B. TECH IN COMPUTER SCIENCE AND ENGINEERING

PROGRAM SPECIFIC OUTCOMES (PSOS)

Program Specific Outcomes (PSOs) of the B. Tech. in Computer Science and Engineering are as follows:

1. Students will be able to apply fundamental knowledge of theoretical computer science and critically analyse problems to develop computational systems for engineering and scientific applications
2. Students will be able to design and develop computing systems by appropriate technology using the concepts of basic science, computer engineering and other related disciplines for engineering / social applications.
3. Students will be able to apply domain knowledge and expertise for enhancing research capability to transform innovative ideas into reality

COURSE CURRICULUM FOR B. TECH IN COMPUTER SCIENCE AND ENGINEERING

(w.e.f. 2018 batch)

Semester I

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	CH 101	Chemistry	3	1	0	4
2	MA 101	Mathematics I	3	1	0	4
3	CS 101	Introduction to Programming	3	1	0	4
4	EC 101	Basic Electronics	3	1	0	4
5	CE 102	Environmental Science & Engineering	3	0	0	3
6	CH 111	Chemistry Laboratory	0	0	3	2
7	CS 111	Programming Laboratory	0	0	3	2
8	EC 111	Basic Electronics Laboratory	0	0	3	2
9	ME 111	Workshop Practice	0	0	3	2
10		Extra-Curricular Activities (EAA)[1]	0	0	2	0
Total Credit						27

TOTAL CREDIT (Semester I) 27

Semester II

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	PH 101	Physics	3	1	0	4
2	MA 102	Mathematics II	3	1	0	4
3	ME 101	Engineering Mechanics	3	1	0	4
4	EE 101	Basic Electrical Engineering	3	1	0	4
5	HS 101	Communicative English	3	0	0	3
6	CE 101	Engineering Graphics & Design	1	0	3	3
7	PH 111	Physics Laboratory	0	0	3	2
8	EE 111	Basic Electrical Engineering Laboratory	0	0	3	2
9	HS 111	Language Laboratory	0	0	3	2
10		Extra-Curricular Activities (EAA)[1]	0	0	2	0
Total Credit						28

TOTAL CREDIT (Semester II) 28

1 EAA consists of YOGA/Physical Training/NCC/NSS/NSO, where YOGA is compulsory as a one semester course (first or second semesters), while any one from the rest is compulsory as a one semester course. Thus, if YOGA is registered in first semester then any one from the rest four is to be opted in second semester and vice-versa.

Semester III

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	CS 201	Data Structure	3	1	0	4
2	MA 201	Mathematics III	3	1	0	4
3	CS 202	Discrete Structures	3	1	0	4
4	EC 221	Circuits and Switching	3	1	0	4
5	EE 223	Microprocessor	3	1	0	4
6	CS 203	Data Structure Laboratory	0	0	3	2
7	EE 224	Microprocessor Laboratory	0	0	3	2
8	EC 222	Circuits and Switching Laboratory	0	0	3	2
Total Credit						26

TOTAL CREDIT (Semester III) 26

Semester IV

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	CS 204	Theory of Computation	3	1	0	4
2	CS 205	Computer Architecture and Organization	3	1	0	4
3	CS 206	Algorithms	3	1	0	4
4	MA 221	Mathematics-IV (Introduction to Stochastic Processes)	3	1	0	4
5	CS 207	Signals & Data Communication	3	1	0	4
6	CS 208	Object Oriented Programming Laboratory	1	0	3	3
7	CS 209	Algorithms Laboratory	0	0	3	2
8	CS 210	Signals & Data Communication Laboratory	0	0	3	2
9	CS 211	Applied Probability Laboratory	0	0	3	2
Total Credit						29

TOTAL CREDIT (Semester IV): 29

Semester V

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	CS 301	Computer Network	3	1	0	4
2	CS 302	Database Management Systems	3	1	0	4
3	CS 303	Operating System	3	1	0	4
4	CS 304	Software Engineering	3	1	0	4
5	CS 305	Graph Theory	3	1	0	4
6	CS 311	Computer Network Laboratory	0	0	3	2
7	CS 312	Database Laboratory	0	0	3	2
8	CS 313	Operating System Laboratory	0	0	3	2
9	CS 314	Software Engineering Laboratory	0	0	3	2
Total Credit						28

TOTAL CREDIT (Semester V): 28

Semester VI

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	CS 306	Principles of Programming Language	3	1	0	4
2	CS 307	Compiler Design	3	1	0	4
3	CS 308	Graphics & Multimedia	3	1	0	4
4	CS 33X	Professional Core Elective I	3	1	0	4
5	CS 38X	Open Elective I	3	1	0	4
6	CS 315	Object Oriented Design Laboratory	0	0	3	2
7	CS 316	Compiler Laboratory	0	0	3	2
8	CS 317	Graphics & Multimedia Laboratory	0	0	3	2
9	CS 32Y	Professional Core Elective- I Laboratory	0	0	3	2
Total Credit						28

TOTAL CREDIT (Semester VI): 28

Semester VII

Sl. No.	Code	Subject	Hours per week			Credit
			L	T	P	
1	CS 401	Artificial Intelligence	3	1	0	4
2	CS 43X	Professional Core Elective II	3	0	0	3
3	CS 48X	Open Elective II	3	0	0	3
4	HS 402	Business Management	3	0	0	3
5	CS 497	Industrial Training (Minimum 6 weeks)				2
6	CS 498	Project-I	0	0	6	4
Total Credit						19

TOTAL CREDIT (Semester VII): 18

Semester VIII

Sl. No.	**Code**	**Subject**	**Hours per week**			**Credit**
			L	**T**	**P**	
1	HS 401	Managerial Economics	3	0	0	3
2	CS 44X	Professional Core Elective III	3	1	0	4
3	CS 48X	Open Elective III	3	0	0	3
4	CS499	Project II	0	0	6	6
Total Credit						16

TOTAL CREDIT (Semester VIII): 16

Professional Core Elective- I (6th Semester) (CS 331 - CS 336)

1. CS 331 Social Network Analysis
2. CS 332 Natural Language Processing
3. CS 333 Digital Image Processing
4. CS 334 Speech Processing
5. CS 335 Artificial Neural Network
6. CS 336 Linux Operating System

Open Elective- I (6th Semester) (CS 381 - CS 382)

1. CS 381 Simulation and Modeling
2. CS 382 Introduction to Blockchain

Professional Core Elective- I Laboratory (6th Semester) (CS 321 - CS 326)

1. CS 321 Social Network Analysis Laboratory
2. CS 322 Natural Language Processing Laboratory
3. CS 323 Digital Image Processing Laboratory
4. CS 324 Speech Processing Laboratory
5. CS 325 Artificial Neural Network Laboratory
6. CS 326 Linux Operating System Laboratory

Professional Core Elective- II (7th Semester) (CS 431 - CS 439)

1. CS 431 Machine Learning
2. CS 432 Pattern Recognition
3. CS 433 Computational Geometry
4. CS 434 Cryptography and Security
5. CS 435 Wireless Network
6. CS 436 VLSI Physical Design
7. CS 437 Distributed System
8. CS 438 Internet of Things
9. CS 439 Data Mining

Open Elective- II (7th Semester) (CS 481 - CS 482)

1. CS 481 Web Technology
2. CS 482 Introduction to GPU Computing

Professional Core Elective- III (8th Semester) (CS 440 - CS 445)

1. CS 440 Quantum Computing
2. CS 441 Text Mining and Analytics
3. CS 442 Wireless Sensor Network
4. CS 443 Applied Parallel Programming
5. CS 444 Information Theory and Coding
6. CS 445 Big Data Analysis

Open Elective- III (8th Semester) (CS 483 - CS 485)

1. CS 483 Time Series Analysis
2. CS 484 Cloud Computing
3. CS 485 Machine Translation

DETAILED SYLLABI OF BTECH IN COMPUTER SCIENCE & ENGINEERING

CS 101	**Introduction to Programming**	**L**	**T**	**P**	**C**
	B. Tech (All branches) First Year (Core)	**3**	**1**	**0**	**4**

Unit-1 What is a program; Digital computer fundamentals; What is a language; How program executes

Unit-2 C programming: Data types; Operators; Expressions; Scope resolution and variable types; Control flow structures; Functions; Arrays and pointers; Structures and Unions; Stream data processing.

Unit-3 Introduction to Object Oriented Programming: Objects and classes; Object hierarchy

Books:

1. Gottfried B.S., *Programming in C*, TMH
2. Kernighan B.W. and Ritchie D.M., *The C Programming Language*, PHI
3. Balagurusamy E., *Programming in ANSI C*, TMH
4. H. M. Deitel and P. J. Deitel, *C: How to program*, Pearson Ed.
5. A.R. Bradley, *Programming for Engineers*, Springer
6. R. G. Dromey, *How to Solve it by Computer*, PHI
7. Stroustrup B., *The C++ Programming Language*, Addison-Wesley

Course Outcomes (COs):

At the end of the course, students are expected to

1. Learn formulation of simple algorithms for arithmetic and logical problems.
2. Able to translate the algorithms into programs (in C language).
3. Able to use derived types, control structures, functions and pointers for problem solving

CS 111	Programming Laboratory	L	T	P	C
B. Tech (All branches)	First Year (Core)	0	0	3	2

Basic arithmetic operations, control statements, functions, arrays and pointers, structures and unions, file handling etc.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand a functional hierarchical code organization
2. Attain the ability to define and manage data structures based on problem subject domain
3. Attain the ability work with textual information, characters and strings

CS 201	Data Structure	L	T	P	C
	B.Tech (CSE) Third Semester (Core)	3	1	0	4

Unit-1 **Introduction**: Introduction to data types, Data structures and Abstract Data Types (ADT), asymptotic notations; complexity analysis of algorithms.

Unit-2 **Lists**: Linked list, doubly linked list: header list, polynomial arithmetic, stack, recursion and their implementation; evaluation of postfix expression, conversion for infix to postfix expression and their algorithms; queue, circular queue; priority queues; Dequeue; multiple stacks and queues

Unit-3 **Trees**: Introduction, Binary tree, BST, AVL trees, B Trees, B+ Trees; Multiway Search trees: Implementation of dictionary and binary search tree; heap; hashing and hash table.

Unit-4 **Graphs**: Basic concepts; Representation schemes; graph traversals; spanning tree; shortest path algorithm.

Unit-5 **Sorting & Searching**: Different sorting techniques; Tree searching and graph searching techniques.

Unit-6 **Memory management issues**: Introduction, storage allocation, garbage collection, compaction.

Books:

1. Tanenbaum A.S., Langsam Y., Augenstein M. J. , *Data Structures using C/C++*, PHI
2. Aho V., Ullman J.D., *Data Structure Addision*, Wesley
3. Knuth D.E , *The Art of Computer Programming (Vol. 1, 2, 3)* , Addision- Wesley
4. Horowitz E., Sahni S. , *Fundamentals of Data Structures*, Galgotia Pub.
5. Wirth N , *Algorithms, Data Structures, Programs* . PHI

Course Outcomes (COs):

At the end of the course, students are expected to

1. be able to select appropriate data structure to be used for specified problem definition.
2. be able to implement linear and non-linear data structures.
3. be able to handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
4. be able to implement projects requiring the implementation of the learned data structures.

CS 202	Discrete Structure	L	T	P	C
	B.Tech (CSE) Third Semester (Core)	3	1	0	4

Unit-1 **Logic**: Propositional logic and its applications; Propositional equivalences; Predicates and Quantifiers; Rules of inference; Introduction to Proofs; Proof Methods; Proof by Mathematical Induction (Weak and Strong).

Unit-2 **Set theory**: Sets, operations on sets, cardinality, inductive definition of sets and proof by induction; Relations, representation of relations, properties of relations, equivalence relations and partitions; Partial orderings; Posets; Well-ordered sets.

Unit-3 **Functions**: Mappings; Injection and Surjection; Composition of functions; Inverse functions; Special functions; recursive function theory.

Unit-4 **Algebraic Structures**: Definition and elementary properties of groups; semigroups; monoids; rings; fields, vector spaces; lattices and Boolean Algebra.

Unit-5 **Elementary combinatorics**: Basic Counting Principles; Permutations and Combinations; Binomial Coefficients and Identities; Generalized Permutations and Combinations; Sterling's number of the second kind; Pigeon-hole Principle and its application; Inclusion-Exclusion Principle and its application; Recurrence Relations; Solving Linear Recurrence Relations; Generating Functions; Catalan Numbers; Fibonacci numbers.

Unit-6 **Number Theory**: Divisibility and Modular Arithmetic; Integer Representations and Algorithms; Prime numbers and related Theorems; Greatest Common Divisors; Euclid's Algorithm; Solving Congruence; Applications of Congruence, Fermat's Little Theorem, The Chinese Remainder Theorem; Applications in Cryptography.

Books:

1. K. H. Rosen , *Discrete Mathematics and Applications*, TMH
2. C. L. Liu, D. P. Mohapatra, *Elements of Discrete Mathematics* , McGraw-Hill
3. J. L. Mott, A. Kandel, T. P. Bake, *Discrete Mathematics for Computer Scientists and Mathematicians* , PHI

4. J. P. Tremblay, R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*, McGraw-Hill

Course Outcomes (COs):

At the end of the course, students are expected to

1. Understand the interpretations of propositional and predicate logic and express mathematical properties formally via the formal language of propositional and predicate logic.
2. Learn and manipulate basic mathematical objects such as sets, functions, and relations and verify simple mathematical properties that these objects possess.
3. Understand the elementary combinatorics and recurrence relations and apply combinatorial ideas to practical problems.
4. Learn the concepts of number-theory and modular arithmetic essential for the mastery of some of the higher-level computer science courses and solving engineering problems.
5. Use different methods of proofs to formulate and solve applied problems, to analyze and interpret algorithms and functions and logically verify them.

EE 223	Micro Processor	L	T	P	C
	B. Tech (CSE) Third Semester (Core)	3	1	0	4

Unit-1 **Introduction**: Basic features of 8085 microprocessors and its addressing modes, 8085 microprocessor architecture.

Unit-2 **Memory and I/O interfacing**: Address decoding, Address aliasing, Memoryread and write operations, Timing diagrams, Memory mapped I/O and I/O mapped I/O.

Unit-3 **Programming of 8085**: Instruction Set, Assembly Language Programming and Illustrative examples. 8085 Interrupt Structure.

Unit-4 **Data Transfer Techniques**: Synchronous and Asynchronous modes of data transfer, Interrupt driven I/O, DMA.

Unit-5 **Introduction to advanced microprocessors**: 8086 as an example, 8086Architecture and Internal Register Set, Instruction Set, Min-Max mode, Concept of Co-processor and its interfacing, Memory and I/O Interfacing, Programming of 8086.

Books:

1. R. Gaonkar, *Microprocessor Architecture, Programming and Applications with 8085* , Penram
2. Rafiquzzaman , *Microprocessors: Theory and Applications*, Pearson Ed

Course Outcomes (COs):
At the end of the course, students are expected to

1. Use of assembly language for solving engineering problems.
2. Design microprocessor based system for solving engineering problems.
3. Able to analyze microprocessor based system.

CS 211	Data Structure Laboratory	L	T	P	C
	B. Tech (CSE) Third Semester (Core)	0	0	3	2

Use of special data structures for solving real-life problems, Implementation of customized data structures and defining their access & retrieval mechanism, Analyzing merit & demerit of different data structures.

Course Outcome (CO):
At the end of the course, students are expected to

1. Be able to design and analyze the time and space efficiency of the data structure.
2. Be capable to identity the appropriate data structure for a given problem.
3. Able to apply concepts for solving real-life problems.

EE 224	Microprocessor Laboratory	L	T	P	C
	B. Tech (CSE) Third Semester (Core)	0	0	3	2

Design and implementation of assembly level programs for different microprocessor families, Design and implementation of programs for interfacing devices with microprocessor.

Course Outcome (CO):

At the end of the course, students are expected to

1. Develop skill-set for assembly language programming, use of assembler directives, interrupts, branch and loop operations.
2. Able to interface a microprocessor to various peripheral devices for simple applications.
3. Able to effectively utilize microprocessor peripherals.

CS 204	Theory of Computation	L	T	P	C
	B.Tech (CSE) Fourth Semester (Core)	3	1	0	4

Unit-1 Alphabets and Languages, Finite Automata (FA), Deterministic and Non-deterministic FA, FA with ε-move, Two-way FA, FA with output

Unit-2 Regular Expression and regular set, Closure properties, Pumping lemma, Decision algorithms, Myhill-Nerode theorem.

Unit-3 Context-free Grammar (CFG), Derivation tree, Simplification, Chomsky Normal Form and Greibach Normal Form, Ambiguity.

Unit-4 Push Down Automata (PDA), PDA and Context Free Language (CFL), Properties of CFL, Pumping lemma, Closure properties and decision algorithms.

Unit-5 Computability theory: Fundamental concepts of Turing machine model, computable languages and functions; Turing machine construction technique;The Problem of undecidability; Properties of recursive and recursively enumerable languages; Universal Turing Machine.

Unit-6 P and NP problems: Basic concepts, polynomial time and space, understanding the P-class problems, boolean satisfiability, Cook's Theorem, understanding NP-class problems, polynomial time reduction, Basic concept of NP-Complete problems.

Books:

1. Hopcroft J. E., Motwani R., Ullman J. D., *Introduction to Automata Theory, Languages, and Computation*, PearsonEd.
2. Lewis H. R., Papadimitriou C. H., *Elements of the Theory of Computation* , PearsonEd
3. Martin J. C., *Introduction to Languages and the Theory of Computation* , TMH
4. Sipser M. , *Introduction to The Theory of Computation* , Cengage Learning

Course Outcome (CO):
At the end of the course, students are expected to

1. Able to understand and use basic concepts and correlate same to mathematical principles.
2. Able to apply the knowledge to solve computational and compilation problems.
3. Able to correlate different types of automata to real world applications
4. Able to decide about computable/non-computable problems.

CS 205	Computer Architecture and Organization	L	T	P	C
	B. Tech (CSE) Fourth Semester (Core)	3	1	0	4

Unit-1 **Basic functional blocks of a computer**: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU - registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study - instruction sets of some common CPUs.

Unit-2 **Data representation**: signed number representation, fixed and floating point representations, character representation. Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication - shift-and-add, Booth multiplier, carry save multiplier, etc. Division - non-restoring and restoring techniques, floating point arithmetic.

Unit-3 **CPU control unit design**: hardwired and micro-programmed design approaches, Case study - design of a simple hypothetical CPU.

Unit-4 Peripheral devices and their characteristics: Input-output subsystems, I/O transfers - program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes - role of interrupts in process state transitions.

Unit-5 Performance enhancement techniques.

Unit-6 Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.

Unit-7 Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs block size, mapping functions, replacement algorithms, write policy.

Books:

1. David A. Patterson, John L. Hennessy , *Computer Organization and Design: The Hardware/Software Interface* , Elsevier
2. Carl Hamachar, ZvoncoVranesic, SafwatZaky , *Computer Organization* , McGraw-Hill
3. John P. Hayes, *Computer Architecture and Organization*, McGraw-Hill
4. William Stallings , *Computer Organization and Architecture: Designing for Performance* , Pearson Ed

5. Vincent P. Heuring, Harry F. Jordan , *Computer Systems Design and Architecture* , Pearson Ed.

Course Outcomes (COs):

At the end of the course, students are expected to

1. To gain an in depth understanding of the various types of Processor Organization.
2. Understanding how the timing & control signal is generated by the processor for the execution of an instruction.
3. To be capable of analyzing and understanding the performance of any computer with different types of memory present along with their organization.
4. To know how the processor takes data from the memory devices, how the I/O devices are interlinked with the processor using I/O processor or interfaces.

CS 206	Algorithms	L	T	P	C
B.Tech (CSE)	Fourth Semester (Core)	3	1	0	4

Unit-1 **Introduction**: Algorithms, Algorithms as a technology, Designing algorithms, Analyzing algorithms, Case studies.

Unit-2 **Divide and Conquer Algorithms**: Merge Sort; Recurrence Relations: The substitution method, The recursion-tree method, The master theorem; Heapsort: Heaps, Maintaining the heap property, Building a heap, The heapsort algorithm, Analysis of heapsort, Priority queues; Quicksort: Description of quicksort, Performance of quicksort, Analysis of quicksort, A randomized version of quicksort; Lower bounds for sorting, Counting sort, Radix sort, Bucket sort; Medians.

Unit-3 **Dynamic Programming**: Assembly-line scheduling, Matrix-chain multiplication, Elements of dynamic programming, longest common subsequence, optimal binary search trees, Knapsack, Independent sets in trees.

Unit-4 **Greedy Algorithms**: Activity-selection problem, Elements of the greedy strategy, Huffman codes, Theoretical foundations for greedy methods, Task-scheduling problem.

Unit-5 **Backtracking**: Basics, 4- Queen Problem, 8-Queen problem.

Unit-6 **Branch and Bound**: Basics, 15 Puzzle problem, Traveling Salesman problem

Unit-7 **Amortized Analysis**: Aggregate analysis, The accounting method, The potential method, Dynamic tables.

Unit-8 **Graph Algorithms**: Elementary Graph Algorithms: Representations of graphs, Breadth-first search, Depth-first search, Topological sort, Strongly connected components; Minimum Spanning Trees: Kruskal and Prim algorithms; Single-Source Shortest Paths: Dijkstra's algorithm, Shortest paths in the presence of negative edges, Shortest paths in DAGs; All-Pairs Shortest Paths: The Floyd-Warshall algorithm; Maximum Flow: Flow networks, The Ford-Fulkerson method, Maximum bipartite matching

Unit-9 **String Matching**: The naive string-matching algorithm, The Rabin-Karp algorithm, String matching with finite automata, The Knuth-Morris-Pratt algorithm.

Books:

1. T. H. Coremen, C. E. Leiserson, R. L. Rivest, C. Stein , *Introduction to Algorithms*, McGraw-Hill
2. S. Dasgupta, C. H. Papadimitriou, U. V. Vaziran, *Algorithms*, McGraw-Hill
3. Michael T. Goodrich, R. Tamassia , *Algorithm Design and Applications* , Wiley
4. E. Horowitz, S. Sahni, S. Rajasekaran , *Fundamentals of Computer Algorithms* , University Press

Course Outcome (CO):
At the end of the course, students are expected to be

1. Able to prove correctness and analyze running time of algorithms.
2. Able to apply the algorithms and design techniques to solve problems.
3. Able to analyze the complexities of various problems in different domains.

CS 207	Signal and Data Communication	L	T	P	C
	B.Tech (CSE) Fourth Semester (Core)	3	1	0	4

Unit-1 Introduction, Classification of Signals (Deterministic and Random, Periodic and Non-periodic, Analog and Discrete, Energy and Power, Continuous- time and Discrete-time signals). Properties of System; Linear system, Baseband system, Time-varying systems, Time-Invariant System, Linear Time-Invariant (LTI) Systems, Linear time-varying Systems, Input-output modelling using differential equations and linear difference equations.

Unit-2 Convolution representation of LTI and discrete and continuous signals, Signals in terms of frequency components, Fourier transform as limiting form of Fourier series, Properties, Response to sinusoidal, periodic and aperiodic inputs, Sampling.

Unit-3 Analog modulation and demodulation of signals, Simultaneous transmission of signals, Digital signals modulation and demodulation, Analog and digital data transmission, Transmission impairments, Channel capacity.

Unit-4 Wired and wireless transmission, Signal encoding techniques, Bandwidth Utilization: Multiplexing and Spreading, Digital Subscriber Line: ADSL, HDSL, SDSL, VDSL, Error handling, Introduction X.25, Frame Relay.

Books:

1. Oppenheim A.V, Willsky A.S. and Nawab A.H. , *Signals and System*, PHI
2. Das A. , *Digital Communication: Principles and System Modelling* , Spinger
3. Haykin S., Veen B. V. , *Signals and Systems* , Willey
4. Stallings W. *Data and Computer Communications* , Pearson Ed.
5. Freeman R. L. , *Practical Data Communications* , Willey
6. Roden M. S., *Digital and Data Communication Systems*, Prentice Hall
7. Ahmad A. , *Data Communication Principles: For Fixed and Wireless Networks* , Kluwer

Course Outcome (CO):

At the end of the course, students are expected to be

1. Able to classify signals in different domains and explain properties of different systems.
2. Able to analyze characteristics of signals using Fourier analysis and to demonstrate relations.
3. Able to use signal modulation and demodulation techniques.

CS 212	Object Oriented Programming Laboratory	L	T	P	C
	B.Tech (CSE) Fourth Semester	1	0	3	3

Unit-1 Object model evolution and their elements, application of object models, Objects and their relationships, classes and their relationships, inter play of objects and classes, Class diagram, object diagram, interaction diagram, module diagram, process diagram.

Unit-2 Fundamental Programming Structures in objected oriented programming, methods, access specifiers, static members, Comments, Data Types, Variables, Operators, Control Flow and Arrays, Input/output Basics, Streams, byte streams and character streams, Reading and Writing Console, Reading and Writing files.

Unit-3 Inheritance, Super class - sub class, Protected members, constructors in sub- classes, Object class, abstract classes and methods, final methods and classes, Interfaces, defining an interface, implementing interface, differences between classes and interfaces, extending interfaces, Object cloning, inner classes, functions, virtual functions & class, overloading – operator & function.

Unit-4 Exceptions, exception hierarchy, throwing and catching exceptions, built-in exceptions, creating own exceptions, Stack Trace Elements.

Books:

1. *Object- Oriented Analysis and Design with Applications* – Booch G., Maksimchuk R. A., Engle M. W. (Addison- Wesley)
2. *Introduction to Object- Oriented Programming* – Timothy B. (Pearson Ed)
3. *Object- oriented modelling and design* – Rumbaugh J. (Prentice Hall)
4. *C++ How to Program* – Paul Deitel and Harvey Deitel (Prentice Hall)
5. *C++ Primer Plus* – Stephen Prata(Sams)
6. *Java The complete reference* – Herbert Schildt (McGraw-Hill)
7. *Core Java Volume – I Fundamentals* – Cay S. Horstmann, Gary Cornell (Prentice Hall)

Course Outcomes (COs):

At the end of the course, students are expected to be

1. Able to design a system and develop program within class-object hierarchy.
2. Able to analyze operation of a system designed within class-object hierarchy.
3. Able to handle exceptional conditions arising during real-life operation of a system.

CS 213	Algorithms Laboratory	L	T	P	C
	B.Tech (CSE) Fourth Semester	0	0	3	2

Write program in C/C++ for solving different problems of searching, sorting, matrix chain multiplication, graph traversal, Spanning tree, path finding in graphs, 15 puzzle, 8-queen problems using different algorithmic paradigms, execute the programs for different inputs and problem instances, analyze performance of the approaches used.

Course Outcome (CO):

At the end of the course, students are expected to be

1. Able to devise suitable algorithms for solving engineering problems.
2. Able to choose best suitable approach for obtaining solution optimally.

CS 214	Signal and Data Communication Laboratory	L	T	P	C
	B.Tech (CSE) Fourth Semester	0	0	3	2

Familiarization with MATLAB, Matrix Operations & Plotting using MATLAB, Relational Operators, Loops & Functions using MATLAB, Generation of Signals & Signal Operations, Synthesis of signals using Fourier Series, convolution on Continuous Time Signals, Smoothing Data and Difference Equations, modulation/demodulation – PSK, QPSK, PAM, QAM..

Course Outcome (CO):

At the end of the course, students are expected to be

1. Able to generate signals of requisite nature using MATLAB.
2. Able to operate on signals using MATLAB to achieve communication requirements.

CS 215	Applied Probability Laboratory	L	T	P	C
	B.Tech (CSE) Fourth Semester	0	0	3	2

Basics of programming in R; Vectors, lists, matrices and data frames; Writing functions in R; Associative arrays/hashes; Handling missing data.

Reading a file; Reading a file involving dates; Reading and writing both ASCII files and binary files; sending an R data object; Exporting and importing data; Reading .gz .bz2 files and URLs; directly reading Microsoft Excel files.

Plotting graphs; a grid of multiple pictures on one screen; histogram with tails; plotting two series on one graph.

Tables, joint and marginal distributions; "Moving window" standard deviation; Quartiles/deciles tables/graphs; Distribution of sample mean and sample median; MLE with custom likelihood function; Cauchy distribution; two CDFs and a two-sample Kolmogorov-Smirnoff test; simulation to measure size and power of a test.

Linear regression; OLS; Dummy variables in regression; Least squares dummy variable model; Nonlinear regression; Standard tests; use of orthogonal polynomials.

Books:

1. Garrett Grolemund and Hadley Wickham , *R for Data Science* , O'Reilly
2. Phil Spector , *Data Manipulation with R*, Springer
3. Paul Teetor, *The R Cookbook*, O'Reilly
4. Winston Chang, *The R Graphics Cookbook*, O'Reilly

Course Outcome (CO):
At the end of the course, students are expected to be

4. Use of open-source software for data handling.
5. Able to use various statistical techniques.
6. Able to forecast trend based on data.

CS 301	Computer Network	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	3	1	0	4

Unit - 1 Direct Link Networks, encodings, modulation, Error detection and correction, CRC, Internet Checksum, MAC protocols, CSMA/CD, Ethernet, Addressing, Bridges, Spanning Tree, Flooding/Multicasting, Switching Vs routing, Switching architectures.

Unit - 2 ARP, IP, The best effort service model, IP header structure, IP delivery review, options and encapsulation. ICMP, path MTU discovery and traceroute operation, IP Addressing, Forwarding, LPM forwarding algorithm, IP delivery, layer 3/tag switching, IP multicast model, multicast forwarding, link-layer support, IGMP, Internet Multicast forwarding and routing, Addressallocation/use.

Unit -3 Routing protocols: distance vector vs link-state routing, DV problems, Intra-domain routing (RIP, OSPF), DUAL, Inter-domain routing, BGP, CIDR, IPv6 introduction.

Unit - 4 Introduction to Transport Layer, Port numbers, service models, UDP, Introduction to reliability, Flow control vs. congestion control, Congestion collapse, Window-based and rate-based congestion control, Congestion control model, packet scheduling and buffer management, FIFO, FQ, RED, Congestion control taxonomy, fairness and effectiveness, Intro. to TCP congestion control, Additive-increase/multiplicative decrease, Fairness and Efficiency, recent enhancements In TCP.

Unit - 5 Application layer protocols: HTTP, SMTP, and DNS and their working principles. Security: Overview of threats, cryptography, authentication, and firewalls, Introduction to Wireless and mobile networks.

Books:

1. Peterson L. L., Davie B. S. , *Computer Networks: A Systems Approach* , Elsevier India.
2. Tanenbaum A. S. , *Computer Network* , PHI
3. Kurose J. F., Ross K. W, *Computer Networking: A Top- Down Approach* , Pearson Ed
4. Stallings W. , *Computer Networking with Internet Protocols*, Pearson Ed
5. Comer D , *Internetworking with TCP/IP*, Volume1, PHI

Course Outcome (CO):

At the end of the course, students are expected to

1. Able to design a TCP/IP network.
2. Able to apply principles of congestion control, fairness, efficiency in design.
3. Able to extend knowledge to newer technologies.

CS 302	Database Management System	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	3	1	0	4

Unit -1 **Introduction:** Purpose and Applications of Database Systems; File System vs. DBMS; Data models; Levels of Data Abstraction.
Introduction to the Relational Model: Structure of Relational Databases; Database Schema; Keys; Schema Diagrams; Relational Query Languages, Relational Operations; Relational Algebra; Relational Calculus

Unit-2 **SQL:** SQL Data definition; Basic SQL Query Structure, Set Operations, Null Values, Aggregate Functions, Nested Sub-queries, aggregation, Database Modification; Join expressions; Views.

Unit-3 Database Design and the E-R model: E-R diagram; Reduction to Relational Schema, E-R design issues, Database Integrity, Specifying Integrity Constraints in SQL; Foreign Key; Triggers.

Unit-4 Relational Database Design: Features of Good Relational Designs; Atomic Domains and First Normal Form; Decomposition using Functional dependencies; Functional Dependency Theory; Algorithms for Decomposition; Other Normal forms, Second Normal Form, Third Normal Form, Boyce-Codd Normal Form; Multi-valued dependency and Fourth Normal Form.

Unit-5 Data Storage and Querying: Overview of Secondary Storage; File Organization, Organization of Records in Files; Data-Dictionary; Conceptsof indexing, Ordered indices; B+-tree indices; Hashing; Query Processing; Measures of Query Cost; Query Optimization .

Unit-6 Transactions Management: Transaction concepts; ACID properties of Transactions and their necessity, Serializability; Transaction Isolation Levels; Concurrency Control: Lock-based protocols, 2-phase locking; Deadlock Handling; Multiple Granularity; Timestamp based protocols.

Books:

1. A. Silberschatz, H. Korth, and S. Sudarshan, *Database System Concepts*, 6th Ed., McGraw-Hill, (2010).
2. R. Elmasri, S. Navathe, *Fundamentals of Database Systems*, 6th edition, Addison-Wesley, (2010).
3. R. Ramakrishnan, J. Gehrke, *Database Management Systems*, 3rd Ed., McGraw-Hill, (2002).

Course Outcome (CO):

At the end of the course, students are expected to

1. Understand the basic terms and concepts related to database design and management.
2. Describe, define and apply the major components of the relational database model to design database systems.
3. Learn and apply the Structured Query Language (SQL) for database definition and manipulation in the database development process.
4. Understand and implement the principles and concepts of normalization, information integrity constraints, security and privacy issue.
5. Design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementation of DBMS.

CS 303	Operating System	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	3	1	0	4

Unit-1 Process Management: process, thread, scheduling; Concurrency: mutualexclusion, synchronization, semaphores, and deadlocks.

Unit-2 Memory Management: allocation, protection, hardware support, paging, segmentation.

Unit-3 Virtual Memory: demand paging, allocation, replacement, swapping, segmentation, TLBs.

Unit-4 File Management: naming, file operations and their implementation; File Systems: allocation, free space management, directory management, mounting.

Unit-5 I/O Management: device drivers, disk scheduling.

Books:

1. Charles Crowley, *Operating System: A Design-oriented Approach*, 1st Ed., TataMcGraw-Hill.
2. Peter Baer Galvin, Greg Gagne, Abraham Silberschatz, *Operating System Concepts*, 9th Ed., Wiley Asia Student Edition.
3. William Stallings, *Operating Systems: Internals and Design Principles*, 5th Ed., Prentice Hall of India.
4. Robert Love, *Linux Kernel Development*, 3rd Ed., Addison-Wesley Professional.

Course Outcome (CO):

At the end of the course, students are expected to

1. Describe and explain the fundamental components of a computer operating system.
2. Define, discuss and explain the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.
3. Describe and extrapolate the interactions among the various components of computing systems.
4. Design and construct the following OS components: System calls, Schedulers etc.

CS 304	Software Engineering	L	T	P	C
	B.Tech (CSE) Semester (Core)	3	1	0	4

Unit-1 Introduction to Software Engineering: The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Incremental process models, Evolutionary process models, specialized process models, The Unified process.

Unit-2 Software Requirements: Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management. System models: Context Models, Behavioural models, Data models, Object models, structured methods.

Unit-3 Project Planning: Overview, Effort Estimation and COCOMO, project Scheduling, Risk Management, Monitoring Plan and SCM.

Unit-4 **Design Engineering**: Design process and Design quality, Design concepts, the design model, pattern based software design. Creating an architectural design: software architecture, Data design, Architectural styles and patterns, Architectural Design, assessing alternative architectural designs, mapping data flow into software architecture. Modelling component-level design: Designing class-based components, conducting component-level design, object constraint language, designing conventional components. Performing User interface design: Golden rules, User interface analysis, and design, interface analysis, interface design steps, Design evaluation.

Unit-5 **Testing Strategies**: A strategic approach to software testing, test strategies for conventional software, Black-Box and White-Box testing, Validation testing, System testing, the art of Debugging. Product metrics: Software Quality, Frame work for Product metrics, Metrics for Analysis Model, Metrics for Design Model, Metrics for source code, Metrics for testing, Metrics for maintenance. Metrics for Process and Products: Software Measurement, Metrics for software quality.

Unit-6 **Risk management**: Reactive vs. Proactive Risk strategies, software risks, Risk identification, Risk projection, Risk refinement, RMMM, RMMM Plan. Quality Management: Quality concepts, Software quality assurance, Software Reviews, Formal technical reviews, Statistical Software quality Assurance, Software reliability, The ISO 9000 quality standards.

Text Books:

1. Roger S Pressman, *Software Engineering: A practitioner's Approach*, McGraw Hill International Edition.
2. Pankaj Jalote, *Software Engineering, A Precise Approach*, Wiley India, (2010).
3. Rajib Mall, Fundamentals of Software Engineering, PHI, (2005).

Reference Books:

1. Waman S Jawadekar, *Software Engineering: A Primer*, Tata McGraw-Hill, (2008).
2. Deepak Jain, *Software Engineering, Principles and Practices*, Oxford University Press.

Course Outcomes (COs):

At the end of the course, students are expected to

1. Ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.
2. Ability to design, implements, and evaluate a computer-based system, process, component, or program to meet desired needs.
3. Ability to apply design and development principles in the construction of software systems of varying complexity.

CS 305	Graph Theory	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	3	1	0	4

Unit-1 Fundamental Concepts: Graphs and Graph Models; Vertex degree, Matrix representation of graphs, Isomorphism; Contraction and Sub-graphs; Paths, Cycles, Connectivity in graphs; Bipartite graphs.

Unit-2 Trees and Distances**:** Properties of Trees, Distance in Trees and Graphs; Enumeration of Trees; Spanning Trees, Fundamental Circuits; Finding all Spanning Trees of a Graph; Minimum Spanning Trees; Shortest Paths.

Unit-3 Matching and Covers**:** Maximum Matching's, Hall's Theorem; Min-Max Theorem; Independent Sets and Covers; Maximum Bipartite Matching Connectivity and Paths: Paths, Cycles, and Trails; Cuts and Connectivity, Edge Connectivity; Connectedness in Undirected and Directed Graphs; 2-connected Graphs, *k*-connected Graphs, *k*-edge-connected Graphs; Paths and Isomorphism; Counting Paths between Vertices; Euler Paths and Circuits; Hamiltonian Paths and Circuits.

Unit-4 Cut-sets and Cut-vertices: Properties of Cut-sets, All Cut-sets in a Graph; Fundamental Circuits and Cut-sets; Connectivity and Separability; Network Flows;

Planar Graphs and Dual Graphs: Combinatorial and Geometric Graphs; Planar Graphs, Drawings in the Plane, Euler's Formula; Dual Graphs, Geometric Dual, Combinatorial Dual; Kuratowski's Theorem; Detection of Planarity; Thickness and Crossings

Unit-5 **Coloring of Graphs**: Chromatic Number, Chromatic Partitioning, Chromatic Polynomial; Matching's; Coverings; The Four-Color Problem

Books:

1. **N. Deo**, *Graph Theory with applications to Engineering and Computer Science*, Prentice Hall of India.
2. **K. H. Rosen**, *Discrete Mathematics and applications*, 7th edition, Tata McGraw Hill.
3. **R. Diestel**, *Graph Theory*, 2nd edition, Springer-Verlag.

Course Outcomes (COs):
After completion of this course, the students are expected to

1. Understand and describe some important classes of graph theoretic problems and formally apply graph-theoretic terminologies and notations.

2. Formulate and prove central theorems about trees, matching, connectivity, coloring and planar graphs.
3. Apply the knowledge and understanding of graph-theoretic concepts in solving real world problems in (especially) computer science applications.

CS 311	Computer Network Laboratory	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	0	0	3	2

Simulation of computer network using Open-Source simulators, Implementation of design problems in the simulator, experimentation and interpretation of results, Use of TCPDump & Wireshark for extracting information from network, Socket programming for implementation of applications over TCP & UDP.

Course Outcomes (COs):

1. Able to analyze behavior of a computer network.
2. Able to apply different techniques for behavior improvement.
3. Able to interpret results of experimentation

CS 312	Database Management System Laboratory	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	0	0	3	2

E-R Model, Design a database using the E-R Model, **Relational Model, Normalization, DDL commands using MySQL, DML commands, Integrity constraints, Database Querying, Triggers, Procedures.**

Books:

1. **N. Shah,** *Database Systems Using Oracle: A Simplified Guide to SQL and PL/SQL,* Pearson-Prentice Hall.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Understand, appreciate and effectively explain the underlying concepts of database technologies.
2. Normalize a database, populate and query a database using SQL DML/DDL commands, and declare and enforce integrity constraints on a database using a state-of-the-art RDBMS
3. Design and implement a simple Database as projects in collaboration with other students.

CS 313	Operating System Laboratory	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	0	0	3	2

The laboratory exercises will include familiarization with UNIX system calls for process management and inter-process communication; Experiments on process scheduling and other operating system tasks through simulation/implementation.

Course Outcomes (COs):
After completion of this course, the students are expected to

1. familiarize the concepts, design and structure of the UNIX operating system.
2. Able to write system level programs

CS 314	Software Engineering Laboratory	L	T	P	C
	B.Tech (CSE) Fifth Semester (Core)	0	0	3	2

Class Diagram, Deployment diagram, Activity diagram, Software Development Model, Requirement Development, Requirement Verification, Software Design, and Testing, etc..

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Able to handle software development models
2. Able to generate test cases for software testing.
3. Able to handle software development models through rational methods.

CS 306	Principles of Programming Languages	L	T	P	C
	B.Tech (CSE) Sixth Semester (Core)	3	1	0	4

Unit-1 Language Design Issues: **History of Programming Languages, Role of Programming Languages and Language Paradigms; Programming Environments**

Unit-2 Language Translation Issues**: Programming Language Syntax, Syntactic Elements of a Language, Stages in Translation, Analysis of Source Program, Synthesis of the Object Program; Formal Translation Models.**

Unit-3 Elementary Data Types: Properties of Data Objects, Variables and Constants, Data Types, Declarations, Type Checking and Type Conversion, Assignment and Initialization; Scalar Data Types; Composite Data Types, Pointers and Programmer Constructed Data Objects.

Unit-4 Structured Data Types**: Vectors and Arrays, Records, Lists, Sets, Executable Data Objects.**

Unit-5 Abstract Data Types: Information Hiding; Encapsulation by Subprograms, Type Definitions, Type Equivalence, Inheritance, Polymorphism.

Unit-6 Sequence Control: Implicit and Explicit Sequence Control, Sequencing with Arithmetic and Non-Arithmetic Expressions, Sequence Control between Statements

Unit-7 Subprogram Control: Sequence Control, Simple Call-ReturnSubprograms, Recursive Subprograms; Names and Referencing Environments, Static and Dynamic Scope, Block Structure, Local Data and Local Referencing Environments; Actual and Formal Parameters, Methods for Transmitting Parameters; **Static and Dynamic Scope, Block Structure**.

Unit-8 Storage Management**: Programmer and System Controlled Storage; Static Storage Management; Heap Storage Management**.

Books:

1. **Terrence. W. Pratt**, Marvin V. Zelkowitz. *Programming Languages Design and Implementation*, 4th edition, Prentice Hall of India.
2. **K. C. Louden**, *Programming Languages – Principles and Practice*, 4th edition, Addison-Wesley.

3. **A. Tucker, R. Noonan**, *Discrete Mathematics for Computer Scientists and Mathematicians*, Tata McGraw-Hill.

Course Outcome (CO):

After completion of this course, the students are expected to

1. Understand, interpret, and define the semantics of a programming language and increase their vocabulary of useful programming constructs.
2. Understand and delve into the underlying language design concepts and their impact on language implementation.
3. Use the knowledge of a variety of programming paradigms and assess the effectiveness of each programming paradigm for a particular problem.
4. Learn as well as design new languages with ease.

CS 307	Compiler Design	L	T	P	C
	B.Tech (CSE) Sixth Semester (Core)	3	1	0	4

Unit-1 **Introduction**: An overview to language processors and different phases of a compiler, cousins of compiler, compiler construction tools.

Unit-2 **Lexical analysis**: specification of tokens, recognition of tokens, input buffering, finite automata- NFA and DFA, construction of NFA and DFA from regular expressions, subset construction.

Unit-3 **Syntax analysis**: context free grammars, top down - recursive-decent parsing, LL(1) grammars, non-recursive predictive parsing and bottom up parsing - shift-reduce parsing, SLR, CLR, LALR.

Unit-4 **Semantic analysis**: syntax-directed definitions, evaluation order of SDD's, syntax-directed translation applications and schemes, implementing L- Attributed SDD's.

Unit-5 **Intermediate code generation**: three-address code, type checking, control flow, back patching, switch-statements, run-time environments.

Unit-6 **Code generation**: issues in the design of code generations, addresses in the target code, basic blocks and flow-graphs, optimization of basic blocks, simple code-generator.

Unit-7 **Code optimization**: Introduction to code optimization techniques and instruction-level parallelism.

Text Books:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, *Compilers: Principles, Techniques, and Tools*, 2nd Ed., Pearson, (2007).
2. V. Raghavan, *Principles of Compiler Design*, McGrawHill, (2010).

References Books:

1. Andrew W. Appel, Jens Palsberg, *Modern compiler implementation in Java*, Second Edition, Cambridge University Press, (2002).
2. C.N. Fischer and R.J. Le Blanc, *Crafting a Compiler with C*, Pearson Education, (2009).
3. K. D. Cooper and L. Torczon, *Engineering a Compiler*, Morgan Kaufmann Publishers, (2004).

Course Outcomes (CO):

After completion of this course, the students are expected to

1. Students will be aware of the major concepts in areas of language translation and compiler design.
2. Students will be able to develop a language translator or compiler covering a broad range of engineering and scientific applications.
3. Learn and apply the various concepts of context free grammars, compiler parsing techniques, construction of abstract syntax trees, symbol tables, actual code generation and code optimization techniques.

CS 308	Graphics and Multimedia	L	T	P	C
	B.Tech (CSE) Sixth Semester (Core)	3	1	0	4

Unit-1 Introduction: Computer graphics and its applications, input and output devices - Graphics Software's – Output Primitives: Points and Lines, Line Drawing Algorithms (DDA & Bresenham's), Circle and Ellipse Generating Algorithms, Conic Sections.

Unit-2 Two-Dimensional Concepts: Different types of transformations and their matrix representations, Homogeneous Coordinates, Composite Transformations, transformations between Coordinate Systems, Affine transformations, Window-to-Viewport Coordinate transformation, Clipping-Point, Line, Polygon.

Unit-3 3-D Concepts: Translation, Rotation and Scaling. Hidden Surface elimination Basic Illumination Model: Diffuse reflection, Specular reflection, Phong Shading, Gouraud shading, Color models.

Unit-4 Multimedia basics: Multimedia applications − Multimedia system architecture − Evolving technologies for multimedia − Defining objects for multimedia systems − Multimedia data interface standards − Multimedia databases. Compression and decompression − Lossless/Lossy Compression techniques, Image, Audio & Video Compressions, MPEG Standards
,Multimedia Architecture, Multimedia databases - Data and file format standards − Multimedia I/O technologies − Digital voice and audio − Full motion video − Storage and retrieval technologies.

Unit-5 Animation: Uses of Animation, Principles of Animation, and Computer based animation, 3D Animation, Animation file formats..

Text Books:

1. D. Hearn & M.P. Baker , *Computer Graphics*, 4/e , Pearson Education, New Delhi, 2005
2. Prabat K Andleigh and Kiran Thakrar, *Multimedia Systems and Design*, PHI, (2005).

Reference Books:

1. W.M. Newman. et. al. *Principle of Interactive Computer Graphics*, Mc Graw Hill Publication, New Delhi, (1995).
2. S. Harrington, *Computer Graphics- A Programming Approach*, Mc Graw Hill Publication, New Delhi, (1994).

3. J.D. Foley et. Al., *A Fundamental of Computer Graphics*, Wesley, London, (1993).
4. Judith Jeffcoate, *Multimedia in practice: Technology and Applications*, PHI, (1998).
5. Foley, Vandam, Feiner and Hughes, *Computer Graphics: Principles and Practice*, 2nd Edition, Pearson Education, (2003).
6. Hill F S Jr., *Computer Graphics*, Maxwell Macmillan, (1990).

Course Outcomes (CO):

After completion of this course, the students are expected to

1. Learn the basic principles and commonly used paradigms and techniques of computer graphics and develop a facility with the relevant mathematics of computer graphics. Also, Students will create interactive graphics applications using one or more graphics application programming interfaces.
2. Students will have an understanding of 2D and 3D graphics and algorithms including scan conversions, polygon filling, clipping, transformations, 3D viewing, Shading and Illumination model, lighting and Texture mapping.
3. Students will learn the techniques behind various audio-video compression and de-compression, the file formats and animation.
4. Be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.

CS 331	Social Network Analysis	L	T	P	C
	B.Tech (CSE) Sixth Semester (Elective)	3	1	0	4

Unit-1 Social Network Fundamentals**: Basic terminologies, Network modelling and representation, Network formation and evolution, Growth pattern of network, Network visualization and analysis, Social platforms and architecture, Technologies and applications.**

Unit-2 Community detection**: Definition of community, Methods for community detection, Evaluating communities, Community detection in dynamic networks and multiple featured networks; Link prediction;Recommender System; Viral marketing- Information diffusion, Advertisement, Targeted Advertising**

Unit-3 Social Media**: Opinion Mining, Review Mining, Sentiment Analysis, Rumour Detection Privacy, Security and Trust- Trust networks and evolution of trust, Privacy in social networks, Dark web and crimenetwork analysis, Cyber Security and Intelligence.**

Books:

1. M. E. J. Newman , *Networks An Introduction*, Oxford University Press.
2. J. Scott, *Social network analysis: A handbook,* Sage Publication.
3. David Konke, *Social Network Analysis*,, Sage Publication.
4. , Lei Tang and Huan Liu, *Community Detection and Mining in Social Media*, Morgan & Claypool Publishers.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. The students will be able to explain the concepts of graphs and networks applicable for analyzing social networks.
2. The students will be able to interpret the current research on social network analysis.
3. The students will be able to analyze social network related problems and their solutions.
4. The student will be able to identify the research gap in order to formulate research questions relevant to social network analysis.

CS 332	Natural Language Processing	L	T	P	C
	B.Tech (CSE) Sixth Semester (Elective)	3	1	0	4

Unit-1 Introduction, Regular Expressions, Text Normalization, Edit Distance, N-gram Language Models, Ambiguity, Naive Bayes and Sentiment Classification, Vector Semantics.

Unit-2 Neural Networks and Neural Language Models, RNN, LSTM, GRU, Part-of- Speech Tagging, HMM, Maximum Entropy, CRF, Sequence Processing with Recurrent Networks.

Unit-3 Formal Grammars of English, Tree banks as Grammars, Syntactic Parsing, Statistical Parsing, PCFG, and Dependency Parsing.

Unit-4 The Representation of Sentence Meaning, WSD, Information Extraction, Semantic Role Labeling, Lexicons for Sentiment, Discourse Coherence.

Unit-5 Machine Translation, Question Answering, Dialog Systems and Chatbots, Speech Recognition and Synthesis

Text Books:

1. Jurafsky D., Martin J. H. , *Speech and Language Processing*, Prentice Hall
2. Manning C., Schütze H , *Foundations of Statistical Natural Language Processing*, MIT Press.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Understanding of basic concepts in linguistics.
2. Understanding of the fundamental mathematical models and algorithms in the field of NLP
3. Apply these mathematical models and algorithms in applications in software design and implementation for NLP.
4. Students will understand the theoretical underpinnings of natural language processing in linguistics and formal language theory.

CS 333	Digital Image Processing	L	T	P	C
	B.Tech (CSE) Sixth Semester (Elective)	3	1	0	4

Unit-1 **Introduction**: Background, Digital Image Representation, Fundamental Stepsin Image Processing, Elements of a Digital Image Processing System, Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry.

Unit-2 Image Enhancement : Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering – Frequency Domain: convolution and correlation - Introduction to Fourier Transform - Other Separable Image Transforms, Walsh-Hadamard and K-L transform– Smoothing andSharpening frequency domain filters – Ideal, Butterworth and Gaussian filters,Enhancement by point processing, Generation of Spatial Masks from Frequency Domain Specifications.

Unit-3 Image Restoring and segmentation: Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Formulation, Removalof Blur Caused by Uniform Linear Motion- Wiener filtering Segmentation: Detection of Discontinuities–Edge Linking and Boundary detection – Region based segmentation- Morphological processing- erosion and dilation.

Unit-4 Wavelets and Image compression: Wavelets – Subband coding – Multiresolution expansions – Compression: Fundamentals – Image Compression models – Error Free Compression – Variable Length Coding – Bit-Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding – Compression Standards.

Unit-5 **Image representation and recognition**: Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors –Topological feature, Texture – Patterns and Pattern classes – Recognition based on matching – Color Image Processing.

Text book:

1. Rafael C. Gonzalez, *Digital Image Processing*, 3rd Ed., Pearson, (2010).
2. Bernd Jahne, *Digital Image Processing*, 7th Ed., Springer, (2017).
3. Scott E Umbraugh, *Digital Image Processing &Analysis*, 2nd Ed., CRC press, (2010).

References:

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, *Digital Image Processing Using MATLAB*, Third Edition Tata Mc Graw Hill Pvt. Ltd., (2011).
2. Anil Jain K. *Fundamentals of Digital Image Processing*, PHI Learning Pvt. Ltd., (2011).
3. Willliam K Pratt, *Digital Image Processing*, John Willey, (2002).
4. Malay K. Pakhira, *Digital Image Processing and Pattern Recognition, First Edition*, PHI Learning Pvt. Ltd., (2011).

Course Outcomes:
After completion of this course, the students are expected to

1. Discuss digital image fundamentals.
2. Apply image enhancement and restoration techniques.
3. Use image compression and segmentation Techniques.
4. Apply the Image Processing techniques in solving real-time problems in various areas viz., Medical Imaging, Satellite Imaging, Defence area.

CS 334	Speech Processing	L	T	P	C
	B. Tech (CSE) Sixth Semester (Elective)	3	1	0	4

Unit-1 Fundamentals of speech Processing, Modelling speech production, Short-term processing of speech.

Unit-2 Linear prediction analysis, MFCC, Cepstral analysis, Speech coding and synthesis, Speech enhancement.

Unit-3 Recognition using templates and DTW, Speech Classification using Hidden Markov models, VQ, SVM, NN and other algorithm techniques.

Books:

1. Deller J., Hansen J.,Proakis J. , *Discrete- Time Processing of Speech Signals* , Wiley-IEEE.
2. Rabiner, Schafer , *Digital Processing of Speech Signals* , Prentice Hall.
3. Quatieri T. F. , *Discrete- Time Speech Signal Processing: Principles and Practice* , Prentice Hall.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Learn Fundamental Principles, Paradigms and Requirement of Speech Processing.
2. Understand Human Speech Production and Perception Model.
3. Feature extraction and analysis methods e.g. LPC. , and different speech processing algorithms applied.
4. Application of speech and its issues during implementation process.
5. Students will be able to learn the concept of Dynamic Time Warping (DTW) and Hidden Markov Model (HMM).

CS 335	Artificial Neural Network	L	T	P	C
	B.Tech (CSE) Sixth Semester (Elective)	3	1	0	4

Unit-1 Introduction: Biological neurons and artificial neurons, Models of an ANN (McCulloch and Pitts, Rosen Blatt's Perceptron and Adaline) Activation functions used in ANNs, Typical classes of network architectures.

Unit-2 Mathematical Foundations and Learning mechanisms: Re- visiting vector and matrix algebra, State- space concepts, Concepts of optimization, Error-correction learning, Memory- based learning, Hebbian learning, Competitive learning.

Unit-3 Single layer perceptrons: Structure and learning of perceptrons, Pattern classifier-introduction and Bayes' classifiers, Perceptron as a pattern classifier, Perceptron convergence, Limitations of a perceptrons.

Unit-4 Feed forward ANN: Structures of Multi- layer feed forward networks, Back-propagation algorithm, Back propagation- training convergence and, Functional approximation with back-propagation, Practical and design issues of back-propagation learning

Unit-5 Radial Basis Function Networks: Pattern separability and interpolation, Regularization Theory, Regularization and RBF networks, RBF network design and training, Approximation properties of RBF.

Unit-6 Competitive Learning and Self-Organizing ANN: General clustering procedures, Learning Vector Quantization(LVQ), Competitive learning algorithms and architectures, Self-Organizing feature maps, Properties of feature maps.

Books:

1. Haykin S., *Neural Networks: A comprehensive foundation*, Pearson Education
2. Kumar S., *Neural Networks: A classroom approach*, TMH
3. Schalkoff R. J. , *Artificial Neural Networks*, McGraw- Hill
4. Patterson D. W., *Artificial Neural Networks: Theory and Applications*, Prentice Hall
5. Hertz, Krogh, Palmer, *Introduction to the Theory of Neural Computatio,* Addison- Wesley

Course Outcomes (COs):

At the end of the course, students are expected to

1. understand the fundamental concept of Artificial Neural Networks.
2. understand the different kinds of learning algorithms.
3. understand the different kinds of ANN approaches and techniques.
4. design the ANN models to solve machine learning tasks/problems.

CS 336	Linux Operating System	L	T	P	C
	B.Tech (CSE) Sixth Semester (Elective)	3	1	0	4

Unit-1	**Introduction**: Structure of Linux kernel, system booting, debugging
Unit-2	**Process management:** process creation, scheduling, synchronization
Unit-3	**Interrupts**: interrupts, interrupt handlers
Unit-4	**Memory management**: memory segmentation, paging. page cache
Unit-5	**File Systems**: abstraction layer, VFS objects, Inode object, Dentry object
Unit-6	**Device drivers**: device drivers, module programming

Books:

1. Daniel Bovet and Marco Cesat, *Understanding the Linux Kernel (ULK)*, 3rd Edition
2. Robert Love , *Linux Kernel Development (LKD)*, 3rd Edition

Course Outcomes (COs):
After completion of this course, the students are expected to

1. Describe and explain the fundamental components of a Linux operating system.
2. Describe and explain the various functions of the Linux kernel, including file system, scheduler, and memory management.

CS 381	Simulation and Modelling	L	T	P	C
	B.Tech (CSE) Sixth Semester (Elective)	3	1	0	4

Unit-1 Introduction to simulation and modelling, application areas, system and system environment, components of the system, type of systems, model of a system, types of models and steps in simulation study.

Unit-2 Simulation of queuing systems such as single channel and multi-channel queue, lead time demand, inventory system, reliability problem, time-shared computer model, job-shop model.

Unit-3 Concepts of discrete event simulation, model components, a discrete event system simulation, simulation formalisms, simulation of single channel queue, multi-channel queue, inventory system and dump truck problem usingevent scheduling approach.

Unit-4 Use of probability and statistics in simulation, useful statistical model, discrete distribution, continuous distribution, empirical distribution and Poisson process.

Unit-5 Characteristics of queuing systems, queuing notations, long run measures of performance of queuing systems, steady state behaviour of Markovian models, overview of finite capacity and finite calling population models, network of queues.

Unit-6 Properties of random numbers, generation of true and pseudo random numbers, techniques for generating random numbers, hypothesis testing, various tests for uniformity and independence.

Books:

1. N. Deo, *Simulation with Digital Computer*, PHI
2. Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, *Theory of Modelling and Simulation*, Academic press.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Describe the role of important elements of discrete event simulation and modeling paradigm.

2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
3. Develop skills to apply simulation software to construct and execute goal-driven system models.
4. Interpret the model and apply the results to resolve critical issues in a real world environment.

		L	T	P	C
CS 382	**Introduction to Blockchain**				
	B.Tech (CSE) Sixth Semester (Elective)	**3**	**1**	**0**	**4**

Unit-1 Introduction: Blockchain's History and Basic Concepts: Satoshi Nakamoto's Bitcoin white paper, history and exploration of blockchain, crypto anarchists, and cipher punks into a functional digital currency.

Unit-2 Blockchain Technology: the basics of how Blockchain's work "under the hood" at the technical level, This includes definition and terminology, different types of Blockchain, and details of how they function. Specific topics: Cryptography, Networking, Consensus mechanisms, Coins and tokens, Smart contracts, Distributed applications (dAPPS), Decentralized autonomous organizations (DAOs).

Unit-3 Blockchain Applications and Use Cases: How blockchain technologies will revolutionize processes and industries, how blockchain is being put to use today, and how people are thinking about using it tomorrow. Specific topics: Business drivers of blockchain, Digital currency and finance (including ICOs and alternative funding), Identity, Supply Chain, Healthcare, Ownership and property rights, Governance and compliance.

Unit-4 Blockchain Challenges and Constraints: Blockchain technologies face a number of critical hurdles and limits. Specific topics: Blockchain risks,Technological challenges, Standards (or lack thereof), Scalability issues, Security and privacy, Legal and regulatory problems, Social and cultural constraints.

Unit-5 Blockchain Philosophy and Implications: Aspect of philosophical and political values. Specific topics: Philosophical underpinnings of blockchain (crypto-anarchy revisited), Centralization vs. decentralized systems, Open vs. closed systems, Will blockchain change the way we think or live, Technology hype vs. reality, Similarities with the development of networking & the Internet, Corporate adoption and co-opting of blockchain technology.

Books:

1. Arshdeep Bahga and Vijay K. Madisetti, , ***Blockchain Applications: A Hands-on Approach*** ISBN: 9780996025560

2. Andreas M. Antonopoulos, **Mastering Bitcoin: Programming The Open Blockchain**, O'Reilly, ISBN: 9789352135745

Course Outcome (COs):

After completion of this course, the students are expected to

1. An basic idea about Blockchain technology
2. Applications and implementation strategies of Blockchain
3. Understandings of current trends of Blockchain, and ability to imagine its use cases, open research challenges and future directions.

CS 315	Object Oriented Design Laboratory	L	T	P	C
	B. Tech (CSE) Sixth Semester	3	1	0	4

Case study of Unified Library application which is mentioned in the theory as well as own problem and Model it in different views i.e. Use case view, logical view, component view, Deployment view, Database design, forward and Reverse Engineering, and Generation of documentation of theproject.

Reference Books:

1. Meilir Page-Jones, *Fundamentals of Object Oriented Design in UML*, Pearson Education.
2. Pascal Roques , *Modeling Software Systems Using UML2*, WILEY-Dreamtech India Pvt. Ltd.
3. AtulKahate, *Object Oriented Analysis & Design*, The McGraw-Hill Companies.
4. Mark Priestley , *Practical Object-Oriented Design with UML*, TATAMcGrawHill
5. Gandharba Swain, *Object Oriented Analysis & Design Through Unified Modeling Language*, Lakshmi Publications Pvt.Ltd , New Delhi.

Course outcomes (COs):

After completion of this course, the students are expected to

1. Know the syntax of different UML diagrams.
2. Create different UML diagrams for a software system
3. Identify appropriate models to represent a software system.
4. Analyze and design a software system in an object oriented style using tools like Rational Rose.

CS 316	Compiler Laboratory	L	T	P	C
	B. Tech (CSE) Sixth Semester	0	0	3	2

Designing and implementing the basic concepts of compiler using tools such as Lex / Flex and Yacc / Bison etc.

Reference books:

1. JohnLevine, Tony Mason, DougBrown, *Lex and Yacc*, O'Reilly. (1995).
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, *Compilers: Principles, Techniques, and Tools*, 2nd Ed., Pearson, (2007).

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Students will be aware of the major concepts in areas of language translation and compiler design.
2. Students will be able to develop a language translator or compiler covering a broad range of engineering and scientific applications.
3. Learn and apply the various concepts of context free grammars, compiler parsing techniques, construction of abstract syntax trees, symbol tables, actual code generation and code optimization techniques.

CS 317	Graphics and Multimedia Laboratory	L	T	P	C
	B.Tech (CSE) Sixth Semester	0	0	3	2

Implementation of algorithms for drawing 2D primitives –line, circle and ellipse, 2Dtransformations and composite transformations, 3D transformations, Clipping algorithms, Creating 3D scenes, Image editing and Manipulation- Basic operations on image using any image editing software, creating gif animated images, image optimization, 2D animation- to create interactive animation using any authoring tool like visual simulation of wind, water and fire, ray tracing, bump mapping, morphing, coloring and shading.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. To understand the 3D transformation of objects into 2D displays by creating 3D graphical scenes.
2. To understand the different kinds of transformations by animating 2D objects.
3. To understand the algorithms on projection, shear, coloring and modeling of various shapes.
4. To understand and apply multimedia effect on objects and realize its importance in the graphics industry through image enhancement, manipulation and animation.

CS 321	Social Network Analysis Laboratory	L	T	P	C
	B.Tech (CSE) Sixth Semester	0	0	3	2

Graph representation and visualization, centrality measures, community detection, evaluation metrics, diffusion models, link prediction, influence maximization etc.

Course Outcomes (COs):

1. Students will be able to use tools and libraries to generate and visualize social networks.
2. Student will be able to analyze properties of complex network applicable to social networks.
3. Student will be able to explore pros and cons by performing empirical analysis of existing algorithms for the problems related to social network analysis.

CS 322	Natural Language Processing Laboratory	L	T	P	C
	B. Tech (CSE) Sixth Semester	0	0	3	2

Basic regular expressions, tokenization, stemming, language modeling, text classification and categorization, experiment on dependency parser, experiment on machine translation, design and implement simple question-answering system, design and implement simple chatbot.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Learn basics of text processing using different techniques
2. Be able to analyse and understand important tools used in NLP
3. Be able to design and implement some basic applications in NLP

CS 323	Digital Image Processing Laboratory	L	T	P	C
	B. Tech (CSE) Sixth Semester	0	0	3	2

Study of Mat lab toolbox, simple arithmetic operations on images, image enhancement using histogram equalization, addition of different type of noise's to images, low pass and high pass filter using Gaussian filter, edge detection, morphological operations in images, texture effect on images, image segmentation, bit plane coding, wavelet-based watermarking, image Hiding using LSB substitution.

Reference Book:

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Ed , *Digital Image Processing Using MATLAB,* 2nd ed, Gatesmark publishing.

Course Outcomes:

After completion of this course, the students are expected to

1. After completion of this course student will be able to
2. Perform image related operations
3. Apply a proper filter for given a set of noisy images.
4. Analyse different image segmentation, compression techniques and Demonstrate different morphological operations.
5. Develop any application using different image processing techniques.

CS 324	Speech Processing Laboratory	L	T	P	C
	B.Tech (CSE) Sixth Semester	0	0	3	2

Record, analyse and study characteristics of the speech signals and implement them based on spectograms, Implement feature extraction techniques including LPCC and MFCC, Modelling of speech based on various classification techniques such as DTW, HMM, VQ, SVM, NN and other new algorithmic techniques..

Course Outcomes:
After completion of this course, the students are expected to

1. Know how to create speech data and in that process environmental factors to be considered.
2. Implement various types of feature extraction techniques.
3. Implement and design various classification algorithms.

CS 325	Artificial Neural Network Laboratory	L	T	P	C
	B.Tech (CSE) Sixth Semester	0	0	3	2

Models of an ANN (Mc Culloch and Pitts, Rosen Blatt's Perceptron and Adaline): Single layer perceptrons: Feed forward ANN: Radial Basis Function Networks: Self Organizing ANN.

Course Outcomes:
After completion of this course, the students are expected to

1. Design and implementation of single and multi-layer feed-forward neural networks
2. Design and implementation of radial basis networks and kohonen networks
3. Design and implementation of ANN models to solve machine learning tasks.

CS 326	Linux Operating System Laboratory	L	T	P	C
	B.Tech (CSE) Sixth Semester	0	0	3	2

Configure, build, and install the Linux kernel, Read and write Linux kernel modules, Implement customized extensions to the Linux kernel

Course Outcome (CO):
After completion of this course, the students are expected to

1. Able to read and write kernel modules for the Linux kernel
2. Able to implement customized extensions to the Linux kernel

CS 401	Artificial Intelligence	L	T	P	C
	B. Tech (CSE) Seventh Semester (Core)	3	0	0	3

Unit-1 **Introduction**: Introduction and techniques of AI, Importance of AI, Agents and rationality, task environments, agent architecture, Application of AI.

Unit-2 **Search strategies**: Search space, Uninformed Search technique, Bread First Search, Depth First search, Informed Search, Heuristic Search technique, constraint satisfaction problems, stochastic search methods, Hill climbing, backtracking, graph search, A* algorithm, monotone restriction, production systems, AO* algorithm, **Searching game trees**: MINIMAX procedure, alpha-beta pruning.

Unit-3 Knowledge representation: Knowledge representation and reasoning, Propositional logic, First Order logic, Situation calculus, Theorem Proving in First Order Logic, STRIPS robot problem solving system, Structured representations of knowledge (Semantic Nets, Frames, Scripts), Rule based representations, forward and backward chaining.

Unit-4 Uncertain Knowledge and Reasoning: Non monotonic & monotonic reasoning, Confidence factors, Bayes theorem, Dempster & Shafers Theory of evidence, Probabilistic inference, Fuzzy reasoning.

Unit-5 Application: AI in Natural Language Processing and Understanding, E- commerce, E-tourism, Industry, Healthcare, vision and Robotics.

Books:

1. Stuart J. Russell and Peter Norvik, *Artificial Intelligence: A Modern Approach*, Pearson Education.
2. Rich, Knight and Nair, *Artificial Intelligence*, Tata Mcgraw Hills
3. Nils Nilsson, Morgan Kaufmann, *Artificial Intelligence: A New Synthesis*,
4. N.P. Padhy, *Artificial Intelligence and Intelligent Systems*, Oxford

Course Outcome (CO):

After completion of this course, the students are expected to

1. Student will demonstrate knowledge of the building blocks of AI.
2. Ability to apply Artificial Intelligence techniques for problem solving.

3. Student will participate in the design of systems by applying knowledge representation, reasoning techniques to real-world problems that act intelligently and learn from AI experience.

CS 431	Machine Learning	L	T	P	C
	B. Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 Introduction, Decision Trees learning, Probability Primer, Bayes Decision Theory, Maximum- likelihood and Bayesian Parameter Estimation, Non- parametric Techniques, Bayes Networks, Optimization, Primer, Linear Discriminant Functions, Support Vector Machines.

Unit-2 Unsupervised Learning, Semi Supervised Learning, Reinforcement Learning, Statistical learning methods, PAC learning framework, Occam's Razor.

Books:

1. Mitchell T. M. , *Machine Learning* , McGraw Hill
2. Duda R. O., Hart P. E., Strok D. G. , Pattern Classification, Wiley Interscience

Course outcomes (COs):

After completion of this course, the students are expected to

1. Understand the principles, advantages, limitations and possible applications of machine learning
2. Identify the appropriate machine learning techniques for classification.
3. Apply various pattern recognition, optimization and decision problems in Machine learning.

CS 432	Pattern Recognition	L	T	P	C
	B. Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 Introduction – Introduction to pattern recognition; Applications of pattern recognition (OCR, speech recognition, fingerprints, signatures etc.); Statistical, neural and structural approaches.

Unit-2 Statistical Pattern Recognition – Patterns and classifications; Discriminant functions; Bayes decision rule; Nearest neighbour rule; Probability of error.

Unit-3 Linear Discriminate Functions and Discrete and Binary Feature Cases: Introduction, Discrete and Binary Classification Problems, Techniques to Directly Obtain Linear Classifiers.

Unit-4 Syntactic Pattern Recognition: Overview Quantifying Structure in Pattern Description and Recognitions, Grammar Based Approach and Application, String Generation as Pattern Description, Recognition by String Matching and Parsing. The Cocke-Younger Kasami (ck) parsing algorithm.

Unit-5 Neural Pattern Recognition: Introduction to Neural Networks, Neural Network Structure from Pattern Recognition Applications, Physical Neural Network. The Artificial Neural Network Model, Neural Network Based Pattern Associators.

Books:

1. Schalkoff R. J., *Pattern Recognition: Statistical, Structural and Neural Approache* , Wiley.
2. Duda R. O., Hart P. E , *Pattern Classification and Scene Analysis* , Wiley.
3. Miclet L., *Structural methods in Pattern Recognition*, North Oxford Academic.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Design systems and algorithms for pattern recognition.
2. Be able to analyze classification problems probabilistically and estimate classifier performance.
3. Understand and analyses methods for automatic training of classifications systems.

CS 433	Computational Geometry	L	T	P	C
	B.Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 Introduction: Historical perspective, Application Domains, Models of Computation.

Unit-2 Convex Hulls: Convexity definition, Convex Sets, Simple Hull, and Incremental Algorithm for Convex Hull, Divide and Conquer approach, Jarvis' March.

Unit-3 Line Segment Intersection**: The Doubly-Connected Edge List, Computing the Overlay of Two Subdivisions, Boolean Operations.**

Unit-4 Polygon Triangulation: Partitioning a Polygon into Monotone Pieces, Triangulating a Monotone Polygon.

Unit-5 Orthogonal Range Searching: 1-Dimensional Range Searching, Kd-Trees, Range Trees, Higher-Dimensional Range Trees, General Sets of Points.

Unit-6 Voronoi Diagram: Definition and Basic Properties, Computing the Voronoi Diagram.

Unit-7 Delaunay Triangulations: Triangulations of Planar Point Sets, The Delaunay Triangulation, Properties of the Delaunay Triangulation, A randomized incremental algorithm for computing the Delaunay Triangulation.

Unit-8 More Geometric Data Structures: Interval Trees, Priority Search Trees, Segment Trees. **Quadtrees**: Uniform and Non-uniform Meshes, Quadtrees forpoint sets.

Books:

1. **M. de Berg, M. van Kreveld, M. Overmars, and O. Cheong**,*Computational Geometry - Algorithms and Applications*,3rd edition, (Springer-Verlag), (2000)**.**
2. **Joseph O'Rourke**, *Computational Geometry in C*, (Cambridge University Press)
3. **Franco P. Preparata, Michael Ian Shamos**, *Computational Geometry: An Introduction*(Springer)

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Understand the methods of proof used to prove the correctness of different geometric-algorithms and apply these to solve applied problems.
2. Understand the popular computational geometric problems like, Construction of Voronoi Diagram, Art Gallery Problem, Delaunay Triangulation and judge whether they can be applied to solve a new computational problem.
3. Formulate real-world problems in graphics and other application domains such that they can be solved using computational geometric techniques.
4. Understand the basic computational models like divide-and-conquer, line-sweep, plane-sweep paradigms and apply them to solve new problems wherever feasible.

CS 434	Cryptography and Security	L	T	P	C
	B. Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 Introduction to cryptography and classical cryptosystem: Introduction to cryptography, Traditional cryptosystems, Cryptanalysis type, Monoalphabetic cipher, Playfair, Hill cipher, Cryptanalysis of Hill cipher.

Unit-2 Mathematical foundation: Extended Euclidian algorithm, Diophantine equation, Modular arithmetic, Linear equation, sets of linear equations with same modulus, LFSR, Fermat's little theorem, Euler's Phi function, Euler's theorem, Chinese remainder theorem, Primality test, factoring.

Unit-3 Symmetric Key Ciphers: S-DES, Differential cryptanalysis, DES, S-DES, AES, RC4.

Unit-4 Asymmetric Key Ciphers and Hashing: RSA, ECC, ElGamal cryptosystem, ECDSA, Hashing, SHA.

Unit-5 Key Management: Symmetric Key Distribution, Kerberos, Symmetric Key Agreement, Public Key Distribution.

Unit-6 Security: E-Mail, PGP, Secure Socket layer**.**

Books:

1. Forouza B. A ., *Cryptography and Network Security*, TMH
2. Stallings W., *Cryptography and Network Security*, TMH
3. Stinson D., *Cryptography Theory and Practice*, Chapman & Hall/CRC
4. Oded Goldreich, *Foundation of Cryptography.*
5. Jeffrey Hoffstein, *An introduction to mathematical cryptography*

Course outcomes (COs):

After completion of this course, the students are expected to

1. Students will have mathematical knowledge of cryptography and understand the various symmetric and asymmetric key cryptography algorithms.
2. Students will have the skills to implement state of the art cryptosystem.
3. With research and creative thinking students will be able identify any flaw or weakness in existing cryptosystems and develop better cryptosystem.

CS 435	Wireless Network	L	T	P	C
	B. Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 Introduction to wireless communication systems and networks., Wireless network generations viz. 1G, 2G, 3G, 4G, 5G networks: features, differences and challenges.

Unit-2 Wireless technologies:- Cellular wireless networks and systems principles, antennas and radio propagation, signal encoding and modulation techniques. Spread spectrum, Coding and error control.

Unit-3 Wireless Networking:- Multiple access techniques, Mobile IP and WAP, Wireless systems and standards.

Unit-4 Wireless LANs:- Wireless LAN technology, Wireless standard (IEEE 802.11 etc), Adhoc and Infrastructure oriented Networks, Bluetooth, ZigBee.

Unit-5 Wireless network routing:- Wireless routing as an optimization problem, Proactive and reactive routing, Distance Vector and Link state routing protocols, AODV, DSDV, DSR,OLSR protocols

Books:

1. TS Rappaport, *Wireless Communications: Principles & Practice*, Pearson Publications
2. William Stallings, *Wireless Communications and Networks*, Pearson Publications.

Course Outcomes (CO):

After completion of this course, the students are expected to

1. Learn fundamentals of Wireless communication and Wireless Networks.
2. Able to learn and compare wireless network standards, MAC and routing protocols.
3. Able to use learned concepts in application specific problem solving.

CS 436	VLSI Physical Design	L	T	P	C
	B.Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 Introduction: Introduction to Physical Design, Layout Synthesis, and Metrics Used in Physical Design, Basic Data Structures, Basic Algorithmic Techniques, Optimization Techniques for Circuit Design Applications, Partitioning and Clustering.

Unit-2 Floor planning: Floor planning: Early Research, Slicing Floor plans, Floor plan Representations, Packing Floor plan Representations, Recent Advances in Floor planning, Industrial Floor planning and Prototyping.

Unit-3 Placement: Placement: Introduction/Problem Formulation, Partitioning- Based Methods, Placement Using Simulated Annealing, Analytical Methods in Placement, Force-Directed and Other Continuous Placement Methods, Enhancing Placement with Multilevel Techniques, Legalization and Detailed Placement, Timing-Driven Placement, Congestion-Driven Physical Design.

Unit-4 Net Layout and Optimization: Global Routing Formulation and Maze Routing, Minimum Steiner Tree Construction, Timing-Driven Interconnect Synthesis, Buffer Insertion Basics, Generalized Buffer Insertion, Buffering in the Layout Environment, Wire Sizing.

Unit-5 Routing Multiple Signal Nets: Estimation of Routing Congestion, Rip-Up and Reroute, optimization Techniques in Routing, Global Interconnect Planning, and Coupling Noise.

Unit-6 Manufacturability and Detailed Routing: Modeling and Computational Lithography, CMP Fill Synthesis: A Survey of Recent Studies, Yield Analysis and Optimization, Manufacturability-Aware Routing.

Unit-7 Physical Synthesis: Placement-Driven Synthesis Design Closure Tool, X Architecture Place and Route: Physical Design for the X Interconnect Architecture.

|Unit-8 Designing Large Global Nets: Inductance Effects in Global Nets, Clock Network Design: Basics, Practical Issues in Clock Network Design, Power Grid Design.

Unit-9 **Physical Design for Specialized Technologies:** Field-Programmable Gate Array Architectures, FPGA Technology Mapping, Placement, and Routing, Physical Design for Three-Dimensional Circuits.

Textbooks:

1. C. J. Alpert, D. P. Mehta, S. S. Sapatnekar, *Handbook of Algorithms for Physical Design Automation*, Auerbach Publications.
2. S. K. Lim, *Practical Problems in VLSI Physical Design Automation*, Springer.
3. S. M. Sait and H. Youssef, *VLSI Physical Design Automation: Theory and Practice*, World Scientific.
4. Naveed A. Sherwani, *Algorithms for VLSI Physical Design Automation*, 3/E, Springer.

Course Outcomes (CO):

After completion of this course, the students are expected to

1. Students are able to know how to place the blocks and how to partition the blocks while for designing the layout for IC.
2. Students are able to solve the performance issues in circuit layout.
3. Students are able to analyze physical design problems and Employ appropriate Aut omation algorithms for partitioning, floor planning, placement and routing
4. Students are able to decompose large mapping problem into pieces, including
5. Students are able to analyze circuits using both analytical and CAD tools.

CS 437	Distributed System	L	T	P	C
	B. Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 **Introduction:** Concepts of Distributed System and its general architecture; Basic design issues in distributed system.

Unit-2 **Naming**: Naming of entities and concept of name space; Name space implementation; locating mobile entities.

Unit-3 **Process Management:** Basic concepts of process and thread; Threads in Distributed System; Code Migration and its models; Migration in heterogeneous environment; Introduction to RPC and RMI.

Unit-4 **Synchronization**: Basic synchronization techniques; Physical and. logical time and clocks; Clock Synchronization algorithms; Global State; Election algorithms.

Unit-5 **Distributed Mutual Exclusion:** Requirements, Types and Models of Mutual Exclusion algorithms; Discussion of algorithms.

Unit-6 **Distributed Deadlock Handlin:** Introduction to Deadlock; Deadlock Prevention and Avoidance techniques; Deadlock Detection/ Resolution algorithms.

Unit-7 **Fault tolerance and recovery**: basic concepts, fault models, agreement problems and its applications, commit protocols, voting protocols, check pointing and recovery, reliable communication.

Unit-8 **Agreement Protocols**: Basic concept of agreement protocols; Different agreement problems: Byzantine agreement problem, Consensus problem, Relations among agreement problems; Solution to Byzantine agreement problem; Application of agreement algorithm.

Unit-9 **Special Topics**: distributed objects, distributed databases, directory services, web services.

Books:

1. Tanenbaum A. S., Steen M. V., *Distributed Systems: Principles and Paradigms*, (Pearson Ed.)

2. Singhal M., Shivaratri N. G., *Advanced Concepts in Operating System*, TMH
3. Distributed Operating System – Sinha P. K. (PHI.)
4. Coulouris G., Dollimore J., Kindberg T., *Distributed Systems: Concepts and Design* 3rd Ed., Pearson
5. Tanenbaum A. S., *Distributed Operating Systems*, Pearson Ed.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Identify the advantages and challenges in designing distributed algorithms for different primitives like mutual exclusion, deadlock detection, agreement, etc.
2. Students will identify the core concepts of distributed systems: the way in which several machines orchestrate to correctly solve problems in an efficient, reliable and scalable way.
3. Students will examine how existing systems have applied the concepts of distributed systems in designing large systems, and will additionally apply these concepts to develop sample systems.

CS 438	Internet of Things	L	T	P	C
	B. Tech (CSE) Seventh Semester (Elective)	3	1	0	4

Unit-1 Internet of Things, An Overview: Introduction, Internet of Things Definition Evolution, IoT Architectures, Resource management, IoT Data Management and Analytics, Communication Protocols, IoT Applications, Security, Identity Management and Authentication, Privacy, Standardization Open Source Semantic Web Infrastructure for Managing IoT Resources in the Cloud, Device/Cloud Collaboration Framework for Intelligence Applications, Fog Computing: Principles, Architecture and Applications.

Unit-2 IoT Enablers and Solutions: Programming Frameworks for Internet of Things, Virtualization on Embedded Boards as an Enabling Technology for the Cloud of Things, Micro Virtual Machines (MicroVMs) for Cloud-Assisted Cyber-Physical Systems (CPS).

Unit-3 IoT Data and Knowledge Management: Stream Processing in IoT: Foundation, State-of-the-Art, and Future Directions, A Framework for Distributed Data Analysis for IoT.

Unit-4 IoT Reliability, Security, and Privacy: IoT Security and Privacy in the Internet of Things, Internet of Things- Robustness and Reliability, Governing Internet of Things: Issues, Approaches and New Paradigms, TinyTO: Two- Way Authentication for Constrained Devices in the Internet of Things, Obfuscation and Diversification for Securing the Internet of Things.

Unit-5 IoT Applications: Applied Internet of Things, Internet of Vehicles and Applications, Cloud-Based Smart-Facilities Management.

Books:

1. Rakjumar Buyya and Amir Vahid Dastjerdi, Morgan Kaufmann, *Internet of Things Principles and Paradigms*
2. Vlasios Tsiatsis Stamatis Karnouskos Jan Holler David Boyle Catherine Mulligan, *Internet of Things: Technologies and Applications for a New Age of Intelligence,* Academic Press.
3. Arshdeep Bahga, Vijay Madisetti, *Internet of Things (A Hands-on-Approach),* ISBN-13: 978-0996025515 ISBN-10: 0996025510.
4. Samuel Greengard, *The Internet of Things,* MIT Press.

5. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, *Internet of Things*, Wiley.

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Understand the key components that make up an IoT system.
2. Apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis.
3. appreciate the role of big data, cloud computing and data analytics in a typical IoT system

CS 439	Data Mining	L	T	P	C
B.Tech (CSE)	Seventh Semester (Elective)	3	1	0	4

Unit-1 Overview of Data Mining: Motivation, Functionalities, Need of Data Warehouse, Data Pre-processing, Architecture of a Typical Data Mining Systems, Tools and Techniques, Applications and Challenges, Data Mining Research Trends.

Unit-2 Classification and Prediction: Decision Tree Induction, Bayes Classification Methods, Rule-Based Classification, Classification by Back propagation, Support Vector Machines, Prediction-Linear Regression and Non linear Regression.

Unit-3 Clustering: Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Probabilistic Model-Based Clustering, Outlier Analysis.

Unit-4 Frequent Pattern/Iitemset Mining: Frequent pattern/Itemsets and Association Rules, Frequent Pattern Mining Methods.

Unit-5 Mining special kinds of Data: Text Mining, Graph Mining, Social Network Analysis, Privacy, Security, and Social Impacts of Data Mining.

Text Books:

1. Jiawei Han and Micheline Kamber, Morgan Kaufmann, *Data Mining - Concepts and Techniques*, (2006).
2. Margaret Dunham, Prentice Hall, *Data Mining: Introductory and Advanced Topics, (*2003).
3. Paulraj Ponniah, *Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals* by John Wiley & Sons, Inc., (2001).

Course Outcomes (COs):

After completion of this course, the students are expected to

1. Students will be able to analyze different kind of data.
2. Students will be able to apply algorithms of Classification and Prediction, clustering, Frequent Pattern mining in problem solving.
3. Students will be able to use Data Mining Tools and Techniques in real world applications.

CS 481	Web Technology	L	T	P	C
B. Tech (CSE)	Seventh Semester (Open Elective)	3	0	0	3

Unit-1 Introduction to WWW: Protocols and programs, secure connections, application and development tools, the web browser, What is server, choices, setting up UNIX and Linux web servers, Logging users, dynamic IP Web Design: Web site design principles, planning the site and navigation.

Unit-2 Introduction to PHP: Declaring variables, data types, arrays, strings, operators, expressions, control structures, functions, Reading data from web form controls like text boxes, radio buttons, lists etc., Handling File Uploads. Connecting to database (MySQL as reference), executing simple queries, handling results, Handling sessions and cookies.

Unit-3 File Handling in PHP: File operations like opening, closing, reading, writing, appending, deleting etc. on text and binary files, listing directories.

Unit-4 XML: Introduction to XML, Defining XML tags, their attributes and values, Document Type Definition, XML Schemas, Document Object Model, XHTML Parsing XML Data–DOM and SAX Parsers in java.

Unit-5 Introduction to Servlets: Common Gateway Interface (CGt), Life cycle of a Servlet, deploying a servlet, The Servlet API, Reading Servlet parameters, Reading Initialization parameters, Handling Http Request & Responses, UsingCookies and Sessions, connecting to a database using JDBC.

Unit-6 Introduction to JSP: The Anatomy of a JSP Page, JSP Processing, Declarations, Directives, Expressions, Code Snippets, implicit objects, Using Beans in JSP Pages, Using Cookies and session for session tracking, connecting to database in JSP.

Unit-7 Client side Scripting: Introduction to Javascript: Javascript language – declaring variables, scope of variables, functions. event handlers (on click, on submit etc.), Document Object Model, Form validation. Simple AJAX application.

Text books:

1. Uttam K Roy, *Web Technologies*, Oxford University Press
2. Steven Holzner, *The Complete Reference PHP* ,Tata McGraw-Hill
3. *Web Technologies*, Black Book, Dream tech Press

4. Knuckles, *Web Applications : Concepts and Real World Design*, Wiley-India
5. P.J. Deitel&, H.M. Deitel, I*nternet and World Wide Web How to program*, Pearson

Reference books

1. Web Programming, building internet applications, Chris Bates 2nd edition, Wiley Dreamtech
2. Java Server Pages —Hans Bergsten, SPD O'Reilly,
3. Java Script, D.Flanagan, O'Reilly SPD
4. Beginning Web Programming-Jon Duckett WROX.
5. Programming world wide web, R.W.Sebesta, Fourth Edition, Pearson.
6. Internet and World Wide Web — How to program. Dietel and Nieto, Pearson.

Course Outcomes:

After completion of this course, the students are expected to

1. The students will gain knowledge of client side scripting, validation of forms and AJAX programming
2. Students will have understanding of server side scripting with PHP language, Java servlets and JSP and would have capability to make own web site and host their own web site on internet.
3. Students will have understanding of what is XML and how to parse and use XML Data with Java
4. Also students would have enough knowledge about what are the technologies used in internet.

CS 482	Introduction to GPU Computing	L	T	P	C
	B. Tech (CSE) Seventh Semester (Open Elective)	3	0	0	3

Unit-1 Introduction: Fundamental of Graphics Processing Unit (GPU), GPU Evolution – Past and Present, Moore's Law, GPU vs CPU, How GPUaccelerate Science and Engineering, Various GPU types, GFLOPS, Latency vs. throughput, cores. GPU Usage, Dedicated vs Integrated Graphics Card.

Unit-2 GPU Architecture : Hardware structure - typical CPU vs GPU, GPU Architecture – Global Memory and Steaming and Multi-processors, SIMD (Single-Instruction Multiple-Data) execution model, Scalar and vector instructions, Nested control flow, Thread divergence, Memory hierarchy, GPU Cache, Core Architecture (two, four, sixteen), Shader Core, Various GPU accelerated libraries. Compute Unified Device Architecture (CUDA), Various types of NVIDIA GPUs, NVIDIA vs Intel, 3 Ways to Accelerate Applications.

Unit-3 GPU Programming Languages: OpenCL programming model, TensorFlow – CPU vs GPU, TensorFlow with GPU, CPU and GPU for training a neural network.

Unit-4 Application: Current and future application of CUDA architecture, TensorFlow with GPU, Application in - Image Text, Speech.

Books:

1. B. Gaster, L. Howes, D. Kaeli, P. Mistry, D. Schaa, Morgan Kaufmann, *Heterogeneous Computing with OpenCL*, 1st Edition, August 31, (2011).
2. Jason Sanders, Edward Kandrot, *CUDA by Example: An Introduction to General-Purpose GPU Programming*, 1st Edition

Course Outcomes (COs):
After completion of this course, the students are expected to

1. Learn about GPU architecture and programming for solving engineering or computer science research and theory to advance the art, science and practice of the discipline.
2. Students will have an ability to design and conduct experiments as well as to analyze, interpret, apply and disseminate the data
3. Students will understand of research by using GPU programming

CS 440	Quantum Computing	L	T	P	C
	B.Tech (CSE) Eighth Semester (Elective)	3	1	0	4

Unit-1 **Introduction and overview**: Basics of quantum computing, Quantum Bits or Qubit, differences in bit and qubit, representation of qubits, reversible Computation, basics of Quantum mechanics and linear algebra, Quantum Algorithms, Parallelism, Postulates of Quantum Mechanisms, bracket notation, single and multiple qubit, Entanglement, EPR pair, Bloch sphere.

Unit-2 **Quantum Circuits**: Characteristics, Design, Single and multi-qubit operations, Operators, Quantum States, Control Operations, Measurement, Universal Quantum Gates, design of common quantum circuits, List of merits in quantum circuits, Quantum cost, Quantum delay, synthesis of reversible logic-MDM method etc, Optimization of list of merits, Simulation of Quantum Systems.

Unit-3 **Common quantum algorithms**: Deutsch's algorithm, Deutsch-Jozsa algorithm, Simon's algorithm, Quantum Fourier transform (QFT), General applications of QFT, Phase estimation, Quantum search algorithms, Oracle, Grover search etc.

Unit-4 **Quantum noise and Quantum Operations**: Classical Noise and Markov Processes, Noise and Environment, Bit flip and phase flip channels, Trace and Partial trace etc.

Unit-5 **Quantum error** correction: Introduction, Three qubit flip code, Three qubit phase code, Shor code for error correction, Stabilizers codes etc.

Unit-6 Basics of Entropy and information, quantum information theory, Quantum Cryptography, Different Physical realization of quantum computers, Discussion of research topics in Quantum Computation and information.

Books:

1. Micheal A. Nielsen and Issac L. Chiang, *Quantum Computation and Quantum Information* , Cambridge University Press
2. Colin P. Williams, *Explorations in Quantum Computing*, Springer Science & Business Media
3. Eleanor G. Rieffel and Wolfgang H. Polak, *Quantum Computing: A Gentle Introduction*, MIT Press

4. Robert Wille, Rolf Drechsler, *Towards a Design Flow for Reversible Logic*, Edition illustrated, Publisher Springer Science & Business Media, 2010, ISBN9048195799, 9789048195794.

Course outcome (CO):

After completion of this course, the students are expected to

1. Introduction of quantum computation, classical bit and qubit, basics of linear algebra, Postulates, notations and representation.
2. Basic notations of Quantum Computing- Qubits, mathematical representation, Quantum gates, Operators, Measurement operators, Quantum Evolution, Quantum Circuits, Entanglement, merits of quantum circuits etc.
3. Quantum algorithms, parallelism, search algorithm etc.
4. Quantum noise, Error correction. Quantum cryptography, Physical realization etc.
5. Explore knowledge in research areas in quantum computing

CS 441	Text Mining and Analytics	L	T	P	C
	B.Tech (CSE) Eighth Semester (Elective)	3	1	0	4

Unit-1 Introduction: Natural Language Content Analysis, Text Representation, Word Association Mining and Analysis, Paradigmatic Relation Discovery, Entropy, Conditional Entropy, Mutual Information.

Unit-2 Topic Mining and Analysis: topics, coverage of topic, Overview of Statistical Language Models, parameters of a probabilistic model, generative model, Mixture model estimation, Probabilistic Latent Semantic Analysis, Latent Dirichlet Allocation.

Unit-3 Text Clustering: Clustering, document clustering, term clustering, clustering bias, perspective of similarity, Hierarchical Agglomerative Clustering, k- Means, direction evaluation, (of clustering), indirect evaluation (of clustering).

Unit-4 Text Categorization: text categorization, topic categorization, sentiment categorization, email routing , spam filtering, naïve Bayes classifier, smoothing, Generative Probabilistic Models, Discriminative Classifier, training data, logistic regression, K-Nearest Neighbour classifier,

classification accuracy, precision, recall, F-measure, macro-averaging, micro-averaging.

Unit-5 **Opinion Mining and Sentiment Analysis**: Sentiment Classification, Ordinal Logistic Regression, Latent Aspect Rating Analysis, Text-Based Prediction.

Unit-6 **Contextual Text Mining**: Contextual Probabilistic Latent Semantic Analysis, Mining Topics with Social Network Context, Mining Casual Topics with Time Series Supervision.

Books:

1. Zhai, C. &Massung, S., *Text data management and analysis: A practical introduction to information retrieval and text mining*, Morgan & Claypool Publishers
2. Charu C Aggarwal, *Machine Learnig for Text* , Springer
3. Daniel Jurafsky and James H. Martin, Speech and Language Processing, Pearson Ed.
4. , Steven Bird, Ewan Klein, and Edward Loper , *Natural Language Processing with Python, Analyzing Text with the NaturalLanguage Toolkit* , O'Reilly
5. Dipanjan Sarkar, *Text Analytics with Python: A Practical Real-World Approach to GainingActionable Insights from your Data*, Apress

Course Outcomes (COs):

After completion of this course, the students are expected to

1. To learn the basic of principles of text mining and analytics
2. Able to use some of the commonly used algorithms for text mining and analytics
3. Able to use different techniques of word association mining and analysis, topic modeling, text clustering, text categorization, opinion mining and contextual text mining etc.
4. Able to use different area of application such as text mining and analytics, text clustering and categorization, opinion mining and contextual text mining

CS 442	Wireless Sensor Network	L	T	P	C
	B.Tech (CSE) Eighth Semester (Elective)	3	1	0	4

Unit-1 Introduction: Introduction to wireless sensor network. Definitions, Challenges, Application requirements, Protocol Stack, Special features, Difference with other kinds of networks, issues and research problems.

Unit-2 Wireless fundamentals. Antennas, propagation, and path loss, Digital radio communication, RF spectrum, modulation, 2-ray model, others.

Unit-3 Low power PAN, LAN Standards, IEEE 802.11, 802.15, 802.15.4 and Zigbee.

Unit-4 Medium Access: Medium access problem related to sensor network, Aloha, CSMA, Slotted Aloha, RTS/CTS, ACKs, TRAMA, SMAC and other WSN MAC protocols, Energy management.

Unit-5 Network layer / Routing: Adhoc network routing, Data centric routing,Hierarchical routing protocols, Geographical routing, Location based routing.

Unit-6 Localization: Localization challenges, needs, and state of the art solutions Localization, range free and range based localization.

Unit-7 Application: Application specific network design and deployment, mobile sensor network, Linear and grid based networks, Network infrastructure management and control.

Books:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, Wiley-Interscience
2. Feng Zhao, Leonidas Guibas, *Wireless Sensor Networks: An Information Processing Approach*, Morgan Kaufmann Publishers
3. (Ed) Pradeep Kumar Singh, Bharat K. Bhargava, Marcin Paprzycki, Narottam Chand Kaushal, Wei-Chiang Hong, *Handbook of Wireless Sensor Networks: Issues and Challenges in Current Scenario's*, Springer
4. William Stallings, *Wireless Communications & Networks*, Pearson Pub
5. T.S. Rappaport, *Wireless Communications: Principles and Practice*, Pearson Education India

Course Outcomes (CO):

After completion of this course, the students are expected to

1. Learn the unique features, limitations and applications of Wireless sensor network.
2. Able to learn WSN specific MAC, Routing and Transport protocols.
3. Able to apply energy efficiency, optimal usage network resources in application domain.

CS 443	Applied Parallel Programming	L	T	P	C
	B.Tech (CSE) Eighth Semester (Elective)	3	1	0	4

Unit-1 **Parallel Computer Architectures**: Distributed memory systems, Shared memory systems and cache coherence, Heterogeneous system architecture (GPU and Xeon Phi), Interconnection networks and routing.

Unit-2 Principles of parallel algorithm design: Decomposition techniques, Characteristics of tasks and interactions, mapping techniques for load balancing, Parallel algorithm models.

Unit-3 Programmingscalable systems: Programming using MPI paradigm, Programming using global address space language UPC.

Unit-4 **Programming shared- address space systems** : OpenMP, Cilk Plus Programming heterogeneous systems: CUDA and OpenCL, OpenACC and OpenMP (4.0).

Unit-5 Analytical modeling of parallel program : Scalability of parallel systems, Sources of overhead in parallel programs, Asymptotic analysis of parallel programs. Basic communication operations, Graph algorithms, Dense matrix algorithms, Numerical algorithms, Search algorithm for discrete optimization.

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, and Vipin Kumar. *Introduction to parallel computing*, second edition, Addison- Wesley, 2003, ISBN: 0201648652
2. Yuefan Deng , *Applied Parallel Computing*, worldscientific

Course Outcome (COs):

After completion of this course, the students are expected to

1. the basic construction and use of parallel computers.
2. the content and use of the terminology for how one measures the performance of parallel algorithms and parallel computers.
3. how to develop computer programs for different types of parallel computers.

CS 444	Information Theory and Coding	L	T	P	C
	B.Tech (CSE) Eighth Semester (Elective)	3	1	0	4

Unit-1 Introduction: Concept of entropy and mutual information; Application of entropy in feature extraction.

Unit-2 Entropy in stochastic processes : Entropy rates; Markov chains; Hidden Markov models.

Unit-3 Data Compression: Kraft inequality and optimal coding; Huffman codes and optimality; Shanon-Fano-Elias coding; Arithmetic codes.

Unit-4 Channel capacity and Coding: Different channel models; Concept of channel capacity; Channel coding theorem; Fano's inequality; Huffman codes; Channel capacity theorem; Shanon's limit; Random selection of codes.Noiseless coding.

Unit-5 Error control codes: Concept of Linear Block Codes, Cyclic Codes, BCH Codes, RS Codes, Convolution Codes.

Unit-6 Error Correcting techniques: Short-random-error correction by error- trapping; Burst-error correction for block codes.

Unit-7 Coding and Digital Modulation: Trellis coded modulation.

Books:

1. Cover T. M., Thomas J. A. , *Elements of Information Theory* , Wiley
2. Bose R. , *Information Theory, Coding and Cryptography* , TMH.
3. Rhee M. Y. , *Error Correcting Coding Theory* , (McGraw-Hill
4. Morelos-Zaragoza R. H. , *The Art of Error Correcting Coding,* Wiley
5. Roman S. , *Introduction to Coding and Information Theory* , Springer
6. Huffman W. C., Pless V, *Fundamentals of Error-Correcting Codes*, Cambridge
7. Reed I. S., Chen X., *Error Control Coding for Data Network,* Kluwer
8. Wada G. , *Coding Techniques: an introduction to compression and error control,* (Palgrive).
9. Garret P. , *The Mathematics of Coding Theory* , Pearson

Course Outcomes (CO):

After completion of this course, the students are expected to

1. Learn the basic notions of information, entropy and channel capacity.
2. Learn about convolution and block codes, decoding techniques, and automatic repeat request (ARQ) schemes.
3. Understand the concept of various theorems proposed by Shannon for efficient data compression and reliable transmission.
4. Analyse error control coding techniques are applied in communication systems and solving encoding and decoding of convolution codes.

CS 445	Big Data Analysis	L	T	P	C
	B. Tech (CSE) Eighth Semester (Elective)	3	1	0	4

Unit-1 **Introduction**: History of Big Data, Big data: definition and taxonomy, Overview on Big Data Analytics, Big Data in business process.

Unit-2 **Big Data Storage Technology**: DAS, NAS and SAN, Block store, File System- Metadata server, Replication, Deduplication, Fault-tolerance, Load balancing, Object store- Metadata, Data, and Unique ID, NoSQL- Key- value, Document-store, Columnar, Row-store, and Graph.

Unit-3 **Hadoop Distributed File System**: Architecture, NameNode, DataNode, SecondaryNameNode, Heartbeat, Replication, Fault-tolerance, Issues and Challenges. Hadoop Stack: Yarn, Pig, Mahout, Cassandra, HBase, Ambari, Zookeeper, Oozie, Kafka & Storm, Spark.

Unit-4 **MapReduce**: Architecture, Job Tracker, Task Tracker, Heartbeat, MapReduce programming, LATE Scheduler, Delay Scheduler, Issues and Challenges.

Unit-5 **Big Data and Machine Learning**: Quick introduction to Machine learning - Big Data & Machine Learning - Machine learning tools.

Unit-6 **Big Data Analytics**: Predictive Analytics, Prescriptive Analytics, Decision Analytics, Diagnostic Analytics, Behavioural Analytics , Issues and Challenges.

Unit-7 **Big Graph**: Big Graph Databases, Big Graph processing, Big Graph Analytics.

Books:

1. Fei Hu, *Big Data: Storage, Sharing, and Security*, 1st Edition, Chapman and Hall/CRC, Published May 3, 2016
2. Arun K. Somani, Ganesh Chandra Deka, *Big Data Analytics: Tools and Technology for Effective Planning*, 1st Edition, Chapman and Hall/CRC, Published October 26, 2017
3. Jason Venner, *Pro Hadoop*, Apress; 1st ed. edition (June 17, 2009)

Course outcomes (COs):

After completion of this course, the students are expected to

1. be able to know various storage technologies of Big Data.
2. be able to know the importance of Big Data in business process.
3. be able know Hadoop Distributed File Systems and MapReduce programming paradigm.
4. be able write MapReduce programming and the underlying issues and challenges.
5. be able to know about Hadoop ecosystem and Big Data analytics.

CS 483	Time Series Analysis	L	T	P	C
	B. Tech (CSE) Eighth Semester (Open Elective)	3	0	0	3

Unit-1 **Models for time series**: Time series data, Trend, seasonality, cycles and residuals, Stationary processes, Auto regressive processes, Moving average processes, White noise.

Unit-2 **Models of stationary processes**: Purely in-deterministic processes, ARMA processes, ARIMA processes, Estimation of the auto-covariance function, Identifying a MA(q) process, Identifying an AR(p) process, Distributions of the ACF and PACF.

Unit-3 **Spectral methods**: Discrete Fourier transform, Spectral density, Analyzing the effects of smoothing.

Unit-4 **Estimation of the spectrum**: Periodogram, Distribution of spectral estimates, Fast Fourier transform.

Unit-5 **Linear filters**: Filter Theorem, Application to auto regressive processes, Application to moving average processes, General linear process, Filters and ARMA processes, Calculating auto-covariance in ARMA models.

Unit-6 **Estimation of trend and seasonality**: Moving averages, Centered moving averages, Slutzky- Yule effect, Exponential smoothing, Calculation of seasonal indices.

Unit-7 **Fitting ARIMA models**: Box- Jenkins procedure, Identification, Estimation, Verification, Tests for white noise, Forecasting with ARMA models.

Unit-8 **State space models**: Models with unobserved states, Kalman filter, Prediction, Parameter estimation.

Books:

1. Brockwell P. J., Davis R. A. , *Time Series: Theory and Methods* , Springer
2. Chatfield C. , *The Analysis of Time Series: Theory and Practice*, Chapman and Hall
3. Kendall M., *Time Series* , Charles Griffin
4. Box G. E. P., Jenkins G., Reinsel G. , *Time Series Analysis - Forecasting and Control*, Pearson Ed

Course Outcome (CO):

After completion of this course, the students are expected to be

1. Able to define time series data in an appropriate statistical framework.
2. Able to summarize and carry out exploratory and descriptive analysis of time series data.
3. Able to use open-source software to model and produce forecasts & interpret results.

CS 484	Cloud Computing	L	T	P	C
B. Tech (CSE)	Eighth Semester (Open Elective)	3	0	0	3

Unit-1 Introduction: Definition, characteristics, public, private, hybrid and community cloud, SaaS, PaaS, IaaS, and barriers of Cloud Computing, Issues and Challenges.

Unit-2 Cloud Computing: Discovery, Selection, Allocation, Pay-as-you-go model, metering, multi-tenant architecture, SLA, SLA dependency, legal issues, VM Mobility, data portability, monitoring, networking, autonomy, virtualization, Big Data Cloud, HPC Cloud.

Unit-3 Inter-cloud Computing: Provisioning, Federated SLA (FSLA), FSLA dependency, FSLA legal issues, authorization & identity management.

Unit-4 Cloud Security: Trust, authorization & identity management, vulnerability issues, privacy & security in cloud, issues and challenges.

Unit-5 Services: SOAP, REST, Storage as a Service, Disaster Management as a Service, MapReduce as a Service, Anything as a Service.

Unit-6 Applications: Google Doc, Wordpress, E-Commerce, Big Data Analytics as a Service, OS as a Service, Educational institutions, Banking and other business process, Medical.

Books:

1. RajkumarBuyya, Christian Vecchiola, and ThamaraiSelvi, *Mastering Cloud Computing*, Tata McGraw Hill, (2013)
2. G Shroff, *Enterprise Cloud Computing: Technology, Architecture, Applications*, Cambridge University Press, (2010).
3. Ronald L. Krutz and Russell Dean Vines, *Cloud Security: A Comprehensive Guide to Secure Cloud Computing*, Wiley, (2010).

Course Outcomes:

After completion of this course, the students are expected to

1. Understand the basic Cloud Computing paradigm.
2. Understand and analyze various Component of Cloud Computing.
3. Relate Cloud Computing and Inter-cloud computing.
4. Understand various security and privacy issues in Cloud Computing.
5. Adapt the Cloud Computing in various technologies.

CS 485	Machine Translation	L	T	P	C
	B.Tech (CSE) Eighth Semester (Open Elective)	3	0	0	3

Unit-1 **Introduction**: Overview, Why is MT hard?, Approaches to MT: RBMT, SMT, NMT

Unit-2 **SMT**: Intuition, Statistics, Alignment, IBM models (word based SMT),Basic Language Models, Phrase Based SMT, re-odering models, decoding

Unit-3 **Evaluation,** Quality Estimation, What's wrong with SMT?

Unit-4 **Practical**: install, train and run Moses/Jane

Unit-5 **Neural MT** : Intuition, Neural Networks, Basic ML, backpropagation, RNNs, Embed, encode, attend and decode: RNN sequence to sequence, attention, attention only transformer models

Unit-6 **Practical**: install, train and run OpenNMT /Marian

Books:

1. Philipp Koehn, *Statistical Machine Translation*, Cambridge University Press, (2009)
2. Philipp Koehn, *Neural Machine Translation*, Online Version [http://mt-class.org/jhu/assets/nmt-book.pdf]
3. Daniel Jurafsky, James H Martin, Speech and Language Processing, Second Edition, PHI, (2008)

Course Outcomes (COs):
After completion of this course, the students are expected to

1. To learn the basic of principles of machine translation.
2. Analyse and use some of the commonly used algorithms for machine translation.
3. Analyse and use different techniques of language modeling.
4. Design and develop machine translation systems for different applications.