Course Structure for CSE, BTech (4-Year, 8 Semester Course)

(to be applicable from 2012 batch onwards)

CS- Computer Science & Engineering

Course No.	Course Name	L	T	P	C	Course No.	Course Name	L	T	P	C
Semester - 1						**Semester -2**					
CH-1101/PH-1101	Chemistry/Physics	3	1	0	8	EC-1101	Basic Electronics	3	0	0	6
EE-1101	Basic Electrical Engineering	3	0	0	6	CS-1101	Introduction to Computing	3	0	0	6
MA-1101	Mathematics - I	3	1	0	8	MA-1102	Mathematics - II	3	1	0	8
CE-1101	Engineering Graphics	1	0	3	5	ME-1101	Engineering Mechanics	3	1	0	8
HS-1101	Communication Skills	3	0	0	6	PH-1101/CH-1101	Physics /Chemistry	3	1	0	8
CH-1111/PH-1111	Chemistry/Physics Laboratory	0	0	2	2	CS-1111	Computing Laboratory	0	0	2	2
ME-1111	Workshop	0	0	3	3	EE-1111	Electrical Sciences Lab	0	0	2	2
	Physical Training-I	0	0	2	0	PH-1111/CH-1111	Physics /Chemistry Laboratory	0	0	2	2
	NCC/NSO/NSS	0	0	2	0		Physical Training - II	0	0	2	0
		13	**2**	**8**	**38**		NCC/NSO/NSS	0	0	2	0
								15	**3**	**6**	**42**
Semester 3						**Semester 4**					
EC1221	Electonic Circuits and Switching	3	0	0	6	CS1204	Formal Language and Automata Theory	3	1	0	8
CS1201	Data Structure	3	1	0	8	CS1205	Signals & Data Communication	3	1	0	8
CS1202	Object Oriented Design	3	0	0	6	CS1206	Computer Graphics	3	0	0	6
CS1203	Discrete Structures	3	1	0	8	HS-1201	Manageral Economics	3	0	0	6
MA-1201	Mathematics - III	3	1	0	8	MA1251	Mathematics - IV (Introduction to Stochastic Processes)	3	1	0	8
CS1211	Data Structure Lab	0	0	2	2	CS1212	Computer Graphics Lab	0	0	2	2
EC1222	Electonic Circuits and Switching Lab	0	0	2	2	CS1213	Signals & Data Communication Lab	0	0	2	2
	Physical Training - III	0	0	2	0		Physical Training - IV	0	0	2	0
	NCC/NSO/NSS	0	0	2	0		NCC/NSO/NSS	0	0	2	0
		15	**3**	**4**	**40**			**15**	**3**	**4**	**40**
Semester 5						**Semester 6**					
CS1301	Computer Architecture	3	1	0	8	CS1304	Operating System	3	0	0	6
CS1302	Computer Network	3	0	0	6	CS1305	Compiler Design	3	0	0	6
CS1303	Microprocessor & System Programming	3	1	0	8	CS1306	Design and Analysis of Algorithm	3	1	0	8
MA1351	Mathematics - V (Numerical Methods)	3	1	0	8	CS1307	Database Management System	3	0	0	6
HS-1301	Business Management	3	0	0	6	CS1308	Software Engineering	3	1	0	8
CS1311	Computer Network Lab	0	0	2	2	CS1313	Operating System Lab	0	0	2	2
CS1312	Microprocessor & System Programming Lab	0	0	2	2	CS1314	Database Management System Lab	0	0	2	2
		15	**3**	**4**	**40**	CS1315	Compiler Lab	0	0	2	2
								15	**2**	**6**	**40**
Semester 7						**Semester 8**					
CS1401	VLSI Physical Design	3	0	0	6	CS1404	Advanced Computer Architecture	3	0	0	6
CS1402	Theory of Computation	3	1	0	8	CS1405	Machine Learning	3	0	0	6
CS14XX	Dept. Elective - I	3	0	0	6	CS14XX	Dept. Elective - III	3	0	0	6
CS14XY	Dept. Elective - II	3	0	0	6	CS14XY	Dept. Elective - IV	3	0	0	6
XX-1XXX	Open Elective - I	3	0	0	6	XX-1XXX	Open Elective - II	3	0	0	6
CS1490	Project - I	0	0	8	8	CS1491	Project - II	0	0	10	10
		15	**1**	**8**	**40**			**15**	**0**	**10**	**40**

NB: Industrial Training after Sixth Semester for a period of 4-6 weeks as an audit course

EE-1111 will be jointly offered by EE and EC Departments

	Elective-I		Elective-II
CS1421	Artificial Intelligence	CS1431	Computational Geometry
CS1422	Digital Image Processing	CS1432	Wireless Networks
CS1423	Applied Graph Theory	CS1433	Information Theory and Coding
CS1424	Mobile AdHoc Network	CS1434	Distributed System
CS1425	Simulation and Modeling	CS1435	Data Mining
CS1426	Human Computer Interaction	CS1436	Natural Language Processing

	Elective-III		Elective-IV
CS1441	Programming Language Concepts	CS1451	Introduction to Network Calculus
CS1442	Applied Parallel Programming	CS1452	Logic of Computer Science
CS1443	Pattern Recognition	CS1453	Wireless Sensor Network
CS1444	Cryptography and Security	CS1454	Speech Processing
CS1445	VLSI Design, Test and Verification	CS1455	Formal Methods of System Verification
CS1446	Linux Operating System	CS1456	Network Storage Management

	Open Elective-I		Open Elective-II
CS1471	Neural Network	CS1481	Soft Computing Techniques for Non-linear Optimization
CS1472	Time Series Analysis	CS1482	Cloud Computing

CS 1101 **Introduction to Computing** **3-0-2-8**

2nd sem (all branch) **Prerequisites: None**

What is a program; Digital computer fundamentals; What is a language; How program executes.
C programming: Data types; Operators; Expressions; Scope resolution and variable types; Control flow structures; Functions; Arrays and pointers; Structures and Unions; Stream data processing.
C++ Programming: Introduction to objects and classes; Object hierarchy; Inheritance; Polymorphism; Operator overloading; Templates; Virtual class and Friend class.

Lab assignments on ANSI C and C++ only:

Basic arithmetic operations, control statements, functions, arrays and pointers, structures and unions, file handling etc.
Creation of classes and objects, Inheritance, Operator overloading, Polymorphism, Implementation of Virtual class and Friend class.

Books:

1. Programming in C – Gottfried B.S. (TMH)
2. The C Programming Language - Kernighan B.W., Ritchie D.M. (PHI)
3. C++: The Complete Reference (4th Ed) – Schildt H. (TMH)
4. The C++ Programming Language – Stroustrup B. (Addison-Wesley)
5. Programming in ANSI C - Balagurusamy E. (TMH)

CS 1201 **Data Structure** **3-1-2-10**

3rd sem **Prerequisites: CS 1101**

Introduction to data types, Data structures and Abstract Data Types (ADT), Complexity analysis of algorithms, Linked list, Stack, Queue and Recursion.
Introduction to trees, Binary tree, BST, AVL trees, B Trees, B+ Trees, Binary search tree, Hashing, Basic concepts of graphs and their representation schemes.
Bubble sort, Selection sort, Insertion sort, Shell sort, Quick sort, Heap sort, Radix sort, Tree searching and graph searching techniques.
Memory management, Storage Allocation, Garbage Collection, Compaction.

Lab assignments:

Lab programs will be assigned by the course coordinator from within the topics covered in theory classes.
There shall be minimum of ten (10) programming assignments out of which minimum of five (05) assignments shall be implemented in C++ and minimum of five (05) assignments shall be implemented in Java.

Books:

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

CS 1202 **Object Oriented Design** **3-0-0-6**

3rd sem **Prerequisites: CS 1101**

Software complexity and design approach, Object model evolution and their elements, application of object models
Objects and their relationships, classes and their relationships, interplay of objects and classes, importance of classification and identification, key abstraction and mechanisms
Class diagram, object diagram, interaction diagram, module diagram, process diagram, micro and macro development process
Staffing, release management, Reuse, quality assurance and metrics, documentation, risk and benefits of object oriented development

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 modeling and design – Rumbaugh J. (Prentice Hall)
4. Object-oriented design – Coad P., Yourdon E. (Yourdon Press)
5. Object-oriented analysis – Coad P., Yourdon E. (Yourdon Press)

CS 1203 **Discrete Structure** **3-1-0-8**

3rd sem **Prerequisites: NIL**

Set theory: sets, relations, functions, countability
Logic: formulae, interpretations, methods of proof, soundness and completeness in propositional and predicate logic
Number theory: division algorithm, Euclid's algorithm, fundamental theorem of arithmetic, Chinese remainder theorem, special numbers like Catalan, Fibonacci, harmonic and Stirling
Combinatorics: permutations, combinations, partitions, recurrences, generating functions
Graph Theory: paths, connectivity, subgraphs, isomorphism, trees, complete graphs, bipartite graphs, matchings, colourability, planarity, digraphs
Algebraic Structures: semigroups, groups, subgroups, homomorphisms, rings, integral domains, fields, lattices and boolean algebras

Books:

1. Discrete Mathematics & its Applications – Rosen K. H. (TMH)
2. Discrete Structures, Logic, and Computability – Hein J. L. (Jones and Bartlett)
3. Elements of Discrete Mathematics – Liu C. L. (TMH)
4. Concrete Mathematics – Graham R. L., Knuth D. E., and Patashnik O. (Addision-Wesley)
5. Discrete Mathematics with Applications to Computer Science - Tremblay J. P. and Manohar R. P. (TMH)
6. Graph Theory - Deo N. (PHI)

CS 1204 **Formal Language and Automata Theory** **3-1-0-8**

4th sem **Prerequisites: CS 1201, CS 1203**

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

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

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

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

Books:

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

CS 1205 **Signals and Data Communication** **3-0-2-8**

4th sem **Prerequisites: MA 1101, MA 1102**

Introduction, Continuous-time and Discrete-time signals, Linear system, System properties
Input-Output modeling using linear differential equations and linear difference equations, Time-Varying systems
Convolution Representation of LTI and discrete and continuous signals, Linear time-varying systems
Signals in terms of frequency components, Fourier transform as limiting form of Fourier series, Properties, Response to sinusoidal, periodic and aperiodic inputs, Sampling
Analog modulation and demodulation of signals, Simultaneous transmission of signals, Digital modulation
Analog and digital data transmission, Transmission impairments, Channel capacity
Wired and wireless transmission, Signal encoding techniques, FDM, Synchronous and Sat TDM, ADSL; XDSL
Spread spectrum analysis (FHSS, DSSS, OFDM), Error handling, Introduction X.25, Frame Relay

Lab assignments using MATLAB:

Lab programs will be assigned by the course coordinator from within the topics covered in theory classes.
There shall be minimum of eight (08) programming assignments covering convolution of discrete and continuous time signals, sum of sinusoids in time and frequency domain, convergence of Fourier series, PAM, QAM, FSK etc.

Books:

1. Signals and Systems – Oppenheim A. V., Willsky A. S. and Nawab A. H. (PHI)
2. Digital Communication: Principles and System Modelling – Das A. (Springer)
3. Signals and Systems: Analysis Using Transform Methods & MATLAB – Roberts M. J. (MHill)
4. Signals and Systems with MATLAB Computing and Simulink Modeling – Karris S. T. (Orchard)
5. Signals and Systems using MATLAB – Chaparro L. (Academic Press)
6. Signals and Systems - Haykin S., Veen B. V. (Willey)
7. Data and Computer Communications – Stallings W. (Pearson Ed.)
8. Practical Data Communications - Freeman R. L. (Willey)
9. Digital and Data Communication Systems - Roden M. S. (Prentice Hall)
10. Data Communication Principles: For Fixed and Wireless Networks - Ahmad A. (Kluwer)

CS 1206 **Computer Graphics** **3-0-2-8**

4th sem **Prerequisites: CS 1201, MA 1101, MA 1102**

Introduction, Input/Output primitives and graphical devices
2D Transformation, translation, rotation, scaling, matrix representations and homogeneous coordinates system, reflection and shear, transformations between coordinate systems, affine transformation, 3D transformations, translation, rotation, scaling etc.
Line, circle and ellipse drawing algorithms, Area filling algorithms
Viewing procedure, 2D Window to Viewport coordinate transformation, Point clipping, Line clipping and Polygon clipping algorithms, Viewport clipping, Depth cueing.
Curves and surfaces, Bezier curves, B-Spline curves, rational B-Spline curves.
Hidden line elimination - Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, Painter's algorithm.
Coloring and shading models, Modeling Light Intensities and sources, Diffuse reflection, Lambert's Cosine Law, Specular Reflection, Halftoning; Color Models - RGB, CMYK

Lab assignments:

Lab programs will be assigned by the course coordinator from within the topics covered in theory classes.
There shall be minimum of eight (08) programming assignments using C/C++ with OpenGL.

Books:

1. Procedural elements of Computer Graphics – Rogers D. F. (TMH)
2. Computer Graphics (C version) – Hearn D., Baker M. P. (Pearson Ed)
3. Computer Graphics: Principles and Practice – Foley J. D., Van Dam A., Feiner S. K., Hughes R. L. P. (Pearson Ed)
4. Mathematical elements for Computer Graphics – Rogers D. F., Adams J. A. (TMH)
5. Computer Graphics Using OpenGL – Hill F. S. (PHI)
6. Interactive Computer Graphics: A Top-Down Approach Using OpenGL - Angle E. (Pearson Ed.)
7. Computer Graphics with OpenGL - Hearn D., Baker M. P. (Pearson Ed)

CS 1301 **Computer Architecture** **3-1-0-8**

5th sem **Prerequisites: EC 1101, EC 1221**

Introduction: Generations of architecture, fundamental concepts of design methodologies, basic organization of computer
Processor Design: Basic organization, instruction set, ALU organization, fixed-point and Floating-point arithmetic
Controller Design: Basic concepts, design of hardwired control and micro-programmed control units
Memory Organization: Basic organization, virtual memory, memory hierarchical structure, paging and segmentation concept, memory interleaving, cache & associative memories
Peripheral processing & devices: I/O accessing and data transfer techniques, I/O channel and processor, I/O management

Books:

1. Computer Organization and Design: The Hardware/Software Interface – Patterson D. A., Hennessy J. L. (Elsevier)
2. Computer Organization – Hamachar C., Vranesic Z., Zaky S. (TMH)
3. Computer Architecture and Organization – Hayes J. P. (TMH)
4. Computer Organization and Architecture: Designing for Performance - Stallings W. (Pearson Ed)

5. Computer Systems Design and Architecture – Heuring V. P., Jordan H. F. (Pearson Ed)

CS 1302 **Computer Networks** **3-0-2-8**

5th sem **Prerequisites: MA 1201, CS 1205**

Data Link layer: Data Link layer Services, wired/wireless case studies
Network layer: Network layer services, routing principles, Internet protocol (IP), introduction to quality of service (QoS)
Transport layer: Transport layer services, protocols of transport layer
Application layer: Application layer protocols e.g. HTTP, SMTP, DNS
Network Management: Basic concept, SNMP

Lab assignments:

Simulation experiments for protocol performance, configuring, testing and measuring network devices and parameters/policies; network management experiments; Exercises in network programming

Books:

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

CS 1303 **Microprocessors and System Programming** **3-0-2-8**

5th sem **Prerequisites: CS 1101, CS 1201**

8086 architecture, Segments, Flags, Instruction set, assembly language programming on 8086 using assembler, Interrupts, Writing interrupt services routines, Debugging programs, 8086 pin functions 80286/386/486 register set, Data types, Overview of instruction set, Memory segmentation with descriptor tables including LDT and GDT, Privilege levels
Basic concepts of assembler and its design procedures
Basic concepts about a loader, different loader schemes, design principles of loader, overview of linker, design principles of linkers

Lab assignments:

Simulation experiments for 8085/8086, Assembly Language Programming for x86 etc.

Books:

1. Microprocessor & Interfacing – Hall D. (TMH)
2. Advanced 80386 Programming Techniques – Turley J. (TMH)
3. Linkers and Loaders - Levine J. (Morgan Kauffman)
4. Microprocessor Architecture, Programming and application with 8085/8080 – Gaonkar R. S. (Wiley Eastern)
5. System Programming - Donovan J. J. (McGraw-Hill)
6. System Programming and Operating Systems - Dhamdhere D. M. (TMH)
7. System Software - Beck L. L. (Addison-Wesley)
8. Advance Microprocessor – Tabak D. (TMH)

CS 1304 **Operating System** **3-0-2-8**

6th sem **Prerequisites: CS 1201, CS 1301, CS 1303**

Introduction to OS: Process management, Memory management, File system management, System calls
Process management: Scheduling, preemptive/non preemptive, FIFO, shortest job first, shortest remaining job first, round robin, priority, multilevel queues, multilevel feedback queues, Threads
Concurrent processes: Mutual exclusion and Bernstein's conditions, semaphores, critical section, monitors, message passing, case studies: Dining Philosophers' problem, Producer-Consumer problem and disk head scheduler problem.
Memory management: Single user contiguous, fixed partition multiprogramming, fragmentation, relocation, compaction, paging, segmentation, paging and segmentation together; virtual memory, page replacement policies
File systems : Directory organization, data hierarchy, blocking and buffering, file organization, free space management, contiguous and non contiguous allocation, block chaining , index block chaining, block oriented file mapping
Dead locks: Resource concepts, necessary conditions, resource allocation graph, three strategies of Havender, Bankers algorithm, reduction of resource allocation graph, deadlock recovery
Disk scheduling: operations of disks, FCFS, SSTF, SCAN, C-SCAN, M-STEP SCAN, Eschenbach, rotation optimization, disk caching

Lab assignments:

Simulation of CPU scheduling algorithms, simulation of file allocation strategies, user-level process management, Development of a LINUX kernel module for a character device

Books:

1. Operating system concepts – Silberschatz A., Galvin P. B., Gagne G. (Wiley)
2. Operating Systems – Stallings W. (Pearson Ed.)
3. Modern Operating Systems – Tanenbaum A.S. (PHI)
4. Operating systems: a Design-oriented approach – Crowley C. (TMH)
5. Operating Systems – Dhamdhere D. M. (TMH)

CS 1305 **Compiler Design** **3-0-2-8**

6th sem **Prerequisites: CS 1201, CS1204, CS 1301**

Introduction: Overview of Language and implementations, Analysis and synthesis model of compilation, Tool based approach to compiler construction, Retargetability and portability, Trends in compiler construction

Lexical Analysis: Basic concept, Design Issues, Implementation issues, building a simple LA, RE/FSA based LA, Lexical error recovery, From REs to lex generator

Syntax Analysis: Basic concept, basic Parsing techniques, Shift-reduced Parser, Operator-Precedence Parser, Predictive Parser, Top-down and Bottom-up parsing, LL(1) grammars, Recursive decent parsers, Predict-predict conflicts and Error-recovery, DFAs and Parsers for LR(0), SLR(1), LR(1), LALR(1)

Semantic Analysis: Basic concept, Syntax-directed definitions, Attribute grammar (Synthesized and Inherited), Evaluation order, Attribute computation for synthesized, inherited and L-attributes of Bottom-up compilation, Getting type attributes, Type matching and conversion

Run-time Environment: Symbol Table management, Memory management, Activation record and parameter passing

Intermediate Code Generation: Basic concept, Three-address codes, quadruples and triples, Arithmetic expression and assignment statements, Boolean expression, Control flow and backpatching (Conditional and iterative statements), Method calls, list of statements

Target Code Generation: Registers and runtime data structures, Method invocation and bookkeeping, phases of code improvement, Peephole optimization, Control flow and basic-blocks, Redundancy and data flow analysis

Lab assignments:

Design of a lexical analyzer, implement the lexical analyzer using lexical analyzer generating tools, design of a predictive parser/LALR bottom up parser for a given language, Convertion of BNF rules into yacc form and to write code for generating abstract syntax tree

Books:

1. Principles of Compiler Design – Aho A. V., Ullman J. D. (Narosa Pub.)
2. Compilers: Principles, Techniques and Tools – Aho A. V., Sethi R., Ullman J. D. (Addison-Wesley)

3. The Theory and Practice of Compiler Writing – Tremblay J. P., Sorenson P. G. (McGraw-Hill)
4. Advanced Compiler Design & Implementation – Muchnick S. S. (Narosa)
5. Lex and Yacc – Levine J. R., Mason T., Brown D. (O'Reilly)

CS 1306 **Design and Analysis of Algorithms** **3-1-0-8**

6th sem **Prerequisites: CS 1201**

Introduction: Basic concepts about algorithms
Analysis of algorithms: Idea about time and space analysis, concept of loop invariants, importance of sorting algorithms in analysis, analysis of bubble sort, insertion sort, selection sort algorithms
Design of Algorithms: Introduction to different design approaches, concept of divide-and-conquer approach, analysis of merge sort and quick sort algorithm, concept of randomized algorithms, analysis of heap sort and, radix sort algorithms
Dynamic Programming: Basic concept, Matrix chain multiplication, characteristics of dynamic programming, longest common subsequence, binary search trees and optimal binary search trees
Greedy Algorithms: Basic concepts, Huffman coding scheme, Task scheduling problem, Knapsack problem
Graph Algorithms: Bread-first-search and depth-first-search algorithms, Kruskal's and Prim's algorithms, Dijkstra's algorithm, Ford-Fulkerson algorithm
NP-completeness: Basic concepts

Books:

1. Introduction to Algorithms – Cormen T. H., Leiserson C. E., Rivest R. L., Stein C. (PHI)
2. The Art of Computer Programming (Vol. 1, 2 & 3) - Knuth D. E. (Addison-Wesley)
3. The Design and Analysis of Computer Algorithms – Aho V., Ulman J.D., Hopcroft J. E. (Addison-Wesley)

4. Algorithm Design: Foundation, Analysis and Internet Examples - Goodrich M. T., Tamassia R. (Wiley India)

CS 1307 **Database Management System** **3-0-2-8**

6th sem **Prerequisites: CS 1201, CS1203, CS1204**

Introduction: File System vs. DBMS, data models, levels of Data Abstraction
Entity Relationship (ER) Model: Basic concept, features of ER Model, relational algebra and relational calculus
Design: SQL queries, constraints and triggers, functional dependency, decomposition of relational schemes, normalization, 1NF, 2NF, 3NF, BCNF; Multi-valued Dependency and 4NF; Join Dependency and 5NF; Inclusion Dependency, Query Optimization
File Organization: Properties of Indexes, B+ Tree and its application; Hashing
Transaction processing: Concept of Transaction, concurrency control and database consistency, incomplete transaction, serializibility, locking, concurrency control without lock

Lab assignments:

Design of a ER diagram and DFD for a given problem, table creation, updation and manipulation, implementation of concurrency control methods

Books:

1. Database Management Systems – Ramakrishnan R., Gehrke J. (McGraw-Hill)
Database Management Systems – Silberschatz, A., Korth H. F., Sudarshan S. (McGraw-Hill)
3. Fundamentals of Database Systems – Elmasri R., Navathe S. B. (Addison-Wesley)
4. Database Systems Using Oracle – Shah N. (Pearson Ed./PHI)
5. Oracle Essentials (10g) – Greenwald R., Robert etc. (O'reilly)
6. Core Java (Vol. 1 & 2) – Horstmann C. S, Cornell G. (Pearson Ed.)

CS 1308 **Software Engineering** **3-1-0-8**

6th sem **Prerequisites: CS 1101, CS1202**

Introduction: Role of Software Engineering, Concept of process
Software Process: Different process models, Waterfall, Prototype, Iterative, TimeBox, Comparison among the models
Requirement Analysis: Basic concepts of requirement analysis and specification, analysis models, specification language, Use Case concept
Software Architecture: Analysis of different architectures (pipe and filter, shared data style, client-server style), comparison of architectures
Project Planning: Overview, Effort Estimation and COCOMO, project scheduling and team structure, risk management, monitoring plan and SCM
Object-Oriented Design: Basic concepts, overview of UML, design methodologies
Detailed Design: Detailed design and verification, different metrics
Coding: Concept of structured programming, coding process, unit testing with Junit, verification approaches, analysis metrics
Testing: Overview, Black-Box and White-Box techniques, testing process, defect analysis and prevention

Books:

1. An integrated approach to software engineering (3rd ed.) – Jalote P., (Narosa Pub)
2. Software engineering: a practitioners approach – Pressman R. S. (McGraw-Hill)
3. Object-oriented system analysis and design using UML – Bennett S., McRobb S., Farmer R. (TMH).

4. Software engineering: Principles and Practice (3rd ed.) – Vliet H. V. (Wiley India)
5. Introduction to Object-Oriented Analysis – Brown D. W. (Wiley India)

CS 1401 **VLSI Physical Design** **3-0-0-6**

7th sem **Prerequisites: CS1201, CS 1306**

Introduction, data structures and basic algorithms, partitioning, top-down approach for placement and routing, performance Issues in circuit Layout, single-layer routing and applications

Books:

1. An introduction to VLSI physical design – Sarrafzadeh M., Wong C. K. (McGraw Hill)
2. Algorithms for VLSI physical design automation – Sherwani N. A. (Springer)
3. VLSI Placement and Routing: The PI Project – Sherman A. T. (Springer)
4. Routing, Placement, and Partitioning – Zobrist G. W. (Intellect Books)

CS 1402 **Theory of Computation** **3-1-0-8**

7th sem **Prerequisites: CS 1201, CS1204, CS 1306**

Computability theory: Fundamental concepts of Turing machine model, computable languages and functions; Turing machine construction technique; Modification of Turing machine and Church's hypothesis; The Problem of Undecidability; Properties of recursive and recursively enumerable languages; Universal Turing Machine; Rice's theorem; Post's correspondence problem and Intractable problems

Complexity theory: Time- and space-bounded Turing machines, reduction and complete problems, oracle machines and the polynomial hierarchy

P and NP problems: Basic concepts, polynomial time and space, understanding the P-class problems, boolean satisfiability, understanding the NP-class problems, polynomial time reduction, introduction to Cook's theorem, Basic concept of NP-Complete problems

Books:

1. Introduction to Automata Theory, Languages, and Computation – Hopcroft J. E., Ullman J. D. (Narosa Pub)
2. Elements of the Theory of Computation – Lewis H. R., Papadimitriou C. H. (Pearson Ed)
3. Introduction to Languages and the Theory of Computation – Martin J. C. (TMH)
4. Introduction to the Theory of Computation – Sipser M. (PWS Publishing)
5. Introduction to Computability – Hennie F. C. (Addison-Wesley)
6. The Theory of Computation – Moret B. M. (Pearson Ed)

CS 1404 **Advanced Computer Architecture** **3-0-0-6**

8th sem **Prerequisites: CS 1301, CS 1302, CS 1304**

Introduction: Evolution of computer architecture, Flynn's Classification, Types of Parallelism, Performance Metrics, Different Parallel Computer models
Instruction-level parallelism: Basic concept, Dependency Analysis, Partitioning and Scheduling. Pipeline architecture: Principles & general structures of pipeline, linear & non-linear model, pipelined instruction processing (arithmetic, Boolean, load/store)
Superscalar pipeline architecture: Basic concept, design issues, shelving, register renaming, preserving sequentialities, case studies; VLIW architecture & case studies.
Code scheduling for ILP processors: Issues in processing control transfer instructions, concepts of code scheduling.
Data Parallel architectures: Basic concept, SIMD architecture (design space approach, overview of fine-grained & coarse-grained SIMD); Vector architectures (Basic concept, case studies); Concepts of data-pipelined and systolic array architectures.
Thread/process-level parallelism: Introduction to MIMD architecture, basic concept of Multi-threaded architecture, design issues related to shared-memory & distributed-memory MIMD architectures

Books:

1. Advanced Computer Architectures: A Design Space Approach) – Sima D., Fountain T., Kacsuk P. (Pearson Ed)
2. Advanced Computer Architecture: Parallelism, Scalability, Programmability – Hwang K. (TMH)

3. Modern Processor Design: Fundamentals of Superscalar Processors – Shen J. P., Lipasti M. H. (TMH)

4. Computer Architecture: A Quantitative Approach – Hennessy J. L., Patterson D. A. (Elsevier)
5. High performance computer architecture – Stone H. S. (Addison-Wesley)

CS 1405 **Machine Learning** **3-0-0-6**

8th sem **Prerequisites: CS 1301, CS 1302, CS 1304**

Introduction, Decision Trees, Probability Primer, Bayes Decision Theory, Maximum-likelihood and Bayesian Parameter Estimation, Non-parametric Techniques, Bayes Networks, Optimization Primer, Linear Discriminant Functions, Support Vector Machines, Unsupervised Learning, Semi Supervised Learning, Reinforcement Learning

Books:

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

CS 1421 **Artificial Intelligence** **3-0-0-6**

7th sem (Elective I) **Prerequisites: None**

Introduction, problems and techniques related to artificial intelligence
Problem spaces and search, state space graph, production systems BFS and DFS
Inroduction to heuristic search, hill climbing, best first search, A* algorithm, admissibility, AND/OR graph – AO*
Predicate logic, rule-based systems, forward vs backward reasoning, non-monotonic reasoning, statistical reasoning, Dempster Shafer theory, Min-Max search, Alpha-Beta cut-offs
Case studies: MYCIN, R1
Programming languages: PROLOG, LISP

Books:

1. Artificial Intelligence – Rich, Knight (TMH)
2. Principles of Artificial Intelligence – Nilson N. J. (Narosa)
3. Paradigms of AI programming – Norvig P. (Elsevier)
4. Introduction to Expert System – Jackson P. (Addison-Wesley)

CS 1422 **Digital Image Processing** **3-0-0-6**

7th sem (Elective I) **Prerequisites: CS 1205**

Introduction: Fundamental steps in image processing, digital image representation, image acquisition and storage
Visual Perception: Basic concepts, structure of human eye, image formation in eye, discrimination of brightness and adaptation, sampling and quantization
Image transforms: Convolution and correlation, FFT and inverse FFT, Walse-Hadamard and K-L transforms, single value decomposition
Image enhancement: Fundamental concepts, enhancement by point processing, intensity transform, histogram processing, spatial filtering, smoothening, median, sharpening and derivative filters, enhancement in frequency domain, low-pass and high-pass filtering
Image restoration: Degradation model - continuous and discrete, inverse filtering, removal of blur caused by uniform linear motion
Image segmentation: Edge detection techniques, edge linking and boundary detection, local and global approaches, thresholding, region-oriented segmentation, region growing, split and merge techniques
Image Compression: Lossy and loss-less compression techniques, feature extraction

Books:
1. Digital Image Processing – Gonzalez R. C., Woods R. E. (Addison-Wesley)
2. Fundamentals of Digital Image Processing – Jain A. K. (PHI)
3. Digital Image Processing and Analysis – Chanda B., Majumder D. D. (PHI)

CS 1423 **Applied Graph Theory** **3-0-0-6**

7th sem (Elective I) **Prerequisites: CS 1203**

Introduction to graphs and their representation, finite and infinite graphs, incidence and degree, path
Directed graph, single source shortest path, all pair shortest path, directed acyclic graph, Euler's graphs, Hamiltonian paths and circuits
Basic results of trees, minimum cost spanning tree
Introduction to cut-sets and cut-vertices, connectivity and separability
Basic concepts of vector space of graph, sets with one or two operations, basis vector, circuit and cut-set subspaces, orthogonal vectors and spaces
Matrix representation of graph, incidence matrix, circuit matrix, path matrix, cut-set matrix and adjacency matrix

Books:

1. Graph theory with applications to engineering and computer science – Deo N. (PHI)
2. Introduction to Algorithms – Cormen T. H., Leiserson C. E., Rivest R. L., Stein C. (PHI)
3. Algorithmic graph theory – Gibbons A. (Cambridge Univ. Press)
4. Schaum's outline of theory and problems of Graph theory – Balakrishnan V.K. (TMH)
5. Fundamentals of Data Structures – Horowitz E., Sahni S. (Galgotia Pub.)
6. Handbook of Graph Theory – Gross J. L., Yellen J. (CRC Press)

CS 1424 **Mobile AdHoc Network** **3-0-0-6**

7th sem (Elective I) **Prerequisites: CS 1302**

Mobile Ad-Hoc networking with a View of 4G Wireless, Off-the-Shelf Enables of Ad Hoc, IEEE 802.11 in Ad Hoc Networks: Protocols, Performance and Open Issues, Scatternet Formation in Bluetooth Networks , Antenna Beamforming and Power Control for Ad Hoc Networks, Topology Control in Wireless Ad Hoc Networks, Broadcasting and Activity Scheduling in Ad Hoc Networks, Location Discovery, Routing Approaches in Mobile Ad Hoc Networks, Energy-Efficient Communication in Ad Hoc Wireless, Ad Hoc Networks Security, Self-Organized and Cooperative Ad Hoc Networking, Simulation and Modeling of Wireless, Mobile, and Ad Hoc Networks, Modeling Cross-Layering Interaction Using Inverse Optimization Algorithmic Challenges in Ad Hoc Networks

Books:

1. Mobile Adhoc Networks – Aggelou , George (McGraw-Hill)
2. Mobile Adhoc Networking – Stefano Basagni (Editor), Marco Conti (Editor), Silvia Giordano (Editor), Ivan Stojmenovi & Cacute (Editor) (Wiley-IEEE Press)

CS 1425 **Simulation and Modeling** **3-0-0-6**

7th sem (Elective I) **Prerequisites: MA 1251**

Introduction to simulation and modeling, application areas, system and system environment, components of system, type of systems, model of a system, types of models and steps in simulation study

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

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 using event scheduling approach

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

Characteristics of queueing systems, queueing notations, long run measures of performance of queueing systems, Steady state behavior of Markovian models (M/G/1, M/M/1, M/M/C), overview of finite capacity and finite calling population models, Network of Queues

Properties of random numbers, generation of true and pseudo random numbers, techniques for generating random numbers, hypothesis testing, various tests for uniformity (Kolmogorov-Smirnov and chi-Square) and independence (runs, autocorrelation, gap, poker)

Books:

1. System Simulation With Digital Computer – Deo N. (PHI)

2. Theory of Modeling and Simulation – Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim (Academic Press)

3. Discrete Event System Simulation – Banks J., Carson J. S., Nelson B. L., Nicol D. M (Pearson Ed)

CS 1426 **Human Computer Interaction** **3-0-0-6**

7th sem (Elective I) **Prerequisites: None**

Introduction to HCI, a brief history of HCI, user interface design, direct manipulation, cognitive framework of HCI, perception and representation, attention and interface design, memory in interface design, knowledge representation, user modeling, interaction with natural languages, next generation interface, user interface evaluation: heuristic evaluation, evaluation with cognitive models, evaluation with users model-based evaluation

Books:

1. The essential guide to user interface design – Galitz W. O. (Wiley)
2. Designing the user interface – Shneidermann B. (Pearson Ed)
3. Human – Computer Interaction – Dix A., Finlay J., Abowd G., Beale R. (Prentice Hall)
4. Interaction Design – Prece, Rogers, Sharps (Wiley)
5. User Interface Design – Lauesen S. (Pearson Ed)

CS 1431 **Computational Geometry** **3-0-0-6**

7th sem (Elective II) **Prerequisites: None**

Introduction: Historical perspective, geometric preliminaries. Convex hulls algorithms in 2d and 3d, lower bounds
Triangulations: Polygon triangulations, representations, point-set triangulations
Voronoi diagrams: Algorithms, closest pair problems
Delaunay triangulations: Algorithms (divide-and-conquer, flip, incremental), duality of Voronoi diagrams, properties (min-max angle)
Geometric searching: Point-location, 2D linear programming with prune and search
Visibility: Algorithms for weak and strong visibility, visibility with reflections, art-gallery problems
Arrangements of lines: 2D arrangements, zone theorem, many-faces complexity, algorithms
Sweep techniques: Plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, topological sweep for line arrangements
Combinatorial geometry: Ham-sandwich cuts, Helly's theorems, k-sets
Rectilinear geometry: Intersection and union of rectangles, rectangle searching
Robust geometric computing
Applications of computational geometry

Books:
1. Computational Geometry: Algorithms and Applications – Berg M., Schwarzkopf O., Kreveld M., Overmars M. (Springer)
2. Computational Geometry: An Introduction – Preparata F. P., Shamos M. I. (Springer)
3. Computational Geometry in C – Rourke J. O. (Cambridge University Press)

CS 1432 **Wireless Networks** **3-0-0-6**

7th sem (Elective II) **Prerequisites: CS 1302**

Introduction to wireless communication systems and networks
Wireless technologies: Cellular wireless networks and systems principles, antennas and radio propagation, signal encoding and modulation techniques, spread spectrum, coding and error control
Wireless Networking: Multiple access techniques, Mobile IP and WAP, Wireless systems and standards
Wireless LANs: Wireless LAN technology, Wireless standard (IEEE 802.11 etc.), Ad-hoc Networks, Bluetooth

Books:

1. Wireless Communications: Principles & Practice – Rappaport T. S. (Pearson Ed)
2. Wireless Communications and Networks – Stallings W. (Pearson Ed)

CS 1433 **Information Theory and Coding** **3-0-0-6**

7th sem (Elective II) **Prerequisites: CS 1203, CS 1205**

Introduction: Concept of entropy and mutual information, application of entropy in feature extraction
Entropy in stochastic processes: Entropy rates, markov chains, Hidden Markov models
Data Compression: Kraft inequality and optimal coding, Huffman codes and optimality, Shanon-Fano-Elias coding, Arithmetic codes
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
Error control codes: Concept of Linear block codes, cyclic codes, BCH codes, RS codes, Convolution codes
Error Correcting techniques: Short-random-error correction by error-trapping, burst-error correction for block codes
Coding and Digital Modulation: Trellis coded modulation

Books:

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

CS 1434 **Distributed System** **3-0-0-6**

7th sem (Elective II) **Prerequisites: CS 1302, CS 1304**

Introduction: Concepts of distributed system and its general architecture, basic design issues in distributed system
Naming: Naming of entities and concept of name space, name space implementation, locating mobile entities
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
Synchronization: Basic synchronization techniques, physical and logical clocks, clock synchronization algorithms, global state, election algorithms
Distributed mutual exclusion: Requirements, types and models of mutual Exclusion algorithms, discussion on mutual exclusion algorithms
Distributed deadlock handling: Introduction to deadlock, deadlock prevention and avoidance techniques, deadlock detection/ resolution algorithms
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

Books:

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

CS 1435 **Data Mining** **3-0-0-6**

7th sem (Elective II) **Prerequisites: CS 1306**

Introduction: Types of data mining problems, process of data mining
Statistical evaluation of big data: Statistical prediction, performance measures, pitfalls in data-mining evaluation
Data preparation: Data models, data transformations, handling of missing data, time-dependent data, textual data
Data reduction: Feature selection, principal components, smoothing data, case subsampling
Predictive modeling: Mathematical models, linear models, neural nets, advanced statistical models, distance solutions, logic solutions, decision trees, decision rules, model combination
Solution analyses: Graphical trend analyses, comparison of methods
Future trends: Text mining, visualization, distributed data. Use of open-source software

Books:

1. Data Mining: Concepts and Techniques – Han, J. and Kamber, M. (Morgan Kaufmann)
2. Introduction to Data Mining – Tan P., Steinbach M., Kumar V. (Addison Wesley)
3. Principles of Data Mining – Hand D. J., Mannila H., Smyth P. (MIT Press)

CS 1436 **Natural Language Processing** **3-0-0-6**

7th sem (Elective II) **Prerequisites: CS 1302, CS 1304**

Introduction: NLP tasks in syntax, semantics, and pragmatics, applications in information extraction, question answering, machine translation, problem of ambiguity, role of machine learning, brief history
N-gram language models: Role of language models, simple N-gram models, estimating parameters and smoothing, evaluating language models
Part of speech tagging and sequence labeling: Lexical syntax, hidden markov models, maximum entropy models, conditional Random Fields
Syntactic parsing: Grammar formalisms and treebanks, efficient parsing for CFGs, statistical parsing and probabilistic CFGs (PCFGs), lexicalized PCFGs
Semantic Analysis: Lexical semantics and word-sense disambiguation, compositional semantics, semantic role labeling and semantic parsing

Books:

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

CS 1441 **Principles of Programming Language** **3-0-0-6**

8th sem (Elective III) **Prerequisites: CS 1201**

Introduction: Syntax, semantics and pragmatics, formal translation models
Variables, Expressions & Statements: Binding time spectrum, variables and expressions, assignment, l-values and r-values, storage allocation, constants and initialization
Types: Primitive types, pointers, structured types, coercion, notion of type equivalence, polymorphism, encapsulation, information hiding and abstraction
Storage management: Static, dynamic, stack-based, heap-based
Sequence control: Implicit and explicit sequencing with arithmetic and non-arithmetic expressions, sequence control between statements
Subprogram control: Subprogram sequence control, data control and referencing environments, parameter passing, static and dynamic scope, block structure

Books:
1. Programming Languages – Pratt T.V. (Pearson Ed)
2. Programming Languages: Principles and Practice – Louden K.C. (Addision-Wesley)
3. Programming Languages: Principles and Paradigms - Tucker A., Noonan R. (TMH)
4. Programming Languages: Principles and Practice – Louden K.C. (Addision-Wesley)

CS 1442 **Applied Parallel Programming** **3-0-0-6**

8th sem (Elective III) **Prerequisites: CS 1301**

Introduction, Introduction to CUDA C, CUDA Parallel Execution Model with Fermi updates, CUDA featurs and debugging, Memory bandwidth, Tiled Convolution, Parallel Computation Patterns - Reduction Trees, Parallel Computation Patterns - Prefix Sum (Scan), Floating Point Considerations, Atomic Operations and Histogramming, MPI and CUDA Programming

Books:
1. Programming Massively Parallel Processors: A hands-on Approach – Kirk D. B., Hwu W. W. (Morgan Kaufmann)
2. CUDA by Example: An Introduction to General-Purpose GPU Programming – Sanders J., Kandrot E. (Addison-Wesley)

CS 1443 **Pattern Recognition** **3-0-0-6**

8th sem (Elective III) **Prerequisites: CS 1201**

Introduction: Introduction to pattern recognition, applications of pattern recognition, statistical, neural and structural approaches

Statistical Pattern Recognition: Patterns and classifications, discriminant functions, Bayes decision rule, Nearest neighbour rule, probability of error

Linear Discriminant functions: Perceptrons and training, LMSE approaches, unsupervised learning and clustering, feature extraction

Syntactic Pattern Recognition: Formal languages and grammars, pattern grammars and higher dimensional grammars, parsing, automata realizations, stochastic grammars, grammatical interference, computation learning theory, Valiant's framework

Books:

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

CS 1444 **Cryptography and Security** **3-0-0-6**

8th sem (Elective III) **Prerequisites: CS 1433**

Introduction and Mathematical Foundations: Introduction, Overview on Modern Cryptography, Number Theory Probability and Information Theory
Cryptosystems: Classical Cryptosystems, Cryptanalysis of Classical Cryptosystems, Shannon's Theory
Symmetric Key Ciphers: DES, AES
Cryptanalysis of Symmetric Key Ciphers: Linear Cryptanalysis, Differential Cryptanalysis, Other Cryptanalytic Techniques, Overview on S-Box Design Principles, Modes of operation of Block Ciphers
Stream Ciphers: Pseudorandom functions, Hash functions - The Merkle Damgard Construction, Message Authentication Codes (MACs)
Asymmetric Key Ciphers: RSA Cryptosystem, Primality Testing, Factoring Algorithms, Discrete Logarithm Problem (DLP) and the Diffie Hellman Key Exchange algorithm, ElGamal Encryption Algorithm, Cryptanalysis of DLP
Asymmetric Key Cryptography: Elliptic curve based cryptography
Security: Secret Sharing Schemes, Kerberos, Pretty Good Privacy (PGP), Secure Socket Layer

Books:

1. Cryptography Theory and Practice – Stinson D. (Chapman & Hall/CRC)
2. Cryptography and Security – Shyamala C. K., Harini N., Padmanabhan T. R. (Wiley India)
3. Foundations of Cryptography, vol. I and vol. II – Goldreich O. (Cambridge Press)
4. An Introduction to Mathematical Cryptography – Hoffstein, Pipher, Silvermman (Springer)
5. Algorithmic Cryptanalysis – Joux A. (CRC Press)
6. Cryptography & Network Security – Forouzan B. A. (TMH)
7. Cryptography and Network Security – Stallings W. (TMH)
8. Number Theory – Telang S. G. (TMH)

CS 1445 **VLSI Design, Test and Verification** **3-0-0-6**

8th sem (Elective III) **Prerequisites: CS 1301, CS 1401, CS 1404**

Introduction: Digital VLSI Design Flow Specification, High level Synthesis, RTL Design, Logic Optimization, Verification and Test Planning, Design Representation, Hardware Specific Transformations

Scheduling, Allocation and Binding: Basic Scheduling Algorithms (Time constrained and Resource Constrained), Allocation Steps - Unit Selection, Functional Unit Binding, Storage Binding, Interconnect Binding, Allocation Techniques - Clique Partitioning, Left-Edge Algorithm, Iterative Refinement

Logic Optimization and Synthesis: Heuristic Minimization of Two-Level Circuits, Finite State Machine Synthesis, Multi-Level Logic Synthesis, Multi-Level Minimization

Binary Decision Diagram: Introduction and construction, Reduction rules and Algorithms, Operation on BDDs and its Algorithms, Representation of Sequential Circuits

Temporal Logic: Introduction and Basic Operators, Syntax and Semantics of LTL, CTL and CLT*, Equivalence and Expressive Power

Digital Testing: Introduction, Test process and Test economics, Functional vs. Structural Testing Defects, Errors, Faults and Fault Modeling (stuck at fault modeling), Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem

Fault Simulation: Circuit Modeling and Algorithms for Fault Simulation, Serial Fault Simulation, Parallel Fault Simulation, Deductive Fault Simulation, Concurrent Fault Simulation

Circuit Testing: Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras, D-Calculus and D-Algorithm, Basics of PODEM and FAN, ATPG for Single-Clock Synchronous Circuits, Introduction to BIST architecture BIST Test Pattern Generation

Books:

1. High-Level Synthesis: Introduction to Chip and System Design – Gajski D. D., Dutt N. D., Wu A. C. H., Lin S. Y. L. (Springer)
2. Verilog HDL: A Guide to Digital Design and Synthesis – Palnitkar S. (Prentice Hall)
3. Synthesis and optimization of digital circuits – Micheli G. D. (TMH)
4. Logic in Computer Science modeling and reasoning about systems – Huth M., Ryan M. (Cambridge Press)
5. Essentials of Electronic Testing for Digital, Memory & Mixed-Signal Circuits – Bushnell, Agrawal (Kluwer Academic Publishers)

CS 1446 **Linux Operating System** **3-0-0-6**

8th sem (Elective III) **Prerequisites: CS 1304**

Introduction, Process management, Process scheduling, System calls, Interrupts and interrupt handlers, Memory management, VFS, Block I/O layer

Books:

1. Linux Kernel Development – Love R. (Pearson Education)
2. Understanding the Linux Kernel – Bovet D. P. (O'reilly)

CS 1451 **Introduction to Network Calculus** **3-0-0-6**

8th sem (Elective IV) **Prerequisites: CS 1203, CS 1205, CS 1302, CS 1423**

Network Calculus: Models for Data Flows, Arrival Curves, Service Curves, Network Calculus Basics, Greedy Shapers, Maximum Service Curve, Variable and Fixed Delay, Handling Variable Length Packets, Lossless Effective Bandwidth and Equivalent Capacity
Mathematical Background: Basic Min-plus and Max-plus Calculus, Min-Plus Calculus, Max-Plus Calculus, Min-plus and Max-Plus System Theory, Min-Plus and Max-Plus Operators, Closure of an Operator
Application of Network Calculus to the Internet: GPS and Guaranteed Rate Schedulers, The Integrated Services Model of the IETF, Schedulability, Application to Differentiated Services
Optimal Multimedia Smoothing: Constraints Imposed by Lossless Smoothing, Minimal Requirements on Delays and Playback Buffer, Optimal Smoothing Strategies, Optimal Constant Rate Smoothing, Optimal Smoothing versus Greedy Shaping, Comparison with Delay Equalization
FIFO Systems and Aggregate Scheduling: Introduction, General Bounds for Aggregate Scheduling, Stability of a Network with Aggregate Scheduling, Bounds for a FIFO Service Curve Element, Bounds for a Network of FIFO CBR Servers
Packet Scale Rate Guarantees: Introduction, Adaptive Guarantee, Application to the Internet - Packet Scale Rate Guarantee
Time Varying Shapers: Introduction, Time Varying Shapers, Time Invariant Shaper with Non-zero Initial Conditions, Time Varying Leaky-Bucket Shaper
Stochastic Network Calculus: Traffic Models for Stochastic Network Calculus, Server Models for Stochastic Network Calculus, Basic Properties of Stochastic Network Calculus, Analysis on Scheduling Disciplines

Books:

1. Network Calculus – Le Boudec J. Y., Thiran P. (Springer, LNCS 2050)
2. Stochastic Network Calculus – Jiang Y., Liu Y. (Springer)

3. Communication Networking: An Analytical Approach – Kumar A., Manjunath D., Kuri J. (Elsevier)

CS 1452 **Logic of Computer Science** **3-0-0-6**

8th sem (Elective IV) **Prerequisites: CS 1203, CS 1204, CS 1402**

Propositional Logic: Orders and Trees, Propositions, Connectives, Truth Tables, Truth Assignments, Valuations, Tableau Proofs in Propositional Calculus, Soundness and Completeness of Tableau Proofs, Deductions from Premises and Compactness, Resolution, Refining Resolution, Linear Resolution, Horn Clause and PROLOG
Predicate Logic: Predicates and Quantifiers, Terms and Formulas, Formation Trees, Structures, Lists, Semantics - Meaning and Truth, Proofs - Complete Systematic Tableaux, Soundness and Completeness of Tableau Proofs, Prenex Normal Form, Skolemization, Herbrand's Theorem, Uification, Unification Algorithm, Resolution, Linear Resolution
Modal Logic: Possibility and Necessity, Knowledge or Belief, Frames and Forcing, Modal Tableaux, Soundness and Completeness

Books:
1. Logic for Applications – Nerode A., Shore R. A. (Springer)
2. First-Order Logic and Automated Theorem Proving – Fitting M. (Springer)
3. Mathematical Logic for Computer Science – Ben-Ari M. (Springer)

CS 1453 **Wireless Sensor Network** **3-0-0-6**

8th sem (Elective IV) **Prerequisites: CS 1205, CS 1302, CS 1432**

Introduction to sensor network, Unique constraints and challenges, Localization and Tracking, Networking Sensors, Infrastructure establishment, Sensor Tasking and Control, Sensor network databases, Sensor Network Platforms and tools, Industrial Applications and Research directions

Books:

1. Wireless Sensor Networks: An Information Processing Approach – Zhao F., Guibas L. (Elsevier)
2. Handbook of Sensor Networks: Algorithms and Architectures – Stojmenovi I., Cacute (Wiley)

CS 1454 **Speech Processing** **3-0-0-6**

8th sem (Elective IV) **Prerequisites: CS 1205**

Fundamentals of speech science, Modeling speech production, Short-term processing of speech, Linear prediction analysis, Cepstral analysis, Speech coding and synthesis, Speech enhancement, Recognition using templates and DTW, Recognition using hidden Markov models

Books:

1. Discrete-Time Processing of Speech Signals – Deller J., Hansen J.,Proakis J. (Wiley-IEEE)
2. Digital Processing of Speech Signals – Rabiner, Schafer (Prentice Hall)

3. Discrete-Time Speech Signal Processing: Principles and Practice – Quatieri T. F. (Prentice Hall)

CS 1455 **Formal Methods of System Verification** **3-0-0-6**

8th sem (Elective IV) **Prerequisites: CS 1205**

Introduction: Formal methods and hardware verification, Review of Propositional Calculus and Predicate Calculus, Axioms and rules of Floyd-Hoare Logic, Application of Floyd-Hoare logic to verify hardware circuits, Describing hardware directly in higher order logic
Circuit representation: Combinational and sequential behaviour of circuits, Specification of hardware systems, Concept of OBDDs and ROBDDs and operation on ROBDDs
State space explosion problem: Symbolic data structure and symbolic model checking algorithms, Concept of on-the-fly model checking and automata-theoretic model checking **Study of verification tools:** SMV and PVS

Books:

1. Logic in Computer Science: Modelling and Reasoning about Systems – Huth M., Ryan M. (Cambridge University Press)
2. Higher Order Logic and Hardware Verification – Melham T. F. (Cambridge University Press)
3. Model Checking – Clarke E. M., Grumberg O., Peled D. (MIT Press)
4. Symbolic Model Checking – McMillan K. L. (Kluwer Academic Publisher)

CS 1456 **Network Storage Management** **3-0-0-6**

8th sem (Elective IV) **Prerequisites: CS 1304, CS 1307**

Storage System: introduction, storage system environment – Disk drive components, Data protection - RAID, Intelligent storage system
Storage networking technologies and virtualizaton: Direct-attached storage, introduction to SCSI, SAN, Network attaché storage, IP SAN, content-addressed storage, virtualization
Business Continuity: Backup and recovery
Storage security and management

Books:
1. Information Storage and Management Storing, Managing and protecting Digital information – Ed. by Somasundaram G., Shrivastava A. (Wiley)

CS 1471 **Neural Network** **3-0-0-6**

8th sem (Open Elective) **Prerequisites: None**

Introduction: Biological neurons and artificial neurons, Model of an ANN, Activation functions used in ANNs, Typical classes of network architectures

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

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

Feedforward ANN: Structures of Multi-layer feedforward networks, Back propagation algorithm, Back propagation - training and convergence, Functional approximation with back propagation, Practical and design issues of back propagation learning

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

Support Vector machines: Linear separability and optimal hyperplane, Determination of optimal hyperplane, Optimal hyperplane for nonseparable patterns, Design of an SVM, Examples of SVM

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

CS 1472 **Time Series Analysis** **3-0-0-6**

8th sem (Open Elective) **Prerequisites: MA 1201 (Prob. & Statistics)**

Models for time series: Time series data, Trend, seasonality, cycles and residuals, Stationary processes, Autoregressive processes, Moving average processes, White noise
Models of stationary processes: Purely indeterministic processes, ARMA processes, ARIMA processes, Estimation of the autocovariance function, Identifying a MA(q) process, Identifying an AR(p) process, Distributions of the ACF and PACF
Spectral methods: Discrete Fourier transform, Spectral density, Analysing the effects of smoothing
Estimation of the spectrum: Periodogram, Distribution of spectral estimates, Fast Fourier transform
Linear filters: Filter Theorem, Application to autoregressive processes, Application to moving average processes, General linear process, Filters and ARMA processes, Calculating autocovariances in ARMA models
Estimation of trend and seasonality: Moving averages, Centred moving averages, Slutzky-Yule effect, Exponential smoothing, Calculation of seasonal indices
Fitting ARIMA models: Box-Jenkins procedure, Identification, Estimation, Verification, Tests for white noise, Forecasting with ARMA models
State space models: Models with unobserved states, Kalman filter, Prediction, Parameter estimation

Books:

1. Time Series: Theory and Methods – Brockwell P. J., Davis R. A. (Springer)
2. The Analysis of Time Series: Theory and Practice – Chatfield C. (Chapman and Hall)
3. Time Series – Kendall M. (Charles Griffin)

4. Time Series Analysis-Forecasting and Control – Box G. E. P., Jenkins G., Reinsel G. (Pearson Education)

CS 1481 Soft Computing Techniques for Non-linear Optimization 3-0-0-6

8th sem (Open Elective) Prerequisites: None

Soft and hard computing
GA: Gene, Chromisome, Allele, Schemata theory, genotype, phenotype, competition and Selection – different types, Crossover –different techniques, elitism, mutation – different types, stopping criteria, Flow-chart of GA
Evolutionary algorithm: Simulated Annealing, Evlutionary programming, Hill climbing
Fuzzy: Membership function, fuzzyfication function, fuzzy operator, inference rules, defuzzyfication
Exploration and exploitation
PSO, Ant Colony Optimization

Books:

1. Genetic Algorithms in Search, Optimization, and Machine Learning – Goldberg D. E. (Addison-Wesley)
2. Neural Network, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications – Rajasekaran S., Pai G. A. V. (PHI)
3. Soft Computing and Intelligent Systems: Theory and Application – Sinha N. K., Gupta M. M. (Academic Press)

CS 1482 **Cloud Computing** **3-0-0-6**

8th sem (Open Elective) **Prerequisites: None**

Introduction: Definition, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Deploy application over cloud, Comparison among SAAS, PAAS, IAAS
Cloud computing platforms: Infrastructure as service: Amazon EC2,Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing
Cloud Technologies: Study of Hypervisors, Compare SOAP and REST
Web services: SOAP and REST, SOAP versus REST, AJAX - asynchronous 'rich' interfaces, Mashups - user interface services
Virtualization: Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization
Multitenant software: Multi-entity support, Multi-schema approach, Multi-tenance using cloud data stores, Data access control for enterprise applications
Data in the cloud: Relational databases, Cloud file systems - GFS and HDFS, BigTable, HBase and Dynamo
Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce, Introduction to cloud development, Example/Application of Mapreduce, Features and comparisons among GFS,HDFS etc, Map-Reduce model
Cloud security: Vulnerability assessment tool for cloud, Privacy and Security in cloud, Architectural Considerations - General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Security challenges - Virtualization security management- virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud
Issues: Implementing real time application over cloud platform
Issues in Intercloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment

Books:

1. Cloud Computing for Dummies – Hurwitz J., Bloor R., Kanfman M., Halper F. (Wiley India)
2. Enterprise Cloud Computing – Shroff G. (Cambridge University Press)
3. Cloud Security – Krutz R., Vines R. D. (Wiley India)

Semester-wise M. Tech. course structure

Semester	CSE				Credits
I	CS 1501 3-0-0-6	CS 1502 3-0-0-6	Elective I 3-0-0-6	Elective II 3-0-0-6	24
II	CS 1503 3-0-0-6	CS 1504 3-0-0-6	Elective III 3-0-0-6	Elective IV 3-0-0-6	24
III	Thesis 0-0-22-22				22
IV	Thesis 0-0-22-22				22
Total Credit					**92**

Elective I, II, III, and IV shall be taken from the list of subjects mentioned under Elective I, II, III, and IV for B. Tech respectively.

CS 1501 **Fundamentals of Computer Science I** **3-0-0-6**

1st sem **Prerequisites: None**

Part-I: Church-Turing thesis, Hilbert's problem, decidability, halting problem, reducibility, time and space complexity, Classes P, NP, NP-complete, PSPACE, and PSPACE-complete, intractability

Part-II: Specification of tokens, recognition of tokens, automatic tools, top down and bottom up parsing techniques, construction of efficient parsers, syntax-directed translation, automatic tools, declaration processing, type checking, symbol tables, error recovery, Intermediate code generation, Code generation, flow-graphs, register allocation

Books:

1. Introduction to Automata Theory, Languages, and Computation – Hopcroft J. E., Ullman J. D. (Narosa
2. Elements of the Theory of Computation – Lewis H. R., Papadimitriou C. H. (Pearson Ed)
3. Introduction to Languages and the Theory of Computation – Martin J. C. (TMH)
4. Introduction to the Theory of Computation – Sipser M. (PWS Publishing)
5. Introduction to Computability – Hennie F. C. (Addison-Wesley)
6. The Theory of Computation – Moret B. M. (Pearson Ed)
7. Principles of Compiler Design – Aho A. V., Ullman J. D. (Narosa Pub.)
8. Principles of Compiler Design – Raghavan V. (McGrawHill)

CS 1502 **Advanced Data Structure** **3-0-0-6**

1st sem **Prerequisites: None**

Priority queue, Binomial, Fibonacci, and Pairing Heaps, Double-Ended Priority Queues
Hash tables, balanced binary search trees, Splay trees, Randomized Dictionary Structures
Multidimensional Spatial Data Structures, Quadtrees and Octrees, Binary Space Partitioning Trees, R-trees
Tries, Suffix Trees and Suffix Arrays, PQ Trees
Application of data structure in Information retrieval, data mining, image processing

Books:

1. Handbook of Data Structures and Applications – Sahni S. (CRC Press)
2. Introduction to Algorithms – Cormen T. H., Leiserson C. E., Rivest R. L., Stein C. (MIT Press)
3. Algorithm Design – Kleinberg J., Tardos E. (Addison Wesley)

CS 1503 **Fundamentals of Computer Science II** **3-0-0-6**

2nd sem **Prerequisites: None**

Part-I: Study of major Operating System issues such as Memory Management, Process Management and Scheduling, File Systems, Networking by looking at the internals of actual systems such as Unix, Linux, NT etc. Issues in design of distributed operating systems. Selected case studies such as Amoeba, Chorus, Mach etc

Part-II: Evolution of computer architecture, Flynn's Classification, Types of Parallelism, Performance Metrics, Different Parallel Computer models, Instruction-level parallelism - Basic concept, Dependency Analysis, Partitioning and Scheduling, Pipeline architecture - Principles & general structures of pipeline, linear & non-linear model, pipelined instruction processing (arithmetic, Boolean, load/store)

1. Advanced Computer Architectures: A Design Space Approach) – Sima D., Fountain T., Kacsuk P.
2. Advanced Computer Architecture: Parallelism, Scalability, Programmability – Hwang K. (TMH)
3. Computer Architecture: A Quantitative Approach – Hennessy J. L., Patterson D. A. (Elsevier)
4. Operating system concepts – Silberschatz A., Galvin P. B., Gagne G. (Wiley)
5. Operating Systems – Stallings W. (Pearson Ed.)
6. Modern Operating Systems – Tanenbaum A.S. (PHI)
7. The Magic Garden Explained: The Internals of Unix System V Release 4 – Goodheart B., Cox J. (PHI)

8. The Design and Implementation of the 4.4 BSD Operating System – McKusick M. K. (Addison Wesley)

CS 1504 **Advanced Database Management System** **3-0-0-6**

2nd sem **Prerequisites: None**

Query processing: Measures of query costs, selection operation, sorting, join operation, evaluation of expressions
Query optimization: Translation of SQL queries to relational algebra, heuristic approach and cost based optimization
Recovery: Serializibility, locking, system log, undoing and redoing
Extended entity relationship model and object model, object oriented databases, Object relational and extended relational databases
Parallel and distributed databases, XML and Internet database, Active database

Books:

1. Database Management Systems – Ramakrishnan R., Gehrke J. (McGraw-Hill)
2. Database Management Systems – Silberschatz, A., Korth H. F., Sudarshan S. (McGraw-Hill)
3. Fundamentals of Database Systems – Elmasri R., Navathe S. B. (Addison-Wesley)
4. Database : Principles, Programming, Performance – ONeil P. (Morgan Kaufmann)
5. Database Modeling & Design – Theorey T. J. (Morgan Kaufmann)