Course Structures & Syllabi

for

B.Sc. (Hons.) Program in Computer Science

M.Sc. in Computer Science Program

MCA in Computer Applications Program

(Applicable for new students admitted from the academic session 2016-17)

Department of Computer Science
Institute of Science
Banaras Hindu University

Course Outline
of
Bachelor of Science (Computer Science Hons.)

Course Code	Course Title	Credits
SEMESTER I		
CS101	*Problem Solving through C Programming*	4
CS107	*C Programming Lab*	2
Semester I Total		**6**
SEMESTER II		
CS103	*Digital Logic and Circuits*	4
CS108	*Basic Linux lab*	2
CS4XX	*Minor Elective I (Non-CS Stream Students)*	2
Semester II Total		**8**
SEMESTER III		
CS104	*Numerical Computing*	4
CS109	*Numerical Analysis Lab*	2
Semester III Total		**6**
SEMESTER IV		
CS105	*Computer Organization and Architecture*	4
CS110	*Assembly Language Programming Lab*	2
CS4XX	*Minor Elective II (Non CS-stream Students)*	2
Semester IV Total		**8**
SEMESTER V		
CS106	*Discrete Mathematical Structures*	4
CS201	*Operating System Concepts*	4
CS202	*Data Structures and Algorithm*	7
CS203	*Database Management Systems*	7
Semester V Total		**22**
SEMESTER VI		
CS204	*Computer Networks*	4
CS205	*Software Engineering*	4
CS503	*Project*	14
Semester VI Total		**22**
Grand Total		**72**

Course Outline
Of
Master of Science (Computer Science)

Course Code	*Course Title*	*Credits*
	M.Sc. SEMESTER I	
CS207	*Theory of Computation*	4
CS208	*Artificial Intelligence*	4
CS209	*Advanced Course in Data Structures & Algorithms*	7
CS501	*Technical Writing*	3
	Semester I Total	**18**
	M.Sc. SEMESTER II	
CS3XX	*Elective I*	6
CS3XX	*Elective II*	6
CS3XX	*Elective III*	6
CS4XX	*Minor Elective I (Non-CS Stream Students)*	2
	Semester II Total	**20**
	M.Sc. SEMESTER III	
CS3XX	*Elective IV*	6
CS3XX	*Elective V*	6
CS504	*Mini Project*	8
CS4XX	*Minor Elective II (Non-CS Stream Students)*	2
	Semester III Total	**22**
	M.Sc. SEMESTER IV	
CS507	*Dissertation*	14
CS508	*Comprehensive Viva*	02
CS509	*Reading Elective*	04
	Semester IV Total	**20**
	Grand Total	**80**

Course Outline
Of
Master of Computer Applications

Course Code	*Course Title*	*Credits*
	MCA SEMESTER I	
CS105	*Computer Organization and Architecture*	4
CS106	*Discrete Mathematical Structures*	4
CS201	*Operating System Concepts*	4
CS102	*Introduction to Computer Programming through C*	7
	Semester I Total	**19**
	MCA SEMESTER II	
CS202	*Data Structures and Algorithm*	7
CS203	*Database Management Systems*	7
CS204	*Computer Networks*	4
CS205	*Software Engineering*	4
CS4XX	*Minor Elective I (Non-CS Stream Students)*	2
	Semester II Total	**24**
	MCA SEMESTER III	
CS206	*Object Oriented Programming through JAVA*	7
CS208	*Artificial Intelligence*	4
CS111	*Web Design Lab*	3
CS501	*Technical Writing*	3
CS4XX	*Minor Elective II (Non-CS Stream Students)*	2
	Semester III Total	**19**
	MCA SEMESTER IV	
CS3XX	*Elective I*	6
CS3XX	*Elective II*	6
CS3XX	*Elective III*	6
CS4XX	*Minor Elective III (Non-CS Stream Students)*	2
	Semester IV Total	**20**
	MCA SEMESTER V	
CS3XX	*Elective IV*	6
CS3XX	*Elective V*	6
CS3XX	*Elective VI*	6
CS505	*Mini Project*	3
	Semester V Total	**21**
	MCA SEMESTER VI	
CS506	*Major Project*	12
CS508	*Comprehensive Viva*	02
CS509	*Reading Elective*	03
	Semester VI Total	**17**
	Grand Total	**120**

List of Courses in Computer Science

with

Detailed Syllabus

The Department of Computer Science offers different kinds of courses at undergraduate, and post-graduate. These courses are categorized into following five types:

1. Introductory Courses in Computer Sciences *(Course Codes 1XX)*
2. Core Courses in Computer Science *(Course Codes 2XX)*
3. Major Electives in Computer Science *(Course Codes 3XX)*
4. Minor Electives for Non-CS steam students *(Course Codes 4XX)*
5. Ancillary and Activity-based Courses *(Course Codes 5XX)*

List of Introductory Courses:

Course Code	Course Title	Credits
CS101	Problem Solving through C Programming	04
CS102	Introduction to Computer Programming through C	07
CS103	Digital Logic and Circuits	04
CS104	Numerical Computing	04
CS105	Computer Organization and Architecture	04
CS106	Discrete Mathematical Structures	04
CS107	C Programming Lab	02
CS108	Basic Linux Lab	02
CS109	Numerical Analysis Lab	02
CS110	Assembly Language Programming Lab	02
CS111	Web Design Lab	03

List of Core Courses:

Course Code	Course Title	Credits
CS201	Operating System Concepts	04
CS202	Data Structures and Algorithm	07
CS203	Database Management Systems	07
CS204	Computer Networks	04
CS205	Software Engineering	04
CS206	Object Oriented Programming through JAVA	07
CS207	Theory of Computation	04
CS208	Artificial Intelligence	04
CS209	Advanced Course in Data Structures & Algorithms	07
CS210	Internet Technologies	04

List of Major Elective Courses:

Course Code	Course Title	Credits
CS301	Probability and Statistics *	06
CS302	Information Retrieval	06
CS303	Data Mining	06
CS304	Machine Learning	06
CS305	Evolutionary Algorithm	06
CS306	Network Theory	06
CS307	Artificial Neural Networks	06
	Intentionally Left Blank	
CS309	Bioinformatics Algorithms	06
CS310	Computational Geometry	06
CS311	Parallel Computing	06
CS312	Embedded System	06
CS313	Wireless Networks	06
CS314	Information Security	06
CS315	Operation Research	06
CS316	Simulation and Modeling	06
CS317	Image Processing	06
CS318	Computer Graphics	06
CS319	Compiler Design	06
CS320	Text Analytics	06

*Exclusive for students who do not have studied this course earlier.

List of Minor Elective Courses for Non-CS stream students:

Course Code	Course Title	Credits
CS401	*Fundamentals of Computing*	02
CS402	*Introduction to Information Technology*	02
CS403	*Programming for Problem Solving*	02
CS404	*E-Commerce**	02
CS405	*Human Computer Interaction**	02
CS406	*Massive Open Online Courses**	02

*These courses are exclusively offered only to MCA students at RGSC as Minor Electives.

List of Ancillary and Activity-based Courses:

Course Code	Course Title	Credits
CS501	Technical Writing	03
CS502	Communication Skills	03
CS503	Undergraduate Project (Computer Science)	12
CS504	Mini Project (Computer Science)	08
CS505	Mini Project (Computer Applications)	04
CS506	Major Project (Masters Level)	12
CS507	Dissertation (Masters)	16
CS508	Comprehensive Viva	02
CS509	Reading Elective	02

Detailed Syllabus

CS101	Problem Solving through C Programming	L	T	P	C
		4	0	0	4

Basic Programming Concepts: Problem solving methods: top down and bottom up approach, Using Computers for Problem solving, Flowchart, Algorithm.

Introduction to Programming Language C: Overview of C language, Lexical elements of C- Data Types, managing input/output operations, Operators and Hierarchy of Operations, Expressions in C, Decision Making and Repetitive Statements, break, continue, Array, Pointers, dynamic memory allocation, String handling, Functions: User Defined Functions and Library Functions, Parameter Passing, Storage Classes, enumerated data types, Command line arguments, C Preprocessors, Union & Structures.

Suggested Readings:

1. B.W. Kernighan and D.M.Ritchie, the C Programming Language, PHI.
2. R.C. Hutchinson and S.B. Just, Programming using the C Language, McGraw-Hill.
3. B.S. Gottfried, Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill.

CS102	Introduction to Computer Programming through C	L	T	P	C
		4	0	3	7

Basic Programming Concepts: Programming Paradigms, Imperative programming, Algorithm and Program, Concept of Variables, Operators and expressions.

Introduction to Programming Language C: Overview of C language, Lexical elements of C- Data Types, managing input/output operations, Operators and Hierarchy of Operations, Expressions in C, Decision Making and Repetitive Statements, break, continue, Array, Pointers, dynamic memory allocation, String handling, Functions: User Defined Functions and Library Functions, Parameter Passing, Storage Classes, enumerated data types, Command line arguments, C Preprocessors, Union & Structures, File handling in C.

Suggested Readings:

1. B.W. Kernighan and D.M.Ritchie, the C Programming Language, PHI.

2. R.C. Hutchinson and S.B. Just, Programming using the C Language, McGraw-Hill.
3. B.S. Gottfried, Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill.

CS103	Digital Logic and Circuits	L	T	P	C
		4	0	0	4

Number System: Weighted and Unweighted Codes, Binary, Octal, and Hexadecimal numbers; Fixed and Floating Point Number Representations, number base conversion, Complements, Binary Arithmetic: Addition, Subtraction, Multiplication and Division, BCD Code.

Boolean algebra and Logic Gates: Introduction to Boolean algebra, laws of Boolean algebra, logic gates, universal logic gates, POS and SOP notations, Canonical logic forms, Logic families.

Simplification of Boolean Functions: Laws of Boolean algebra and K-Maps, Tabulation Method.

Combinational Circuits: Design Procedure of Combinational Circuits, Adders, Subtractors, Code Converters, Magnitude Comparator, Encoder, Decoder, Multiplexer, Demultiplexer, ROM, PLAs, PALs.

Sequential Circuits: Flip-Flops: SR, D, JK, T, Master/Slave F/F, Edge-trigerred F/F, Excitation Tables; Registers, Counters: synchronous and asynchronous, Design of Counters, Shift Registers, RAM.

Suggested Readings:

1. M. M. Mano, Digital Logic and Computer Design, PHI.
2. M.M.Mano, Computer System Architecture, PHI.
3. M. M. Mano and C. R. Kime, Logic and Computer Design Fundamentals," 3rd ed., Prentice Hall.
4. Malvino, Leach, Digital Principles and Applications, McGraw-Hill.
5. Thomas C. Bartee, Digital Computer Fundamentals, McGraw-Hill.

CS104	*Numerical Computing*	L	T	P	C
		4	0	0	4

Errors in Computer Arithmetic, Normalization.

Bisection, Falsiposition and Newton-Raphson methods for solution of nonlinear equations. Errors in the solutions, Convergence of Solutions.

Gauss, Gauss-Siedel and Iterative methods for system of linear equations. Ill conditioned system, Pivotal Condensation, Matrix Inversion, Eigen-values, Eigen-vector, Diagonalization of Real Symmetric Matrix by Jacobi's Method.

Introduction to Finite Differences.

Polynomial Interpolation using Newton's and Lagrange's formulae.

Numerical Differentiation: Numerical Integration: Trapezoidal Rule, Simpson's Rule, Weddle's Rule, Gauss Quadrature Formula. Error in numerical Integration.

Numerical Solution of differential Equations: Picards Method, Taylor's Series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Method, Predictor-Corrector Method.

Note: The Emphasis of the course is on computational implementation of the methods.

Suggested Readings:

1. V. Rajaraman, Computer Oriented Numerical Methods, PHI.
2. F.Acton, Numerical Methods that Work, Harper and Row.
3. S.D.Conte and C.D.Boor, Elementary Numerical Analysis, McGraw Hill.
4. S.S. Shastri, "Introductory Methods of Numerical Analysis", PHI.
5. C. F. Gerald and P.O. Wheatley Applied Numerical Analysis, Addison Wesley.

CS105	***Computer Organization and Architecture***	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Basic Organization: Stored Program Concept, Components of a Computer System, Machine Instruction, Opcodes and Operands, Instruction Cycle, Organization of Central Processing Unit: ALU, Hardwired & Micro programmed Control Unit, General Purpose and Special Purpose Registers.

Memory Organization: Memory Hierarchy, Cache Memory, Main Memory (DRAM and ROM), Secondary Memory, Virtual Memory, Characteristics of different types of Memory.

I/O Organization: Peripheral devices, I/O interface, Modes of Transfer, Priority Interrupt, Direct Memory Access, Input-Output Processor, and Serial Communication. I/O Controllers, Asynchronous data transfer, Strobe Control, Handshaking.

Functioning of CPU: Instruction Formats, Op Codes, Instruction Types, Addressing Modes, Common Microprocessor Instructions, Multi-core Architecture, Multiprocessor and Multicomputer.

Suggested Readings:

1. M. M. Mano, Computer System Architecture, PHI.

2. V. Rajaraman, T. Radhakrishnan, An Introduction to Digital Computer Design, PHI.
3. William Stallings, Computer Organization and Architecture: Designing For Performance, Prentice Hall.

CS106	Discrete Mathematical Structures	L	T	P	C
		4	0	0	4

Sets, Relations & Functions: Property of binary relations, equivalence, compatibility, partial ordering relations, hasse diagram, functions, inverse functions, composition of functions, recursive functions

Mathematical Logic: Logic operators, Truth tables, Theory of inference and deduction, mathematical calculus, predicate calculus, predicates and quantifiers

Boolean Algebra: Truth values and truth tables, the algebra of propositional functions, Boolean algebra of truth values

Combinatorics & Recurrence Relations: Permutation, Combination, Principle of Inclusion and Exclusion, Recurrence Relations, Generating Functions

Graph theory: Basic Concepts of Graphs and Trees, Adjacency and Incidence Matrices, Spanning Tree, Transitive Closure, Shortest Path, Planar Graphs, Graph Coloring, Eularian and Hamiltonian graphs, Applications of Graph Theoretic Concepts to Computer Science

Introduction to Grammar and Languages, Regular Expression, Machines Recognizing languages: Finite State Automata: Deterministic and non-deterministic

Suggested Readings:

1. J.P. Trembley and R.P.Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill.
2. Dornhoff and Hohn, Applied Modern Algebra, McMillan.
3. N. Deo, Graph Theory with Applications to Engineering and Computer Science, PHI.
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hill.
5. Rosen, Discrete Mathematics, Tata McGraw Hill.
6. K.L.P. Mishra, N. Chandrasekaran, Theory of Computer Science: Automata, Languages and Computation, PHI.

CS107	**C Programming Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**2**

This lab course is designed to teach problem solving and programming skills. Exercises in problem solving using C programming language will be carried out by the students in lab.

CS108	**Basic Linux Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**2**

This lab course is designed to teach students using Linux computing environment. It will comprise of basic Linux commands, vi editor and elementary Shell programming.

CS109	**Numerical Analysis Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**2**

This lab course is designed to teach students how to solve numerical analysis problems by writing programs. It is based on course CS104.

CS110	**Assembly Language Programming Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**2**

This lab course is designed to teach Assembly language programming skills to students. Simulators of 8085/ 8086 will be used for assembly language programming environment. Students will learn basic microprocessor instructions and programming.

CS111	**Web Design Lab**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**3**

This is a first lab course in Web Design. Students will learn basic HTML, DHTML, PHP, and Java Script. They will be required to complete one Web design project.

CS201	Operating System Concepts	L	T	P	C
		4	0	0	4

Introduction: Definition, Design Goals, Evolution; Batch processing, Multi-programming, Time sharing; Structure and Functions of Operating System.

Process Management: Process states, State Transitions, Process Control Structure, Context Switching, Process Scheduling, Threads.

Memory Management: Address Binding, Dynamic Loading and Linking Concepts, Logical and Physical Addresses, Contiguous Allocation, Fragmentation, Paging, Segmentation, Combined Systems, Virtual Memory, Demand Paging, Page fault, Page replacement algorithms, Global Vs Local Allocation, Thrashing, Working Set Model, Paging.

Concurrent Processes: Process Interaction, Shared Data and Critical Section, Mutual Exclusion, Busy form of waiting, Lock and unlock primitives, Synchronization, Classical Problems of Synchronization, Semaphores, Monitors, Conditional Critical Regions, System Deadlock, Wait for Graph, Deadlock Handling Techniques: Prevention, Avoidance, Detection and Recovery.

File and Secondary Storage Management: File Attributes, File Types, File Access Methods, Directory Structure, Allocation Methods, Free Space management; Disk Structure, Logical and Physical View, Disk Head Scheduling.

Suggested Readings:

1. Silberschatz and Galvin, Operating System Concepts, Addison Wesley.
2. William Stalling, Operating Systems: Internals and Design Principles, PHI.
3. Tanenbaum, Modern operating Systems, PHI.

CS202	Data Structures and Algorithm	L	T	P	C
		4	0	3	7

Defining a Data Structure: Notion of DFA triplet, Types of Data Structures.

Linear Structures: Array, List, Stack, Queue, Applications of arrays, lists, stacks and queues.

Non-Linear Data Structures: Tree, Tree Traversals, Binary Tree, Applications of Trees, Binary Search Tree, Graph, Hashing and Collision Resolution Techniques.

Searching and Sorting: Linear Search, Binary Search, Selection Sort, Insertion Sort and Shell Sort.

Introduction to Algorithm Analysis and Design: Time Complexity Analysis**,** Asymptotic Notations, Introduction to Design Techniques such as Divide and Conquer, Dynamic Programming, Greedy algorithms Backtracking, Branch and Bound.

Suggested Readings:

1. Lipshutz, Data Structure, McGraw Hill.
2. Standish, Data Structure, Addison-Wesley.
3. B. Salzberg, File Structures - An Analytic Approach, Prentice-Hall.
4. A. M. Tennenbaum, Y. Langsam and M. J. Augenstein, Data Structures using C, PHI.
5. D. E. Knuth, Fundamental Algorithms, Narosa Publication.
6. N. Wirth, Algorithms+Data Structures= Program, Prentice Hall.

CS203	Database Management Systems	L	T	P	C
		4	0	3	7

Introduction: Database Systems, View of Data Models, Database Languages, DBMS Architecture, Database Users and Data Independence.

ER Modeling: relation types, role and Structural Constraints, Extended ER Modeling Features, Design of an ER Database Schema, Reduction of ER Schema to Tables.

Relational Model: Relational Model Concepts, Relational Algebra.

Introduction to SQL: SQL data types and literals, Types of SQL commands, SQL operators, Tables, views and indexes, Queries and sub queries, Aggregate functions.

Relational Database Design: Functional and multi-valued Dependencies, Desirable Properties of Decomposition, Normalization up to 3 NF and BCNF.

Selected Database Issues: Security, Transaction Management, Introduction to Query Processing and Query Optimization, Concurrency Control, and Recovery Techniques.

Suggested Readings:

1. C.J.Date, An Introduction to Database Systems, Vol I & II, Addison Wesley.
2. Korth Silberschatz, Data Base System Concepts, McGraw Hill.
3. J.D.Ullman, Principles of Database Systems, Galgotia.
4. Wiederhold, Database Design, McGraw Hill.
5. R. Elmasri, and S.B. Navathe, Fundamentals of Database Systems, Pearson Education Asia.
6. Raghu Ramakrishnan, Database Management Systems, McGraw-Hill Education.

CS204	Computer Networks	L	T	P	C
		4	0	0	4

Introduction to Computer Networks Network definition; network topologies; network classifications; network protocol; layered network architecture; overview of OSI reference model; overview of TCP/IP protocol suite.

Data Communication Fundamentals and Techniques Analog and digital signal; data-rate limits; digital to digital line encoding schemes; pulse code modulation; parallel and serial transmission; digital to analog modulation-; multiplexing techniques- FDM, TDM, WDM; transmission media.

Networks Switching Techniques and Access mechanisms: Circuit switching; Packet switching- connectionless datagram switching, connection-oriented virtual circuit switching.

Data Link Layer Functions and Protocol: Error detection and error correction techniques; data-link control- framing and flow control; error recovery protocols- stop and wait ARQ, go-back-n ARQ; selective-repeat ARQ, Point to Point Protocol on Internet.

Multiple Access Protocol and Networks: CSMA/CD protocols; Ethernet LANS; connecting LAN and back-bone networks- repeaters, hubs, switches, bridges, router and gateways;

Networks Layer Functions and Protocols: Routing; routing algorithms; network layer protocol of Internet- IP protocol, Internet control protocols.

Transport Layer Functions and Protocols: Transport services- error and flow control, Connection establishment and release- three way handshake; Congestion control;

Overview of Application layer protocol: Overview of DNS protocol; overview of WWW &HTTP protocol.

Suggested Readings:

1. B. A. Forouzan: Data Communications and Networking, Fourth edition, THM .
2. A. S. Tanenbaum: Computer Networks, Fourth edition, PHI.
3. Douglas E. Comer: Computer Networks and Internets, Pearson.

CS205	Software Engineering	L	T	P	C
		4	0	0	4

Introduction to Software Engineering: Definition, Software development and life-cycle models, CMM, Software Quality, role of metrics and measurement.

Requirements Analysis and Specification: SRS Building Process, Specification Languages, Validation of SRS, metrics, monitoring and control, Object Oriented analysis.

Software Project Planning: Software Cost Estimation Techniques, Project Scheduling & Tracking, Project Team Standards, software configuration management.

Software Architecture: Role of Software Architecture, Architecture Views, Component and Connector View, Architecture Styles for C&C View, Architecture Evaluation

Software Design and Implementation: Design Concepts and Notations, Functional & Object Oriented Design Concepts, Design Strategies, Design specification and verification, Metrics, Design Translation Process.

Software Testing and Reliability: Strategies & Techniques, Debugging, Software Maintenance,Software Reliability and Availability Models, Software Reengineering, Cleanroom Approach, Software Reuse. Introduction to IEEE Standards, Case Studies.

Suggested Readings:

1. Pankaj Jalote, "An Integrated Approach to Software Engineering", IIIrd Edition, Narosa Publishing House.
2. Waman S. Jawadekar "Software Engineering: Principles and Practices", Tata McGraw-Hill.
3. Roger S. Pressman , "Software Engineering: A Practitioner's approach", ,McGraw-Hill.
4. Ian Sommerville, "Software Engineering: Pearson Education.
5. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli "Fundamentals of Software Engineering", PHI.
6. S. L. Pfleeger, Software Engineering: Theory and Practice, Pearson Education.
7. R. Mall, Fundamentals of Software Engineering, PHI.

CS206	Object Oriented Programming through JAVA	L	T	P	C
		4	0	3	7

Object Oriented Concepts: Objects and Classes, Bottom-up approach, O-O design principles, O-O Design and Modeling.

Basic O-O language Constructs: Primitive Data Types and Operations, Selection Statements, Loops, Arrays, Strings, Objects and Classes, Inheritance and method overriding, Polymorphism

Java Language Fundamentals: Object Design: constructors, instance variables, methods. Memory models, scope, streams and I/O programming, Inner classes, Interfaces and packages, Exception Handling, Multithreading

Advanced Concepts: Creating GUIs and Displaying Data, Event Driven Programming.

Frameworks: The framework concept, Frameworks in the Java API: Collections Framework, Graphics Framework

Suggested Readings:

1. Simon Kendal, Object oriented programming using java, Ventus Publishing.
2. C. Thomas Wu, An introduction to Object Oriented Programming with JAVA, Mc Graw Hill.
3. Rajkumar Buyya, S Thamarai Selvi, Xingchen Chu, Object Oriented Programming with Java: Essentials and Applications, Mc Graw Hill.
4. E. Balagurusamy, Programming with Java, TMH
5. Bruce Eckel, Thinking in Java, Pearson.
6. Peter Van Der Linden, Just Java 2, Sun Microsystems, PHI

CS207	Theory of Computation	L	T	P	C
		4	0	0	4

Grammars: Production systems, Chomsky Hierarchy, Right linear grammar and Finite state automata, Context free grammars, Normal forms, Derivation trees and ambiguity
Finite state Automata: Non deterministic and deterministic FSA, NFSA with ε- moves, Regular Expressions, Equivalence of regular expression and FSA, Pumping lemma, closure properties and decidability, Myhill - Nerode theorem and minimization, Finite automata with output.
Pushdown automata: Acceptance by empty store and final state, Equivalence between pushdown automata and context-free grammars, Closure properties of CFL, Deterministic pushdown automata.

Turing Machines: Techniques for Turing machine construction, Generalized and restricted versions equivalent to the basic model, Godel numbering, Universal Turing Machine, Recursively enumerable sets and recursive sets, Computable functions, time space complexity measures, context sensitive languages and linear bound automata.
Decidability: Post's correspondence problem, Rice's theorem, decidability of membership, emptiness and equivalence problems of languages.
Time and tape complexity measures of Turing machines, Random access machines, the classes P and NP, NP-Completeness, Satisfiability and Cook's theorem, Polynomial reduction and some NP-complete problems.

Suggested Readings:

1. J.E.Hopcraft, R. Motwani and J.D. Ullman, “Introduction to Automata Theory, Languages and Computation”, Pearson.

2. Cohen, “Introduction to Computer Theory”, John Wiley.
3. M. Sipser, Introduction to Theory of Computation, PWS Publishing Corporation.
4. T.C. Martin, Theory of Computation, Tata McGraw-Hill.
5. H.R. Lewis, C.H. Papadimitrou, Elements of the Theory of Computation, PHI.
6. K.L.P. Mishra, N. Chandrasekaran, Theory of Computer Science: Automata, Languages and Computation, PHI.

CS208	Artificial Intelligence	L	T	P	C
		4	0	0	4

Introduction: Definitions and Approaches, History of AI, Concept of Intelligent Agents.

AI Problem Solving: Problem solving as state space search, production system, control strategies and problem characteristics; Search techniques: Breadth First and Depth-first, Hill-climbing, Heuristics, Best-First Search, A* algorithm, Problem reduction and AO* algorithm, Constraints satisfaction, Means Ends Analysis, Game Playing.

Knowledge Representation and Reasoning: Predicate and prepositional logic, Resolution, Unification, Deduction and theorem proving, Question answering; Forward versus backward reasoning, Matching, Indexing, Semantic Net, Frames, Conceptual Dependencies and Scripts.

Applications: Introduction to Natural Language Processing and Expert System.

Suggested Readings:

1. S. Russel, P. Norvig, Artificial Intelligence: A Modern Approach, Pearson.
2. E. Rich and K. Knight, Artificial Intelligence, Tata McGraw Hill.
3. N.J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann.

CS209	Advanced Course in Data Structures & Algorithms	L	T	P	C
		4	0	3	7

Binary Search Trees, Red-Black Trees, B-Trees, Binomial Heaps, Fibonacci Heaps, Data Structures for Disjoint Sets, String Matching, Elementary Graph algorithms, Minimum Spanning Trees, Single Source Shortest Path, All-Pairs shortest Paths

Review of Algorithm Design Techniques, Solving different problems, Merge Sort, Quick Sort, Shortest Paths, Queens problem, 0/1 Knapsack problem, Travelling Salesperson, Bin Packing, Introduction to Probabilistic Algorithms .

Maximum s-t flows and their relationship with minimum s-t cuts. Flow decomposition. Augmenting path algorithms. Minimum-cost flow problems and algorithms,.

Intractable Problems, Basic Concepts, Nondeterministic Algorithms, NP Completeness, Cook's Theorem, Fundamentals of NP-Hard and NP-Complete problems.

Suggested Readings:

1. Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, PHI.
2. Weiss M. A., Data Structures and Problem Solving Using Java, Addison Wesley.
3. A.Aho, V. Alfred, J. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley.
4. E. Horowitz and S. Sahani, Fundamentals of Computer Algorithms, Galgotia.
5. S.E. Goodman and S.T. Hedetniemi, Introduction to the Design and Analysis of Algorithms, McGraw Hill.
6. G. Brassard and P. Bratley, Algorithmics, PHI.
7. S. K. Basu, Design Methods and Analysis of Algorithms, PHI, 2013.
8. Anany V. Levitin, Introduction to the Design & Analysis of Algorithms, Addison Wesley.

CS210	Internet Technologies	L	T	P	C
		4	0	0	4

Internet and W WW: History of Internet and World Wide Web, Introduction to JAVA Scripts – Object Based Scripting for the web. Structures, Functions, Arrays, Objects.

DYNAMIC HTML: Introduction, Object refers, Collectors all and Children. Dynamic style, Dynamic position, frames, navigator, Event Model – On check – On load – One nor – Mouse rel – Form process – Event Bubblers – Filters – Transport with the Filter – Creating Images – Adding shadows – Creating Gradients – Creating Motion with Blur – Data Binding – Simple Data Binding – Moving with a record set – Sorting table data – Binding of an Image and table. Client Side Scripting and Server side Scripting – Accessing Web servers – IIS – Apache web server.

SQL – ASP – Working of ASP – Objects – File System Objects – Session tracking and cookies – ADO – Access a Database from ASP – Server side Active-X Components – Web Resources – XML – Structure in Data – Name spaces – DTD – Vocabularies – DOM methods.

Introduction – Servlet Overview Architecture – Handling HTTP Request – Get and post request – redirecting request – multi-tier applications – JSP – Overview – Objects – scripting – Standard Actions – Directives.

Suggested Readings:

1. Deitel, Deitel and Nieto, “Internet and World Wide Web – How to program”, Pearson.
2. Elliotte Rusty Harold, “Java Network Programming”, O’Reilly.
3. R. Krishnamoorthy & S. Prabhu, “Internet and Java Programming”, New Age International Publishers.
4. Thomno A. Powell, “The Complete Reference HTML and XHTML”, Tata McGraw Hill.

CS301	Probability and Statistics	L	T	P	C
		4	2	0	6

Introduction: Data Collection and Descriptive Statistics, Inferential Statistics and probability Models, Population and Samples.

Descriptive Statistics: Describing Datasets, Single Point Summarization, Paired Datasets.

Probability: Sample Space and Events, Axioms of Probability, Conditional Probability.

Random Variables and Expectations: Random variables, Jointly Distributed Random variables, Expectation, Variance, Co-variance, Probability Distributions.

Parameter Estimation-Maximum Likelihood Estimates; Regression Models; Applications.

Suggested Readings:

1. S. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
2. W. Feller, An Introduction to probability Theory and its Applications- Vol. 1, Wiley.
3. Sheldon M. Ross, Probability and Statistics for Engineers, Elsevier, 2012.
4. Judea Pearl, Probabilistic Reasoning in Intelligent Systems, Morgan Kaufmann.
5. K.S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, Wiley.

CS302	Information Retrieval	L	T	P	C
		4	0	2	6

Introduction: Information, Information Need and Relevance; The IR System; Early developments in IR, User Interfaces.

Retrieval Evaluation: Notion of Precision and Recall; Precision-Recall Curve, Standard Performance Measures such as MAP, Reciprocal ranks, F-measure, NDCG, Rank Correlation.

Retrieval and IR Models: Boolean Retrieval; Term Vocabulary and Postings list; Index Construction; Ranked and other alternative Retrieval Models.

Document Processing: Representation; Vector Space Model; Feature Selection; Stop Words; Stemming; Notion of Document Similarity; Standard Datasets.

Applications/ Laboratory Exercises.

Suggested Readings:

1. Ricardo Baeza-Yaets and Berthier Ribeiro-Neto, Modern Information Retrieval: The Concept and Technology behind Search, 2nd Edition, Addison-Wesley.

2. C.D. Manning, P. Raghvan and H. Schutze, Introduction to Information Retrieval, Cambridge University Press.
3. David A. Grossman and Ophir Frieder, Information Retrieval: Algorithms and Heuristics, 2nd Ed., Springer.
4. Stephen Buettcher, Charles L.A. Clarke and Gordon V. Carmack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press.
5. Bruce Croft, Donald Metzler and Trevor Strohman, Search Engines: Information Retrieval in Practice, Addison Wesley.

CS303	Data Mining	L	T	P	C
		4	0	2	6

Data Mining and its importance, Data Mining on kind of data, Data Mining Functionalities: Association Analysis, Classification and Prediction, Cluster Analysis, Outlier Analysis, Evolution Analysis, Major issues in Data Mining, KDD process.

Difference between Data Mining, Data Warehouse, OLAP and DBMS

Data Preprocessing: Data cleaning, Data Integration and Transformation, Data Reduction.

Data Mining Primitives, Architectures of Data Mining Systems.

Mining Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Database, Mining multilevel association rules from transaction databases, constraint based association mining.

Classification and Prediction: Issues, Classification by Decision Tree induction, Prediction.

Cluster Analysis: types of data in cluster analysis, Methods: Partitioning.

Mining complex Types of Data: Spatial Databases, Multimedia Databases, Time-series and sequence data, Text databases, WWW.

Applications and Trends in Data Mining: Application, Social Impacts.

High Performance Data Mining: PC cluster, MPICH2 cluster, homogeneous and heterogeneous cluster.

Suggested Readings:

1. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques”, Academic Press.
2. Ian H Witten et al., Data Mining: Practical machine Learning Tools and Techniques, Morgan Kaufmann Publisher.
3. Anand and Ullman, Mining of massive datasets, CUP.

CS304	Machine Learning	L	T	P	C
		4	0	2	6

Machine Learning Concepts: Designing a Learning System, Styles of Learning; Supervised learning; Unsupervised Learning; Semi-Supervised Learning; Basics of Decision Theory, Information Theory and Probability Distributions; Linear and Logistic Regression.

Bayesian Learning: Notion of Prior, Likelihood and Posterior; Naïve Bayes and Conditional Independence; Estimation using Maximum Likelihood; Hidden variables and Missing Data; Bayesian Models.

Applications: Naive Bayes, Nearest Neighbour and Linear Classification Models; K-means and Expectation Maximization for Clustering; Mixture Models.

Machine Learning Applications and Laboratory Exercises.

Suggested Readings:

1. David Barber, Bayesian Reasoning and Machine Learning, CUP.
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.
3. Tom M. Mitchell, Machine Learning, Mc Graw Hill.
4. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press..
5. Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques, MIT Press..
6. Peter Harrington, Machine Learning in Action, Manning Publications..

CS305	Evolutionary Algorithms	L	T	P	C
		4	0	2	6

Introduction: State Space Search, Traditional vs Heuristic Search, Review of Single State Methods: Hill Climbing, Simulated Annealing, Tabu Search, Iterated Local Search.

Population-based Methods: Genetic Algorithms- Representation & Encoding, Operators, Convergence, Steady State vs Generational GA, Elitism; Differential Evolution- Representation, Operators, Algorithm, Variants and Hybrids; Particle Swarm Optimization- Representation, Algorithmic Approach, Local and Global Best.

Combinatorial Optimization Problems: Characteristics of COPs, Greedy Randomized Adaptive Search procedures, Ant Colony Optimization.

Multi-objective Optimization, Laboratory Exercises and Applications.

Suggested Readings:

1. S. Luke, Essentials of Metaheuristics, lulu press.
2. R.C.Eberhart, J. Kennedy and Y. Shi, Swarm Intelligence, Morgan Kauffman..
3. K. Deb, Multi-objective Optimization using Evolutionary Algorithms, Wiley.

CS306	Network Theory	L	T	P	C
		4	0	2	6

Introduction: History of Study of Networks, The new science of Networks, Networks in the real world: Social Networks, Information Networks, Technology Networks, Biological Networks.

Network Fundamentals: Network Representation, Hypergraphs, Bipartite Networks, Planner Networks, Measures and Metrics: Degree, Path, Degree Centrality, Eigen Vector Centrality, Closeness Centrality, Between-ness Centrality, Page Rank, Hub and Authority.

Models of Networks and Network Growth: Random Graph Model, Small World Network, Scale Free Network, Growth Models: Preferential Attachment, Price's Model, Model of Barabasi and Albert, Vertex Copying Model.

Network Dynamics/ Applications: Spread of Epidemics and Rumors, Information Dynamics.

Laboratory Exercises.

Suggested Readings:

1. M. Newman, Networks- AN Introduction, OUP.
2. M. Newman, A-L Barabasi and DJ Watts, The Structure and Dynamics of Networks, PUP.
3. D. Easley and J.Kleinberg, Networks, Crowds and Markets, CUP.

CS307	Artificial Neural Networks	L	T	P	C
		3	0	3	6

Introduction: Biological Neural Networks, Mathematical Model of Neuron, Mc Culloch and Pitts Model, Concepts of Threshold and Activation Functions, Typically used Non-linearity.

ANN Topologies and Learning: Rosenblatt Perceptron, Linear Separation and MLP, Feed-forward and Feed-backward Networks; Delta and Gradient Descent learning rules, Hebbian Learning, Back Propagation learning, Radial basis Function Networks, Associative Memory Paradigms, Hopfield Networks, Recurrent Networks, Self-organizing feature Maps.

Applications: ANN for Pattern Classification, Pattern Matching and Time Series Analysis.

Suggested Readings:

1. Laurance Fausett et al., Fundamentals of Neural Networks, Pearson.

2. Simon Haykin, Neural Networks, Pearson.
3. M T Hagan, Neural Network Design, Cengage.

CS309	Bioinformatics Algorithms	L	T	P	C
		3	1	2	6

Biological Algorithms versus Computer Algorithms, Algorithmic Notations. Introduction to Algorithm Design Techniques.

Introductory Molecular Biology, DNA Analysis, Regulatory Motifs in DNA Sequences, Finding Motifs, Greedy Approach to Motif finding, Longest Common Subsequences, Global and Local Sequence Alignments, Multiple Alignment, Gene Prediction.

Constructing Algorithms in sub-quadratic time, Shortest Superstring Problem, Sequencing by Hybridization, Protein Sequencing and Hybridization, Spectrum Graphs, Spectral Convolution, Repeat Finding.

Hash Tables, Keyword Trees, Suffix Trees and its Applications, Approximate Pattern Matching, Hierarchical Clustering, Evolutionary Trees, Parsimony Problem.

Hidden Markov Models, Applications of HMM.

Suggested Readings:

1. N. C. Jones and P. A. Pevzner, "An Introduction to Bioinformatics Algorithms", MIT
2. D. W. Mount, Bioinformatics: Sequence and Genome Analysis.
3. D. Gusfield, "Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology", CUP.

CS310	Computational Geometry	L	T	P	C
		4	0	2	6

Constructive problems in computational geometry: convex hulls, triangulations, Voronoi diagrams, arrangements of hyperplanes; relationships among these problems. Search problems: advanced data structures; subdivision search; various kinds of range searches. Models of computation; lower bounds.

Suggested Readings:

1. Franco P. Preparata, Michael Shamos, Computational Geometry: An Introduction, Springer
2. Joseph O'Rourke, Computational Geometry in C, CUP.

CS311	Parallel Computing	L	T	P	C
		3	1	2	6

Introduction to Parallel Computing: Supercomputers and grand challenge problems, Modern Parallel Computers, Data Dependence Graph, Data Parallelism, Functional Parallelism, Pipelining and Data Clustering.

Interconnection Networks: Switch Network Topologies, Direct and Indirect Network Topology, Bus, Star, Ring, Mesh, Tree, Binary Tree Network, Hyper Tree Network, Hybrid, Hypercube, Perfect Shuffle Network, Torus and Butterfly Network.

Performance Analysis: Introduction, Execution Time, Speedup, Linear and Superlinear Speedup, Efficacy and Efficiency, Amdahl's Law and Amdahl Effect, Gustafson-Barsis's Law, Minsky's Conjecture, The Karp-Flatt Metric, The Isoefficiency Metric, Isoefficiency Relation, Cost and Scalability.

Parallel Computational Models: Flynn's Taxonomy, PRAM, EREW, CREW, ERCW, CRCW, Simulating CRCW, CREW & EREW, PRAM algorithms.

Introduction to Parallel Algorithms: Parallel Programming Models, PVM, MPI Paradigms, Parallel Programming Language, Brent's Theorem, Simple parallel programs in MPI environments, Parallel algorithms on network, Addition of Matrices, Multiplication of Matrices.

Suggested Readings:

1. Hwang and Briggs, Computer Architecture and Parallel Processing, McGraw Hill.
2. Crichlow, Introduction to Distributed and Parallel Computing, PHI.
3. M.J.Quinn, Designing Efficient Algorithms for Parallel Computers, McGraw-Hill.
4. V.Rajaraman, Elements of Parallel Computing, PHI.
5. Joseph JA JA, Introduction to Parallel Algorithms, Addison Wesley.
6. S.G.Akl, The Design and Analysis of Parallel Algorithms, PHI.
7. Shashi Kumar M et al. Introduction to Parallel Processing, PHI.
8. S. K. Basu, Parallel and Distributed Computation: Architectures and Algorithms, PHI.

CS312	Embedded System	L	T	P	C
		4	2	0	6

Introduction to Embedded System and Hardware Fundamentals: Examples of Embedded Systems-Typical Hardware- Terminology-Gates-A Few Other Basic Considerations-Timing Diagrams-Memory- Interrupts:Microprocessor Architecture-Interrupt Basics-The Shared-Data Problem-Interrupt Latency.

Software Architectures For Embedded Systems: Round-Robin-Round-Robin with Interrupts-Function-Queue-Scheduling Architecture- Real-Time Operating System Architecture-Selecting an Architecture Forth/Open Firmware: Introducing Forth-. String Words-Stack Manipulation- Creating New Words- Comments- if .else- Loops-. Data Structures-Interacting with Hardware and Memory-Forth Programming Guidelines

Real-Time Operating Systems: Tasks and Task States-Tasks and Data-Semaphores and Shared Data-Operating System Services-Message Queues, Mailboxes, and Pipes-Timer Functions-Events-Memory Management-Interrupt Routines in an RTOS Environment.

Basic Design Using A Real-Time Operating System: Overview-Principles-An Example-Encapsulating Semaphores and Queues-Hard Real-Time Scheduling Considerations-Saving Memory Space-Saving Power-Embedded Software Development Tools-Host and Target Machines.-Linker/Locators for Embedded Software-Getting Embedded Software into the Target System

Debugging Techniques And An Example System: Testing on Your Host Machine-Instruction Set Simulators-The assert Macro-Using Laboratory Tools- An Example System-What the Program Does-Environment in Which the Program Operates-A Guide to the Source Code-Source Code.

Suggested Readings:

1 David Simon , An Embedded Software Primer, Addison Wesley.

2 John Catsoulis, Designing Embedded Hardware, O'Reilly Publications.

3 Raj Kamal, Embedded Systems: Architecture and Programming, McGraw Hill.

CS313	***Wireless Networks***	**L**	**T**	**P**	**C**
		4	**2**		**6**

Introduction: Fundamentals of Wireless Communication - Transmission fundamentals – Wireless Communication Technology - Antennas and Propagation, Spread Spectrum, Modulation Techniques, Coding and Error Control.

Wireless Networking: Wireless LANs & PANs: Wireless Networking – Satellite Communication, Cellular Wireless Networks, Mobile IP and Wireless Access Protocol, Wireless LANs -Wireless LAN Technology, IEEE 802.11 Wireless LAN Standards, Bluetooth, HIPERLAN Standard, HomeRF.

Ad-Hoc Wireless Networks & Security: Introduction - Issues in Ad Hoc Wireless Networks - Classifications of MAC Protocols - Classifications of Routing Protocols - Classifications of Transport Layer Protocols - Classification of Energy Management Schemes – Wired Equivalent Privacy(WEP) – The Extensible Authentication Protocol - Security in Ad Hoc Wireless Networks.

Wireless Sensor Networks: Introduction - Sensor Network Architecture - Data Dissemination - Data Gathering - MAC Protocols for Sensor Networks - Location Discovery - Quality of a Sensor Network - Evolving Standards - Other Issues.

Suggested Readings:

1. William Stallings, Wireless Communications and Networking,Pearson.
2. Siva Ram Murthy C, Manoj B.S, Ad Hoc Wireless Networks: Architectures and Protocols, PHI.
3. Kaveh Pahlavan and Prashant Krishnamurthy, Principles of Wireless Networks, Pearson.
4. Rappaport T.S, Wireless Communications: Principles and Practice, PHI.
5. Matthew Gast, Matthew Gast S, 802.11 Wireless Networks: The Definitive Guide (O'Reilly Networking) , O'Reilly Publication.

CS314	***Information Security***	**L**	**T**	**P**	**C**
		4	**2**	**0**	**6**

Security Goals, Security Attacks (Interruption, Interception, Modification and Fabrication), Security Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internetwork security, Internet Standards and RFCs.

Conventional Encryption Principles & Algorithms(DES, AES, RC4), Block Cipher Modes of Operation, Location of Encryption Devices, Key Distribution, Public key cryptography principles, public key cryptography algorithms(RSA, RABIN, ELGAMAL, Diffie-Hellman, ECC), Key Distribution

Approaches of Message Authentication, Secure Hash Functions(SHA-512, WHIRLPOOL) and HMAC - Digital Signatures: Comparison, Process- Need for Keys, Signing the Digest, Services, Attacks on Digital Signatures, Kerberos, X.509 Directory Authentication Service

Security at layers(Network, Transport, Application): IPSec, Secure Socket Layer(SSL), Transport Layer Security(TLS), Secure Electronic Transaction(SET), Pretty Good Privacy(PGP), S/MIME

Viruses and related threats, Anatomy of Virus, Virus Counter Measures - Software Flaws: Buffer Overflow, Incomplete Mediation, Race Conditions, Malware: Brain, Morris Worm, Code Red, Malware Detection - Firewalls, Design principles, Types of Firewalls, Firewall Architectures, Trusted Systems.

Suggested Readings:

1. Network Security Essentials (Applications and Standards) by William Stallings, Pearson.
2. Information Security Principles & Practice, Mark Stamp, WILEY INDIA.
3. Cryptography and network Security, Fourth edition, Stallings, PHI/Pearson.
4. Cryptography & Network Security by Behrouz A. Forouzan, TMH.

5. Network Security: The complete reference, Robert Bragg, Mark Rhodes, TMH.
6. Computer Security Basics by Rick Lehtinen, Deborah Russell & G.T.Gangemi Sr., SPD O'REILLY.

CS315	*Operation Research*	L	T	P	C
		4	0	2	6

Network Analysis: Terminology of network, shortest route problem, minimal spanning tree problem, max-flow problem.

Project Scheduling by PERT, CPM: Diagram, representation, critical path calculation, construction of time chart and resource labeling, probability and cost consideration in project scheduling, project control.

Linear Programming: Simplex Method, Revised simplex method, Duality in Linear programming, Application of Linear Programming to Economic and Industrial Problems.

Nonlinear Programming: The Kuhn-Tucker conditions, Quadratic programming, Convex programming.

Replacement Models: Introduction, Replacement policies for items whose efficiency deteriorates with time, Replacement policies for items that fail completely.

Sequencing Model: Classification of self problems, processing of n jobs through two machines, three machines, processing of two jobs through m machines.

Suggested Readings:

1. Taha, Operations Research, Macmillan.
2. B.E. Gillet, Introduction to Operations Research, McGraw-Hill.
3. S.S.Rao, Optimization Theory and Applications, Wiley Eastern.
4. G.Hadley, Linear programming, Addison-Wesley.

CS316	*Simulation and Modeling*	L	T	P	C
		4	0	2	6

Simulation and its uses, Definition of System, Types of Systems, Simulation Experiments and Field Experiments, Random Number Generators from Uniform and other Continuous and Discrete Distributions, Tests of Randomness and Goodness of Fit.

Modeling Process and Concepts of Mathematical Models, Differential, Partial Differential and Difference Equation Models, Modeling through Graphs, Stochastic Models, Monte-Carlo

Integration, Simulation of Single Server System, Inventory System, Time Sharing Computer System, and Ethernet Model. Verification, Validation and Comparison of Real System and Simulation Experiments Data, Variance Reduction Techniques, Simulation Languages: SIMULA, SIMSCRIPT and GPSS.

Suggested Readings:

1. J. A. Payne, Introduction to Simulation, Programming Techniques and Methods of Analysis, TMH.
2. A. M. Law, W. D. Kelton, Simulation Modeling and Analysis, McGraw Hill.
3. M. H. MacDougall, Simulating Computer Systems: Techniques and Tools, The MIT Press.
4. Z. A. Klarian, EJ Dudewicz, Modern Statistical Systems and GPSS Simulation, Computer Science Press.
5. G. Gordon, System Simulation, PHI.
6. Narsingh Deo, System Simulation with Digital Computer, PHI.
7. JN Kapoor, Mathematical Modeling, Wiley Eastern Ltd.
8. BP Zeigler, H Praehofer, TG Kim, Theory of Modeling and Simulation-Integrating Discrete Event and Continuous Complex Dynamic Systems, Academic Press.

CS317	***Image Processing***	**L**	**T**	**P**	**C**
		4	**0**	**2**	**6**

Continuous And Discrete Images And Systems: Light - Luminance - Brightness and Contrast - Eye - The Monochrome Vision Model, Image Processing Problems and Applications - Vision Camera - Digital Processing System - 2-D Sampling Theory - Aliasing - Image Quantization, Lloyd Max Quantizer - Dither - Color Images - Linear Systems and Shift Invariance - Fourier Transform - Z - Transform - Matrix Theory Results - Block Matrices and Kronecker Products.

Image Transforms: 2-D orthogonal and Unitary transforms - 1-D and 2-D DFT - Cosine - Sine - Walsh - Hadamard - Haar - Slant - Karhunen-loeve - Singular value Decomposition transforms.

Image Enhancement: Point operations - Contrast stretching, clipping and thresholding density slicing -Histogram equalization - Modification and specification - Spatial operations – Spatial averaging - Low pass - High pass - Band pass filtering - Direction smoothing – Medium filtering - Generalized cepstrum and homomorphic filtering - Edge enhancement using 2- D IIR and FIR filters - Color image enhancement.

Image Restoration: Image observation models - Sources of degradation - Inverse and Wiener filtering - geometric mean filter - Non linear filters - Smoothing splines and interpolation - Constrained least squares restoration.

Image Data Compression and Reconstruction: Image data rates - Pixel coding, predictive techniques transform coding and vector DPCM - Block truncation coding - Wavelet transform coding of images - Color image coding - Random transform - Back projection operator - Inverse random transform – Back projection algorithm - Fan beam and algebraic restoration techniques.

Suggested Readings:

1. Gonzalaz R. and Wintz P, Digital Image Processing, Addison Wesley, 3rd Edition 2008.
2. Anil K. Jain, Fundamentals of Digital Image Processing, PHI, 1995.
3. Sid Ahmed M.A., Image Processing, McGraw Hill Inc, 3rd Edition 2000.
4. William. K. Pratt, Digital Image Processing, Wiley Interscience, 2nd Edition, 1991.

CS318	***Computer Graphics***	**L**	**T**	**P**	**C**
		4	**0**	**2**	**6**

Introduction to Computer Graphics, Display Technologies, Random and Raster Scan, frame buffer, bit plane, Input Devices, Graphics Standards, Graphics Hardware.

Line and Circle Drawing Algorithms, Scan Conversion, filling algorithms, clipping, Two Dimensional transformations, Homogeneous Coordinates, Rigid Body and Affine transformations, Parallel and perspective projections, vanishing points, viewing transformation, Hidden line removal method, Cubic Spline, Bezier curve, B-Spline Curves, Fractal Curves.

Suggested Readings:

1. Computer Graphics (Principles and Practice) by Foley, van Dam, Feiner and Hughes, Addisen Wesley .
2. Computer Graphics by D Hearn and P M Baker, PHI.
3. Mathematical Elements for Computer Graphics by D F Rogers, McGraw Hill.

CS319	***Compiler Design***	**L**	**T**	**P**	**C**
		4	**0**	**2**	**6**

Introduction: Translators, Various phases of compiler, tool based approach to compiler construction.

Lexical analysis: token, lexeme and patterns, difficulties in lexical analysis, error reporting, implementation, regular definition, transition diagrams, LEX.

Syntax Analysis: top down parsing (recursive descent parsing, predictive parsing), operator precedence parsing, bottom-up parsing (SLR, LALR, Canonical LR), YACC.

Syntax directed definitions: inherited and synthesized attributes, dependency graph, evaluation order, bottom-up and top-down evaluation of attributes, L-attributed and S-attributed Definitions.

Type checking: type system, type expressions, structural and name equivalence of types, type conversion, overloaded functions and operators, polymorphic functions.

Run time system: storage organization, activation tree, activation record, parameter passing, dynamic storage allocation, symbol table: hashing, linked list, tree structures.

Intermediate code generation: intermediate representation, translation of declarations, assignments, control flow, Boolean expressions and procedure calls, implementation issues.

Code generation and Optimization: issues, basic blocks and flow graphs, register allocation, code generation, dag representation of programs, code generation from dags, peephole optimization.

Suggested Readings:

1. Aho, Ullman and Sethi, Principles of Compiler Design, Addison Wesley.
2. J. P. Trembley and P. G. Sorensen, The Theory and Practice of Compiler Writing, McGraw Hill.
3. Holub, Compiler Design in C, PHI.

CS320	***Text Analytics***	**L**	**T**	**P**	**C**
		4	**0**	**2**	**6**

Basics of Text Processing: Statistical and Graphical NLP; Representation; Boolean and Vector Space Models; Feature Selection; Stop Words; Stemming; Parts of Speech Tagging; Graph Based Representations; IR view of Text Processing; Similarity measures; Notion of Information Need, Precision and Recall.

Classification and Clustering: Supervised and Unsupervised methods for Text Processing; Classification Methods such as Naïve Bayes, Nearest Neighbour, Rochio's and Support Vector Machines; Clustering Methods such as Partitional and Hierarchical, Soft and Hard, K-Means, EM, Agglomerative Clustering; Datasets and Performance Measures.

Applications: Open and Targeted Information Extraction; Named Entity Recognition; Question Answering; Sentiment Analysis; Semantic Annotation; Document Summarization.

Laboratory Exercises.

Suggested Readings:

4. C.D. Manning, P. Raghvan and H. Schutze, Introduction to Information Retrieval, CUP..
5. R. Mihalcea and D. Radev, Graph based Natural Language Processing and Information Retrieval, CUP.
6. U.S. Tiwary and Tanveer Siddiqui, Natural Language Processing and Information Retrieval, OUP.
7. G.S. Ingersol, T.S. Morton and A.L. Farris, Taming Text: How to Find, Organize and Manipulate It, Manning Publications.
8. S. Bird, E. Klein and E. Loper, Natural Language Processing with Python, O'Reilly.

CS401	*Fundamentals of Computing*	L	T	P	C
		2	0	0	2

Characteristics of Computers, Evolution of Computing, Binary Number Systems, Types of Computer Software, Operating Systems, Programming Languages, Problem Solving Techniques using Computers: Algorithm, Flow Charts, Pseudocode. Introduction to Computer Networks, Internet, World Wide Web, Getting Connected to Internet, Use of Internet for Scholarly Purposes.

Suggested Readings:

1. E Balagurusamy: Computing Fundamentals & C programming, TMH.
2. A.P. Godse and D.A. Godse: Fundamental of Computing and Programming (Technical Publications).

CS402	*Introduction to Information Technology*	L	T	P	C
		2	0	0	2

Concepts of Data and Information, Data Processing, Components of a Computer System, Computer Networks, LAN and WAN, Internet, World Wide Web, Search Engine, Concept of E-mail, File Transfer over Internet, Computer viruses. Application of ICT in day to day life: Education, Business, Health, Use of Internet for Scholarly Purposes, Software Platforms like Google Scholar, Jstor, Mendeley, Academia, ResearchGate etc.

Suggested Readings:

1. V.Rajaraman, Fundamentals of Computers, PHI
2. Pannu, Y.A.tomer, ICT4D Information and Communication Technology for Development, I.K. International Publishing House Pvt Ltd.

CS403	*Programming for Problem Solving*	L	T	P	C
		2	0	0	2

Problem Solving, Concept of Algorithms, Introduction to Computer Programming, Editing and Compiling a Program, Basic syntax of C programming language, Sequence, Selection and Repetition Constructs, Solving simple problems by programs such as Searching, Sorting, etc.

Suggested Readings:

1. R.C. Hutchinson and S.B. Just, Programming using the C Language, McGraw-Hill.

CS404	*E-Commerce**	L	T	P	C
		2	0	0	2

Objectives, Advantages and disadvantages, Forces driving E-Commerce, Traditional commerce Vs. E-Commerce, E-Commerce opportunities for Growth.
E-Commerce Models
Electronic Payment Systems, Types of E-payment systems.
E-Marketing, E-Customer Relationship Management, E-Supply Chain Management.
Security Issues in E-Commerce, Security tools and risk management approach. Cyber laws, Business Ethics, IT Acts.

Suggested Readings:

1. Bharat Bhaskar, Electronic Commerce – Frameroork Technologies and Applications, TMH.
2. Ravi Kalakota & A.B. Whinston, Frontiers of Electronic Commerce, Pearson.
3. Ravi Kalakota & A.B. Whinston, Electronic Commerce – A Manager's Guide, Pearson .
4. Agarwala Kamlesh, N and Agarwala Deeksha, Business on the Net_Introduction to the E-Com., Macmillan.
5. P. T. Joseph, E-Commerce: A Managerial Perspective, PHI.

CS405	*Human Computer Interaction**	L	T	P	C
		2	0	0	2

Introduction, History of HCI, Aspect of Human Cognition, the Computer, Models of Interaction, HCI frameworks & paradigms, Predictive Evaluation Interpretive Evaluation, Task Analysis, Empirical Evaluation, Gathering Usability Data, Usability principles.

Suggested Readings:

1. Dix, Finlay, Abowd and Beale, ''Human-Computer Interaction'', 3rd edition, by Pearson Education, 2004.

2. John carroll, ''Human-Computer Interaction in the New Millennium'', by Pearson Education, 2002.

CS406	*Massive Open Online Courses**	L	T	P	C
		2	0	0	2

Internet based.

CS501	Technical Writing	L	T	P	C
		0	3	0	3

This course is designed to teach students about writing a good technical report or a paper. Students will be required to understand basic organization, and prepare a report on a topic approved by the department.

CS502	Communication Skills	L	T	P	C
		0	3	0	3

This course is designed to help students improve their communication skills. Students will be taught through activities such as Group Discussion, Presentation, etc.

CS503	Undergraduate Project	L	T	P	C
		0	0	0	12

This is Project Work for Undergraduate Students. Students of Undergraduate program will have to work on a project work involving design of information systems using databases and Web-based user interface.

CS504	Mini Project (Computer Science)	L	T	P	C
		0	0	0	8

This course is preparatory course for Computer Science Masters students. They will carry out literature survey in a selected area, prepare a review paper and a prototype of a system that can be further elaborated during their Dissertation work.

CS505	Mini Project (Computer Applications)	L	T	P	C
		0	0	0	4

This course is first hands on course on full-scale project for Computer Applications Masters students. They will carry out literature survey in a selected area, prepare a review paper and a working prototype of a computational system.

CS506	Major Project (Masters Level)	L	T	P	C
		0	0	0	12

This course is a full-scale project involving design of a complete computational/ information system. Students of Masters in Computer Applications will have the option to carry out this course in Industrial setting.

CS507	Dissertation (Masters Level)	L	T	P	C
		0	0	0	16

This course involves computational work and thesis writing by Masters in Computer Science Students for their Dissertation.

CS508	Comprehensive Viva	L	T	P	C
		0	0	0	2

This course involves examination of learning outcome of students through a Viva Voce from the entire syllabus covered in their program.

CS509	Reading Elective	L	T	P	C
		0	0	0	2

This is a self-study course. Students will have to choose one Reading Elective from a list to be prepared by the department on an annual basis. They will study and complete the course on their own and then present themselves for evaluation at the end of the semester. Students will be encouraged to complete and obtain certificate of online courses from popular E-learning portals like Coursera, Udacity, MIT Open Course Ware, NPITEl etc.