School of Electrical Sciences

Curriculum and Syllabus for Dual Degree Program B.Tech (Computer Science and Engineering) and M.Tech (Computer Science and Engineering)

Curriculum for Dual Degree B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science and Engineering)

School of Electrical Sciences

Subject Name		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	23/24	
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	22/23	

Subject Name		Code	L-T-P	Credit	Contact Hour
SEMESTER – III					
Introduction to Electronics		EC2L001	3-1-0	4	4
Introduction to Bio Science and Technology		ID2L002	2-0-0	2	2
Discrete Structures		CS2L001	3-1-0	4	4
Data Structure		CS2L004	3-0-0	3	3
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		CS2P002	0-0-3	2	3
			Total	26	
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	
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	
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			3-0/1-0	3/4	3/4

Subject Name		Code	L-T-P	Credit	Contact Hour
Database Systems Laboratory		CS3P002	0-0-3	2	3
Computer Networks Laboratory		CS3P004	0-0-3	2	3
			Total	18/20	
SEMESTER – VII					
Compiler Design		CS4L001	3-1-0	4	4
Advanced Algorithms		CS6L007	3-1-0	4	4
Networks and Systems Security		CS6L002	3-1-0	4	4
Elective-2			3-0-0	3	3
Compiler Design Lab		CS4P001	0-0-3	2	3
Security & Forensics Lab-I/ML & DA Lab-I		CS6P002/CS6P003	0-0-3	2	3
Project- Part 1		CS4D001	0-0-6	4	0
Industrial Training Defense		CS4T001	0-0-3	2	0
			Total	24/25	
SEMESTER – VIII					
Breadth-4			3/4-0-0	3/4	3/4
Cloud Computing		CS6L008	4-0-0	4	4
High performance Computer Architecture		CS6L009	3-1-0	4	4
Elective-3			3-0-0	3	3
Security & Forensics Lab-II/ML & DA Lab-II		CS6P004/CS6P005	0-0-3	2	3
Project- Part 2		CS4D002	0-0-0	6	0
			Total	22/23	
SEMESTER – IX					
Elective-4			3-0/1-0	3/4	3/4
Computer Systems Lab		CS6P001	0-0-3	2	3
Research Review		CS6D001		4	
Thesis (Part –I)		CS6D002	0-0-0	12	0
			Total	21/22	
SEMESTER – X					
Elective-5			3-0-0	3	3
Thesis (Part –II)		CS6D004	0-0-0	13	0
			Total	16	
Total		221/231			

List of Elective Courses

Name	Code	L-T-P	Credit	Contact Hours
Computational Geometry	CS4L030	3-0-0	3	3
Computer Graphics	CS4L010	3-1-0	4	4
Computer Vision	EC6L029	3-0-0	3	3
Multimedia Systems	CS6L013	3-0-0	3	3
Mathematical Foundations of Computer Science	CS6L015	3-0-0	3	3
VLSI circuits	CS6L016	3-0-0	3	3
Embedded Systems	EC4L008	3-0-0	3	3
Digital Signal Processing	EC3L003	3-1-0	4	4
Mobile Computing	EC4L007	3-0-0	3	3
Applied Graph Theory	CS4L005	3-0-0	3	3
Principles of Programming Languages	CS4L029	3-0-0	3	3
Complexity Theory	CS6L012	3-0-0	3	3
Parallel and Distributed Algorithms	CS6L032	3-0-0	3	3
Data Mining	CS4L012	3-0-0	3	3
Machine Learning and Data Analytics- I	ID6L004	3-0-0	3	3
Machine Learning & Data Analytics-II	ID6L005	3-0-0	3	3
Natural Language Processing	CS6L027	3-0-0	3	3
Dependable Computing	CS6L033	3-0-0	3	3
Complex Networks	CS6L022	3-0-0	3	3
Internet of Things	CS6L024	3-0-0	3	3
Computational Aspects of Smart Grids	CS6L028	3-0-0	3	3
Wireless Sensor Networks	CS6L026	3-0-0	3	3
Sensor Networks	EC4L009	3-0-0	3	3
Fault-Tolerant Systems	CS6L006	3-0-0	3	3
Symbolic Logic and Automated Reasoning	CS4L015	3-0-0	3	3
Web Technology	CS6L011	3-0-0	3	3
Enterprise and Network Forensics	CS6L021	3-0-0	3	3
Cryptography	CS6L005	3-0-0	3	3
Interconnection Networks	EC4L010	3-0-0	3	3
Object Oriented System Design	CS6L025	3-0-0	3	3
Software Testing and Verification	CS6L023	3-0-0	3	3
Theory of Computation	CS6L035	3-0-0	3	3
Software Engineering	CS6L034	3-0-0	3	3
Software Reliability	CS6L003	3-0-0	3	3
Digital Forensics-I	CS6L010	3-0-0	3	3
Digital Forensics-II	CS6L020	3-0-0	3	3
Advanced Databases and Mining	CS6L017	3-0-0	3	3
Artificial Intelligence	CS6L019	3-0-0	3	3
Game Theory	CS6L031	3-0-0	3	3
Image and Video Processing	EC6L002	3-1-0	4	4
Information Theory and Coding	EC6L003	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

Curricula-Component Weights

Components		Proposed Curricula			
		MTech (CSE)		MTech (CSE) Dual-4th and 5th Years	
		Cr.	%	Cr.	%
Core		12	15%	12	14%
Elective		20/21	24-25%	15-20	18-24%
Lab		6	7%	6	7%
Misc	i. Seminar ii. Project iii. Thesis iv. Training	44	54%	48	53-57%
Breadth		NIL	NIL	3/4	4-5%
Total		82/83		84-90	

Project: Part 1

Subject Code: CS4D001	Name: Project: Part I	L-T-P: 0-0-6	Credit: 4

Project: Part 2

Subject Code: CS4D002	Name: Name: Project: Part II	L-T-P: 0-0-9	Credit: 6

Thesis: Part 1

Subject Code: CS6D002	Name: Thesis: Part I	L-T-P: 0-0-0	Credit: 12

Thesis: Part 2

Subject Code: CS6D004	Name: Thesis: Part II	L-T-P: 0-0-0	Credit: 13

Compliance Report for Dual Degree B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science and Engineering)

Category	Dual Degree Curriculum (Requirement)		Proposed Dual Degree (CSE) Curriculum
	Subjects	Credits	Credits
Semester I to VI (Theory + Lab + Electives+ Other)	Semester I to VI should be same as B.Tech CSE curriculum		All courses of Semester I-VI of B.Tech (CSE) curriculum with total credits of 138/145

Semester VII to X Theory (Core, Breadth-4, Industrial Training Defense) • Compiler Design • Advanced Algorithms • Networks and Systems Security • Industrial Training Defense • Cloud Computing • High performance Computer Architecture • Breadth-4	All compulsory courses of B.Tech (CSE) Semester VII and VIII, and all M.Tech (CSE) core theory courses)		All compulsory courses of B.Tech (CSE) Semester VII and VIII, and all M.Tech (CSE) core theory courses) with total credits of 25/26
Semester VII to X Lab Courses • Computer Systems Lab • Compiler Design Lab • Security & Forensics Lab-I/ML & DA Lab-I • Security & Forensics Lab-II/ML & DA Lab-II	To include all compulsory labs of B.Tech CSE semester VII and VIII, and all compulsory M.Tech labs		All compulsory labs of B.Tech (CSE) Semester VII and VIII, and all compulsory M.Tech labs with total credits of 8/8
Semester VII to X Electives	4 Elective courses		12/13
1. B.Tech Project	Part-I (Semester VII) Part-II (Semester VIII)	4 6	4 6
2. M.Tech Project/Thesis	Part-I (Semester IX) Part- II (Semester X)	12 13	12 13
Research Review (Semester IX) Equivalent to MTech Research			4

Review-1			
Total		220/225	221/231

Syllabus of Dual Degree B. Tech. (Computer Science and Engineering) and M.Tech. (Computer Science and Engineering)

Common Core:

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

Prerequisite: None

Syllabus: Digital computer fundamentals, concepts of algorithms and introduction to programming – examples; Constants and variables – data types, operators and expressions - type conversions, types of expressions; Assignment statements, input-output statements - concepts of data formats; Control statements: branching – if-else statements; iteration – while, do-while, for statements. nested control structures, switch, break and continue statements; Functions and recursion – examples; concepts of parameter passing by values and by reference; Arrays – single and multidimensional, examples – searching and sorting; Introduction to pointers, character strings and arrays, pointers and arrays; Structures, linked lists, dynamic allocation, stacks and queues, binary trees and tree traversals; Data files – creating, opening, closing and operating data files; (The programming language C to be used as the basis language).

Text Books:

1. B. Gottfried, “Schaum’ s Programming with C,” Tata McGraw-Hill.
2. E. Balaguruswamy, “Programming in ANSI C,” Tata McGraw-Hill.
3. Y. Kanetkar, “Let us C,” BPB Publications.
4. S. Lipschutz, “Data Structures, Schaum’s Outlines Series,” Tata McGraw-Hill.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, “The C Programming Language,” Prentice Hall of India.
2. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, “Fundamentals of Data Structures in C,” W. H. Freeman and Company.

Lateral Subjects

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

Prerequisite: None

Syllabus: 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).

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

Prerequisite: None.

Syllabus: 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

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: 3-1-0	Credit: 4

Prerequisite: None.

Syllabus: 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.

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.

Vertical Theory (Core)

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

Prerequisite: None

Syllabus: 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.

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: CS2L004	Name: Data Structures	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structure

Syllabus: 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.

Text book:

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

Prerequisite: Programming and Data Structure, Data Structure

Syllabus: 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.

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:

1. Sara Baase and Allen Van Gelder. Computer Algorithms: Introduction to Design and Analysis, Pearson education (Singapore) Pvt. Ltd, New Delhi 2007.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman.. The Design and Analysis of Computer Algorithms, Pearson Education (Singapore) 2006.
3. 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

Prerequisite: None

Syllabus: 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.

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

Prerequisite: Digital Electronic Circuits

Syllabus: 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.

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

Prerequisite: None

Syllabus: 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.

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

Prerequisite: None

Syllabus: 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.

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

Prerequisite: None

Syllabus: 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.

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

Prerequisite: Programming and Data Structure

Syllabus: 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.

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.

Subject Code: CS6L007	Subject Name: Advanced Algorithms	L-T-P: 3-1-0	Credits: 4

Prerequisite: None

Syllabus: Models of computation: RAM model, Asymptotic Complexity, Amortized complexity.

Algorithmic paradigms: divide and conquer, recursion, dynamic programming, greedy, branch and bound, backtracking.

Randomized algorithms: Randomized algorithms for Binary Search Tree, Quick Sort, Quick Select etc.

Graph Algorithms: Shortest Path, Spanning Tree, Maximum Flows: Augmenting Paths and Push-Relabel Methods. Minimum Cost Flows. Bipartite Matching.

Reducibility between problems and NP-completeness: discussion of different NP-complete problems like satisfiability, clique, vertex cover, independent set, Hamiltonian cycle, TSP, knapsack, set cover, bin packing, etc.

Approximation algorithms: Constant ratio approximation algorithms, PTAS, FPTAS.

Geometric algorithms: Convex hulls, Closest pair of points, Voronoi diagram, etc.

Algebraic and number-theoretic algorithms: FFT, primality testing, etc.

Optimization techniques: Linear programming

Text books:

1. Thomas H. Cormen, Charles E. Leiserson, R.L. Rivest.. Introduction to Algorithms, Prentice Hall of India Publications.
2. Algorithm Design by Kleinberg and Tardos, Pearson.

Reference books:

1. Sara Baase and Allen Van Gelder. Computer Algorithms: Introduction to Design and Analysis, Pearson education (Singapore) Pvt. Ltd, New Delhi 2007.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman.. The Design and Analysis of Computer Algorithms, Pearson Education (Singapore) 2006.
3. Algorithmics: Theory and Practice by Brassard and Bratley, Prentice Hall.
4. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press.
5. Vijay Vazirani, Approximation Algorithms, Springer.
6. Merc De-Berg eta al. Computational Geometry: Algorithms and Applications, 3rd Edition, Springer.

Subject Code: CS6L002	Subject Name: Networks and Systems Security	L-T-P: 3-0-0	Credits: 3

Prerequisite: operating systems, computer network, programming, and information security

Syllabus:

Introduction to Networking principles: Introduction to networking, datalink layer, network layer and transport layer protocols, DNS, mail servers, web servers, peer to peer network Security, wireless communication protocol. Overview of System Security: Exploiting bugs in programs. Buffer overflows, fuzzing, Certification, secure socket layer (SSL), Kerberos, SQL injection, concepts of vulnerability, risk management, worm, virus, malwares, IDS, anti-viruses. Basics of Cryptography: Basic cryptography and techniques, block ciphers, message authentication, symmetric key encryption, hash functions, public key encryption, digital signatures. Data Privacy: Privacy changing online, mathematical definitions of privacy, attacks on privacy and anonymity, K-anonymity, Differential privacy, Private information retrieval, basics of multiparty computation and relationship to privacy. Network Security: Access control, stateful firewall, IPSec, modeling and analysis of various security violation in wireless and sensor networks, trusted computing techniques, ARP Poisoning, IP spoofing, hidden tunnels, denial of service attack, firewalls.

Text books:

1. *Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.*
2. *Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn IdoDubrawsky, Steve W.Manzuik and Ryan Permeh, Wiley Dreamtech.*

Reference books:

1. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning.
2. Network Security- Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.
3. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
4. Principles of Information Security, Whitman, Cengage Learning

Subject Code: CS6L008	Subject Name: Cloud Computing	L-T-P: 3-0-0	Credits: 3

Prerequisite: operating systems, computer network

Syllabus:

Enabling Technologies and System Models for Cloud Computing, Introduction to Cloud Computing including benefits, challenges, and risks, Cloud Computing Models including Infrastructure/Platform/Software – as-a-service, Virtualization concepts: Types of virtualization and its benefits, Virtualization operating systems, Virtual Machine migration, Public cloud, private cloud and

hybrid clouds, Cloud OS, Cloud Architectures including Federated Clouds, Scalability, Performance, QoS, Data centers for Cloud Computing, Principles of Virtualization platforms, Security and Privacy issues in the Cloud, VMWare ESX Memory Management, Capacity Planning and Disaster Recovery in Cloud Computing

Text books:

1. Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing: by Haley Beard

Reference books:

1. Cloud computing Black Book: by Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, and Deven Shah

Subject Code: CS6L009	Subject Name: High Performance Computing Architecture	L-T-P: 3-1-0	Credits: 4

Prerequisite: Computer Organization and Architecture

Syllabus: Introduction: review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors. Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling. Pipeline optimization techniques. Compiler techniques for improving performance. Hierarchical memory technology: Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies. Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, superpipelined and VLIW processor architectures. Array and vector processors. Multiprocessor architecture: taxonomy of parallel architectures. Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures. GPU architectures: NVIDEA and AMD architectures, gem5 and GPGPU-sim simulators, GPU Computing: CUDA and OpenCL programming with case studies.

Text books:

1. John L. Hennessy and David A. Patterson, Computer Architecture -- A Quantitative Approach, Morgan Kaufmann
2. David Patterson and J.L. Hennessy, Computer Organization and Design MIPS: The hardware/software interface
3. Benedict Gaster, Lee Howes, David R. Kaeli, Heterogeneous Computing with OpenCL, Elsevier

Reference books:

1. P. Pacheco, Parallel Programming with MPI, Elsevier
2. Shane Cook, CUDA programming, Morgan Kaufmann

Laboratory Courses

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

Prerequisite: Programing and Data Structures

Syllabus: 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.

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.

Subject Code: CS2P002	Name: Data Structure Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite: Programing and Data Structures

Syllabus: 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.

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.

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

Prerequisite: Data Structures

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.]

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):

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

Prerequisite: Digital Electronics

Syllabus: 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.

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.

Reference Books

1. John P. Hayes, Computer Architecture and Organization, McGraw Hill.
2. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education.
3. Vincent P. Heuring and Harry F. Jordan, Computer Systems Design and Architecture, Pearson Education.

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

Prerequisite: None

Syllabus: 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.

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

1. Gary J. Nutt, Operating Systems: A Modern Perspective, Addison-Wesley.

2. Maurice Bach, Design of the Unix Operating Systems, Prentice-Hall of India.
3. Daniel P. Bovet, Marco Cesati, Understanding the Linux Kernel, O'Reilly and Associates.

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

Prerequisite: None

Syllabus: 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.

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

Prerequisite: None

Syllabus: 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.

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

Prerequisite: Formal Language and Automata Theory

Syllabus: 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).

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

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

Code: CS6P002	Name: Security and Forensics Lab-I	L-T-P:0-0-3	Credits: 2

Prerequisite: Computer Networks, Programming and Data Structures

Syllabus: Experiments related to Digital Signatures and MITM attacks; Hashing, password cracking, and biometrics, Memory Corruption Exploits: Buffer overflows, Format string attacks, Code injection attacks, Heap-spraying, Memory Protection with Page guards, SQL injection, XSS, Cross-site scripting and CSRF attacks, Bit-Torrent File Sharing, Torrent Attacks, Botnets, Malware Detection and Forensics

IP Spoofing, Sniffing, SYN Flooding and DoS Attacks using Wireshark, TCPDump and Smurf Tools, Stateful Firewalls, Network Intrusion Detection, Honeypots Penetration Testing Tools, Null-pointer dereference, code integrity, system call filters, Sandboxing Security and Forensics Tools: BitTorrent, Sleuthkit, WinHex

Text books:

1. William Stallings, Lawrie Brown, Computer Security - Principles and Practice, Addison Wesley Professional, 2008

Reference Books:

1. Introduction to Computer Networks and Cybersecurity, Chwan-Hwa (John) Wu, J. David Irwin, CRC Press, Edition 2013

Code: CS6P003	Name: Machine Learning and Data Analytics Lab-I	L-T-P:0-0-3	Credits: 2

Prerequisite: None

Syllabus: Softwares: Matlab/R/Python, Weka

Implementation of Clustering, Classification and Regression Algorithms

SVM toolboxes: SVMlight, SVMtorch etc

Deep Learning platforms: Tensorflow/Caffe/Theano, implementation of popular architectures related to CNN, RNN, LSTM, Auto-encoder etc

Implementation of Time Series clustering and alignment algorithms

Text Books

1. R.P. Deng, R Programming for Data Science, (https://leanpub.com/rprogramming)
2. J. Verzani, Using R for Introductory Statistics, Chapman & Hall/CRC .

Reference Books:

1. H. Wickham, Advanced R, Chapman & Hall/CRC.
2. P.K. Janert, Data Analysis with Open Source Tools: A Hands-On Guide for Programmers and Data Scientists, O' Reilly
3. Dan Van Boxel, Hands-On Deep Learning with TensorFlow

4. Deron A., Hands-on Machine Learning with Scikit-learn and Tensorflow, O'Reilly

Code: CS6P004	Name: Security and Forensics Lab-II	L-T-P:0-0-3	Credits: 2

Prerequisite: Security and Forensics Lab-I

Syllabus: Experiments related to Hard drive acquisition, searching evidence, email analysis lab, Hash analysis lab, Recycle bin analysis, Parsing FAT, Parsing NFTS, Tracking Activity, Malware Analysis, Thumbnail cache analysis, Live/Online forensics, Reverse Engineering,

Forensics Tools: Sleuthkit, Splunk, FireWalk, Windows Forensics Toolchest (WFT), Computer Online Forensic Evidence (COFE).

Text Books

1. Davis, Philipp, and Cowen, Hacking Exposed: Computer Forensics, Second Edition, McGraw-Hill Education

Reference Books:

1. H. Carvey, Windows Forensics Analysis DVD Toolkit, Syngress publishers

Code: CS6P005	Name: Machine Learning and Data Analytics Lab-II	L-T-P:0-0-3	Credits: 2

Prerequisite: Machine Learning and Data Analytics Lab-I

Syllabus: Probabilistic Modeling Toolboxes: GMM, HMM, MRF/CRF etc

Implementation of Topic Modeling Algorithms, Topic Modeling toolboxes

Implementation of Online learning and Reinforcement Learning algorithms

Text Books

1. Murphy, K., Machine Learning: A Probabilistic Perspective, MIT Press, 2012

Reference Books:

1. Blei, D. (2014). Build, compute, critique, repeat: Data analysis with latent variable models. Annual Review of Statistics and Its Application, 1:203–232.

Subject Code: CS6P001	Name: Computer Systems Lab	L-T-P:0-0-3	Credits: 2

Prerequisite: Programming and Data Structures

Syllabus: Object-oriented programming concepts and UML, Implementation of graph algorithms, Randomized and approximation algorithms, Numerical computing algorithms, Basics of System programming: process creation, Inter process communication (IPC), Implementation of scheduling algorithms, synchronization, shared memory and semaphore, shell programming and implementation of file management..

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

1. Systems Analysis and Design: an Object-oriented Approach with UML (5th edition), Alan Dennis, Barbara Haley Wixom, David Tegarden. ISBN-13: 978-1118804674 ISBN-10: 1118804678

Vertical Theory (Elective):

Subject Code: CS4L030	Subject Name: Computational Geometry	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structure, Designing and Analysis of Algorithms

Syllabus: History of Computational Geometry, CG theory, CG in Applications. Basic Euclidean geometry: Plane, space, point, line, half-plane, line segment, intersection, proper intersection, polygon, edges, vertices, circle, and distances. Convexity, convex hull, finding convex hull, development of a slow convex hull algorithm, alternate approaches of convex hull, proof of correctness, computational complexity analysis, divide-and conquer approach, convex hull in 3D (convex polyhedron). Map overlay problem, line segment intersection, finding intersection points of n line segments in a plane, input sensitive and output sensitive algorithms, 1D problem, 2D line segment, plane sweep algorithm, data structure for line sweep algorithm, storage and computation complexity of the algorithm, how to deal with degenerate cases. Map overlay problem, subdivision representation, planar subdivision, important components to represent planar subdivision, Euler's formula for planar graph, representing subdivision, doubly connected edge list representation of planar subdivision, map-overlay: plane sweep algorithm, Boolean operations on polygons, complexity of the plane weep algorithm. Triangulation of polygon, Art gallery problem, proof of existence of triangulation, dual graph and 3-coloring, finding minimum number of cameras to monitor a closed

geographical area, y-monotone polygon, segmenting a polygon into y-monotone polygons, a line sweep algorithm, computational complexity, degenerate cases, triangulation of a monotone polygon and its complexity. Smallest closing circles, randomized incremental construction, smallest closing circles with two points, finding the narrowest strip, rotating caslipers algorithm, minimum bounding box, lowest point in circle, separation of set of points (RED BLUE). Range searching, 1-D range query problem, balanced binary search tree representation for 1D range query, computational and storage complexity analysis, range queries in 2D, KD-trees, KD-trees for range query, computational complexity analysis. Planar point locations, trapezoidal decomposition, vertical decomposition and faces, point location solution using vertical decomposition. Voronoi diagrams, construction of Voronoi diagram for a given set of points, plane sweep algorithm for Voronoi diagram construction, data structure to implement the plane sweep algorithm, events during execution of plane sweep algorithm, computational complexity of the algorithm, Voronoi diagram for line segments. Delaunay triangulation, terrains by interpolation, angle vector of triangulation, edge flipping, illegal edges, Thales theorem, legal triangulation, Voronoi diagram and Delaunay graph, planarity of the Delaunay graph, Angle optimality, Applications of Delaunay triangulation, Euclidean MST, Euclidean TSP.

Text books:

2. M. de Berg, M. Van Kreveld, M. Overmars, and O. Schwarzkopf, Computational Geometry: Algorithms and Applications (3rd Edition), Springer, 2008.

Reference books:

1. Computational Geometry Algorithm Library (CGAL): http://www.cgal.org

Subject Code: CS4L010	Subject Name: Computer Graphics	L-T-P: 3-1-0	Credits: 4

Prerequisite: Programming and Data Structure, Designing and Analysis of Algorithms

Syllabus: Graphics display devices, Input devices, Rendering pipeline, Raster Graphics: Line and Circle drawing algorithms, Windowing, Clipping: Cohen and Sutherland line clipping, Cyrus-beck clipping method, 2D and 3D Geometrical Transformations, Viewing Transformations: parallel and perspective projection, Curves and Surfaces: Cubic splines, Bezier curves, B-splines, Tensor product surfaces, Surface of revolution Sweep surfaces, Fractal curves and surfaces, Hidden line/surface removal methods, Illumination model, Polygon Shading: Gouraud, Phong, Introduction to Ray-tracing, Animation.

Graphics Programming: Getting started with OpenGL, Input and Interaction in OpenGL, Geometrical Objects and Transformations in 2D and 3D, homogeneous coordinates, matrix representation, windows and viewports, Viewing in 3D, projections, hidden surface removal, Light, shading and materials. Illumination and Shading, light sources, (surface detail, ray tracing, radiosity), and possibly one or more from the following in less detail: From Vertices to Fragments: modeling, geometry

processing, rasterization, fragment processing. Clipping, hidden surface removal, antialiasing. Discrete techniques: buffers, bit and pixel operations, texture mapping, compositing. Programmable shaders: OpenGL shading language, fragment shaders, cub and bump maps. Modelling Techniques, trees, scene graphs. Curve and surface representation Advanced rendering techniques: ray tracing, radiosity, image based rendering.

Text books:

1. Donald Hearn, M. Pauline Baker, Computer Graphics, 2nd edition, C version, Prentice Hall, 1996.
2. James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, Computer Graphics : Principles & Practices, Addison Wesley Longman, 2nd edition in C, 1994

Reference books:

1. Computational Geometry Algorithm Library (CGAL): http://www.cgal.org
2. M. de Berg, M. Van Kreveld, M. Overmars, and O. Schwarzkopf, Computational Geometry: Algorithms and Applications (3rd Edition), Springer, 2008.

Subject Code: EC6L029	Subject Name: Computer Vision	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structure

Syllabus: Introduction to computer vision, fundamentals of image formation, camera imaging geometry. Filtering, Image Representations, and Texture Models, Color Vision, Multi-view Geometry, Projective Reconstruction, Bayesian Vision; Statistical Classifiers, Clustering & Segmentation; Voting Methods, Tracking and Density Propagation, Visual Surveillance and Activity Monitoring, Medical Imaging, Image Databases, Image-Based Rendering.

Feature detection and matching, stereo, motion estimation and tracking, image classification, scene understanding, and deep learning with neural networks. Basic methods for applications , finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment, tracking, boundary detection, and recognition. Intuitions and mathematics of vision algorithms.

Text books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

Reference books:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

Subject Code: CS6L013	Subject Name: Multimedia Systems	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structures

Syllabus: Fundamentals of multimedia, media and data streams, sound/audio, image, graphics, video and animation. Topics in data compression including coding requirements, source, entropy, and hybrid coding, JPEG, H.261 (px64), MPEG, MP3 and etc. Computer technology issues such as communication architecture, multimedia workstations, cache systems, storage systems and optical storage. Multimedia operating system issues such as real-time operation, resource management, process management, file systems, and Multimedia networking. Multimedia synchronization, presentation requirements, reference model, and synchronization techniques. Multimedia database issues such as data organization, indexing and retrieval. Multimedia applications including digital libraries, system software, toolkits, conferencing paradigms, structured interaction support, and examples from video/audio/graphics conferencing. Latest Web technologies, such as XML, X3D and Semantic Web.

Text books:

1. Fundamentals of Multimedia, Ze-Nian Li, and Mark S. Drew, Pearson Prentice Hall, October 2003.

Reference books:

1. Multimedia Database Management Systems", B. Prabhakaran, Kluwer Academic publishers.

Subject Code: CS6L015	Subject Name: Mathematical Foundations of Computer Science	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Discrete Structures -- Sets, Relations and Functions; Algebraic Structures, Morphisms, Lattices and Boolean Algebras. Logic -- Propositional calculus and Predicate Calculus, Satisfiabiliy and validity, Soundness and completeness Languages & Automata Theory -- Chomsky Hierarchy of Grammars and language acceptors, Turing Machines, Recursive and Recursively Enumerable Languages Computability -- Church-Turing Thesis,

Decision Problems, Decidability and Undecidability, Halting Problem of Turing Machines Computational Complexity -- Time Complexity, The class P, The class NP, NP-Completeness, Reduction, co-NP, Polynomial Hierarchy. Space Complexity -- Savich's Theorem, The class PSPACE.

Text books:

1. J.P. Trembley and R. Manohar -- Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Book Co.
2. John E. Hopcroft, Motwani and J.D.Ullman -- Inrtroduction to Automata Theory, Languages and Computation, Narosa Pub. House, N. Delhi.
3. R.L. Graham, D. Knuth, O. Patashnik, Concrete Mathematics: A foundation to Computer Science, Addison Wesley

Reference books:

1. Michael Sipser -- Introduction to the Theory of Computation, Thomson Course Technology.
2. H.R. Lewis and C.H.Papadimitrou -- Elements of the Theory of Computation, Prentice Hall International.

Subject Code: CS6L016	Subject Name: VLSI Circuits	L-T-P: 3-0-0	Credits: 3

Prerequisite: Introduction to Electronics**,** Digital Electronics Circuit

Syllabus: Introduction: Design hierarchy, layers of abstraction, integration density and Moore's law, VLSI design styles, packaging styles, design automation principles; Fabrication Technology: Basic steps of fabrication, bipolar, CMOS and Bi-CMOS fabrication processes, layout design rules; MOS and Bi-CMOS characteristics and circuits: MOS transistor characteristics, MOS switch and inverter, Bi-CMOS inverter, latch-up in CMOS inverter, super-buffers, propagation delay models, switching delay in logic circuits, CMOS analog amplifier; Logic Design: switch logic, gate restoring logic, various logic families and logic gates, PLA; Dynamic Circuits: Basic concept, noise considerations, charge sharing, cascading dynamic gates, domino logic, clocking schemes; Sequential Circuits: Basic regenerative circuits, bi-stable circuit elements, CMOS SR latch, clocked latch and flip-flops; Low-power Circuits: low-power design through voltage scaling, estimation and optimization of switching activity, reduction of switched capacitance, adiabatic logic circuits; Subsystem Design: design of arithmetic building blocks like adders, multipliers, shifters, area-speed-power tradeoff; Semiconductor Memories: SRAM, DRAM, non-volatile memories; Bipolar ECL Inverter: Features of ECL gate, logic design in ECL, single-ended and differential ECL gates; Testability of VLSI: Fault models, scan-based techniques, BIST, test vector generation; Physical Design: Brief ideas on partitioning, placement, routing and compaction.

Text Books:

1. CMOS VLSI Design: A Circuits and Systems Perspective, 4e, Neil Weste, David Harris, Pearson.
2. S. Kang and Y Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design," 3rd Ed., Tata McGraw Hill, New Delhi, 2003.
3. J. P. Uyemura, "Introduction to VLSI circuits and Systems," John Wiley, New Delhi, 2002.

Reference Books:

1. L Wang, C.Wu and X. wen, VLSI Test Principles and Architecture, Morgan Kaufmann, San Francisco, 2006.

Subject Code: EC4L008	Subject Name: Embedded Systems	L-T-P: 3-0-0	Credits: 3

Prerequisite: Digital Electronics**,** Computer Organization and Architecture

Syllabus: Embedded Processing Systems: Introduction, Components of Embedded Systems – Embedded Processor, Microcontrollers (PIC and ARM architectures), DSP and ASICs and SoC, Memory Devices: ROM and RAM family, Interfacing Memory, Simple I/O programming, Interrupts and their servicing, Timing Devices and Interfacing, Analog I/O Techniques, Introduction to HDL, Design of Embedded Processors and Components, Design Case Studies, Embedded Communication: Parallel Bus Standards, Serial Bus Standards, Networking Standards and Wireless Standards, Real Time Operating Systems (RTOS): Introduction, Memory Management, I/O Management and Device Drivers, Scheduling, Introduction to Software Design: Embedded System Life Cycle, Multicore and Heterogeneous Embedded Systems.

Text books:

1. W. Wolf, Computers as Components: Principles of Embedded Computing System Design, 2nd Ed., Burlington, 2008.
2. T Noergaard, Embedded Systems Architecture: A comprehensive Guide for Engineers and Prgrammers, Elsevier,Oxford, 2005.

Reference books:

1. Steve Heath, Embedded System Design, 2nd Edition, Newnes, Burlington, 2003.

Subject Code: EC3L003	Subject Name: Digital Signal Processing	L-T-P: 3-1-0	Credits: 4

Prerequisite: Signals and Systems

Syllabus: Introduction to DSP, Signals and Systems Characterization, FIR and IIR : Recursive and Non Recursive, Z-Transform, Discrete Time Signals and Systems in Frequency Domain, Sampling, Quantization, Discrete Fourier Transform, Fast Fourier Transform, Short-time Fourier Transform,

Digital Filter Structure, Analog Filter Design, Digital Filter Design.

Text books:

1. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications, 4th Ed., Pearson, 2012.
2. A. V. Oppenheim and R. W. Shafer, “Discrete-Time Signal Processing,” Prentice Hall, 2009.

Reference books:

1. R. G. Lyons, “Understanding Digital Signal Processing,” 3rd Ed., Prentice Hall, 2010.
2. V. K. Ingle and J. G. Proakis, “Digital Signal Processing using MATLAB,” Thomson Learning, 2000.

Subject Code: EC4L007	Subject Name: Mobile Computing	L-T-P: 3-0-0	Credits: 3

Prerequisite: Computer Networks

Syllabus: Introduction to mobile computing highlighting requirements for design of mobile applications. Computational model and distributed algorithms for mobile environment. Mobility management including handoff, location management and IP mobility Cellular wireless communication, FDMA, TDMA, CDMA, MAC protocols. Wireless LAN, Personal Area Wireless Network: Bluetooth, and zigbee. A hoc and sensor networks. Data delivery models, broadcast disks, and application of caching for speeding up data dissemination and delivery. Distributed file system and indexing techniques for mobile environment. Mobile Agent System.

Text books:

1. T. Rappaport, "Wireless Communication: Principles and Practice", Pearson Education.
2. Paolo Bellavista and Antonio Corradi (Eds.), "Handbook of Mobile Middleware", Auerbach Publication.

Reference books:

1. Reza B'Far (Ed), "Mobile Computing Principles", Cambridge University Press.

Subject Code: CS4L005	Subject Name: Applied Graph Theory	L-T-P: 3-0-0	Credits: 3

Prerequisite: Discrete Structure

Syllabus: Introduction, Paths and Cycles, Trees and Distances, Matching and Covering, Connectivity and Flow, Coloring, Planarity.

Text books:

3. Introduction to Graph Theory, by Douglas B. West.

Reference books:

4. Graph Theory, by Reinhard Diestel.
5. Modern Graph Theory, by Bela Bollobas.
6. Graph Theory with Applications, by J. A. Bondy and U. S. R. Murty.

7.			
Subject Code: CS4L029	Subject Name: Principles of Programming Languages	L-T-P: 3-0-0	Credits: 3

Prerequisite: Data Structures, and Computer Architecture.

Syllabus: Theory: The aim is to study and appreciate different types of languages and the underlying mathematical theories. This may help to design and also to appreciate new language features.

Introduction: Overview of different programming paradigms e.g. imperative, object oriented, functional, logic and concurrent programming.

Syntax and semantics of programming languages: A quick overview of syntax specification and semiformal semantic specification using attribute grammar.

Imperative and OO Languages: Names, their scope, life and binding. Control-flow, control abstraction; in subprogram and exception handling. Primitive and constructed data types, data abstraction, inheritance, type checking and polymorphism.

Functional Languages: Typed-calculus, higher order functions and types, evaluation strategies, type checking, implementation, case study.

Logic Programming Languages: Computing with relation, first-order logic, SLD-resolution, unification, sequencing of control, negation, implementation, case study.

Concurrency: Communication and synchronization, shared memory and message passing, safety and liveness properties, multithreaded program.

Formal Semantics: Operational, denotational and axiomatic semantics of toy languages, languages with higher order constructs and types, recursive type, subtype, semantics of nondeterminism and concurrency.

Text books:

1. Ravi Sethi, Programming Languages: Concepts and Constructs, Addison-Wesley.
2. H. P. Barendregt, The Lambda Calculus: Its Syntax and Semantics, North-Holland.
3. Michael Scott, Programming Language Pragmatics, Morgan Kaufmann, 2000.
4. Tennant. Principles of Programming Languages, PHI, 1981.

Reference books:

1. Glynn Winskel, A Formal Semantics of Programming Languages: An Introduction, MIT Press.
2. John C. Mitchell, Foundations for Programming Languages, MIT Press.
3. Benjamin C. Pierce, Types and Programming Languages, MIT Press.
4. Daniel P. Friedman, Mitchell Wand and Christopher T. Haynes, Essentials of Programming Languages, Prentice Hall of India.

Subject Code: CS6L012	Subject Name: Complexity Theory	L-T-P: 3-0-0	Credits: 3

Prerequisite: Formal Languages and Automata Theory

Syllabus: Models of computation, resources (time and space), algorithms, computability, complexity; complexity classes, P/NP/PSPACE, reductions, hardness, completeness, hierarchy, relationships between complexity classes; Randomized computation and complexity; Logical characterizations, incompleteness; approximability; circuit complexity, lower bounds; parallel computation and complexity; counting problems; interactive proofs; probabilistically checkable proofs; communication complexity; Quantum computation.

Text books:

1. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
2. John E. Hopcroft and Jeffrey D. Ullman, Introduction to Automata, Languages and Computation, Addison-Wesley, 1979.

Reference books:

1. J. Balcazar, J. Diaz, and J. Gabarro, Structural Complexity, Volumes I and II, Springer.
2. Christos H. Papadimitriou, Computational Complexity, Addison-Wesley Longman.
3. Sanjeev Arora and Boaz Barak, Computational Complexity: A Modern Approach

Subject Code: CS6L032	Subject Name: Parallel and Distributed Algorithms	L-T-P: 3-0-0	Credits: 3

Prerequisite: Design and Analysis of Algorithms / Advanced Algorithms

Syllabus: Parallel Algorithms: Parallel Programming Models: Shared-memory model (PRAM, MIMD, SIMD), network model (line, ring, mesh, hypercube), performance measurement of parallel algorithms.

Algorithm Design Techniquess for PRAM Models: Balancing, divide and conquer, parallel prefix computation, pointer jumping, symmetry breaking, pipelining, accelerated cascading.

Algorithms for PRAM Models: List ranking, sorting and searching, tree algorithms, graph algorithms, string algorithms.

Algorithms for Network Models: Matrix algorithms, sorting, graph algorithms, routing, Relationship with PRAM models.

Parallel Complexity: Lower bounds for PRAM models, the complexity class NC, P-completeness.

Distributed Algorithms:

Basic concepts. Models of computation: shared memory and message passing systems, synchronous and asynchronous systems.

Logical time and event ordering. Global state and snapshot algorithms, clock synchronization.

Distributed Operating Systems: Mutual exclusion, deadlock detection

Classical Algorithms: Leader election, termination detection, distributed graph algorithms.

Fault tolerance and recovery: basic concepts, fault models, agreement problems and its applications, commit protocols, voting protocols, checkpointing and recovery, reliable communication.

Security and Authentication: basic concepts, Kerberos. Resource sharing and load balancing.

Text books:

1. Joseph F Jájá, An Introduction to Parallel Algorithms, Addison-Wesley, 1992.
2. Mukesh Singhal and Niranjan Shivaratri, Advanced Concepts in Operating Systems, McGraw-Hill.

Reference books:

1. Michael J Quinn, Parallel Computing: Theory and Practice, second edition, McGraw Hill, 1994/2002.
2. Michael J Quinn, Parallel Programming in C with MPI and OpenMP, first edition, McGraw Hill, 2004/2003.

3. Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, Introduction to Parallel Computing, second edition, Addison-Wesley/Pearson, 1994/2003.
4. Nancy Lynch, Distributed Algorithms, Morgan Kaufmann.
5. Andrew S. Tanenbaum, Distributed Operating Systems, ACM Press.
6. Jie Wu, Distributed Systems, CRC Press.
7. Hagit Attiya, Jennifer Welch, Distributed Computing: Fundamentals, Simulations and Advanced Topics, McGraw-Hill.

Subject Code: CS4L012	Subject Name: Data Mining	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction: Prediction, Classification, Forecasting, Filtering, Regression, Clustering. Data Exploration and Pre-processing: Data Objects and Attributes; Statistical Measures, Visualization, Data Cleaning and Integration. Dimensionality reduction: Principal Component Analysis. Classification: Nearest-neighbor and Decision Tree. Regression: Linear and Ridge Regression. Clustering: K-means; agglomerative clustering; density-based clustering. Association Analysis: Frequent Itemset Generation and Rule Generation; Apriori Algorithm. Time Series Analysis: Time Series clustering, Time series alignment, Dynamic Time Warping; Discrete Sequence Mining. Introduction to Optimization: Newton-Raphson; Gradient-Descent; constrained optimization. Information Retrieval: Precision, Recall, True/False Positives and negatives. Graph-theoretic Approaches: social and complex networks, community detection.

Text books:

1. Duda, Hart, Stork. "Pattern Classification", Wiley
2. Tan, Steinbach, Kumar. "Introduction to Data Mining", Pearson
3. Charu Aggarwal. "Data Mining", Springer, 2015

Reference books:

Subject Code: ID6L004	Subject Name: Machine Learning and Data Analytics-I	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction: Prediction, Classification, Forecasting, Filtering, Regression, Clustering. Review of Linear Algebra, Probability and Statistics. Data Exploration and Pre-processing: Data Objects and Attributes; Statistical Measures, Visualization, Data Cleaning and Integration. Dimensionality Reduction: Linear Discriminant Analysis; Principal Component Analysis; Transform Domain and Statistical Feature Extraction and Reduction. Regression: Least Mean Square Regression; Ridge Regression and LASSO regression; Support Vector Regression. Clustering: K-Means, Hierarchical, and

Density-based Clustering, Spectral Clustering. Classification: K-nearest-neighbor, Bayesian and Naïve Bayes Classifier, Decision Tree Induction including Attribute Selection, and Tree Pruning, Random Forests, Logistic Regression; Support Vector Machine; Ensemble Classification including Adaboost. Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation Learning, Functional Link Artificial Neural Network, and Radial Basis Function Network, Recurrent Neural Networks, Deep Learning, Convolutional Neural Networks.

Text books:

1. Bishop, C., "Pattern Recognition and Machine Learning", Springer, 2006.
2. Mitchell, T. "Machine Learning", 1997 (freely available online)
3. Duda, Hart, Stork. "Pattern Classification". Wiley
4. Daumé, H. III, "A Course in Machine Learning", 2015 (freely available online).
5. Haykin S., "Neural Networks and Learning Machines", Third Edition, Prentice Hall, 2008.
6. Goodfellow I.,Bengio Y. and Courville A.; "Deep Learning", MIT Press, 2016

Reference books:

1 Hastie, T., R. Tibshirani, J. Friedman, "The Elements of Statistical Learning", Springer 2009 (freely available online).

2 Shai Shalev-Shwartz and Shai Ben-David. "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014

Subject Code: ID6L005	Subject Name: Machine Learning and Data Analytics-II	L-T-P: 3-0-0	Credits: 3

Prerequisite: MLDA-I

Syllabus: Probability-based Machine Learning: Review of statistics; Parameter Estimation by Maximum-Likelihood and Bayesian approach; Probabilistic classification and PCA; Random Projections. Generative Models: Bayesian and Markov Networks; Hidden Markov Model; Markov Random Fields; EM Algorithm; Probabilistic inference – Metropolis-Hastings Algorithm, Gibbs Sampling. Topic Models: PLSI, Latent Dirichlet Allocation, HMM-LDA, modern variants. Introduction to Bayesian Nonparametrics: Chinese Restaurant Process and variants, Indian Buffet Process, Dirichlet Process, Gaussian Process. Online Algorithms: Online Clustering, online learning, Frequent Itemset mining on streaming data. Reinforcement Learning: Markov Decision Processes, and Q-Learning. Learning Theory: PAC Learning, Sample Complexity and VC Dimension, and Structural Risk Minimization. Spectral Methods. Applications to Vision, text, climate, finance domains.

Text books:

1. Bishop, C., "Pattern Recognition and Machine Learning", Springer, 2006.
2. Murphy, K., "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

3. Koller D. and Friedman N.: "Probabilistic Graphical Models: Principles and Techniques", MIT Press, 2009

Reference books:

1. Montgomery, D. C., and G. C. Runger, "Applied Statistics and Probability for Engineers". John Wiley & Sons, Sixth Edition, 2013.
2. Shai Shalev-Shwartz and Shai Ben-David. "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014

Subject Code: CS6L027	Subject Name: Natural Language Processing	L-T-P: 3-0-0	Credits: 3

Prerequisite: MLDA-1 or Data Mining

Syllabus: NLP tasks in syntax, semantics and pragmatics; Applications such as information extraction, question answering, and machine translation, The problem of ambiguity, The role of machine learning, brief history of the field POS-tagging, POS-tagging perspective, POS tagging and HMM, Hidden Markov models (Forward and Viterbi algorithm and EM training), POS-tag set, Machine translation, Parsing algorithms, Probabilistic parsing, Parser Comparison Grammar, constituency and dependency, CYK algorithm, Parse tree construction, Semantics, Word sense disambiguation Knowledge based and supervised WSD, Unsupervised EM based WSD, Multilingual Resource constrained WSD Linear and logistic Regression, Machine translation, Statistical Machine translation, Binding Theory and Merger, X-bar theory

Text books:

1. James Allen, "Natural Language Understanding"
2. Benjamin/Cummins E. Charniack, "Statistical Language Learning", MIT Press
3. Daniel Jurafsky and J.H. Martin, "Speech and Language Processing", Prentice Hall

Reference books:

1. H. Lane, H. Hapke, C. Howard, "Natural language processing in Action: Understanding, analyzing, and generating text with Python", Manning publications.
2. B. Bengfort, R. Bilbro, "Applied Text Analysis with Python: Enabling Language Aware Data Products with Machine Learning", O"Reilly

Subject Code: CS6L033	Subject Name: Dependable Computing	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction to dependable computing; Fault, error, failure, dependability, and reliability. Combinatorial and state-space modeling; combinatorial and non-combinatorial languages; Redundancy. Hardware Fault Tolerance; Circuit Testing. Software Fault Tolerance: Checkpoints and Recovery. Error Control codes: Parity bits, checksums, Cyclic Redundancy Checks, Algebraic Codes; codes for bus systems, memory and disc. Dependability of distributed Systems: Byzantine problem, dependability of storages and networks; recovery and atomic transactions in concurrent and distributed systems

.**Text books:**

1. S. Lin and D.J. Costello, *Error Control Coding* (2nd edition), Prentice-Hall, 2004.
2. Pankaj Jalote, "Fault Tolerance in Distributed Systems" (Prentice Hall)

Reference books:

1. Daniel J. Sorin. "Fault Tolerant Computer Architecture." *Synthesis Lectures on Computer Architecture*, Morgan & Claypool Publishers, 2009.

Subject Code: CS6L022	Subject Name: Complex Networks	L-T-P: 3-0-0	Credits: 3

Prerequisite: Probability statistics

Syllabus: Introduction: Overview of Network science, Motivation, Large scale dynamic networks, Challenges of graph theory, Basic Concepts related to Networks, Small world effect, transitivity and clustering, degree distribution, scale free networks, maximum degree; network resilience; mixing patterns; degree correlations; community structures; network navigation, Community Structure Analysis, Basic concepts of network communities, Modularity, various community finding approaches like Girvan-Newman Algorithm, Spectral Bisection Algorithm, Radicchi Edge Clustering Algorithm (for binary as well as weighted graphs), Wu-Hubermann Algorithm, and Random Walk based Algorithm, Louvain, InfoMap, Random Graphs, Poisson random graphs, generalized random graphs, the configuration model, generating functions, power-law degree distribution, directed graph, bipartite graph, degree correlations, Models of Network Growth, Price model, Barabasi & Albert model, other growth models, vertex copying models, Bipartite Network, Processes taking place on Networks Percolation theory and network resilience, Epidemiological processes, Cascades and information spread, Social Network, Homophily, Cohesiveness, Cliques, Clans, Clubs, Plex, Equivalence of ties, Ego-centric networks, Cascade formation and information diffusion in Social media (say Twitter). Applications, Search on networks, exhaustive network search, guided network search, network navigation; network visualization and semantic zooming. Advanced topics, Temporal network, Multilayer networks, Interdependent networks, Controllability of complex networks, Economic and financial network analytics.

Text books:

1. Networks: An Introduction, Oxford University Press, Oxford, 2010.

Reference books:

1. Evolution of Networks, Oxford University Press, Oxford, 2003.
2. The structure and function of complex networks, SIAM Review 45, 167-256, 2003.
3. Statistical mechanics of complex networks, Rev. Mod. Phys., 74(1), 2002.
4. Papers from the ACM and IEEE digital libraries.

Subject Code: CS6L024	Subject Name: Internet-of-Things	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction to IoT: Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, Interoperability in IoT.

Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi

Introduction to SDN, SDN for IoT Data Handling and Analytics, Cloud Computing, Sensor-Cloud , Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

Text books:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)

Reference books:

1. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)

Subject Code: CS6L028	Subject Name: Computational aspects of Smart-Grid	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction: Introduction to Smart Grid, Introduction to Cloud Computing, Introduction to Big Data Analytics, Fundamental Mathematical Prerequisites, Cloud Computing Applications for Smart Grid: Demand Response, Geographical Load-Balancing, Dynamic Pricing, Virtual Power Plant, Advanced Metering Infrastructure, Cloud-Based Security and Privacy, Smart Grid Data Management and Applications: Smart Meter Data Management, PHEVs: Internet of Vehicles, Smart Buildings, Smart Grid Design and Deployment: Simulation Tools, Worldwide Initiatives

Text books:

1. Smart Grid Technology: A Cloud Computing and Data Management Approach, Sudip Misra

and Samaresh Bera, Publisher: Cambridge University Press, ISBN: 9781108475204, May 2018

Reference books:

Subject Code: CS6L026	Subject Name: Wireless Sensor Networks	L-T-P: 3-0-0	Credits: 3

Prerequisite: Computer Networks

Syllabus: Introduction: Overview, Broad application areas of WSN, Specialty and constrains;

Hardware and software: Overview of hardware architecture of the sensor motes, Types of operating systems for WSN, Overview of event driven programming

MAC layer issues: Types of MAC protocols for WSN, Contention-based and reservation based protocols. Detailed study of specific protocols such as SMAC, RMAC, TMAC, DW-MAC, DMAC, Aloha, CSMA-CA, BMAC, LPL, LPP

Network layer issues: Routing, classification of the protocols, specific protocols such as SPIN, LEACH etc. Data collection, Data dissemination, Data aggregation, Time synchronization.

Text books:

1. Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Network, John Wiley & Sons, 2005, ISBN 0470095105

Reference books:

1. Ibrahiem M. M. El Emary, S. Ramakrishnan, Wireless Sensor Networks: From Theory to Applications, CRC Press, 2013, ISBN 9781466518100.
2. Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, John Wiley & Sons, 2010, ISBN 9780470036013.
3. J Zheng, and A Jamalipour. Wireless sensor networks: a networking perspective, John Wiley & Sons, 2009, ISBN 9780470167632.
4. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons, 2003, ISBN 0470867361.

Subject Code: EC4L009	Subject Name: Sensor Networks	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction: Overview, Broad application areas of WSN, Speciality and constrains; Hardware and software: Overview of hardware architecture of the sensor motes, Types of operating systems for WSN, Overview of event driven programming, Basics of communications, wired communication and wireless communication. Basic communications protocols and requirements, Different layers of communication protocol stack. Basics of Computer Hardware and Operating systems, Data link and MAC layer issues: Basic protocols –

ALOHA, Slotted-ALOHA, CSMA/CD, CSMA/CA, SMAC, DMAC, TMAC, RMAC, DW-MAC etc, Network layer issues: Routing, classification of the protocols, SPIN, LEACH, Data collection protocols.

Text books:

1. Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Network, John Wiley & Sons, 2005, ISBN 0470095105

Reference books:

1. Ibrahiem M. M. El Emary, S. Ramakrishnan, Wireless Sensor Networks: From Theory to Applications, CRC Press, 2013, ISBN 9781466518100.
2. Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, John Wiley & Sons, 2010, ISBN 9780470036013.
3. J Zheng, and A Jamalipour. Wireless sensor networks: a networking perspective, John Wiley & Sons, 2009, ISBN 9780470167632.
4. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons, 2003, ISBN 0470867361.

Subject Code: CS6L006	Subject Name: Fault-Tolerant Systems	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structures, Computer Organization and Architecture

Syllabus: Introduction: Fault Classification, Types of Redundancy, Fault tolerant metrics Hardware Fault Tolerance: Fault rate, Reliability, MTTF, Canonical and Resilient structures, Reliability evaluation techniques, Processor level techniques, Byzantine failures, Information Redundancy: Coding techniques, Resilient Disk Systems, Data replication, Algorithm based fault tolerance, Fault tolerant Networks: Network topologies and their Resilience, Fault tolerant routing, Software Fault tolerance: Single version fault tolerance, N-version programming, Recovery blocks, Conditions and assertions, Exception handling, Fault tolerant remote procedure calls, Checkpointing: Checkpointing in Analytical model, shared memory systems, real-time systems, Case studies: Non-stop systems, Itanium, Defect tolerance in VLSI circuits: Basic yield models, Yield enhancement through redundancy, Faults in Cryptographic Systems: Security attacks, Countermeasures

Text books:

1. I. Koren, C Mani Krishna, Fault tolerant systems, Morgan Kaufmann.

Reference books:

1. D. Pradhan, Fault tolerant Computer Design, Prentice Hall.
2. E. Dubrova, Fault tolerant Design, Springer, 2013.
3. K. Trivedi, Probability and statictics with reliability, queuing and computer science applications, John Wiley.

Subject Code: CS4L015	Subject Name: Symbolic Logic and Automated Reasoning	L-T-P: 3-0-0	Credits: 3

Prerequisite: Formal Language and Automata Theory, Discrete Structure

Syllabus: Introduction and motivation: Role of logic in Computer Science, problem representation. Basic notions: language, models, interpretations, validity, proof, decision problems in logic. Decidability. Propositional logic: Syntax, semantics, proof systems, Validity, satisfiability and unsatisfiability, soundness and completeness. Machinasation: truth tables, normal forms, semantic tableaux, resolution, proof by contradiction, example.First order predicate logic theory: Quantifiers, first order models, validity and satisfiability, semantic tableaux. Normal forms, skolemization: elimination of quantifiers, unification, resolution and various resolution strategies, equality axioms and para-modulation. Horn formulas and programs. Prolog as a restricted resolution-based theorem prover. Undecidability and incompleteness in logic, compactness Theorem. Other topics: Introduction to Modal Logic, Temporal Logic and other logics for concurrency. Some exposure to theorem proving systems such as Prolog, PVS, SPIN, etc

Text books:

1. Michael Huth and Mark Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press.
2. Arindama Singh, Logics for Computer Science, Prentice Hall of India.

Reference books:

1. C. L. Chang and R. C. T. Lee, Symbolic Logic and Mechanical Theorem Proving, Academic Press.4.M. Ben-Ari, Mathematical Logic for Computer Science, Springer.
2. E. Mendelson, Introduction to Mathematical Logic, Chapman and Hall.

Subject Code: CS6L011	Subject Name: Web Technology	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structure, Computer Networks

Syllabus: Basic design and implementation of websites, Discussion of different navigation and organizational strategies, Client-side technologies including HTML5, CSS, JavaScript, JSON, and JQuery, Server-side technologies emphasizing implementations in PhP, Back-end data management, Security issues, Emerging technologies.

Text books:

1. Developing Web Applications, Ralph Moseley and M. T. Savaliya, Wiley-India

Reference books:

1. Web Design, Joel Sklar, Cengage Learning Publishing

Subject Code: CS6L021	Subject Name: Enterprise and Network Forensics	L-T-P:3-0-0	Credits:3

Prerequisite: computer network, programming and data structure, network and system security

Syllabus: Network forensic: collecting and analyzing network-based evidence, reconstructing web browsing, e-mail activity, and windows registry changes, intrusion detection, tracking offenders, etc. Mobile network forensic: introduction, mobile network technology, investigations, collecting evidence, where to seek digital data for further investigations, interpretation of digital evidence on mobile network, network management tools. Enterprise forensic: Organizational relationship between activities directed toward policy enforcement, computer forensics, data recovery, incident response, and privacy protection. Information systems control governance and policy enforcement. Strategies for organizational readiness for computer incident response such that collection, preservation, presentation and preparation of computer-based evidence will optimally satisfy the requirements of business continuity, criminal law enforcement and civil litigation. Organizational information services policies for incident response and business continuity. Strategic and technical levels the organization's computer incident response systems, architecture, and staff capabilities. Organization's computer incident response processes and computer forensics investigation processes. Ethical, technical and economic rationale for specific organization information systems incident response and forensic capabilities.

Text books:

1. Digital Forensics with Open Source Tools. Cory Altheide and Harlan Carvey, ISBN: 978-1-59749-586-8, Elsevier publication, April 2011.
2. Computer Forensics and Cyber Crime: An Introduction (3rd Edition) by Marjie T. Britz, 2013.
3. Handbook of Digital Forensics and Investigation, Academic press Inc., Eoghan Casey.

Reference books:

1. Guide to Computer Forensics and Investigations 5th Edition, Nelson, Phillips, Steuart, Cengage Learning, 2015.

Subject Code: CS6L005	Subject Name: Cryptography	L-T-P: 3-0-0	Credits: 3

Prerequisite: Computer Network, Number Theory

Syllabus: Introductory Concepts: Basic Cryptographic Goals (Confidentiality, Integrity, and Availability), Encryption, Decryption, Types of Cryptosystems, Active and Passive attacks, One Time Pad Mathematical Background: Shannon's Theory, Computational Complexity, Number Theory, Modular Arithmetic, Polynomial Arithmetic, Groups, Finite Fields, Rings, Fermat's Theorem, Euclidian Algorithm, Extended Euclidian Algorithms, Euler Totient Function, Chinese remainder Theorem, Discrete logarithm Problem, Primarily test, Factorization algorithms. Traditional Ciphers: Substitution Cipher (Hill cipher, Vigenere cipher, Playfair cipher) and Transposition Cipher Symmetric Cryptosystems: Stream ciphers (RC4 and LFSR), Block ciphers (DES and AES), Modes of Block ciphers

Attack Models for Block Ciphers: Linear and Differential Analysis and Interpolation attack Public Key Cryptosystems: One way and Trapdoor Functions, RSA cryptosystem, Elgamal Cryptosystems, and Elliptic Curve cryptography Key Exchange: The Diffie Hellman Case Hash Functions: SHA-1, MD4, Keyed Hash Functions Message Authentication and Signatures: Digital Signatures, RSA signature, Elgamal signature, MAC.

Text books:

1. Cryptography and Network Security: (7^{th} Edition) by William Stalling,

Reference books:

1. Cryptography: Theory and Practice: 4^{th} Edition by Douglas Robert Stinson, Maura Paterson

2.			
Subject Code: EC4L010	Subject Name: Interconnection Networks	L-T-P: 3-0-0	Credits: 3

Prerequisite: computer network, Computer Architecture

Syllabus: Introduction to Interconnection Networks, Topology, Switching Techniques, Taxonomy of Routing Algorithms, Flow Control, Router Micro-architecture, Technology and Architecture-Specic Exploration, Case Study on Software Defined Network (SDN) Architecture, Content Delivery Network (CDN) Architecture.

Text books:

1. Interconnection Networks: An Engineering Approach : by Jos Duato, Sudhakar Yala-
manchili, Lionel M. Ni

Reference books:

1. Principles and Practices of Interconnection Networks: by William Dally and Brian Towles.

Subject Code: CS6L025	Subject Name: Object Oriented System Design	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structure

Syllabus:

The purpose of this course is to familiarize students with concepts, methods, and tools for object oriented analysis and design of software systems, with emphasis on methods applied in large product development projects. The course introduces common design principles and patterns that support the development of maintainable, reusable and extensible software. The course gives an introduction to UML. Analysis- and design models are expressed using UML models such as use case diagrams, class diagram, sequence diagrams, and state diagrams. Furthermore,
techniques and guidelines are introduced for analysis of software domain and requirements.

Text books:

2. Systems Analysis and Design: an Object-oriented Approach with UML (5th edition), Alan Dennis, Barbara Haley Wixom, David Tegarden. ISBN-13: 978-1118804674 ISBN-10: 1118804678

Reference books:

1. Some particularly practical are: 'UML Distilled' by Martin Fowler
2. The Unified Modeling Language User Guide (2nd Edition) by Grady Booch, James Rumbaugh, Ivar Jacobson
3. Design Patterns: Elements of Reusable Object-Oriented Software. By Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides

Subject Code: CS6L023	Subject Name: Software Testing and Verification	L-T-P: 3-0-0	Credits: 3

Prerequisite: Discrete Structure

Syllabus: The course is about how to convince oneself that a program unit really does what it should. There are different methods for verifying programs that will be covered in this course. Testing: which has the purpose of finding errors in a program in a systematic way (terminology, coverage, unit tests, a unit test framework). Debugging which has the purpose to systematically trace and eliminate an error (control, workflow, localization, tools). Proving or formal verification: reasoning about the program in order to guarantee correctness (formal specifications (pre-/postconditions, invariants), automatic test case generation, formal

verification (logics, tool support)). Verifying a program only makes sense if we can precisely specify what the program is supposed to do. Many specifications are written in natural language which might lead to imprecision and misunderstandings. In the course you will learn how to use precise methods for specifying functional requirements. Such precise specifications will then be our basis for the verification of programs. But they will also be useful to automatize the generation of test cases. Throughout, the course is concerned with imperative programs in general, and object-oriented programs in particular.

Text books:

1. Introduction to Software Testing by Paul Ammann, Jeff Offutt

Reference books:

1. Why Programs Fail: A Guide to Systematic Debugging by Andreas Zeller
   A definitive and modern treatment of debugging.
2. The Art of Software Testing, 3rd Edition by Glenford J Myers
   The second edition of what is considered to be THE classic book on testing.
3. The Science of Programming by David Gries.
   Covers topics related to program verification and the weakest pre-condition calculus.
4. Code Complete, 2nd Edition by Steve McConnell

Subject Code: CS6L0035	Subject Name: Theory of Computation	L-T-P: 3-0-0	Credits: 3

Prerequisite: Discrete Structure, Data Structures, Design and Analysis of Algorithms

Syllabus:

Introduction: Motivation for studying theory of computation, a quick overview of the subject. Notion of formal language. Language membership problem.

Finite automata and regular expressions: DFA, NFA (with and without transitions), their equivalence. Proof that for some languages NFAs can be exponentially more succinct than DFAs. Dentition of regular expressions. Proof that FAs recognize, and regular expressions denote the same class of languages (regular languages).

Properties of regular languages: Pumping lemma and its use to prove non-regularity of a language, closure properties of class of regular languages, decision properties: converting among representations, testing emptiness, etc. Minimization of DFAs, Myhill-Nerode theorem.

Context-free grammars and languages: Derivation, parse trees. Language generated by a CFG. Eliminating useless symbols, epsilon-productions, unit productions. Chomsky normal form.

Pushdown automata: Dentition, instantaneous description as a snapshot of PDA computation, notion of acceptance for PDAs. Proof that CFGs generate the same class of languages that

PDAs accept.

Properties of context-free languages: Pumping lemma for context-free languages and its use to prove a language to be not context-free. Closure properties of the class of context- free languages. CYK algorithm for CFL membership, testing emptiness of CFLs.

Turing machines: Historical context, informal proofs of undecidability. Dentition of TM, instantaneous description as a snapshot of TM computation, notion of acceptance. Robustness of the model: both natural generalizations and restrictions keep the class of languages accepted invariant. (Generalizations: multi-track, multi-tape, nondeterministic, etc.). Church-Turing hypothesis.

Undecidability: Dentitions of r.e. and recursive languages. Turing machine codes, the diagonalization language and proof that it is not r.e. Universal Turing machine. Universal language, its semi-decidability. Reducibility and its use in proving undecidability. Rices theorem. Undecidability of Posts correspondence problem.

Intractability: Motivation for the notion. The class P as consensus class of tractable sets. Classes NP, co-NP. Polynomial time reductions. NP-completeness, NP-hardness. Cook- Levin theorem. Mention about boundary of tractability: 2SAT vs. 3SAT, 2D matching vs. 3D matching. Some NP-completeness proofs: vertex cover, clique, independent sets, Hamiltonian graphs, subset-sum, set cover.

Text books:

1. M Sipser, Introduction to the Theory of Computation, 2nd Ed., Thomson, 2005.
2. J Hopcroft, JD Ullman, R Motwani, Introduction to Automata Theory, Languages and Computation, 3rd Ed., Pearson, 2008.

Reference books:

1. M Sipser, Theory of Computation, Brooks-Cole, 2008.
2. Daniel I. A. Cohen, Introduction to Computer Theory

Subject Code: CS6L034	Subject Name: Software Engineering	L-T-P: 3-0-0	Credits: 3

Prerequisite: Programming and Data Structure

Syllabus: The course provides a broad but practical view of industrial software development. Students learn the main problems, models and methods of software engineering, including traditional and agile/lean software development. The main software engineering activities, including software requirements engineering, design, implementation, testing and deployment are covered. Supporting workflows, e.g. configuration management and project management

are also discussed. After the course, students have a working understanding of software development in industry, and the necessary knowledge and skills to pursue further studies in software engineering.

Text books:

1. Software Engineering 10th Edition by Ian Sommerville

Reference books:

1. A Concise Introduction to Software Engineering by Pankaj Jalote
2. Software Engineering: A Precise Approach by Pankaj Jalote
3. An Integrated Approach to Software Engineering by Pankaj Jalote

Subject Code: CS6L003	Subject Name: Software Reliability	L-T-P: 3-0-0	Credits: 3

Prerequisite: Probability and Statistics

Syllabus:

Introduction, Definition of Software Reliability: basic Reliability Mathematics: Key concepts in Software Reliability: Software failure mechanisms: The bathtub curve for software reliability: Available tools and techniques and metrics: Software reliability models: Software reliability metrics: Software reliability improvement techniques: Relation of software reliability to domains like Software fault tolerance: software testing and Hardware reliability.

Text books:

1 M.R Lyu: Handbook of Software Reliability Engineering: Mc Graw Hill, 1995.

Reference books

1 M.Xie: Software Reliability Modelling, World Scientific, 1991.
2 J.D. Musa, A. lannino, K. Okumoto: Software Reliability: Measurement, Prediction, Application, 1999

Subject Code: CS6L010	Subject Name: Digital Forensics-1	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction: Understanding the need for computer forensics, digital investigations and evidence, digital crime scene investigation process, data analysis, an overview of sleuthkit toolkit, Computer foundations: Data organizations, booting process, Handling evidence: Hardware write/blockers, Hard drive acquisitions, Hard disk basics, Different ways of wiping and formatting the evidence, processing the scene, Forensically sound evidence collection, Forensic file images, Volume level analysis: Understanding dos partition table and

Global partition table, File system analysis: FAT 12, FAT 16, FAT 32 basic concepts, FAT data Structures, Analysing the evidence with FAT file system, NTFS basics, NTFS data structures, analysing the evidence with NTFS file system, Window artifacts: My documents, Recycle bin, Installed programs, Windows analysis: Windows volatile data acquisition, Windows memory acquisition and analysis, cold boot dump attack for memory dump, Windows Registry, File signature analysis: File signatures, File extensions, Detecting file manipulation, Forensic software: Sleuthkit, Basic search queries, ASCII, UNICODE, Regular expressions, viewing and managing keywords and cases, Antiforensic techniques: Encryption, password protection, Password recovery tools, Forensic Reports: Proper report writing, Explaining forensics to the uneducated

Text books:

1. Brian Carrier. File System Forensic Analysis, Addison-Wesley Professional
2. Cory Altheide, Harlan Carvey. Digital Forensics with Open Source Tools, Syngress

Reference books:

1. A. J. Marcella, G. Guillossou, Cyber Forensics: from data to digital intelligence, Wiley
2. R. Boddington, Practical Digital Forensics, Packt Publishing

Subject Code: CS6L020	Subject Name: Digital Forensics-2	L-T-P: 3-0-0	Credits: 3

Prerequisite: Digital Forensics-1

Syllabus: CyberSecurity Fundamentals: Overview of cybersecurity, Definition and types of cyberthreats, Usecases: Morris worm, DDos Attack

Definition and Types of Malwares: Malware Basics, Worms, Virus, Rootkits, Trojan Horses: Trojans, Ransomware, Spyware, Malware analysis tools, Advanced persistent threat

E-mail Analysis: Finding E-mail Artifcats, converting e-mail formats, Client-based e-mail, web-based e-mail, internet hosted mail, investigating e-mail headers

Tracking User Activity: Tracking Web usage, Internet explorer forensics, firefox/mozilla forensics, operating system user logs

Memory Forensics: Memory acquisition, Memory analysis, memory analysis tools

Incident Response: Introduction to incident response, preparing for incident response, mac time analysis

Forensic Analysis of Mobile Devices: Collecting and analyzing mobile device, password-protected windows devices

Recent Advances in Digital Forensics: Discussing latest papers in the field

Text books:

1. Davis, Philipp, and Cowen, Hacking Exposed: Computer Forensics, McGraw Hill Education
2. K. Mandia, M Pepe, J. Luttgens, Incident Response & Computer Forensics, Third Edition

Reference books:

1. M.H. Ligh, A. Case, J. Levy, A. waters, The art of memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory, Wile
2. A book from honeynet project. Know your enemy: Learning about security threats, Addison Wesley

Subject Code: CS6L017	Subject Name: Advanced Databases and Mining	L-T-P: 3-0-0	Credits: 3

Prerequisite: Database Management System

Syllabus: Transaction Processing: Consistency, Atomicity, Isolation and Durability, Serializable Schedule, Recoverable Schedule, Concurrency Control, Time-stamp based protocols, Isolation Levels, Online Analytical Processing

Database performance Tuning and Query optimization: Query Tree, Cost of Query, Join, Selection and Projection Implementation Algorithms and Optimization

Database Security: Access Control, MAC, RBAC, Authorization, SQL Injection Attacks

Data Mining: stages and techniques, knowledge representation methods, data mining approaches (OLAP, DBMS, Statistics and ML)

Data warehousing: data warehouse and DBMS, multidimensional data model, OLAP operations.

Data processing: cleaning, transformation, reduction, filters and discretization with weka.

Knowledge representation: background knowledge, representing input data and output knowledge, visualization techniques and experiments with weka, Ontologies and knowledge graph

Mining real data: preprocessing data from a real medical domain, data mining techniques to create a comprehensive and accurate model of data.

Parallel Databases: Avenues for parallelism: I/O parallelism, interquery, inter-query and intra operation parallelism, databases for multi-core machines.

Distributed Databases: Distributed data storage, distributed transactions, commit protocols, concurrency control in distributed databases, heterogeneous and cloud-based databases.

Information Retrieval: relevance ranking using terms and hyperlinks,page rank, indexing of documents, measuring retrieval effectiveness.

XML and semi-structured data: necessity, XML document schema, querying: XPath and XQuery languages, applications.

Advanced topics: text mining, text classification, web mining, data mining software

Text books:

1. Michael Steinbach, Pang-Ning Tan, and Vipin Kumar. Introduction to Data Mining, Pearson Education
2. P. Valduriez, M. TamerOzsu. Principles of Distributed Database Systems, Prentice Hall
3. Bing Liu. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer-Verlag Berlin and Heidelberg GmbH & Co. K

Reference books:

1. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Addison-Wesley
3. M. Stonebraker. Readings in Database Systems, Morgan Kaufmann

Subject Code: CS6L019	Subject Name: Artificial Intelligence	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus:

Introduction to Artificial Intelligence: What is AI? Related Fields, Agents and Environments

Problem Solving: problem representation paradigms, state space, satisfiability vs optimality

Search Techniques: Principles of search, uninformed search, informed search, constraint satisfaction problems, adversarial search and games

Knowledge Representation: Knowledge representation : First order and non-monotonic logic; rule based, frame and semantic network approaches, mixed representations, Theorem

Proving, knowledge bases and inference

Uncertainty Treatment : formal and empirical approaches including Bayesian theory, belief functions, certainty factors

Fuzzy Logic: Tagaki-Sugeno Fuzzy Logic;, Mamdani Fuzzy Logic, Fuzzy Bayesian Decision Method, Membership Functions, Fuzzification and Defuzzification, Fuzzy system Modeling

Planning and making decisions

Reinforcement learning: MDPs, Q-learning algorithm, applications, Bandits and Monte carlo tree search

Text books:

1. Russell and Norvig. Artifiicial Intelligence: A Modern Approach. Pearson Education (Low Priced Edition), 2004.
2. Nils J. Nilsson, Artificial Intelligence - A New Synthesis, Morgan Kaufmann Publishers, 2000
3. George F.Luger and William A. Stubblefield, AI: Strcutures and Strategies for Complex problem solving, 2nd edition, Benjamin Cummins Publishers

Reference books:

1. Mark Stefik, Introduction to Knowledge Systems, Morgan Kaufmann.
2. E. Rich and K.Knight, Artificial Intelligence, Tata McGraw Hill
3. E. Charniack and D. Mcdermott, Artificial Intelligence, Addison Wesley

Subject Code: CS6L031	Subject Name: Game Theory	L-T-P: 3-0-0	Credits: 3

Prerequisite: None

Syllabus: Introduction: Introduction to game theory, current trends and modern applications.

Non-Cooperative Game Theory: Key notions, strategic form games, extensive form games, dominant strategy equilibrium, pure strategy Nash equilibrium, mixed strategy Nash equilibrium, two player zero sum game, existence of Nash equilibrium, computation of Nash equilibrium, complexity analysis of Nash equilibrium, Bayesian games

Mechanism Design: Introduction, social choice functions, incentive compatibility and revelation theorem, Gibbart-Satterthwaite impossibility theorem, Arrow's impossibility theorem, VCG mechanisms, Quasilinear environment, revenue equivalence theorem, optimal mechanisms and Myerson auction

Cooperative Game Theory: Correlated equilibrium, coalition games, core of coalition games, Shapley value, Benzhaf index, stable matching

Text books:

1. Y. Narahari. Game Theory and Mechanism Design. IISc Press and the World Scientific. 2014.
2. Michael Maschler, Eilan Solan, and Schmuel Zamir. Game Theory. Cambridge University Press, 2013
3. Roger B. Myerson. Game Theory: Analysis of Conflict. Harvard University Press, September 1997

Reference books:

1. Roger B. Myerson. Game Theory: Analysis of Conflict. Harvard University Press, September 1997.
2. Andreu Mas-Colell, Michael D. Whinston, and Jerry R. Green. Microeconomic Theory. Oxford University Press, New York, 1995.
3. Martin J. Osborne, Ariel Rubinstein. A Course in Game Theory. The MIT Press, August 1994.
4. Philip D. Straffin, Jr. Game Theory and Strategy. The Mathematical Association of America, January 1993.
5. Ken Binmore, "Fun and Games : A Text On Game Theory", D. C. Heath & Company, 1992.
6. Paul Klemperer, Auctions: Theory and Practice, The Toulouse Lectures in Economics, Princeton University Press, 2004.

Subject Code: EC6L002	Subject Name: Image and Video processing	L-T-P: 3-1-0	Credits: 4

Prerequisite: Digital Signal Processing

Syllabus: Introduction to digital image processing, intensity transformation, spatial filtering, frequency domain filtering, point and line detection, edge detection, Hough Transform, image restoration, color processing, thresholding, image segmentation, affine transformation, image transforms, multi-resolution image analysis, shape and texture representation and description, introduction to object recognition, image compression, JPEG, introduction to digital video, video compression standards, motion estimation.

Text books:

1. Gonzalez and Woods, "Digital Image processing," 3rd Ed., Pearson and Prentice Hall, 2009.

Reference books:

1. W.K. Pratt, "Digital image processing," 4th Ed., Wiley India, 2007.
2. K.R. Castleman, "Digital image processing," 2nd Ed., Pearson, 2012.
3. A.K. Jain, "Fundamentals of digital image processing," Prentice Hall, 1989.

Subject Code: EC6L003	Subject Name: Information Theory and Coding	L-T-P: 3-0-0	Credits: 3

Prerequisite: Digital Communication

Syllabus: Introduction: Entropy and mutual information theory: joint entropy, conditional entropy, relationship between entropy and mutual information, chain rules for entropy, relative entropy, mutual information, jensen's inequality fano's inequality; An introduction to codes: coding: kraft inequality, optimal codes, bounds on optimal code length, kraft inequality for uniquely decodable codes, shannon and huffman codes, shannon, fano, elias codes, block codes, linear block codes, cyclic codes; Efficient encoding, information sources; average code word length; huffman encoding; noiseless coding: the noiseless coding theorem; Channel capacity: discrete memoryless channels and capacity, examples of channel capacity, symmetric channels, properties of channel capacity, channel coding theorem; Theory and practice of error-control coding: trellis diagram and the viterbi algorithm, convolution coding in mobile communications and modern graph-based codes (turbo-codes and ldpc codes), the main coding theory problem.

Text books:

1. T. M. Cover and J. A. Thomas, "Elements of Information Theory," 2nd Ed., Wiley-Inter Science, 2006.
2. S. Lin and D. J. Costello, "Error Control Coding," 2nd Ed., Pearson Prentice Hall, 2004.

Reference books:

1. R. G. Gallager, "Information Theory and Reliable Communication," Wiley, 1968.
2. I Csiszar and J. Korner, "Information Theory: Coding Theorems for Discrete Memoryless Systems," Akademiai Kiado, December 1981.
3. T. S. Han, "Information-Spectrum Methods in Information Theory," Springer, 2002.
4. Andre Neubauer, Jurgen Freedenberg, Volker Kuhn, "Coding theory Algorithm, Architectures and Applications," Willey India Editions, 2007.
5. Ranjan Bose, "Information theory, Coding and Cryptography," TMH publication, 2008.
6. Roman, Steven, "Introduction to Coding and Information Theory", Springer, 2000.