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School of Electrical Sciences

B. Tech. (Computer Science and Engineering) Curriculum and Syllabus

SCHOOL OF ELECTRICAL SCIENCES

B. TECH. CURRICULUM

Compliance Report of B. Tech. (Computer Science and Engineering) Curriculum

Components	Proposed B. Tech. Curriculum		
	Subjects	Credit Recommended by Committee	Credit Proposed in B. Tech. (Computer Sc. & Engineering)
1. Common Core	(i) English	4	4
	(ii) Basic Science and Mathematics	20	20
	(iii) General Sciences	6	6
	(iv) Engineering Sciences	27	27
2. Breadth Basket	(i) Breadth-1 (ii) Breadth-2 (iii) Breadth-3 (iv) Breadth-4	12-14	3/4 3 3/4 3/4
3. Misc	(i) Seminar (ii) Internship (iii) Project	14	2 2 10
4. Laterals	(i) Lateral-1 (ii) Lateral-2 (iii) Lateral-3	9-12	3 3/4 3/4
5. Verticals	Theory	58-68	2^{nd} year - 20
			3^{rd} year –23/24
			4^{th} year – 19/25
	Laboratory	18-24	18
TOTAL		168-189	172/184

Curriculum for B. Tech. (Computer Science and Engineering) of School of Electrical Sciences

Subject Name		New Code	L-T-P	Credit	Contact Hour
SEMESTER – I					
Mathematics-1		MA1L001	3-1-0	4	4
Physics/ Chemistry		PH1L001/ CY1L001	3-1-0	4	4
Mechanics / English for Communications or Learning English		ME1L001 / HS1L001 or HS1L002	3-1-0/ 3-0-2 or 3-1-0	4	4/ 5 or 4
Electrical Technology / Introduction to Programing and Data Structures		EE1L001 / CS1L001	3-1-0	4	4
Physics Laboratory/ Chemistry Laboratory		PH1P001/ CY1P001	0-0-3	2	3
Introduction to Manufacturing Processes / Engineering Drawing and Graphics		ME1P001/ CE1P001	0-0-3/ 1-0-3	2/3	3/4
Electrical Technology Laboratory / Introduction to Programing and Data Structures Laboratory		EE1P001/ CS 1P001	0-0-3	2	3
Extra Academic Activity-1		ID1T001	0-0-3	1	3
			Total	22/23+1	25/27 or 26+3
SEMESTER – II					
Mathematics-2		MA1L002	3-1-0	4	4
Chemistry/ Physics		CY1L001/ PH1L001	3-1-0	4	4
English for Communication or Learning English / Mechanics		HS1L001 or HS 1L002/ ME1L001	3-0-2 or 3-1-0/ 3-1-0	4	5 or 4/ 4
Introduction to Programming and Data Structures/ Electrical Technology		CS1L001/ EE1L001	3-1-0	4	4
Chemistry Laboratory/ Physics Laboratory		CY1P001/ PH1P001	0-0-3	2	3
Engineering Drawing and Graphics / Introduction to Manufacturing Processes		CE1P001/ ME1P001	1-0-3/ 0-0-3	3/2	4/3
Extra Academic Activity -2		ID1T002	0-0-3	1	3
			Total	23/22+1	27 or 26/ 25+3
SEMESTER – III					

Subject Name		New Code	L-T-P	Credit	Contact Hour
Introduction to Electronics		EC2L001	3-1-0	4	4
Introduction to Bio Science and Technology		ID2L002	2-0-0	2	2
Data Structures		CS2Lxxx	3-0-0	3	3
Discrete Structures		CS2L001	3-1-0	4	4
Signals & Systems		EC2L002	3-1-0	4	4
Breadth – 1			3-0-0	3	3
Introduction to Electronics Laboratory		EC2P001	0-0-3	2	3
Signals & Systems Laboratory		EC2P002	0-0-3	2	3
Data Structure Laboratory		CS2Pxxx	0-0-3	2	3
			Total	26	29
SEMESTER – IV					
Lateral -1			3-0-0	3	3
Breadth – 2			3-0-0	3	3
Environmental Science Technology and Management		ID2L003	2-0-0	2	2
Combinatory, Probability and Statistics		MA2L006	3-1-0	4	4
Design and Analysis of Algorithms		CS2L002	3-1-0	4	4
Digital Electronic Circuits		EC2L003	3-1-0	4	4
Design and Analysis of Algorithms Laboratory		CS2P001	0-0-3	2	3
Digital Electronic Circuits Laboratory		EC2P003	0-0-3	2	3
Project Seminar		CS2S001	0-0-3	2	0
			Total	26	26
SEMESTER – V					
Lateral -2			3-0/1-0	3 / 4	3 / 4
Breadth-3			3-0/1-0	3 / 4	3 / 4
Formal Languages and Automata Theory		CS3L001	3-1-0	4	4
Computer Organization and Architecture		CS3L002	4-0-0	4	4
Operating Systems		CS3L005	4-0-0	4	4
Computer Organization and Architecture Laboratory		CS3P001	0-0-3	2	3
Operating Systems Laboratory		CS3P003	0-0-3	2	3
			Total	22/24	24/26
SEMESTER – VI					
Lateral -3			3-0/1-0	3/4	3/4
Computer Networks		CS3L006	3-1-0	4	4
Database Systems		CS3L003	3-1-0	4	4
Elective-1			3/4-0-3	5/6	6/7

Subject Name		New Code	L-T-P	Credit	Contact Hour
Computer Networks Laboratory		CS3P004	0-0-3	2	3
Database Systems Laboratory		CS3P002	0-0-3	2	3
			Total	20/22	23/25
SEMESTER – VII					
Compiler Design		CS4L001	3-1-0	4	4
Elective-2			3-0/1-3	5/6	6/7
Elective-3			3-1/2-0	4/5	6/7
Elective-4			3-0/1-0	3/4	3/4
Compiler Design Laboratory		CS4P001	0-0-3	2	3
Project- Part 1		CS4D001	0-0-6	4	0
Industrial Training Defense		CS4T001	0-0-3	2	0
			Total	24/27	22/25
SEMESTER – VIII					
Breadth-4			3/4-0-0	3/4	3/4
Elective-5			3-0/1-0	3/4	3/4
Elective-6			3-0/1-0	3/4	3/4
Project- Part 2	CSA4301	CS4D002	0-0-9	6	0
		Grand Total		15/18	9/12

List of Elective Courses

Subject Name	New Code	L-T-P	Credit	Contact Hour	Existing Code
Elective –1, 3, 5 and 7					
VLSI Design	EC4L003	3-0/1-3	5/6	6/7	EE A4003
Object Oriented System Design	CS4L002	3-0/1-3	5/6	6/7	CSA 4016
Artificial Intelligence	CS4L003	3-0/1-3	5/6	6/7	EE A4007
Modeling and Simulation	CS4L004	3-0/1-3	5/6	6/7	CSA 4010
Digital Communication	EC4L006	3-0-0	3	3	CS A4011
Mobile Computing	EC4L007	3-0-0	3	3	CS A4012
Applied Graph Theory	CS4L005	3-0-0	3	3	CS A4013
Advanced Algorithms	CS4Lxxx	3-0-0	3	3	
Fault-Tolerant Systems		3-0-0	3	3	
Theory of Computation	CS4L006	3-0-0	3	3	CS A4013
Principles of Programming Languages	CS4L007	3-0-0	3	3	CS A4015
Computational Geometry	CS4L008	3-0-0	3	3	CS A4017
Image and Video Processing	EC6L002	3-0-0	3	3	EE A6002
Soft Computing	CS4Lxxx	3-0-0	3	3	
Machine Learning	CS4Lxxx	3-0-0	3	3	
Cryptography	CS4Lxxx	3-0-0	3	3	
Cyber Forensics	CS4Lxxx	3-0-0	3	3	
Elective –2, 4, 6, 8					
Embedded Systems	EC4L008	3-0/1-3	5/6	6/7	EE S4001
Software Engineering	CS4L009	3-0-0	3	3	CS S4010
Software Reliability	CS4Lxxx	3-0-0	3	3	
Computer Graphics	CS4L010	3-0/1-3	5/6	6/7	CS S4011
Computational Complexity	CS4L011	3-0-0	3	3	CS S4012
Data Mining	CS4L012	3-0-0	3	3	CS S4013
Advanced Computer Architecture	CS4L013	3-0-0	3	3	CS S4014
Dependable Computing	CS4L014	3-0-0	3	3	CS S4015
Symbolic Logic and Automated Reasoning	CS4L015	3-0-0	3	3	CS S4016
Parallel and Distributed Algorithms	CS4L016	3-0-0	3	3	CS S4017
Robotics	CS4L017	3-0-0	3	3	CS S4018
Sensor Networks	EC4L009	3-0-0	3	3	CS S4019
Networks and Systems Security	CS6L002	3-0-0	3	3	EE S6016
Digital Signal Processing	EC3L003	3-0-0	3	3	EE S3003
Cloud Computing	CS4L018	3-0-0	3	3	CS S4020
High Performance Computing	CS4L019	3-0-0	3	3	CS S4021
Interconnection Networks	EC4L010	3-0-0	3	3	CS S4022
Computer Vision	CS4Lxxx	3-0-0	3	3	
Data Analytics	CS4Lxxx	3-0-0	3	3	

Subject Name	New Code	L-T-P	Credit	Contact Hour	Existing Code
Game Theory	CS4Lxxx	3-0-0	3	3	

List of Lateral Courses for Other Schools

Subject Name	Code	L-T-P	Credit	Contact Hour
Lateral – I (Any one will be offered)				
Digital Logic and Systems	CS2L003	3-1-0	4	4
Lateral – II (Any one will be offered)				
Microcontrollers and Embedded Systems	CS3L004	3-1-0	4	4
Lateral – III (Any one will be offered)				
Computer Networks and Security	CS3L007	3-1-0	4	4

New Syllabus (B. Tech. in Computer Science & Engineering)

Common Core: (CT- 08)

Subject Code: CS1L001	Name: Introduction to Programming and Data Structure	L-T-P: 3-1-0	Credits: 4

Basic programs : Introduction to the C programming language, Input and Output using C, Computation using variables, Conditional and switch statements, Loop constructs; Pointers and functions: Modular programming using functions, Pointer arguments and pointer return values, Arrays and Strings: Array as a data structure, Arrays storing strings, operations on strings, sorting and searching, Array implementation of Stacks; Structures and unions: Structures as composite data structure, array of structures, Pointers to structures; Linked lists : Single and double-linked lists, basic operation on lists like insertion, deletion and list reversal, Queue data structure, stack memory and heap memory, memory allocation and de-allocation; Trees: Tree as a special graph, Binary trees, Binary search trees, Recursive traversal techniques like in- order, pre-order and post-order, searching using trees.

Prerequisite: None

Text Books:

1. Al Kelley and Ira Pohl. A book on C, 4th Edition, Pearson India, 1998.
2. Brain W. Kernighan & Dennis Ritche, The C Programming Language, Prentice Hall of India.

Reference Books:

1. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, W. H. Freeman and Company.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

Vertical Theory (Core): VT 01 – VT 11

Subject Code: CS2L001	Name: Discrete Structure	L-T-P: 3-1-0	Credits: 4

Set Theory: Paradoxes in set theory; inductive definition of sets and proof by induction; Peono postulates; Relations; representation of relations by graphs; properties of relations; equivalence relations and partitions; Partial orderings; Posets; Linear and well-ordered sets; Size of a set: Finite and infinite sets, countable and uncountable sets, Cantor's diagonal argument and

the power set theorem, Schroeder-Bernstein theorem; Functions: injection and surjections; composition of functions; inverse functions; special functions; Algebraic structures and morphisms: Algebraic structures with one and two binary operations: semi groups, monoids, groups, rings, lattices, Boolean Algebra; Propositional logic: Syntax, semantics, validity of formulas, satisfiable and unsatisfiable formulas, encoding and examining the validity of some logical arguments; soundness and completeness; Proof techniques: Proof by Induction, proof by contradiction, contrapositive proofs, proof of necessity and sufficiency; First order Logic: Brief introduction; Basics of soundness and completeness; Introduction to graphs: Graphs and their basic properties - degree, path, cycle, subgraphs, isomorphism, Eulerian and Hamiltonian walks, graph coloring, planar graphs, trees.

Prerequisite: None

Text Books:

1. Kenneth H. Rosen : Discrete Mathematics and Its Applications, Kenneth H. Rosen, McGraw Hill, 6th edition, 2007
2. J.P.Tremblay & R. Manohar, Discrete Mathematical Structure with Applications to Computer Science, Tata McGraw Hill, 2008.

Reference Books:

1. Norman L. Biggs, Discrete Mathematics, Oxford University Press, 2nd edition, 2002.
2. Liu and Mahapatra, Elements of Discrete Mathematics, Tata McGraw Hill, 3rd edition, 2008.

Subject Code:	Name: **Data Structure**	L-T-P: 3-0-0	Credits: 3

Application of stacks queues and linked lists. Trees, traversals, binary search trees, Balanced BST: AVL Trees, 2-4 trees, Red-black trees, B-trees, Interval Trees.

Dictionaries. Tries, Compressed Tries and suffix trees.

Sorting: comparison based sorting - quick sort, heap sort, merge sort: worst and average case analysis. Decision tree model and (worst case) lower bound on sorting. Sorting in linear time - radix sort, bucket sort, counting sort, etc. Hashing.

Priority queues and binary heaps, binomial and Fibonacci heaps, Skip lists. Data Structure of Disjoint Sets.

Prerequisite: Programming and Data Structure

Textbook:

1. Thomas H. Cormen, Charles E. Leiserson, R.L. Rivest.. Introduction to Algorithms, Prentice Hall of India Publications, 3rd Edition 2015.

2. J. Kleinberg and E. Tardos. Algorithm Design, Pearson, 2006.

Reference Books:

- Fundamentals of Data Structures in C by Horowitz, Sahni, and Anderson-Freed, Universities Press
- Algorithm Design: Foundations, Analysis and Internet Examples by Goodrich and Tamassia, John Wiley
- Computer Algorithms by Baase and Van Gelder, Pearson.
- Algorithms by Sedgewick and Wayne, Addison Wesley, 2011

Subject Code: CS2L002	Name: **Design and Analysis of Algorithms**	L-T-P: 3-1-0	Credits: 4

Analysis Techniques: Introduction to algorithms and its importance, mathematical foundations: growth functions, complexity analysis of algorithms, summations, recurrences, Master's Theorem, Amortized Analysis.

Design Techniques: Divide and conquer, Greedy Algorithm; Dynamic Programming, Branch and Bound, Backtracking Techniques.

Elementary Graph algorithms: DFS, BFS, Topological Sort, Strongly Connected Components, Minimum Spanning Trees, Single source shortest path, All pair shortest path; Network Flows: Ford Fulkerson Algorithm, Max Flow-Min Cut; Bipartite Matching.

String matching Algorithm: Rabin – Karp algorithm, Knuth – Morris Pratt algorithm.

NP-Completeness: Polynomial-time verification, NP-completeness and reducibility, NP-completeness proofs, NP-complete problems. Introduction to Approximation Algorithms.

Prerequisite: Programming and Data Structure, Data Structure

Text Books:

3. Thomas H. Cormen, Charles E. Leiserson, R.L. Rivest.. Introduction to Algorithms, Prentice Hall of India Publications, 3rd Edition 2015.
4. J. Kleinberg and E. Tardos. Algorithm Design, Pearson 2006.

Reference Books:

5. Sara Baase and Allen Van Gelder. Computer Algorithms: Introduction to Design and Analysis, Pearson education (Singapore) Pvt. Ltd, New Delhi 2007.
6. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman.. The Design and Analysis of Computer Algorithms, Pearson Education (Singapore) 2006.
7. Algorithmics: Theory and Practice by Brassard and Bratley, Prentice Hall

Subject Code: CS3L001	Name: Formal Languages and Automata Theory	L-T-P: 3-1-0	Credits: 4

Finite Automata: Basic Concepts, Deterministic Finite Automata (DFA), Non-deterministic Finite Automata (NFA), Equivalence between NFA and DFA; Regular Languages: Regular expression and equivalence to Finite Automata (FA), Algebraic laws for regular expressions, pumping lemma and applications, properties of regular languages, minimization of automata and applications; Context-free languages: Context-free grammars (CFG)and languages, pushdown automaton (PDA), various forms of PDA, equivalence between CFG and PDA, Chmosky normal form of CFG, pumping lemma, properties of CFLs; Turing Machines: Turing machines, decidability and undecidability.

Prerequisite: None

Text Books:

1. Michael Sipser: Introduction to the Theory of Computation, 3rd edition, PWS Publishing Company, 2012.
2. E. Hopcroft, R. Motwani and J. D. Ullman: Introduction to Automata Theory, Languages and Computation. Low priced paperback edition, published by Pearson Education, 2007.

Reference Books:

1. H. R. Lewis and C. H. Papadimitriou. Elements of the Theory of Computation, Eastern economy
edition, 1998.

Subject Code: CS3L002	Name: Computer Organization and Architecture	L-T-P: 4-0-0	Credits: 4

Overview of computer organization – components and system buses, Concepts of assembly and machine language programs, Machine language program execution – instruction cycles, machine cycles and bus cycles; Overview of memory and I/O addressing; CPU organization – components and subsystems, register banks, internal bus structure, information flow; Instruction set – characteristics and functions, types of operation and operands. Addressing modes – various ways of addressing memory and input-output devices and their timing characteristics; CISC and RISC architectures – examples; ALU – flags, logical operations, fixed point number representations and arithmetic, floating point number representations and arithmetic, exceptions; Control Unit – how it operates, hardwired control unit, concepts of microprograms and microprogrammed control unit; Memory hierarchy – main memory – types and interfacing; Cache memory – its organizations and operations, levels of caches; Memory management module – paging and segmentation, virtual memory; Disk memory, RAIDs. Back-up memory; Interrupts and interrupt structures – interrupt cycles, handling multiple simultaneous interrupts, programmable interrupt controllers; I/O interfacing and modes of I/O data transfer. Direct memory access – DMA controller; Instruction level parallelism – instruction pipelining, pipeline hazards; Concepts of multiprocessor systems. Examples will be drawn from real life RISC and CISC processors.

Prerequisite: Digital Electronic Circuits

Text Books:

1. Computer Organization and Architecture – Designing for Performance by W Stallings – Pearson
2. Computer Architecture and Organization by J P Hayes – McGraw-Hill
3. Computer Organization and Design – The Hardware/Software Interface (ARM Edition) by D A Patterson and J L Hennessy – Morgan Kaufmann

Reference Books:

1. Structured Computer Organization by A S Tennenbaum – Prentice Hall
2. Computer Organization by Carl Hamacher, Zvonko Vranesic and Safwat Zaky – McGraw Hill
3. Computer Architecture – A Quantitative Approach by D A Patterson and J L Hennessy – Morgan Kaufmann

Subject Code: CS3L003	Name: Database Systems	L-T-P: 3-1-0	Credits: 4

Introduction: General introduction to database systems; Database-DBMS distinction, Approaches to building a database, Data models, Database management system, Three-schema architecture of a database, Challenges in building a DBMS, Various components of a DBMS; Entity Relationship Model: Conceptual data modeling - motivation, Entities, Entity types, Various types of attributes, Relationships, Relationship types, E/R diagram notation, Specialization and Generalization, Examples; Relational Data Model: Concept of relations, Schema-instance distinction, Keys, referential integrity and foreign keys; Relational Algebra: Selection, Projection, Cross product, Various types of joins, Division, Example queries; Introduction to Tuple relation calculus, Domain relational calculus, Converting the database specification in E/R notation to the relational schema; SQL: Introduction, Data definition in SQL, Table, key and foreign key definitions, Update behaviors, Querying in SQL, Basic select-from- where block and its semantics, Nested queries - correlated and uncorrelated, Notion of aggregation, Aggregation functions group by and having clauses, Embedded SQL; Functional Dependencies and Normal forms: Importance of a good schema design, Problems encountered with bad schema designs, Motivation for normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, Closure of a set of FD's, Minimal covers; Definitions of 1NF, 2NF, 3NF and BCNF, Decompositions and desirable properties of them, Algorithms for 3NF and BCNF normalization; Multi-valued dependencies and 4NF, Join dependencies and definition of 5NF; Data Storage and Indexes: File organizations, Primary, Secondary index structures, Various index structures - hash-based, Dynamic hashing techniques, Multi-level indexes, B trees, B+ trees; Transaction processing and Error recovery: Concepts of transaction processing, ACID properties, Concurrency control, Locking based protocols for CC, Error recovery and logging, Undo, Redo, Undo-redo logging and recovery methods.

Prerequisite: None

Text Books:

1. R. Elmasri and S. B. Navathe, Fundamentals of Database systems, Sixth Edition, Addison Wesley 2010.

2. A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, Sixth Edition McGraw Hill 2010.

Reference Books:

1. Ramakrishnan, Raghu, and Johannes Gehrke. *Database Management Systems*. 3rd ed. McGraw-Hill, 2002

Subject Code: CS3L005	Name: Operating Systems	L-T-P: 4-0-0	Credits: 4

Operating systems – overview and objectives; Process concept – process control block, process life cycle; multi-processing and process management, multi-threaded programming;

Process scheduling – long and short time scheduling, preemptive and non-preemptive scheduling, dispatching, scheduling criteria and algorithms; Concurrent cooperating sequential processes – process synchronization, critical section, synchronization hardware, semaphores, monitors; Deadlocks – conditions for deadlock, deadlock prevention, avoidance, detection and recovery, classic problems. Memory management – partitioning, paging, segmentation, segmentation with paging. Virtual memory – demand paging, page replacement policies; I/O systems – I/O interfaces and busses, interrupt structures and interrupt handlers, Direct memory access. File systems – disk structures and disk accesses, blocking and buffering, directories and file allocation strategies, protection. RAID structures; Overview of Security and protection. Concepts of distributed and real time systems; Examples will be drawn from existing operating systems.

Prerequisite: None

Text Books

1. A. Silberschatz, P. B. Galvin and G. Gagne, "Operating System Principles," John Wiley & Sons.
2. W. Stallings, "Operating Systems– Internals & Design Principles," Pearson Education.

Reference Book:

1. A. S. Tenenbaum, "Modern Operating Systems," Prentice Hall.

Subject Code: CS3L006	Name: Computer Networks	L-T-P: 3-1-0	Credits: 4

Introduction: goals of networking, well-known applications such as web, e-mail and ftp, need for a layered architecture, OSI model and Internet; Host-to-host data communication: RS-232 over serial line; handshaking and error handling – EDC, ECC; packet switching; circuit switching; reliable transmission - stop-and-wait, sliding window protocols; logical connection; Multiple co-located hosts data communication: addressing, LAN access methods; CSMA/CD, Ethernet, Token passing, Token Ring, FDDI, wireless LANs; Simple performance models; WAN access methods – Point to Point protocol (PPP); Remotely located hosts data communication: addressing, interconnection of LANs; repeaters, bridges, routers; ATM cell-switching; IP: routing protocols (distance vector, link state packet routing); congestion control concepts and mechanisms (choke packets, leaky bucket, token bucket); IPv4, CIDR (Classless

Inter-domain routing); End-to-end reliability: the end-to-end argument; protocols - TCP, UDP, RPC; connection establishment, flow control; Application protocols for email, ftp, web, DNS; Advanced Networking: overview to network management systems; security threats and solutions – Firewalls, Access Control Lists, IPSec, IDS.

Prerequisite: None

Text Books:

1. W. Stallings. Data and Computer Communications, 7th Edition, Prentice Hall, 2004.
2. A. S. Tanenbaum. Computer Networks, 3rd Edition, Prentice Hall PTR, 1996.

Reference Books:

1. L. L. Peterson and B. S. Davie. Computer networks: a systems approach, 3rd Edition, Morgan Kaufmann Publishers, 2001.
2. Behrouz A. Forouzan, Data Communication and Networking, McGraw-Hill.
3. W. Richard Stevens, TCP/IP Illustrated, Volume 1, Addison-Wesley.

Subject Code: CS4L001	Name: Compiler Design	L-T-P: 3-1-0	Credits: 4

Introduction: Overview and phases of compilation; Lexical Analysis: Non-deterministic and deterministic finite automata (NFA & DFA), regular grammar, regular expressions and regular languages, design of a lexical analyser as a DFA, lexical analyser generator; Syntax Analysis: Role of a parser, context free grammars and context free languages, parse trees and derivations, ambiguous grammar; Top Down Parsing: Recursive descent parsing, LL(1) grammars, non-recursive predictive parsing, error reporting and recovery; Bottom Up Parsing: Handle pruning and shift reduces parsing, SLR parsers and construction of SLR parsing tables, LR(1) parsers and construction of LR(1) parsing tables, LALR parsers and construction of efficient LALR parsing tables, parsing using ambiguous grammars, error reporting and recovery, parser generator; Syntax Directed Translation: Syntax directed definitions (SDD), inherited and synthesized attributes, dependency graphs, evaluation orders for SDD, semantic rules, application of syntax directed translation; Symbol Table: Structure and features of symbol tables, symbol attributes and scopes; Intermediate Code Generation: DAG for expressions, three address codes - quadruples and triples, types and declarations, translation of expressions, array references, type checking and conversions, translation of Boolean expressions and control flow statements, back patching, intermediate code generation for procedures; Run Time Environment: storage organizations, static and dynamic storage allocations, stack allocation, handlings of activation records for calling sequences; Code Generations: Factors involved, registers allocation, simple code generation using stack allocation, basic blocks and flow graphs, simple code generation using flow graphs; Elements of Code Optimization: Objective, peephole optimization, elimination of local common sub-expressions, redundant and un-reachable codes, flow of control optimization.

Prerequisite: Programming and Data Structure

Text Books:

1. K. D. Cooper and L. Torczon, “Engineering a Compiler,” Morgan Kaufman.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, “Compilers: Principles, Techniques and Tools,” Pearson Education.

Reference Book:

1. Compiler Design in C by Holub – PHI.
2. Modern Compiler Design by Dick Grune et al – Wiley India.

Vertical Theory (Elective): VE-01 to VE-06

Subject Code: EC6L002	Name: Image and Video Processing	L-T-P: 3-0-0	Credit: 3

Introduction: Purpose of computer vision, State-of-the-art, history of computer vision, some typical applications of computer vision in surveillance; Image Formation Models: Monocular imaging system, orthographic & perspective projection, camera model and camera calibration, binocular imaging systems; Image Processing and Feature Extraction: Image representations (continuous and discrete) color representations, edge detection, some important texture representation; Motion Estimation: Regularization theory, optical flow computation, stereo vision, motion estimation, structure from motion; Feature Extraction: SIFT, SURF, HOG, LoG and other relevant features; Image Segmentation: Model based segmentation, pixel grouping, context guided segmentation, errors in segmentation; Object Recognition: Shape representation, shape descriptors, object localization, object representation using low level and high level features; Object Tracking: Basics of object tracking, single object tracking, multiple object tracking, slow moving and fast moving objects and related algorithms, object trajectory analysis; Visual Surveillance: Basics of surveillance, single camera based surveillance, multiple camera guided surveillance, surveillance using moving camera, public place surveillance, healthcare surveillance.
Prerequisite: Image Processing, Data Structures and Algorithms

Text Book:

1. Computer Vision - A Modern Approach by D. A. Forsyth and J. Ponce, Pearson, 2nd edition, 2012

Reference Books:

1. Introductory Techniques for 3D Computer Vision-, by E. Trucco and A. Verri, Publisher: Prentice Hall.
2. Digital Image Processing, by Gonzalez, R. and Woods, R. Addison-Wesley, 1993.
3. Various Recent Research Papers

Subject Code: CS6L002	Name: Network and Systems Security	L-T-P: 3-0-0	Credit: 3

Fundamentals of Network and Security: OSI and TCP/IP model; IP addressing; Subnet basics; Network and Internet Security, Information Security – Assets, Threats, Attacks, Vulnerability, Controls; Security

Components - CIA principle, Security Services and Mechanisms; X.800 OSI Model; Cryptography Basics: Symmetric Key and Public Key Cryptography; Building Security in the Network: Model of Network Security Process – Asset Identification; Threat Assessment; Risk Assessment; Policy Construction – Privacy, Access, Accountability, Authentication, Availability; Network Security Design – Architecture and Control measures; Security Implementation; Security Audit; Security perimeter and zones; Device Level Security: Physical and Logical Security Concepts; Router and Switch Level Security Configurations – Secure Routing, Secure LAN Switching, Cisco IOS AND Security Device Manager (SDM); IEEE 802.1x protocol; Network Firewalls – Cisco PIX; Access Control and Policy based routing; NAT and Security; Tutorials on NS2 and Demo; Internet Security: IP Security; Web Security; Security Attacks; Network Misconfiguration; System Security: Intruders; Malicious software; Principle of Security systems – Firewalls; VPN; IDS; IPSec; Wireless Security: Wireless Network Principles; 802.11 standard; Wireless Router Security Configurations; Wireless jamming; Security Control; Role based Access Control; Security in Ad-hoc Networks: Principle of Mobile Ad-hoc Networks (MANET), Concept of Trust; Modeling and Enforcement of Trust based Security in MANET; Introduction to Vehicular Ad-Hoc Network (VANET) Security; Advanced Security and Case Studies: Cyber Security – Principle; Cyber Attacks: Denial of Service, Wireless Jamming, Misconfigurations; Security Violations; Various Cyber Security Standards; Formal Modeling of Security Configurations in Enterprise Networks; Security Policy Specification Languages; Formal Analysis of Security Policies and its Implementations. Case Study on Enterprise Networks, Smart Grid Networks and VANET.

Prerequisites: Computer Networks, Basic Concepts of Computer and Information Security; Basics of Logic Programming; Network Simulators.

Text Books

1. W. Stallings. Network Security Essentials (2nd edition), Prentice Hall, 2003.
2. Saadat Malik. Network Security Principles and Practices, Pearson Education. 2002.
3. Todd Lammle. CCNA: Cisco Certified Network Associate Study Guide (7th edition), ISBN: 978-0470901071.

Reference Books

4. R. Anderson. Security Engineering, 2nd edition, 2008.
5. Research Papers.

Subject Code: CS2L003 (LT-1)	Name: Digital Logic and Systems	L-T-P: 3-1-0	Credit: 4

Boolean Algebra and combinatorial circuits: Boolean algebra: De-Morgan's theorem, switching functions and simplification using K-maps & Quine McCluskey method, Design of adder, subtractor, comparators, code converters, encoders, decoders, multiplexers and demultiplexers; Synchronous sequential circuits: Flip flops - SR, D, JK and T. Analysis of synchronous sequential circuits; design of

synchronous sequential circuits – Counters, state diagram; state reduction; state assignment; Asynchronous sequential circuits: Analysis of asynchronous sequential machines, state assignment, asynchronous design problem; PROGRAMMABLE LOGIC DEVICES, MEMORY AND LOGIC FAMILIES: Memories: ROM, PROM, EPROM, PLA, PLD, FPGA, digital logic families: TTL, ECL, CMOS; VHDL: RTL Design – combinational logic – Types – Operators – Packages – Sequential circuit – Sub programs – Test benches. (Examples: adders, counters, flipflops, FSM, Multiplexers / Demltiplexers).

Prerequisite: None

Text Books

1. Raj Kamal, Digital systems-Principles and Design, Pearson education 2nd edition, 2007.
2. M. Morris Mano, Digital Design, Pearson Education, 2006.
3. John M.Yarbrough, Digital Logic, Application & Design, Thomson, 2002.

Reference Books

1. Charles H.Roth, Fundamentals Logic Design, Jaico Publishing, IV edition, 2002.
2. Floyd and Jain, Digital Fundamentals, 8th edition, Pearson Education, 2003.
3. John F.Wakerly, Digital Design Principles and Practice, 3rd edition, Pearson Education, 2002.
4. Tocci, Digital Systems : Principles and applications, 8th Edition, Pearson Education.

Subject Code: CS3L004 (LT-2)	Name: Microcontrollers and Embedded Systems	L-T-P: 3-1-0	Credit: 4

Microcontrollers: 8051 Architecture, Functional block diagram - Instruction format and addressing modes – Timing Diagram, Interrupt structure Input / Output Ports and Circuits, External Memory, Counters and Timers, PIC Controllers. Interfacing Processor (8051, PIC), Memory Interfacing, I/O Devices, Memory Controller and Memory arbitration Schemes;
Embedded Systems: Overview of Embedded Systems, Processor Embedded into a system, Embedded Hardware Units and Devices in system, Embedded Software, Complex System Design, Design Process in Embedded System, Formalization of System Design, and Classification of Embedded Systems; Embedded Processors: PSOC (Programmable System-on-Chip) architectures, Continuous Timer blocks, Switched Capacitor blocks, I/O blocks, Digital blocks, Programming of PSOC, Embedded RISC Processor architecture – ARM Processor architecture, Register Set, Modes of operation and overview of Instructions; Interrupts and Device Drivers: Exceptions and Interrupt handling Schemes – Context & Periods for Context Switching, Deadline & interrupt latency. Device driver using Interrupt Service Routine, Serial port Device Driver, Device drivers for Internal Programmable timing devices; Real Time Systems: Basic Concepts, Hard and Soft Real Time Systems, Tasks – periodic and aperiodic tasks, Timing parameters – release time, execution time, deadline, period, Basic real time Task

Scheduling Algorithms, Resource Contention, Deadlocks, Priority Inversion, Basics of Re-entrancy and Thread Safety in Embedded Software Developments

Prerequisite: None.

Text Books:

1. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes / Cole, 1999, Thomas Learning.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.

Subject Code: CS3L007 (LT-3)	Name: Computer Networks and Security	L-T-P: 3-0/1-0	Credit: 3/4

Data Communication: Communication Elements, direction of data flow, Networks, components and categories, types of connections, topologies, basic protocol and standards, ISO/OSI model, Transmission Media – Fibre Optics, Coaxial Cables, Line coding, Modem, RS 232 Interfacing sequences; Data Link Layer: Error Detection and Correction, Parity – LRC – CRC – Hamming code, basics of flow control and error control, LAN – Ethernet; Network Layer: Internetworking, Packet switching and Datagram, IP addressing, Subnets – routing – distance vector and link state routing – routers; Transport and Application Layer: Functions, Multiplexing, basics of TCP and UDP, Congestion control, QoS, DNS, SMTP – FTP – HTTP, WWW; Network Security: Basic Concepts, Access control, Cryptography, Network security, Firewalls, IDS, Security on the Internet and the World Wide Web, Vulnerabilities, Threats, Attack Techniques, Denial of Service.

Prerequisite: None

Text Books:

1. Data Communications and Networking, B. A. Forouzan, McGrawHill, 4th Edition 2007
2. Computer Networks, A. Tanenbaum,
3. Computer Security, Mat Bishop, Pearson Education 2003
4. Fundamentals of Computer Security, Pieprzyk et.al, Allied Publishers 2004

Reference Books:

1. R. Anderson. Security Engineering, 2nd edition, Prentice Hall, 2008
2. W. Stallings. Data and Computer Communications, 7th Edition, Prentice Hall, 2004.

Subject Code:	Name: Data Analytics	L-T-P: 0-0-3	Credit: 3

Introduction: Sources, modes of availability, inaccuracies, and uses of data.

Data Objects and Attributes: Descriptive Statistics; Visualization; and Data Similarity and Dissimilarity.

Pre-processing of Data: Cleaning for Missing and Noisy Data; Data Reduction – Discrete Wavelet Transform, Principal Component Analysis, Partial Least Square Method, Attribute Subset Selection; and Data Transformation and Discretization.

Inferential Statistics: Probability Density Functions; Inferential Statistics through Hypothesis Tests

Business Analytics: Predictive Analysis (Regression and Correlation, Logistic Regression, In-Sample and Out-of-Sample Predictions), Prescriptive Analytics (Optimization and Simulation with Multiple Objectives);

Mining Frequent Patterns: Concepts of Support and Confidence; Frequent Itemset Mining Methods; Pattern Evaluation.

Classification: Decision Trees – Attribute Selection Measures and Tree Pruning; Bayesian and Rule-based Classification; Model Evaluation and Selection; Cross-Validation; Classification Accuracy; Bayesian Belief Networks; Classification by Backpropagation; and Support Vector Machine.

Partitioning Methods – k-means Hierarchical Methods and Hierarchical Clustering Using Feature Trees; Probabilistic Hierarchical Clustering; Introduction to Density-, Grid-, and Fuzzy and Probabilistic Model-based Clustering Methods; and Evaluation of Clustering Methods.

Machine Learning: Introduction and Concepts: Ridge Regression; Lasso Regression; and k-Nearest Neighbours, Regression and Classification.

Supervised Learning with Regression and Classification Techniques: Bias-Variance Dichotomy, Linear and Quadratic Discriminant Analysis, Classification and Regression Trees, Ensemble Methods: Random Forest, Neural Networks, Deep Learning.

Text Books

1. James, G., D. Witten, T. Hastie, and R. Tibshirani, An Introduction to Statistical learning with Application to R, Springer, New York. 2013
2. Jank, W., Business Analytics for Managers, Springer, New York. 2011
3. Witten, I. H., E. Frank, and M. A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann. 2011

Reference Books:

1. Wolfgang, J., Business Analytics for Managers, Springer. 2011
2. Montgomery, D. C., and G. C. Runger, Applied Statistics and Probability for Engineers. John Wiley & Sons. 2010
3. Samueli G., N. R. Patel, and P. C. Bruce, Data Mining for Business Intelligence, John Wiley & Sons, New York. 2010
4. Hastie, T., R. T. Jerome, and H. Friedman, The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer. 2009

Subject Code:	Name: Cyber Forensics	L-T-P: 0-0-3	Credit: 3

Sources of Digital/Electronic Evidence: Storage devices, Mobile phones, Ipods, internet, wifi networks

Physical Evidence: Finger prints on devices

System Forensics: File signatures, volatile/non-volatile data, File formats, Metadata, existing system forensics tools

Network Forensics: Firewalls, Intrusion Detection System, Security event management software

Database Forensics,

Web investigation: IP tracking, Server logs, Domain records

Windows Forensics: malware forensics,

Google Forensics: analysis of search data/information gathered from various google services.

An Indian perspective on digital forensics: Indian IT act, Cyber laws, Case studies

Refernces:

Reading material will mostly be articles published in security/forensics conferences/workshops/journals, related web pages and reference books (e.g., operating systems, computer networks, database management systems).

Seminar: SR1

Subject Code: CS2S001	Name:	L-T-P: 2-0-0	Credit: 2

Project: Part 1

Subject Code: CS4D001	Name:	L-T-P: 0-0-4	Credit: 4

Project: Part 2

Subject Code: CS4D002	Name:	L-T-P: 0-0-6	Credit: 6

Laboratory Courses

Subject Code: CS1P001	Name: Introduction to Programming and Data Structures Laboratory	L-T-P: 0-0-3	Credit: 2

Familiarization of a computer and the environment; Execution of sample programs related to Expression evaluation, Conditionals and branching, Iteration, Functions, Recursion, Tail-recursion, Arrays, String manipulation, Structures, Linked lists, Doubly-linked lists and Binary Trees. Execution of programs involving abstract data types like Stacks and Queues.

Prerequisite: Introduction to Programing and Data Structures

Text Books:

3. Al Kelley and Ira Pohl. A book on C, 4th Edition, Pearson India, 1998.
4. Brain W. Kernighan & Dennis Ritche, The C Programming Language, Prentice Hall of India.

Reference Books:

3. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, W. H. Freeman and Company.
4. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

Subject Code:	Name: **Data Structure Laboratory**	L-T-P: 0-0-3	Credit: 2

Applications of the Data Structures discussed in the class: Two-way Stack, Dequeue, Priority queue, Sorting Algorithms, Dictionary data structures for string handling, Cycle detection and removal, Application of BST, AVL Trees, Data structure for big data maintenance, Tree traversal algorithms, efficient insertion and deletion algorithm with variations across different applications, Hashing Techniques, Application of Union-Find Data Structure for set theoretic problems.

Prerequisite: Introduction to Programing and Data Structures

Text Books:

5. Al Kelley and Ira Pohl. A book on C, 4th Edition, Pearson India, 1998.
6. Brain W. Kernighan & Dennis Ritche, The C Programming Language, Prentice Hall of India.

Reference Books:

5. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, W. H. Freeman and Company.
6. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

Subject Code: CS2P001	Name: Design and Analysis of Algorithms Laboratory	L-T-P: 0-0-3	Credit: 2

Implementation of Algorithms covered in Theory Class: Sorting, Matrix Multiplications, Trees, Graph Traversals, Shortest Paths, Network Flows, Algorithms, Network Flows.

[This will involve running the algorithms under varying input sets and measuring running times, use of different data structures for the same algorithm (wherever applicable) to see its effect on time and space, comparison of different algorithms for the same problem etc.]

Design of Algorithms: This will involve design and implementation of algorithms for problems not covered in class but related to topics covered in class.

[The exact set of algorithms to design and implement is to be decided by the instructor. In addition, there will be at least one significantly large design project involving some real world application. An efficient design of the project should require the use of multiple data structures and a combination of different algorithms/techniques.]

Prerequisite: Design and Analysis of Algorithms

Text Book(s):

1. Thomas H. Cormen, Charles E. Leiserson, R.L. Rivest.. Introduction to Algorithms, Prentice Hall of India Publications, Fourth Edition 2011.

Reference Book(s):

2. Sara Baase and Allen Van Gelder. Computer Algorithms: Introduction to Design and Analysis, Pearson education (Singapore) Pte. Ltd, New Delhi 2007.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman.. The Design and Analysis of Computer Algorithms, Pearson Education (Singapore) 2006
4. J. Kleinberg and E. Tardos, Algorithm Design, Addison-Wesley.

Subject Code: CS3P001	Name: Computer Organization and Architecture Laboratory	L-T-P: 0-0-3	Credit: 2

Familiarization with assembly language programming, Synthesis/design of simple data paths and controllers, processor design, Interfacing - DAC, ADC, keyboard-display modules, etc., Development kits as well as Microprocessors/PCs may be used for the laboratory, along with design/simulation tools as and when necessary.

Prerequisite: Computer Organization and Architecture

Text Books:

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Elsevier.
2. Carl Hamachar, Zvonco Vranesic and Safwat Zaky, 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 Education.
5. Vincent P. Heuring and Harry F. Jordan, Computer Systems Design and Architecture, Pearson Education.

Subject Code: CS3P002	Name: Database Systems Laboratory	L-T-P: 0-0-3	Credit: 2

Database schema design, database creation, SQL programming on database creation, update and querying; Report generation using a commercial RDBMS like ORACLE and SQL-Server, PL/SQL programming, Stored Procedures, Triggers, Accessing through views, Students are to be exposed to front end development tools, ODBC and CORBA calls from application Programs, internet based access to databases and database administration.

Prerequisite: Database Systems

Text Books

1. R. Elmasri and S. B. Navathe, *Fundamentals of Database systems*, Sixth Edition, Addison Wesley 2010.
2. A. Silberschatz, H. F. Korth, S. Sudarshan, *Database System Concepts*, Sixth Edition McGraw Hill 2010.

Reference Books

1. Ramakrishnan, Raghu, and Johannes Gehrke. *Database Management Systems*. 3rd ed. McGraw-Hill, 2002.

Subject Code: CS3P003	Name: Operating Systems Laboratory	L-T-P: 0-0-3	Credit: 2

Familiarization with UNIX system calls for process management and inter-process communication; Experiments on process scheduling and other operating system tasks through simulation/implementation under a simulated environment.

Prerequisite: Operating Systems

Text Books

1. Avi Silberschatz, Peter Galvin, Greg Gagne, Operating System Concepts, Wiley Asia Student Edition.
2. William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall of India.

Reference Books

3. Gary J. Nutt, Operating Systems: A Modern Perspective, Addison-Wesley.
4. Maurice Bach, Design of the Unix Operating Systems, Prentice-Hall of India.
5. Daniel P. Bovet, Marco Cesati, Understanding the Linux Kernel, O'Reilly and Associates.

Subject Code: CS3P004	Name: Computer Networks Laboratory	L-T-P: 0-0-3	Credit: 2

Simulation experiments for Network and Transport layer protocols performance – OSPF, RIP, BGP, TCP, IP, etc., Configuring, testing and measuring network devices (e.g., switches, routers, firewalls) and parameters/policies (interfaces, bandwidth, access control, etc.), Network management experiments; Exercises on network programming, Projects on Network Service Management and Communications.

Prerequisite: Computer Networks

Text Books

3. W. Stallings. Data and Computer Communications, 7th Edition, Prentice Hall, 2004.
4. A. S. Tanenbaum. Computer Networks, 3rd Edition, Prentice Hall PTR, 1996.

Reference Books

6. L. L. Peterson and B. S. Davie. Computer networks: a systems approach, 3rd Edition, Morgan Kaufmann Publishers, 2001.
7. Behrouz A. Forouzan, Data Communication and Networking, McGraw-Hill.
8. W. Richard Stevens, TCP/IP Illustrated, Volume 1, Addison-Wesley.

Subject Code: CS4P001	Name: Compiler Design Laboratory	L-T-P: 0-0-3	Credit: 2

Familiarity with compiled codes (assembly language) of RISC and CISC machines, writing a scanner, writing predictive parser for a small language, small experiment with scanner (lex/flex) and parser (yacc/byson) generator (such as translation of regular expression to NFA or the construction or parse tree), writing scanner-parse specification for a small language, translation of the language to an intermediate form (e.g. three-address code), generation of target code (in assembly language). Code improvement (optional).

Prerequisite: Compiler Design

Text Books

1. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Compilers: Principles, Techniques and Tools, Addison-Wesley.
2. Michael L. Scott, Programming Language Pragmatics, Elsevier.

Reference Books

3. Andrew W. Appel, Modern Compiler Implementation in C/Java, Cambridge University Press.
4. Keith D. Cooper and Linda Torczon, Engineering a Compiler, Elsevier.
5. Allen I. Holob, Compiler Design in C, Prentice-Hall.
6. Steven S. Muchnik, Advanced Compiler Design and Implementation, Elsevier.
7. Randy Allen and Ken Kennedy, Optimizing Compilers for Modern Architectures, Elsevier.