehicles	L6
CO3	**Survey** the client's complex system and safety considerations involved in autonomous driving.	L4
CO4	**Derive** the distributed infrastructure with relevant software tools	L5

	and simulation environments for autonomous driving.	
CO5	**Examine** the various application and design requirements of autonomous driving technology	L4

COURSE CONTENT:	
MODULE 1 - INTRODUCTION TO AUTONOMOUS DRIVING	**7 Hrs**
Autonomous Driving Technologies Overview, Autonomous Driving Algorithms, Autonomous Driving Client System: Robot Operating System, Hardware Platform, Autonomous Driving Cloud Platform: Simulation, HD Map Production.	
MODULE 2 - AUTONOMOUS VEHICLE LOCALIZATION, PREDICTION, AND ROUTING	**8 Hrs**
Localization with GNSS, Localization with LiDAR and High-definition maps, Planning and Control in a broader sense, Traffic prediction introduction, Lane Level Routing: Constructing a weighted directed graph for routing, Typical Routing Algorithms.	
MODULE 3 - CLIENT SYSTEMS FOR AUTONOMOUS DRIVING	**8 Hrs**
Autonomous driving: A complex system, Operating System for Autonomous Driving, System Reliability, Resource Management and Security, Computing Platform, Computer Architecture Design Exploration.	
MODULE 4 - CLOUD PLATFORM FOR AUTONOMOUS DRIVING	**9 Hrs**
Introduction, Infrastructure, Distributed Computing Framework, Distributed Storage, Heterogeneous Computing, Simulation, HD Map generation.	
MODULE 5 – CASE STUDY	**7 Hrs**
Applications/design requirements specifications of Autonomous vehicles (Aerial, under water, ground vehicles), Unmanned aerial vehicles, Google self driving cars.	

TEXT BOOKS:

1. Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, “Creating Autonomous Vehicle Systems”, Morgan and Claypool, 2018.
2. Hong Cheng, “Autonomous Intelligent Vehicles Theory, Algorithms, and Implementation”, Springer, 2011

REFERENCES:

1. Hermann Winner, Stephan Hakuli, Felix Lotz, Christina Singer, “Handbook of Driver Assistance Systems - Basic Information, Components and Systems for
2. Active Safety and Comfort”, Springer Reference
3. Umit Ozguner, Tankut Acarman, Keith Redmill, “Autonomous Ground Vehicles”, Artech House, 2011.
4. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, “Global Navigation Satellite Systems, Inertial Navigation, and Integration”, Third Edition, John Wiley and Sons, 2013.

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4703**					
TITLE OF THE COURSE	**WIRELESS NETWORKS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES :

- Understand the architecture and applications of current and next generation wireless networks
- Get a basic introduction to the key concepts and techniques underlying modern physical layer wireless and mobile communications
- Learn how to design and analyze various medium access and resource allocation techniques
- Learn how to design and analyze network layer routing protocols, along with key component mechanisms
- Learn to design and analyze transport layer protocols

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	**Use** mathematics concept of probability theory and queuing theory for mobile ad-hoc and sensor networks.	L3
CO2	**Implement** various medium access and resource allocation techniques like CSMA, and Error CSMA/CD, CSMA/CA control techniques.	L3
CO3	**Execute** Multiple division techniques and Static and dynamic channel allocation techniques.	L3
CO4	**Compare** principles of the modern mobile and wireless communication systems such as 5G with 3G/4G.	L4

COURSE CONTENT:	
MODULE 1	**7Hrs**

Introduction, Fundamentals of cellular systems, mobile ad-hoc and sensor networks, wireless PAN/LAN/MAN. Overview of probability theory, traffic theory, queuing theory, and discrete event driven simulations.	
MODULE 2	**8Hrs**
Mobile radio propagation, multi-path propagation, path loss, slow fading, fast fading. Channel coding and Error Control Techniques. Cellular concept, frequency reuse, cell splitting, cell sectoring. Multiple radio access protocols, CSMA, CSMA/CD, CSMA/CA and standards.	
MODULE 3	**8Hrs**
Multiple division techniques: FDMA, TDMA, CDMA, OFDM, SDMA. Static and dynamic channel allocation techniques. Mobile Communication Systems: Registration, Roaming, Multicasting, Security and Privacy.	
MODULE 4	**8Hrs**
Ad-hoc networks, routing in MANETs. Wireless sensor networks, MAC protocols for wireless sensor networks, routing in sensor networks. Wireless PAN (Bluetooth), Wireless LAN (Wi-Fi), Wireless MAN (WiMAX)	
MODULE 5	**8Hrs**
Introduction – 5G vision – 5G features and challenges – Applications of 5G – 5G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.	

TEXT BOOKS:

1. Dharma Prakash Agrawal and Qing-An Zeng, Introduction to Wireless and Mobile Systems, Tomson, 2010, 3rd edition
2. William Stallings, "Wireless Communications and networks" Pearson / Prentice Hall of India, 2nd Ed., 2007.

REFERENCES:

1. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, “3G Evolution HSPA and LTE
   for Mobile Broadband”, Second Edition, Academic Press, 2008
2. Vijay K. Grag and Joseph E. Wilkes, Wireless and Personal Communications Systems, 1996.
3. Christian Huitema, Routing in the Internet, Prentice Hall, 1995.
4. Gary. S. Rogers & John Edwards, “An Introduction to Wireless Technology”, Pearson Education, 2007

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4704**					
TITLE OF THE COURSE	**CRYPTOGRAPHY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES:

- Understand OSI security architecture and classical encryption techniques. Acquire fundamental knowledge on the concepts of finite fields and number theory
- To understand the various cryptographic concepts and algorithms
- To understand the underlying mathematical structures of cryptographic algorithm
- To get an overview of the various applications of the cryptographic algorithms and implement them in mini project.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	**Use** basic concepts of encryption, decryption and mathematics associated with cryptography to solve cryptographic problems	L3
CO2	**Apply** basic, intermediate and advanced protocols to design cryptographic algorithms and techniques	L3
CO3	**Implement** cryptographic algorithms and techniques MD5, SHA, RSA, Diffie Hellma using modern mathematics for security applications	L3
CO4	**Analyze** the various cryptographic techniques to solve real world security based problems using modern tools: Metasploit, Wireshark, Burpsuite, Nmap	L4

COURSE CONTENT:	
MODULE 1	**7Hrs**

Introduction &Number Theory `

Services, Mechanisms and attacks-the OSI security architecture-Network security model-Classical Encryption techniques (Symmetric cipher model, substitution techniques, transposition techniques, steganography).

Finite fields and number theory: Overview of Groups, Rings, Fields-Modular arithmetic-Euclid's algorithm. Finite fields- Polynomial Arithmetic –Prime numbers, Fermat's and Euler's theorem- Testing for primality -The Chinese remainder theorem- Discrete logarithms.

MODULE 2	**7Hrs**

Cryptographic Protocols

Foundations – Protocol Building Blocks - Basic Protocols - Intermediate Protocols – Advanced Protocols – Zero Knowledge Proofs - Zero-Knowledge Proofs of Identity -Blind Signatures - Identity-Based Public-Key Cryptography -Oblivious Transfer - Oblivious Signatures – Esoteric Protocols.

MODULE 3	**9Hrs**

Cryptographic Techniques

Key Length - Key Management - Electronic Codebook Mode - Block Replay - Cipher Block Chaining Mode – Stream Ciphers - Self-Synchronizing Stream Ciphers - Cipher-Feedback Mode - Synchronous Stream Ciphers – Output Feedback Mode - Counter Mode - Choosing a Cipher Mode - Interleaving - Block Ciphers versus Stream Ciphers -Choosing an Algorithm - Public-Key Cryptography versus Symmetric Cryptography - Encrypting Communications Channels -Encrypting Data for Storage - Hardware Encryption versus Software Encryption - Compression, Encoding and Encryption - Detecting Encryption – Hiding and Destroying Information.

MODULE 4	**7Hrs**

Cryptographic Algorithms

Information Theory - Complexity Theory - Number Theory - Factoring - Prime Number Generation – Discrete Logarithms in a Finite Field - Data Encryption Standard (DES) – Lucifer - Madryga - NewDES - GOST – 3 Way – Crab– RC5 - Double Encryption - Triple Encryption - CDMF Key Shortening - Whitening.

MODULE 5	**9Hrs**

Cryptographic Algorithms Design and Applications

Symmetric Algorithms (Pseudo-Random-Sequence Generators and Stream Ciphers – RC4 - SEAL - Cipher Design - N-Hash - MD4 - MD5 - MD2 - Secure Hash Algorithm (SHA) - One- Way Hash Functions Using Symmetric Block Algorithms)

Asymmetric Algorithms Using Public-Key Algorithms -Message Authentication Codes. RSA - Pohlig-Hellman - McEliece - Elliptic Curve Cryptosystems -Digital Signature Algorithm (DSA) - Gost Digital Signature Algorithm - Discrete Logarithm Signature Schemes – Ongchnorr - Shamir - Diffie-Hellman - Station-to-Station Protocol -Shamir's Three-Pass Protocol – IBM Secret-Key Management Protocol – Kerberos

Case study: IBM Common Cryptographic Architecture.

TEXT BOOKS:

1. Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, John Wiley & Sons, Inc, 2nd Edition, 2007.
2. William Stallings, Cryptography and Network Security, 6th Edition, Pearson Education, 2013

REFERENCES:

1. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata McGraw Hill, 2007.
2. Man Young Rhee, "Internet Security: Cryptographic Principles", "Algorithms and Protocols", Wiley Publications, 2003.
3. Charles Pfleeger, "Security in Computing", 4th Edition, Prentice Hall of India, 2006.
4. Ulysess Black, "Internet Security Protocols", Pearson Education Asia, 2000.
5. Charlie Kaufman and Radia Perlman, Mike Speciner, "Network Security, Second Edition, Private Communication in PublicWorld", PHI 2002.
6. Bruce Schneier and Neils Ferguson, "Practical Cryptography", First Edition, Wiley Dreamtech
   India Pvt Ltd, 2003.
7. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security", Prentice Hall of
   India, 2002.
8. AtulKahate, Cryptography and Network Security, Tata McGrew Hill, 2003.
9. Wenbo Mao, Modern Cryptography Theory and Practice, Pearson Education, 2004.

SEMESTER	**VII**					
YEAR	**III**					
COURSE CODE	**20CS4705**					
TITLE OF THE COURSE	**NATURAL LANGUAGE PROCESSING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**		****

COURSE OBJECTIVES:

1. To understand the algorithms available for the processing of linguistic information andcomputational properties of natural languages
2. To conceive basic knowledge on various morphological, syntactic and semantic NLP task
3. To understand machine learning techniques used in NLP,
4. To write programs in Python to carry out natural language processing

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Use** mathematics concept of regular expression and NLP text processing techniques including lemmatization, stop word, tokenization, stemming and spelling error correction for text processing	L2
CO2	**Categorize** words in the text using n-grams, Part-of-speech tagging for information extraction.	L3
CO3	**Implement** RNN, LSTM and learning algorithms for NLP with transformer Architectures for Language Modeling	L4
CO4	**Implement** machine learning algorithms for text data classification. Machine translation using Case study for Spam detection, consumer complaint classification.	L4
CO5	**Create** scripts and applications in Python to implement concepts of natural language processing used for text processing, categorization and classification.	L5

COURSECONTENT:	
MODULE1: Introduction	**7 Hrs**
Past, present and future of NLP; Classical problems on text processing; Necessary Math concepts for NLP;Regular expressions in NLP; Basic text processing: lemmatization, stop word, tokenisation, stemming, Spelling errors corrections– Minimum edit distance, Bayesian method	
MODULE2: Words & Sentences	**8 Hrs**
N-grams: Simple unsmoothed n-grams; smoothing, backoff, spelling correction using N-grams, Metrics toevaluate N-grams; Parts of Speech tagging: Word classes, POST using Brill's Tagger and HMMs; nformation Extraction: Introduction to Named Entity Recognition and Relation Extraction WordNet and WordNet based similarity measures, Concept Mining using Latent Semantic Analysis	
MODULE3: Sequence to sequence & Language Modelling	**8 Hrs**
Word embedding: skip-gram model, BERT; Sequence to sequence theory and applications, Attention theory and teacher forcing; Language Modelling: Basic ideas, smoothing techniques, Language modelling with RNN and LSTM;	
MODULE4: ML for NLP	**8 Hrs**
Classification- binary and multiclass, clustering, regression for text data processing; Machine translation: rule-based techniques, Statistical Machine Translation (SMT); Spam detection, consumer complaint classification.	
MODULE 5: Hidden Markov models and Hands on Practices	**8 Hrs**
Hidden Markov models: Morkov chains, likelihood Computation, Semantic Analyzer, Text summarization.Self-Learn & Hands on practice: Python libraries supporting NLP; Hands on Data collection - from social network platforms, pdfs, wordfiles, json, html, Parsing text using regular expression; scraping data from web; Text processing: convert to lowercase, remove punctuation, remove stop words, standardising text, tokenising, stemming, lemmatising.	

TEXT BOOKS :

1. Daniel Jurafsky and James H. Martin. 2009. Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics. 2nd edition. Prentice-Hall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural LanguageProcessing. MIT Press.

REFERENCES :

1 Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning,Release 0.16.0, Jan 2021

2. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT press, 2016.(deeplearningbook.org)

3. Lecture Notes | Advanced Natural Language Processing | Electrical Engineering and computerScience | MIT OpenCourseWare
4 Akshay Kulkarni, Adarsha Shivananda, "Natural Language processing Recipes - Unlocking Text Data with Machine Learning and Deep Learning using Python". ISBN-13 (pbk): 978-1- 4842-4266-7 ISBN-13 (electronic): 978-1-4842-4267-4 https://doi.org/10.1007/978-1-4842-4267-4
5 Palash Goyal, Sumit Pandey, Karan Jain, Deep Learning for Natural Language Processing - Creating Neural Networks with Python. ISBN-13 (pbk): 978-1-4842- 3684-0 ISBN-13 (electronic): 978-1-4842-3685-7, https://doi.org/10.1007/978- 1-4842-3685-7

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4706**					
TITLE OF THE COURSE	**PATTERN RECOGNITION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES :

- Numerous examples from machine vision, speech recognition and movement recognition have been discussed as applications.
- Unsupervised classification or clustering techniques have also been addressed in this course.
- Analytical aspects have been adequately stressed so that on completion of the course the students can apply the concepts learnt in real life problems.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Identify feature extraction techniques and representation of patterns in feature space.	L2
CO2	Use statistical, nonparametric and neural network techniques for pattern recognition.	L3
CO3	Use techniques for recognition of time varying patterns.	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
INTRODUCTION AND STATISTICAL PATTERN RECOGNITION **Introduction:** Feature extraction and Pattern Representation, Concept of Supervised and Unsupervised Classification, Introduction to Application Areas. Statistical Pattern Recognition: Bayes Decision Theory, Minimum Error and Minimum Risk Classifiers, Discriminant Function and Decision Boundary, Normal Density, Discriminant Function for Discrete Features, Parameter Estimation.	
MODULE 2	**8Hrs**
DIMENSIONALITY PROBLEM AND NONPARAMETRICPATTERN CLASSIFICATION Dimensionality Problem: Dimension and accuracy, Computational Complexity, Dimensionality Reduction, Fisher Linear Discriminant, Multiple Discriminant Analysis. Nonparametric Pattern Classification: Density Estimation, Nearest Neighbour Rule, Fuzzy Classification	
MODULE 3	**8Hrs**
LINEAR DISCRIMINANT FUNCTIONS Linear Discriminant Functions: Separability, Two Category and Multi Category Classification, Linear Discriminators, Perceptron Criterion, Relaxation Procedure, Minimum Square Error Criterion, Widrow-Hoff Procedure, Ho-Kashyap Procedure Kesler's Construction	
MODULE 4	**8Hrs**
NEURAL NETWORK CLASSIFIER AND TIME VARYING PATTERN RECOGNITION Neural Network Classifier: Single and Multilayer Perceptron, Back Propagation Learning, Hopfield Network, Fuzzy Neural Network Time Varying Pattern Recognition: First Order Hidden Markov Model, Evaluation, Decoding, Learning	
MODULE 5	**7Hrs**
UNSUPERVISED CLASSIFICATION Unsupervised Classification: Clustering, Hierarchical Clustering, Graph Based Method, Sum of Squared Error Technique, Iterative Optimization	

TEXT BOOKS :

1. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons, 2001
2. Earl Gose, Richard Johsonbaugh and Steve Jost, "Pattern Recognition and Image

Analysis", Prentice Hall, 1999.

REFERENCES :

1. Robert J.Schalkoff, Pattern Recognition Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 1992.
2. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4707**					
TITLE OF THE COURSE	**SEQUENCE NETWORKS AND GAN**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES:

- Provide technical details about sequence networks
- Learn the fundamentals of Generative Adversarial Networks.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Design and implement efficient algorithms using Deep networks and GANs.	L3
CO2	Train and build models to develop real world Machine learning based applications and products.	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
Introduction to Deep Learning: Evolution**,** Sigmoid activation, ReLU, ELU, Stochastic Gradient Descent**,** Learning rate tuning, Regularization, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN) and Long Short Term Memory (LSTM) Networks, Discriminative versus Generative models.	
MODULE 2	**7Hrs**
Techniques to improve Neural Networks: Deep Neural Networks (DNN) Optimization and Regularization and Automated Machine Learning (AutoML), Unsupervised pre-training, transfer learning, and domain adaptation.	
MODULE 3	**8Hrs**

Fundamentals of Generative Adversarial Networks (GANs): Unsupervised learning with GAN, Neural architecture search, network compression, graph neural networks. Automating human tasks with deep neural networks.	
MODULE 4	**8Hrs**
The purpose of GAN, An analogy from the real world, Building blocks of GAN. Implementation of GAN, Applications of GAN, Challenges of GAN Models, Setting up failure and bad initialization, Mode collapse, Problems with counting, Problems with perceptive.	
MODULE 5	**8 Hrs**
Improved training approaches and tips for GAN, Feature matching, One sided label smoothing, normalizing the inputs, optimizer and noise, Batch norm, Avoiding sparse gradients with ReLU, MaxPool	

TEXT BOOKS:

1. Kuntal Ganguly, (2017), Learning Generative Adversarial Networks, Packt Publishing
2. Good fellow,I., Bengio.,Y., and Courville,A., (2016), Deep Learning, The MIT Press.

REFERENCES:

1. Charniak, E. (2019), Introduction to deep learning, The MIT Press.

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4708**					
TITLE OF THE COURSE	**UG Research Project -II/Product Development Foundation-II**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	6	-	3

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES:

- To identify key research questions within a field to carry out research in a team
- To identify and summarize the literature review of the relevant field
- To demonstrate relevant referencing and inculcate new skills in various aspects of academic writing
- To demonstrate the knowledge and understanding of writing the publication/report
- To showcase the strong evidence on the clarity of the argument, understanding of the selected domain area and presentation of its technical information
- To detail description of the process of carrying out the independent research in written document along with results and conclusions with reference to the existing literature
- To analyze and synthesize the new research findings

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy Level**
CO1	Develop the research project by selecting an appropriate research problem.	L4
CO2	Compare the papers relevant to the selected problem domain	L3
CO3	Construct the model and perform the model evaluation and analysis.	L6
CO4	Draft of the Publication or Demonstration of the Proof-of-concept product, Draft of the patent application.	L5

COURSE CONTENT:

The research topic proposed by both the guide and the student team should be approved by the department chairman to proceed further. A degree of industrial input and involvement will be encouraged, and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.

All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from the conception to completion.

The following criteria will be checked by the department chairman to approve for the research proposal:

a. Department staff as course guide

1. Ability to provide research direction to the student in the chosen field of interest
2. Ability to design an appropriate research strategy and methodology to carry out the research by student
3. Ability to provide and evaluate the strong literature review document for the chosen research topic
4. Ability to train students on research paper / technical writing skills
5. Conduct reviews in regular time period and submit the evaluation to department chairman

b. Student Team

1. To be dedicated and committed to work on a new research topic by learning new technical skills
2. To have fair knowledge on what is product development or research topic
3. To have constant interaction with allocated guide by providing weekly updates
4. To be committed to complete the project and submitting the technical paper within the stipulated time framed by the university

Evaluation:

There will be CIA evaluation as well as the Semester end evaluation of the work done. It will be done by a committee of senior researchers of the Department.

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4709**					
TITLE OF THE COURSE	**AWS WEB SERVICES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

- To understand fundamental concepts and hands-on knowledge of Cloud Computing using AWS Platform
- Conceive, Design and Develop state-of-the-art AWS Networking, Database, Storage Services
- Ability to understand and apply evolve Security and privacy in AWS Cloud across various domains like Storage, Database and applications.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Utilize the fundamental concepts of Cloud computing, Amazon EC2, load balancing and Auto scaling in developing AWS cloud platform.	L3
CO2	Examine the services such as compute, network and storage which runs on AWS platform.	L4
CO3	Design and Develop the latest AWS Networking, Database, and Storage Services on AWS Platform.	L3
CO4	Develop Amazon Simple Storage Service, Amazon Elastic File System, Glacier, Amazon Elastic Block storage gateway application using AWS tools.	L3
CO5	Apply AWS database services design principles, framework and protocols to develop dependable systems and appropriate projects for real-world problems.	L3

COURSE CONTENT:	
MODULE 1: Introduction	**8Hrs**
What is Cloud Computing? How Does Cloud Computing Work? What is AWS? AWS Free Tier, Compute Services: Amazon EC2, Elastic Load Balancing, Auto Scaling	
MODULE 2: Networking Services	**6 Hrs**
Amazon VPC, Amazon Route 53	
MODULE 3: AWS Security	**6Hrs**
Shared Responsibility Model, AWS IAM and KMS	
MODULE 4 : Storage Services	**9 Hrs**
Amazon S3, Amazon EBS, Amazon EFS, Amazon Glacier, AWS Storage Gateway, Amazon Cloud Front	
MODULE 5: AWS Database Services, Application Services	**10 Hrs**
Amazon RDS, Amazon DynamoDB, Amazon Elasticache, Amazon Simple Email Service (Amazon SES), Amazon Simple Notification Service (Amazon SNS), Amazon Simple Queue Service (Amazon SQS), Amazon Simple Workflow Service (Amazon SWF)	

TEXT BOOKS:

1. Ben Piper, David Clinton, 'AWS Certified Solutions Architect Study Guide: Associate SAA-C02 Exam (Aws Certified Solutions Architect Official: Associate Exam)" Paperback – 22 February 2021

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4710**					
TITLE OF THE COURSE	**AUGMENTED REALITY AND VIRTUAL REALITY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**--**	**-**	**--**	**39**	**3**

COURSE OBJECTIVES:

- To understand the a scientifically sound principles of Augmented and Virtual Reality.
- Assess and compare technologies in the context of AR and VR systems design.
- Demonstrate the knowledge of the input devices, tracking and output devices for both compositing and interactive applications.
- Demonstrate the use of objects for managing large scale Virtual Reality environment in realtime.
- Discuss the various solutions using Virtual Reality system framework and development tools for industry and social relevant applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Review the Fundamental concepts of Virtual and Augmented Reality with hard and soft component and history	L1
CO2	Design the Perceptual Aspects of VR and Virtual World	L3
CO3	Describe the input devices, tracking and output devices in AR-VR Applications	L2
CO4	Summarize the interaction and real aspect of AR VR systems	L2
CO5	Articulate and illustrate the applications in authorizing and mathematical aspects of AR- VR tools	L4

COURSE CONTENT	
MODULE1	**6Hrs**
Introduction to Virtual and Augmented Reality What is Virtual Reality (VR)? What is Augmented Reality (AR)? What is the purpose of VR/AR? What are the basic concepts? What are the hard- and software components of VR/AR systems? How has VR/AR developed historically?	

MODULE 2	9 Hrs
Perceptual Aspects of VR and Virtual World VR phenomena-double vision and cybersickness. human perception processes, human information processing, different limitations of human perception, Virtual worlds, the contents of VR environments, dynamic behaviour of 3D objects. interactions with 3D objects.	
MODULE 3	9 Hrs
VR/AR Input Devices, Tracking and Output Devices How do Virtual Reality (VR) and Augmented Reality (AR) systems recognize the actions of users, know where the user is, track objects in their movement, input devices for VR and AR. Output devices and technologies for VR and AR. Devices for visual output play, stationary displays, acoustic and haptic outputs.	
MODULE 4	9 Hrs
Interaction in Virtual Worlds, Real-Time Aspects of VR Systems Design and realization of interaction and the resulting user interface of a VR/AR system, system control, selection, manipulation and navigation, real-time capability of VR systems., types of latencies, efficient collision detection.	
MODULE 5	9 Hrs
Authoring and Mathematical Foundations of VR/AR Applications. Authoring of VR and AR applications, the authoring process and the use of the tools, mathematical methods offer fundamental principles to model three-dimensional space.	

Group Activity: Design a Google Cardboard in LAB for VR Experience.

List of Practical Experiments activities to be conducted
1. Open sources VR and AR Tools 2. Introduction to Unity: Interface overview and installation 3. start a new project, add a player character, import common assets, and use the asset store to add objects, lighting, scenes, and prefabs in Unity. 4. Scripting and Interaction using Unity: Object-Oriented Scripting in Unity, Public variables, the inspector 5. Workings on apps related to AR and VR

TEXT BOOKS:

1. Ralf Doerner, Wolfgang Broll, Paul Grimm, Bernhard Jung: Virtual and Augmented Reality (VR/AR)-Foundations and Methods of Extended Realities (XR)-springers-2022

REFERENCES:

1. Schmalstieg D. and Hollerer T., AugmentedAnd Virtual Reality, Addison-Wesley (2016).
2. Aukstakalnis S., Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley (2016).
3. Erin Pangilinan, Steve Lukas, Vasanth Mohan: Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing.
4. Doug A. B., Kruijff E., LaViola J. J. and Poupyrev I. , 3D User Interfaces: Theory and Practice , Addison-Wesley (2005,201lp) 2nd ed.
5. Parisi T., Learning Virtual Reality, O'Reilly (2016) 1st ed.
6. Whyte J., Virtual Reality and the Built Environment, Architectural Press (2002).

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4711**					
TITLE OF THE COURSE	**MOOC**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	--	-	--	**39**	**3**

Course Outcomes:

1. Enabling students to obtain certificates to make students employable in the industry or pursue a higher education program.
2. Relevant exposure to tools and technologies are being offered.

Massive Open Online Courses (MOOCs) – Guidelines & Policy

1. Students shall enroll the MOOC courses that is available on the NPTEL/SWAYAM (Swayam.gov.in) platform whenever it notifies (twice in a year).
2. The list of NPTEL / SWAYAM courses related to Computer Science & Engineering thatis in line with the students interest will be announced at the departmental level for enrollment.
    - That is, the predefined list of courses is provided by the department to the students, and only those courses shall be considered and not others.
3. Students shall also enroll in Coursera / Udemy / Udacity / Infosys Spring Board, where DSU can consider the grades / marks provided by these platforms if they are proctored ones. Examinations are to be conducted by DSU if proctored assessments are not conducted by these platforms.
4. The MOOCs courses option shall be considered only for students having a minimum CGPA of **6.75.**
5. The interested student has to enroll as per the guidelines of the NPTEL / SWAYAM or other platforms mentioned in item 3 within enrollment end date.
6. The credits assigned would depend on the number of weeks. The department shallconsider 12 weeks course to map for 03 Credits.
7. A faculty member shall be appointed as SPOC to keep a track of students undertaking courses and collect certificates from students upon completion on theplatforms mentioned above.

8. Student has to pursue and acquire a certificate for a MOOCs course and after successful completion, the student shall submit the certificate to the Department and credits shall be transferred to the grade card accordingly based on the items 1-3 above.
9. The examination fee for obtaining the certificate shall be borne by the student.
10. In case a student fails to complete the MOOC course, then the student shall repeatthe same on the NPTEL/SWAYAM or other platforms mentioned in item 3 or the student may opt for department elective with permission of the department chair.
11. Following is the proposed range for the award of grades towards the creditstransfer.

Range: Consolidated MOOC Score (Assignment+ Proctored exam)	**Proposed Grade Point**	**Grade**
90-100	10	O
80-89	9	A+
70-79	8	A
60-69	7	B+
55-59	6	B
50-54	5	C
40-49	4	P
Less than 40	0	F

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	20CS4803					
TITLE OF THE COURSE	**PARALLEL COMPUTING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**--**	**--**	**--**	**39**	**3**

Perquisite Courses (if any):			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES:

- To understand the architectural, hardware, OS and programming aspects in High Performance Computing
- To understand the distributed memory programming, shared memory programming, and a few parallel applications

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Analyze the problem for various ways of parallelization, and design the best parallel algorithm.	L4
CO2	Design and implement parallel solutions to the given problem	L3
CO3	Apply the constructs of parallel programming model to convert a sequential program to parallel program	L3
CO4	Develop parallel programs using OpenMP and MPI construct	L3

COURSE CONTENT:	
MODULE 1	**8 Hrs**
Introduction to Computer Systems: Processors, Memory, I/O Devices; Cost, timing, and scale (size) models. Program Execution: Process, Virtual Memory, System Calls, Dynamic Memory Allocation.	
MODULE 2	**8 Hrs**

Machine-Level View of a Program: typical RISC instruction set and execution, Pipelining. Performance issues and Techniques, Cost and Frequency Models for I/O, paging, and caching. Temporal and spatial locality.	
MODULE 3	**8Hrs**
Typical Compiler Optimizations: Identifying program bottlenecks – profiling, tracing. Simple high-level language optimizations – locality enhancement, memory disambiguation. Choosing Appropriate Computing Platforms: benchmarking, cost- performance issues.	
MODULE 4	**8Hrs**
Parallel Computing: Introduction to parallel Architectures and Interconnection Networks, communication latencies. Program parallelization: task partitioning and mapping, data distribution, Message passing, synchronization and deadlocks.	
MODULE 5	**7Hrs**
Distributed memory programming using MPI/PVM.Shared memory parallel programming. Multithreading.	

TEXT BOOKS:

1. Dowd, K., High performance Computing, O'Reilly Series,1993.
2. Culler, D., and Singh, J.P., Parallel Computer Architecture: A Hardware/Software Approach. Morgan Kaufmann Pub.,1999.

REFERENCES:

1. Gropp, W., Lusk, E., and Skjellum, A., Using MPI: Portable Parallel Programming with the Message-passing Interface, MIT Press,1997.
2. Grama, Gupta, A., Karypis, G., Kumar, V., Introduction to Parallel Computing, Addison Wesley, 2003. ISBN:0-201-64865-2

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	20CS4804					
TITLE OF THE COURSE	**SOCIAL NETWORKS AND ANALYTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**--**	**2**	**--**	**26+26**	**3**

Perquisite Courses (if any):			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES:

- To understand the Social network concepts and its issues/challenges, various tools of Social network analysis.
- To know about Social network APIs.
- To know about mining and classification techniques of Social networks.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Use the basic concepts of Social networks like nodes, edges, adjacency matrix, neighborhood, degree, geodesic, diameter and clustering coefficients to analyze the social network data.	L3
CO2	Interpret content-based analysis and static and dynamic analysis for real-time data or online content.	L3
CO3	Examine the importance of social network APIs and community detection in real-time networks..	L4
CO4	Predicting the relationship between nodes by analyzing the impact on the specified social network like twitter, LinkedIn and Facebook	L4
CO5	Simulate and validate the social networks by using different tools of SNA	L5

COURSE CONTENT:	
MODULE 1	**5Hrs**

Introduction Social network concepts – Development of social network and analysis - Online social networks – Social Network Data - Issues and challenges	
MODULE 2	**5Hrs**
Linked-based and structural analysis - Content-based analysis - Static and dynamic analysis Mathematical Representation of social networks	
MODULE 3	**6Hrs**
Social networking systems and API - Statistical Analysis of Social Networks	
Community Detection in Social Networks - Node Classification in Social Networks - Evolution in Dynamic Social Networks	
MODULE 4	**6Hrs**
Social Influence Analysis -Link Prediction in Social Networks -Data Mining in Social Media Text Mining in Social Networks - Social Tagging -Building social services	
MODULE 5	**6Hrs**
UCINET – PAJEK– NETDRAW – StOCNET - SPlus - R – NodeXL- SIENA and RSIENA - Real-world networks (Facebook graph, Twitter networks,) Case Studies	

TEXT BOOKS:

1. Christina Prell, Social Network Analysis: History, Theory and Methodology, SAGE Publications Ltd, Publication Year 2011
2. Stanley Wasserman and Katherine Faust, " Social Network Analysis: Methods and Applications", Cambridge University Press, 1994

REFERENCES:

1. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", 2010
2. Carrington and Scott (eds). The SAGE Handbook on Social Network Analysis SAGE, First Edition 2011

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	20CS4805					
TITLE OF THE COURSE	**COMPUTER VISION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**--**	**2**	**--**	**26+26**	**3**

Perquisite Courses (if any):			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES:

- To introduce various topics of computer vision with their applications.
- Combining the analytics with CV which helps in various Video Analytics processing.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Analyze the concepts of video analytics in a much easier way using Stereo Vision and Structure from motion features	L4
CO2	Identify Depth estimation and views of an object from different position using Homography, Rectification, RANSAC, 3-D reconstruction framework	L3
CO3	Observe the motion parameter to compute the movement of object and structure from motion of an object using Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo Vision.	L4
CO4	Evaluate Shape Representation and approaches for Segmentation using Multi resolution analysis, Region Growing, Edge Based approaches, Graph-Cut, Mean-Shift, Texture Segmentation	L5
CO5	Examine the real-time application of video analytics like. Identifying moving faces, biological perspectives, Computational Theories of temporal identification, identification using holistic temporal trajectories.	L4

COURSE CONTENT:	
MODULE 1	**5Hrs**
Image Formation Models Introduction to Computer Vision, Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Image representations (continuous and discrete), Edge detection, Image Enhancement, Restoration, Histogram Processing	
MODULE 2	**6Hrs**
Depth estimation, views & Object Recognition Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, RANSAC, 3-D reconstruction framework; Auto-calibration. Hough transforms and other simple	
object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition	
MODULE 3	**5Hrs**
Motion Estimation & Analysis Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion, Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.	
MODULE 4	**5Hrs**
Shape Representation and Segmentation Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi resolution analysis, Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, Texture Segmentation; Object detection.	
MODULE 5	**5Hrs**
Multiview Identification: View based model, view correspondence, in identification, Generalization from multiple view. Identifying moving faces, Biological perspectives, Computational Theories of temporal identification, identification using holistic temporal trajectories, Identification by Continuous view transformation.	

TEXT BOOKS:

1. Computer Vision - A modern approach, by David A. Forsyth and Jean Ponce, Pearson, 2nd Edition, 2015
2. Computer Vision: Algorithms and Applications, by Richard Szeliski, Springer-Verlag London Limited 2011.

REFERENCES:

1. Dynamic Vision: From Images to Face Recognition, Imperial College Press, World Scientific Publication Co Ltd, 2000
2. Introductory Techniques for 3D Computer Vision, by EmanueleTrucco and Aalessandro Verri, Publisher: Prentice Hall. 1998
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
5. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**20CS4806**					
TITLE OF THE COURSE	**CLOUD INFRASTRUCTURE MANAGEMENT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	-		**39**	**3**

Perquisite Courses (if any):			
#	Sem/Year	Course Code	Title of the Course
*	***	*	***

COURSE OBJECTIVES:

- **Understand** Cloud Computing architecture for various Cloud based enterprises, challenges, workflow and architectural style of cloud computing.
- **Comprehend** Cloud Enabling Technologies that includes: virtualization technologies and their role in cloud computing, Differentiate between full and para virtualization, and Cloud resource management and scheduling
- **Analyze** Cloud storage Mechanisms and evaluate various infrastructure components in a cloud environment
- **Identify** common security challenges in cloud computing, Discuss security and privacy concern for cloud users, virtual machines and shared images.
- **Evaluate** the key technologies used in Xen VMM and various cloud applications

COURSE OUTCOMES:

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	Examine the cloud computing infrastructure at Amazon, Google, and Microsoft and analyse the challenges of cloud.	L4
2	Identify the different layers of virtualization and make use of the proper scheduling algorithm to manage the resources.	L3
3	Compare the different types of file system used in cloud environment and analyze the transaction process using NoSQL databases.	L4, L5
4	Analyze the core issues of cloud computing, such as security, privacy, and interoperability.	L4

5	Evaluate the effectiveness of different cloud computing solutions for various applications.	L5

COURSE CONTENT:	
MODULE 1: Cloud Infrastructure and Application Paradigms	**9Hrs**
Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. ***(Textbook-1: Chapter 3: 67-95).*** Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model. ***(Textbook-1: Chapter 4: 99-115).***	
MODULE 2: **Virtualization and Resource Management & Scheduling**	**9Hrs**
Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and para virtualization, Hardware support for virtualization. ***(Textbook-1: Chapter 5: 132-142).*** Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Stability of a two level resource allocation architecture, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling. ***(Textbook-1: Chapter 6: 164, 182-201).***	
MODULE 3: **Cloud Storage Structure**	**7Hrs**
The Evolution of Storage Technology, Storage Models, File Systems, and Databases, Distributed File Systems: The Precursors, General Parallel File System, Google File System, Apache Hadoop, Locks and Chubby: A Locking Service, Transaction Processing and NoSQL Databases, BigTable, Megastore. ***(Textbook-1: Chapter 8: 242-278).***	
MODULE 4 : **Cloud Security and Mechanisms**	**7Hrs**
Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor. ***(Textbook-1: Chapter 9: 274-298).***	
MODULE 5 : **Case Study**	**7Hrs**

The Grep The Web application, Cloud for science and engineering, High performance computing on a cloud, Cloud computing for Social computing, digital content and cloud computing ***(Textbook-1: Chapter 4: 118-128).***

Xen a VMM based para virtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization ***(Textbook-1: Chapter 5: 144-156).***

TEXT BOOKS:

1. Cloud Computing: Theory and Practice, Dan C Marinescu Elsevier (MK), 2013.

REFERENCE BOOKS:

1. Computing Principles and Paradigms, RajkumarBuyya , James Broberg, Andrzej Goscinsk,i Willey, 2014.
2. Cloud Computing Implementation, Management and Security John W Rittinghouse, James F Ransome, CRC Press, 2013.

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20CS4701**					
TITLE OF THE COURSE	**Major Project Phase - I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	**4**	**52**	**3**

COURSE OBJECTIVES

- To identify a problem statement within a field to carry out project work in a team.
- To identify and summarize the literature review of the relevant field.
- To demonstrate relevant referencing and inculcate new skills in various aspects of academic writing.
- To demonstrate the knowledge and understanding of writing the publication/report.
- To showcase the strong evidence on the clarity of the argument, understanding of the selected domain area and presentation of its technical information.
- To analyze and design the solution to the selected problem statement.
- Able to work in teams and present the project work.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Identify** a complex engineering problem that would contribute to resolving societal, health, safety, legal and cultural issues	L2
CO2	**Review** research literature in the preferred field of study and be able to **define the problem.**	L3
CO3	**Formulate** the methodology to carry out the project work	L4
CO4	**Apply the** knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to **design a solution using modern tools** for the defined problem.	L3
CO5	**Apply** Project Management principles to **identify** the risks and cost-benefit.	L3

DESCRIPTION:

1. Each B. Tech Project must be carried out by a group of students at the Institute. To ensure uniform participation of each student, the group size should be preferably at least 3 but not more than 4 students.
2. Each project activity must be supervised by the faculty members of the Institute. These faculty members are termed Project Guides.

3. In case the project is of multi-disciplinary nature, the Project group can be formed consisting of students from other Departments. But there must be at least one student and a project Guide from the Department who is offering the Project.
4. The topic proposed by both the guide and the student team should be approved by the department chairman and the department project coordinator to proceed further. A degree of industrial input and involvement will be encouraged and can be facilitated through existing academic-industrial collaborations or by addressing specific topics that are of interest to industrial partners.
5. The problem statement should be big enough to be carried out in two phases over the two semesters i.e., VII and VIII semesters in the VI year.
6. All projects will be closely supervised by the Project Guide with ongoing feedback and guidance at all stages of the project from conception to completion.
7. The following criteria will be checked by the department chairman to approve for the project proposal:
    a. Department staff as Project guide
        i. Ability to provide direction to the student in the chosen field of interest to formulate a suitable title of the project
        ii. Ability to design an appropriate strategy and methodology to carry out the Project by the team
        iii. Ability to provide and evaluate the strong literature review document for the chosen topic
        iv. Ability to train students on paper / technical writing skills

    b. Student Team
        i. To be dedicated and committed to work on the project by sharpening the existing and learning new technical skills.
        ii. To have constant interaction with allocated guide by providing weekly updates and submitting weekly reports.
        iii. To be committed to completing the project and submitting the technical paper or patent or participate in hackathons and project exhibitions as well as apply for various state and national funding agencies within the stipulated time framed by the university
8. Phase-1 comprises of Literature Survey, Problem identification, Objectives and Methodology.
9. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department based on the rubrics
10. Additionally, there will be a Semester end evaluation of the work done that would include an internal Faculty and an external academic expert

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**20CS4801**					
TITLE OF THE COURSE	**Major Project Phase - II**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	12	156	9

COURSE OBJECTIVES

- Detailed design of the solution to the problem statement and project management using software engineering skills
- Write efficient code and test the code to find any bugs and resolve the same leading to completion and deployment of the project using modern tools.
- Analyze and synthesize the project results.
- Demonstrate knowledge and understanding of writing the publication/report.
- Able to work in teams and present the project work

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Conduct** a survey of several available literature in the preferred field of study to find the recent advances and gaps	L3
CO2	**Implement** the mathematics concept and engineering fundamentals, and specialization to **design** a solution using **modern tools** for the defined problem.	L4
CO3	**Experimenting and evaluating** the results from test data to provide a conclusion to the project work.	L6
CO4	**Demonstrate** an ability to work in teams and to prepare quality documents of project work & **exhibit** technical presentation skills.	L3

DESCRIPTION:

1. The problem statement selected in Major Project Phase-I (VII semester) will be carried in the VIII semester.
2. Phase 2 comprises of the detailed design, implementation, and testing results during the internal and external review.
3. Each Project team needs to submit the technical paper or patent or participate in hackathons and project exhibitions as well as apply for various state and national funding agencies within the stipulated time frame by the university

4. There will be CIA evaluation (Project reviews) done by a committee of senior faculty of the Department.
5. Additionally, there will be a Semester end evaluation of the work done that would include an internal Faculty and an external academic expert.

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**20CS4802**					
TITLE OF THE COURSE	**INTERNSHIP**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	**6**	**98**	**3**

Course Objectives:

1. To expose students to the industrial environment
2. To create competent professionals for the industry.
3. To provide possible opportunities to learn, understand and sharpen the real time technical /managerial skills required at the job
4. To work on a problem assigned by a mentor at industry, prepare action plan and complete within time limit
5. To learn, create/prepare report for Project/research as used in industry with productive and efficient way
6. To strengthen industry-institute linkage and increase employability of the students

Guideline for Internship:

The course includes a 16 weeks of on-job training on current industry-relevant problem through supervised self-learning approach The internship is an individual activity. The student should obtain approval from the chairman/supervisor to pursue. A student shall submit a brief proposal about the work to be carried out in the internship, to a coordinator within 3 weeks, after starting the internship.

A comprehensive report is required to be prepared and submit to the department at the end of the semester. A certificate shall be attached with this report duly signed by the competent authority of the industry for the successful completion of the internship. An attendance report shall also be attached with this report.

The CIA evaluation will be done by faculty mentor or Industry Supervisor. There is no SEE Exam for this course.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the modern tools used in the field of Computer science and engineering for product development.	L2
CO2	Demonstrate ethical conduct and professional accountability while working in a team for the benefit of society	L2

CO3	Understand the resources requirement and planning to facilitate the project success	L2
CO4	Develop and refine oral and written communication skills	L3
CO5	Demonstrate knowledge of the industry in which the internship is done	L3