Deccan Education Society's FERGUSSON COLLEGE (AUTONOMOUS), PUNE

Syllabus

For

M. Sc.(Industrial Mathematics with Computer Applications) Part II

(Semester-III and Semester-IV)

[Pattern 2019]

From Academic Year

2020-21

Program Structure of M.Sc. (Industrial Mathematics with Computer Applications) Part-II

Particulars	Paper	Paper code	Title of Paper	Type of Paper	No. of Credits
M.Sc. Semester III	Paper -1	MTS5301	Digital Image Processing	D Elect-1	4
		MTS5302	Statistical Inference	D Elect -2	4
		MTS5303	Complex Analysis	D Elect -3	4
		MTS5304	Financial Mathematics	D Elect -4	4
		MTS5305	Coding Theory	D Elect - 5	4
	Paper -2	MTS5306	Operating Systems	T-Core	4
	Paper -3	MTS5307	Computer Networks	T- Core	4
	Paper -4	MTS5308	Experiential Training Course on Data Structures using C	P -Core	4
Note: Students need to opt any THREE courses from MTS5301 to MTS5305					
M.Sc. Semester IV	Paper -1	MTS5401	Design and Analysis of Algorithms	D Elect-1	4
		MTS5402	Cryptography	D Elect-2	4
		MTS5403	Applied Geometry for Computer Graphics using CAD	D Elect-3	4
		MTS5404	Dynamical Systems	D Elect-4	4
		MTS5405	Machine Learning	D Elect-5	4
	Paper - 2	MTS5406	Theoretical Computer Science	D Elect-6	4
		MTS5407	UNIX Internals	D Elect-7	4
	Paper - 3	MTS5408	Experiential Training Course on Java Programming	T - Core	4
	Paper - 4	MTS5409	Experiential Training Course on Python Programming	P - Elect 1	4
	Paper - 5	MTS5410	Experiential Training Course on Web UI and UX	P – Elect 2	4
Note: Students need to opt **any THREE** courses from MTS5401 to MTS5405, **any ONE** from MTS5406 and MTS5407 and **any ONE** from MTS5409 and MTS5410.					

MTS5301 Digital Image Processing [Credits -4]

Course Outcomes:

After learning this course student will be able to:

CO1 Understand introductory part of Mathematical Concepts of Digital Image

CO2 Focus on Mathematical and Statistical Properties of Digital Image

CO3 Understand Overview of processing of Images with some applications to real life problems using open sources.

Unit I	**Introduction** What is Digital Image Processing, the origins of Digital Image Processing, Examples of Fields that use Digital Image Processing, Gamma-Ray Imaging, X-Ray Imaging, Imaging in the Ultraviolet Band, Imaging in the Visible and Infrared Bands, Imaging in the Visible and Infrared Bands, Imaging in the Visible and Infrared Bands, Imaging in the Microwave Band, Imaging in the Radio Band , Fundamental steps in Digital Image Processing , Components of an Image Processing System
Unit II	**Digital Image Processing Fundamentals** Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships between Pixels, An Introduction to the Mathematical Tools Used in Digital Image Processing: Array versus Matrix Operations, Linear versus Nonlinear Operations, Arithmetic Operations, Set and Logical Operations.
Unit III	**Intensity and Spatial Filtering** Background, Some Basic Intensity Transformation Functions Histogram Processing Histogram Equalization and Normalization, Histogram Matching (Specification), Local Histogram Processing Fundamentals of Spatial Filtering, Sharpening Spatial Filters Combining Spatial Enhancement Methods.
Unit IV	**Filtering in Frequency Domain** Background, Preliminary Concepts, Sampling and the Fourier Transform of Sampled Functions, The Discrete Fourier Transform (DFT) of One variable, Extension to Functions of Two Variables. Some Properties of the 2-D Discrete Transform, The Basics of Filtering in the Frequency Domain, Image Smoothing Using Frequency Domain Filters, Image Sharpening Using Frequency Domain Filters, Selective Filtering
Unit V	**Image Restoration and Reconstruction** A Model of the Image Degradation / Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Band reject Filters: Band pass Filters, Notch Filters, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Geometric Mean Filter
Unit VI	**Morphological Image Processing** Preliminaries, Erosion and Dilation, Opening and Closing The Hit-or-Miss Transformation, Basic Morphological Algorithms, Boundary Extraction, Hole Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Morphological Reconstruction, Introduction to Gray scale and Color Morphology
Unit VII	**Image Segmentation** Fundamentals, Point, Line, and Edge Detection: Background, Detection of Isolated Points, Line Detection, Edge Models, Basic Edge Detection, Edge

	Linking and Boundary Detection, Thresholding: Foundation, Basic Global Thresholding, Optimum Global Thresholding Using Otsu's Method, Using Image Smoothing to Improve Global Thresholding, Using Edges to Improve Global Thresholding Region-Based Segmentation
Unit VIII	**Representation and Description** Representation: Boundary (Border) Following, Chain Codes, Polygonal Approximations Using Minimum-Perimeter Polygons, Other Polygonal Approximation Approaches, Signatures, Boundary Segments, Skeletons Boundary Descriptors, Some Simple Descriptors, Shape Numbers, Fourier Descriptors, Regional Descriptors, Some Simple Descriptors, Topological Descriptors, Texture

Note:
Some Lectures are assigned to Laboratory Course on MATLAB / Open CV

Reference Books:

1) Gonzalez, R. C. and Woods, R. E. [2002 / 2008], Digital Image Processing, 3rd ed., Prentice Hall
2) Sonka, M., Hlavac, V., Boyle, R. [1999]. Image Processing, Analysis and Machine Vision (2nd edition), PWS Publishing, or (3rd edition) Thompson Engineering, 2007
3) Gonzalez, R. C., Woods, R. E., and Eddins, S. L. [2009]. Digital Image Processing Using MATLAB, 2nd edition, Gatesmark Publishing, Knoxville, TN.
4) Anil K. Jain [2001], Fundamentals of digital image processing (2nd edition), Prentice-Hall, NJ.
5) Willian K. Pratt [2001], Digital Image Processing (3rd Edition), John Wiley & Sons, NY.
6) Burger, Willhelm and Burge, Mark J. [2008]. Digital Image Processing
7) Kropatsch, Digital Image Analysis (With CD-ROM), Springer, ISBN: 978038795066
8) Jähne, Digital Image Processing, 6e (With CD), Springer, ISBN: 978-3-540-24035-8 2

MTS5302: Statistical Inference [Credits-4]

Course Outcomes After learning this course student will be able to: CO1 learn Mathematical Concepts in Statistical Inference with some Applications to data	
Unit I	**Introduction to Statistical Inference** Parametric and Non parametric families, Point and interval estimation, Testing Hypothesis, Fitting the underlying distribution
Unit II	**Functions of Random Variables** The Method of Distribution Functions, The Method of Transformations, Distributions of Sum, Quotients and Products, Order Statistics, Generating Functions, Sampling from a Normal Populations
Unit III	**Large Sample Theory** Approximating Distributions: Limiting Moment Generating Functions, The Central Limit Theorem of Levy, Consistency, Large Sample Interval and Point Estimation, Large Sample Hypothesis Testing, Inference concerning Quantiles, Goodness of Fit for Multinomial Distribution
Unit IV	**General Methods of Point and Interval Estimation** Sufficiency, Unbiased Estimation, The Substitution Principle (Method of Moments), Maximum Likelihood Estimation, Bayesian Estimation, Confidence Intervals
Unit V	**Testing of Hypothesis** Neyman Pearson Lemma, Composite Hypotheses, Likelihood Ratio tests, Wilcoxin Signed Rank Test, Some two Sample Tests, Chi Square Test for Goodness of Fit, Kolmogorov Smirnov Goodness of Fit Test, Measures of Association of Bivariate Data
Unit VI	**Analysis of Categorical Data** Chi-Square Test for Homogeneity, Testing of Independence of Contingency Table
Unit VII	**Analysis of Variables- K Sample Problem** One Way ANNOVA, Multiple, Comparison of Means, Two-way ANNOVA, Testing Equality of K Independent Samples:Non-Normal case, The Friedman Test for K Related Samples

Reference Books:

1) Vijay Rohatgi, Statistical Inference, Dover Publications
2) Robert Hogg, Elliot Tannis, Jagan Mohan Rao, Probability and Statistical Inference, Pearson Edition
3) George Casella, Roger Berger, Statistical Inference, Duxbury Advanced Series, Cenage Learning

MTS5303: Complex Analysis [Credits-4]

Course Outcomes

After learning this course student will be able to:

CO1 Focus on Pure Mathematical Aspects of different methods in Complex Analysis along with hands on different examples based on Complex Analysis.

Unit I	**Complex Numbers and Topology of Complex Plane** Algebra of Complex Numbers, Roots of unity and related products.
Unit II	Analytic functions Functions, Limits and Continuity of Complex valued functions, Differentiability: Definition and properties, Cauchy-Riemann Equation, Polar coordinates, Analytic functions and examples, harmonic functions and equations, Zeros of an analytic functions and related examples.
Unit III	**Elementary Functions** The Exponential Function, The Logarithmic Function, Branches and Derivatives of Logarithms, Some Identities Involving Logarithms, Complex Exponents, Trigonometric Functions, Hyperbolic Functions, Inverse Trigonometric and Hyperbolic Functions
Unit IV	**Integrals** Derivatives of Functions w(t), Definite Integrals of Functions w(t), Contours, Contour Integrals and examples, Examples with Branch Cuts Upper Bounds for Moduli of Contour Integrals, Antiderivatives, Cauchy–Goursat Theorem, Simply Connected Domains, Multiply Connected Domains, Cauchy Integral Formula, An Extension of the Cauchy Integral Formula, Liouville's Theorem and the Fundamental Theorem of Algebra, Maximum Modulus Principle
Unit V	**Series** Convergence of Sequences, Convergence of Series, Taylor Series, Proof of Taylor's Theorem and examples, Laurent Series, Proof of Laurent's Theorem and examples, Absolute and Uniform Convergence of Power Series Continuity of Sums of Power Series
Unit VI	**Residues and Poles** Isolated Singular Points, Residues, Cauchy's Residue Theorem, Residue at Infinity, The Three Types of Isolated Singular Points, Residues at Poles and examples, Zeros of Analytic Functions, Zeros and Poles, Behavior of Functions Near Isolated Singular Points
Unit VII	**Applications of Residues** Evaluation of Improper Integrals and examples, Definite Integrals Involving Sine's and Cosines, Argument Principle

Reference Books:

1) James Ward Brown Ruel V. Churchill, Complex variables and applications, Eighth edition, McGraw-Hill
2) S Ponnusamy: Foundations of Complex Analysis, Narosa Publishing House 4th reprint)
3) Elais M Stein and Rami Shakarchi: Complex Analysis,Princeton Lecture Series in Analysis
4) John Conway: Functions of Complex Variable, Springer GTM Series

MTS5304: Financial Mathematics [Credits-4]

Financial Mathematics

Course Outcomes

After learning this course student will be able to:

CO1 Understand Introduction to Mathematical Concepts Mathematical Finance with Applications

Unit I	**Brownian Motion and Geometric Brownian Motion** Brownian Motion, Brownian Motion as Limit of Simpler Models, Geometric Brownian Motion, The Maximum Variable, The Cameron Martin Theorem
Unit II	**Interest Rates and Present Value Analysis** Interest Rates, Present Value Analysis, Rate of Return, Continuously varying Interest Rates
Unit III	**Pricing Contracts vs Arbitrage** An example of Options Pricing, Other Examples of Pricing via Arbitrage, The Arbitrage Theorem, The Multi-period Binomial Model, Proof of Arbitrage theorem
Unit IV	**Black Scholes Formula** Black Scholes Formula, Properties of Black Scholes Option Cost, The Delta Hedging Arbitrage Strategy, Some Derivations, European Put Options
Unit V	**Additional Results and Options** Call Options on Dividend Paying Securities, Pricing American Put Options, Adding Jumps to Geometric Brownian Motion, Estimating Volatility Parameter
Unit VI	**Valuing by Expected Utility** Limitations of Arbitrage Pricing, Valuing Investments by Expected Utility, The Portfolio Selection problem, Value at Risk and Conditional Value at risk, The Capital Assets Pricing Model, Rates of Return: Single Period and Geometric Brownian Motion

Reference Books:

1) Sheldon M Ross, An Elementary Introduction to Mathematical Finance, Third Edition, Cambridge University Press.
2) D.G. Luenberger, Investment Science, Oxford University Press
3) Marek Capinski, An introduction to Financial Engineering, Springer Publications.

MTS5305: Coding Theory[Credits-4]

Course Outcomes After learning this course student will be able to: CO1 Focus on Mathematical Aspects of Coding theory along with hands on applications to real life situations	
Unit I	**Finite Fields** Theorems and Proofs regarding Finite Fields with Examples
Unit II	**Error Detection: Coding and Decoding** Communication channels, Maximum likelihood decoding, Hamming distance, nearest neighbor / minimum distance decoding, Distance of a code.
Unit III	**Linear Codes** Vector spaces over finite fields, Linear codes, Hamming weight, Bases of linear codes, Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome decoding.
Unit IV	**The Main Coding Theory Problem** Idea of bounds Gilbert -Varshamov bound, Hamming bound (Definition only), Binary Hamming codes, q-ary Hamming codes
Unit V	**Cyclic Codes** Definitions, Generator polynomials, Generator and parity check matrices, Decoding of cyclic codes, Burst-error-correcting codes.
Unit VI	**Some Special Type of Cyclic Codes** BCH codes, Definitions, Parameters of BCH codes, Decoding of BCH codes, Reed Solomon codes, quadratic residue codes

Reference Books:

1) San Ling and Chaoing Xing, Coding Theory - A First Course.
2) Lidl and Pilz, Applied Abstract Algebra - 2nd Edition
3) J. H. Van Lint Introduction to Coding Theory, Third Edition
4) Gary L. Mullen, Carl Mummert, Finite Fields and Applications, AMS Publications.

MTS5306: Operating Systems [Credits-4]

Course Outcomes

After learning this course student will be able to:

CO1 Study the basic concepts and functions of operating systems.
CO2 Understand the structure and functions of OS.
CO3 Study about Processes, Threads and Scheduling algorithms.
CO4 Understand the principles of concurrency and Deadlocks.
CO5 Knowledge of various memory management schemes.
CO6 Study I/O management and File systems.
CO7 Understanding the basics of the Linux system and perform administrative tasks on Linux Servers

Unit I	**Introduction:** Basics of Operating Systems: Definition, Generations of Operating systems, Types of Operating Systems, Special Purpose OS, OS structure: Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine, Role of Data structures in OS History Linux, Login to Linux, Basic Commands, Manual Pages and More
Unit II	**File Management:** File concept, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency& performance. Overview of Linux File System, File System Commands, File Permissions, Hard Links, Symbolic Links, File Types:Regular, directory, device (Char, block), Pipe Files (named and unamed), Socket Files, Symbolic Links
Unit III	**Interprocess Communication:** Race Conditions, Critical Section, Mutual Exclusion, Hardware Solution, Strict Alternation, Semaphores, Event Counters, Monitors, Message Passing, and Classical IPCRedirection and pipes, filters(commands) and regular expressions
Unit IV	**Process Management:** **Processes:** Definition , Process Relationship , Process states , Process State transitions , Process Control Block ,Context switching, Threads, Concept of multithreads , Benefits of threads, Types of threads **Process Scheduling:** Definition , Scheduling objectives ,Types of Schedulers, Scheduling criteria : CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time (Definition only) , Scheduling algorithms : Pre-emptive and Non pre-emptive , FCFS, SJF, RR , Multiprocessor scheduling : Types , Performance evaluation of the scheduling.Process management commands, foreground / background processes, fairshare scheduler
Unit V	**Memory Management:** **Basic Memory Management:** Definition, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition – Internal and External fragmentation and Compaction, Paging: Principle of operation – Page allocation – Hardware support for paging – Protection and sharing **Virtual Memory:** Basics of Virtual Memory, Hardware and control structures, Locality of reference, Page fault, Working Set, Dirty page/Dirty bit, Demand paging

	(Concepts only), Page Replacement policies: Optimal (OPT), First in First Out (FIFO), Second Chance (SC), Least Recently used (LRU)
Unit VI	**I/O Management:** Principles of I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithm Disk management commands Vi editor

Reference Books:

1) Silberschatz, Galvin, Gagne. Operating System Concepts. John Wiley & sons, INC
2) Operating systems design and implementation, Andrew s. Tanenbaum, Prentice-Hall.
3) William Stallings, The Operating Systems – Internals and Design Principles, 7th Edition, Prentice Hall, 2011.
4) D M Dhamdhere, The Operating Systems: A Concept-Based Approach, Second Edition, Tata Mc Graw-Hill Education, 2007.
5) Jason Cannon, Linux for beginners

MTS5307: Computer Networks [Credits-4]

Course Outcomes After learning this course student will be able to: CO1 Independently understand basic computer network technology CO2 Understand and explain Data Communications System and its components. CO3 Enumerate the layers of the OSI model and TCP/IP. CO4 Explain the function(s) of each layer	
Unit I	**Introduction to Computer Networks** Data Communication: characteristics of data communication, Components, Data representation, Data Flow Computer Networks: · goals and applications, Network Hardware: broadcast and point-to-point, Network Topologies, Network Types, Protocols and Standards Network Software : Protocol Hierarchies, layers, protocols, peers, interfaces, networkarchitecture, protocol stack, Network architecture ,Design issues of the layers Connection-oriented and connectionless services
Unit II	**Network Models** OSI Reference Model with functionalities of each layer TCP/IP Reference Model with functionality of each layer, Protocol suit Comparison of OSI and TCP/IP model Addressing
Unit III	**Introduction to Physical Layer** Tasks Performed, Signals, Digital Transmission, Switching
Unit IV	**Data Link Layer** Data Link Layer Design Issues: Services provided to the network layer, Framing, Error control, Flow control Error Detection and Correction: Types of Errors, Single Bit, Bursts errors, Detection & Correction: Hamming, CRC (Problem solving), Simplex Protocols: Unrestricted, Stop and Wait, Simplex Protocol for Noisy Channel ,The Medium Access Sub-layer ,The Channel Allocation Problem: Static and Dynamic Allocation in LAN and MANs, Multiple Access: Random Access, Controlled Access, Channelization FDMA, TDMA, CDMA ,Data Link Layer Switching: Bridges from 802.x to 802.y, Local Internetworking, Spanning tree Bridges, Remote Bridges, Repeaters, Hubs, Switches, Routers, Gateways IEEE 802.11 Architecture, Bluetooth Architecture: Piconets and Scatternet, Virtual LANs
Unit V	**Network Layer** Network Layer Design Issues: Store and Forward Packet Switching, Services Provided to Transport Layer, Implementation of Connectionless Services, Comparison of Virtual Circuit and Datagram, Addressing: Internet, Classful, Subnetting, Classless Addressing, Dynamic Address Configuration (Problems on all types of addressing), IPV4 Datagram, Checksum Calculation IPV6 Characteristics, IPV4 Vs IPV6, Routing Algorithm: Properties, Types of Routing Algorithm, Adaptive and Non-Adaptive Algorithm, Congestion Control General Principles of Congestion Control Congestion Prevention Policies

Unit VI	**Transport Layer** Services provided to the Upper layers, Transport Service primitives Elements of Transport Protocols: Addressing, Connection Establishment, Connection Release, Flow Control and Buffering, Multiplexing, Crash Recovery, The Internet Transport Protocols: TCP, UDP, Checksum Calculation
Unit VII	**Upper Layer Protocols** SMTP, FTP, HTTP (functionality and applications only), DNS – Details
Unit VIII	**Current Trends:** Introduction to Virtualization Introduction to Quantum Computing

Reference Books:

1) A. S. Tanenbaum, Computer Networks, Pearson Publication,4th Edition
2) Behrouz Forouzan, Data Communication and Networking, McGraw-Hill Publication, 3rdEdition.
3) S. A. M. Rizvi and V. K. Sharma, An Introduction to Computer Networks, Alpha Science International Limited,

MTS5308: Experiential Training Course on Data Structures using C [Credits-4]

Course Outcomes After learning this course student will be able to: CO1 Describe how arrays, stacks, linked lists, queues, trees, and graphs are represented in memory and used by algorithms CO2 Identify fundamental data structures and algorithms and summarize their typical uses, strengths, and weaknesses CO3 Understand concepts about searching and sorting techniques CO4 Solve problems computationally through the application of fundamental data structures and algorithms CO5 Describe common applications for arrays, records, linked structures, stacks, queues, trees, and graphs	
Unit I	**Introduction to Data Structures and Algorithms** Data, Data Types. Abstract Data Types, Data Structure and its types, Asymptotic Analysis of Algorithms
Unit II	**Array** Concept, Arrays as ADT, 1-D and Multidimensional Arrays, Advantages and Disadvantages **Application** (Sorting, Searching, Polynomial handling)
Unit III	**Stack** Concept, Stack as ADT, Operations (Push and Pop), Stack Representation (Sequential), Advantages and Disadvantages **Applications** (Infix to Postfix conversion of Expression, Postfix Expression Evaluation & Recursion)
Unit IV	Q**ueue** Concept, Queue as ADT, Operations (Insert, Delete and Traversal), Queue Representation (Sequential), Types of Queue (Priority Queue, Circular Queue, Dequeue), Advantages and Disadvantages **Applications** (CPU scheduling Algorithm: FCFS, SJF (Preemptive), Priority)
Unit V	**Linked List** Concept, LinkedList as ADT, Types (Singly, Doubly and Circular), Operations (Insert, Delete and Traversal), Linked List Representation (Sequential, Linked), Advantages and Disadvantages **Applications** (Contiguous File Allocation as well as Linked File Allocation using Sequential Linked List, Linked Representation (Stack, Queue), Disk Scheduling Algorithm using Doubly Linked List- SCAN)
Unit VI	**Tree** Concept, Terminologies, Types of Trees (Binary and Binary Search Tree), Binary Search Tree Representation (Sequential and Linked), Operations on BST (Insert, Delete and Traversal (In-order, Pre-order and Post-order)) **Application** (Heap Sort, AVL tree)

Unit VII	**Searching and Sorting** Searching Concept and its use, Techniques (Linear search, Binary search) Sorting Concept and its use, Techniques (Bubble, Quick, Insertion, Merge, Counting)
Unit VIII	**Graphs** Concept, Terminologies, Graph Representation (Sequential and Linked), Traversals (DFS and BFS) **Applications** (Shortest path algorithm: Dijkstra's algorithm)

Reference Books:

1) Sahni Horowitz, Fundamentals of Computer Algorithms
2) Langsam / Augenstein / Tenenbaum, Data Structures Using C and C++
3) Jean-Paul Tremblay &Paul G. Sorenson, An Introduction to Data Structures with Applications, Tata McGraw Hill.
4) Gilberg & Forouzan Data Structures: A Pseudo-code approach with C, Thomson Learning.
5) Deepali Srivastava and S K Srivastava, Data Structures Through C in Depth

MTS5401: Design and Analysis of Algorithms [Credits – 4]

Course Outcomes After learning this course student will be able to: CO1 learn the fundamentals and techniques to write efficient algorithms that can be programmed using any programming language	
Unit I	**Growth of Functions** Asymptotic Notations, Growth of Functions
Unit II	**Recurrences** The substitution Method, The Recursion Tree Method, The Master Theorem
Unit III	**Sorting of Order Statistics** Heap Sort, Quick Sort, Sorting in Linear Time, Median and Order Statistics.
Unit IV	**Dynamic Programming** Matrix Chain Multiplication, Longest Common Subsequence, Optimal Binary Trees
Unit V	**Greedy Algorithms** An activity selection problem, Elements of Greedy Strategy, Huffman Codes.
Unit VI	**Graph Theoretic Algorithms** Revision of BFS and DFS for Data Structures, Topological Sort, Revision of Kruskal and Prim, Bellman Ford Algorithm, Dijkstra Algorithm
Unit VII	**Hash Tables** Direct Address Tables, Hash Tables, Hash Functions, Open Addressing, Perfect Hashing
Unit VIII	**NP Completeness** Informal Concepts of Deterministic and Non-Deterministic, P, NP and NP Completeness, Statement of Cooks Theorem, Discussion on Vertex Cover Problem, Discussion on Travelling Salesman Problem

Reference Books:

1) Introduction to Algorithms, H Coremen, Rivest, Stein and Leiserson
2) Fundamentals of Computer Algorithms: Horowiitz, Sahani and Rajasekeran
3) Mathematics for Analysis of Algorithms: D Knuth and H. Green
4) An introduction to Analysis of Algorithm: Micheal Soltys
5) Algorithm Design: Jon Kleinberg, Eva Tardos

MTS5402: Cryptography [Credits – 4]

Course Outcomes

After learning this course student will be able to:

CO1 Focus on Mathematical Aspects of Algorithms in Cryptography along with examples and hands-on applications to real life situations.

Unit I	**Preliminaries** Congruence, Chinese Remainder Theorem, Primitive Roots, Quadratic reciprocity, Finite fields, Arithmetic functions Primality Testing and factorization algorithms, Pseudo-primes, Fermat's pseudo-primes, Pollard's rho method for factorization, Continued fractions, Continued fraction method Hash Functions
Unit II	**Introduction to Cryptography** Cryptography in Modern world, Substitution cipher, Ceaser cipher as a special case of substitution cipher, Monoalphabetic ciphers, Transposition Cipher, Polyalphabetic substitution ciphers, Vigenere Cipher, Introduction to polygraphic substitution ciphers, cryptanalysis of substitution cipher
Unit III	**Symmetric Key Cryptography** Introduction and overview, Stream Cipher, one-time Pad, Block cipher, Modes of operation Electronic codebook, cipher block chaining, Cipher feedback, Algorithms: Data Encryption Standard, Advanced Encryption Standard, IDEA (International Data Encryption Algorithm), Attacks against DES, AES, IDEA
Unit IV	**Public Key Cryptography** Introduction and Overview, The RSA algorithm, Generation of keys, Exchange messages, Diffie Hellman Key Agreement protocol, EI Gamal Encryption, Algorithms: Discrete Logarithm, MD5, Attacks against RSA, Discrete Logarithm
Unit V	**Hashing** Motivation and applications, cryptographically secure hashing, message authentication codes (MAC), HMAC, Network security, Secure Socket layer (SSL), Definition of secrete sharing, visual secret schemes, Shamir's sharing scheme.
Unit VI	**Applications of Cryptography** Digital Signature, Kerberos, Pretty Good privacy Internet protocol security Note
Unit VII	**Elliptic Curve Cryptography** Introduction and Overview
Unit VIII	**Introduction to Block chain Technology** Familiarise the functional/operational aspects of crypto currency ECOSYSTEM, Understand emerging abstract models for Block chain Technology.

Reference Books:

1) D. R. Stinson: CRYPTOGRAPHY, Theory and practice, CRC Press, 1995
2) Neil Koblitz: A course in Number theory and Cryptography, 2nd Edition, Springer
3) Robert Edward Lewand: Cryptological Mathematics (Mathematical Association of

America).
4) Jeffrey Hoffstein, Jill Pipher, Joseph H. Silverman: An introduction to Mathematical Cryptography, Springer
5) Adam J. Elbirt: (CRC press): Understanding and Applying cryptography and Data security.
6) Bruice Schneier: Applied Cryptography (Wiley India Edition)
7) Atul Kahate: Cryptography and Network security (Tata McGraw Hill)
8) Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder.
Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University
Press, 2016. (Free download available)
9) Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015 (article available for free download) { curtain raiser kind of generic article, written by seasoned experts and pioneers}.

MTS5403: Applied Geometry for Computer Graphics using CAD [Credits – 4]

Course Outcomes

After learning this course student will be able to:

CO1 Learn the fundamentals and techniques to write efficient algorithms that can be programmed using any programming language

Unit I	**Transformations in a Plane** Translations, Scaling about the Origin, Reflections, Rotation about the Origin, Shears, Concatenation of Transformations, Applications, Instancing, Robotics
Unit II	**Homogeneous Coordinates and Transformations of the Plane** Homogeneous Coordinates ,Points at Infinity Visualization of the Projective Plane, Line Model of the Projective Plane, Spherical Model of the Projective Plane, Transformations in Homogeneous Coordinates, Translations, Scaling about the Origin Rotation about the Origin ,Concatenation of Transformations, Inverse Transformations, Rotation about an Arbitrary Point, Reflection in an Arbitrary Line, Applications: Instancing, Device Coordinate Transformation
Unit III	**Homogeneous Coordinates and Transformations of Space:** Homogeneous Coordinates, Transformations of Space, Translations, Scaling and Reflections, Rotations about the Coordinate Axes, Rotation about an Arbitrary Line, Reflection in an Arbitrary Plane, Applications: Computer-aided Design, Orientation of a Rigid Body
Unit IV	**Projections and the Viewing Pipeline:** Introduction, Projections of the Plane, Projections of Three-dimensional Space, The View plane Coordinate Mapping, The Viewing Pipeline, Classification of Projections, Classification of Parallel Projections, Classification of Perspective Projections
Unit V	**Curves** Introduction, Curve Rendering, Parametric Curves, Arc length and Reparameterization, Application: Numerical Controlled Machining and Offsets
Unit VI	**Bezier Curves** Introduction, Linear Bezier Curves, Quadratic Bezier Curves, Cubic Bezier Curves
Unit VII	**B-splines:** Integral B-spline Curves, Properties of the B-spline Curve, B-spline Types, Application: Font Design, Application: Morphing or Soft Object Animation

Reference Books:

1) Duncan Marsh, Applied Geometry for Computer Graphics and CAD, 2nd Edition, Springer.
2) D.F. Rogers, J. Alan Adams: Computer Graphics, 2nd Edition, McGraw-Hill Publishing Company.
3) David Lay: Linear Algebra Mathematical Elements of Computer Graphics

MTS5404: Dynamical Systems [Credits – 4]

Course Outcomes
After learning this course student will be able to:
CO1 learn the mathematical aspects of dynamical systems with programming applications

Unit I	**Differential Equations** Simple Differential Equations, Applications to Chemical Kinematics, Applications to Electrical Circuits, Existence and Uniqueness Theorem
Unit II	**Planar Systems** Canonical Forms, Eigen values defining Stable and Unstable Manifolds, Phase Plane Portraits, Linearization and Hartman's Theorem, Constructing Phase Plane Diagram
Unit III	**Interacting Species** Competing Species, Predator Prey Models, Other Characteristics Affecting Interacting Species
Unit IV	**Limit Cycles** Existence and Uniqueness of Limit Cycles in a Plane, Non-Existence of Limit Cycles, Pertuburation Methods
Unit V	**Hamiltonian Cycles, Lyapunov Functions and Stability** Hamiltonian Systems in the plane, Lyapanov Systems and Stability
Unit VI	**Bifurcation Theory** Bifurcations of Non-Linear Systems, Normal Forms, Multistability and Bistability
Unit VII	**Three Dimensional Autonomous Systems and Chaos** Linear System and Canonical Forms, Non-Linear Systems and Stability, The Rossler System and Choas, The Lorentz Equations, Chua Circuit and the Belousov Zhabotinski Reaction.Introduction to Poincare Maps

Reference Books:

1) Stephen Lynch, Dynamical Systems with Applications using Python, Birkhauser Publications
2) Morris Hirsch, Stephen Smale, Differential Equations, Dynamical Systems and ntroduction to Choas, Academic Press

MTS5405: Machine Learning [Credits – 4]

Course Outcomes After learning this course student will be able to: CO1 learn the Mathematical Concepts in Machine Learning with applications to data	
Unit I	**Statistical Learning** What is Statistical Learning, Accessing Model Accuracy
Unit II	**Linear Regression** Simple Linear Regression, Multiple Linear Regression, Other Considerations in Regression Model, The Marketing Plan, Comparison of Linear Regression with K Nearest Neighbours, Lab Regression
Unit III	**Classification** An Overview of Classification, Logistic Regression, Linear Discriminant Analysis, A Comparison of Classification methods, Lab: Logistic Regression, LDA, QDA and KNN
Unit IV	**Resampling Methods** Cross Validation, The Bootstrap, Lab: Cross Validation and the Bootstrap
Unit V	**Tree Based Methods** The Basics of Decision trees, Bagging, Boosting, Random Forests, Lab: Decision Trees
Unit VI	**Unsupervised Learning** The Challenge of Unsupervised Learning, Principal Component Analysis, Clustering Methods, Lab 1: Principal Component Analysis, Lab 2: Clustering
Reference Books: 1) Gareth James, Daneila Witten, Trevor Hastie, Robert Tibshirani: An Introduction to Statistical Learning, Springer Publications 2) Christopher Bishop, Pattern Recognition and Machine Learning, Springer Publications	

MTS5406 : Theoretical Computer Science [Credits – 4]

Course Outcomes After learning this course student will be able to: CO1 Give an overview of the theoretical foundations of computer science from the perspective of formal languages CO2 Illustrate finite state machines to solve problems in computing CO3 Explain the hierarchy of problems arising from computer sciences CO4 Understand Regular grammars, context frees grammar.	
Unit I	**Introduction** Symbol, Alphabet, String, Prefix & Suffix of Strings, Formal Language, Operations on Languages, Regular Expressions (RE): Definition & Examples Regular Expression: Identities.
Unit II	**Finite Automata** Finite automata: Concept, transition function, transition diagram Deterministic finite Automaton Definition, Nondeterministic finite automaton Definition and Examples. NFA to DFA: Method (From Book 4) and Problems NFA with ε transitions Definition and Examples. NFA with ε Transitions to DFA: Examples Finite automaton with output Mealy and Moore machine, Definition and Examples, Equivalence. Minimization of DFA, Algorithm & Problem using Table Method. DFA as language recognizer, DFA as a pattern recognizer. Application: token recognizers in Lexical Analysis phase of compiler construction and Lexical Analyzer: LEX Example
Unit III	**Regular Languages** Regular language, Definition and Examples, Conversion of RE to FA Examples, Pumping lemma for regular languages & Applications. Closure properties of regular Languages (Union, Concatenation, Kleene closure, Complement and Intersection)
Unit IV	**Push Down Automaton** Definition of PDA and Example, Language acceptance by empty stack and by final state, Construction of PDA using empty stack Method and Examples Definition DPDA & NPDA, Examples of NPDA Construction of PDA from the given CFG: Method and Examples
Unit V	**Turing Machine** The Turing Machine Model and Definition of TM, Design of Turing Machines Language accepted by TM ,Types of Turing Machines
Reference Book : 1) John E. Hopcroft and Jeffrey Ullman -Narosa Publishing House, Introduction to Automata theory, Languages and computation	

2) Introduction to Automata theory, Languages and computation, 3rd edition Pearson Education

3) Daniel I. A. Cohen ,John Wiley & Sons,Introduction to Computer Theory,2nd edition

4) K. L. P. Mishra & N. Chandrasekaran, PHI Second Edition, Theory of Computer Science ,(Automata, Language & Computation)

5) John C. Martin TMH, Introduction to Languages and The Theory of Computation, 2nd Edition Published by John Wiley & Sons, Inc.

MTS5407: UNIX Internals [Credits – 4]

Course Outcomes

After learning this course student will be able to:

CO1 Understand UNIX operating system concepts and terminology.

CO2 Develop a command of the Unix Shell environment, including UNIX commands and utilities

CO3 Get thorough understanding of the kernel

CO4 Understand the file organization and management

CO5 Enhance knowledge about various system calls

CO6 Have knowledge of process architecture, process control & scheduling and memory management.

Unit I	**GENERAL OVERVIEW OF THE SYSTEM** History, System structure, User perspective, Operating system services, Assumptions about hardware. Introduction to the Kernel: Architecture of the UNIX operating system, Introduction to system concepts, Kernel data structures, System administration, Summary and Preview.
Unit II	**BUFFER CACHE** Buffer headers, Structure of the buffer pool, Advantages and disadvantages of the buffer cache. Internal representation of files:Inodes, Structure of a regular file, Directories, Conversion of a path name to an Inode, Super block, Other file types.
Unit III	**SYSTEM CALLS FOR FILE SYSTEM** Open, Read, Write, File and record locking, Adjusting the position of file I/O, LSEEK, Close, File creation, Creation of special files, Pipes, Dup, Mounting and unmounting file systems.
Unit IV	**THE STRUCTURE OF PROCESSES** Process states and transitions, Layout of system memory, The context of a process, Saving the context of a process. Process Control: Process creation, Signals, Process termination, Awaiting process termination, Invoking other programs, The shell, System boot and the INIT process.
Unit V	**PROCESS SCHEDULING AND MEMORY MANAGEMENT POLICIES** Process Scheduling, Memory Management Policies: Swapping, A hybrid system with swapping and demand paging. The I/O Subsystem: Driver Interfaces, Disk Drivers, Terminal Drivers

Reference Books:

1) Maurice J. Bach, “The Design of the Unix Operating System”, Prentice Hall of India, 2004.
2) Vahalia, “Unix Internals: The New Frontiers”, Pearson Education Inc, 2003.
3) Sumithbha Das, Unix Concepts and Applications, The McGraw-Hill Companies.
4) John Lion, “Lion’s Commentary on UNIX”, 6thedition, Peer-to-Peer Communications, 2004.
5) Daniel P. Bovet & Marco Cesati, “Understanding the Linux Kernel”, O’REILLY, Shroff Publishers &Distributors Pvt. Ltd, 2000

MTS5408 Experiential Training Course on Java Programming [Credits – 4]

Course Outcomes

After learning this course student will be able to:

CO1Use an integrated development environment to write, compile, run, and test simple object-oriented Java programs
CO2 Understand how to implement object-oriented designs with Java
CO3 Identify Java language components and how they work together in applications
CO4 Understand how to use Java APIs for program development
CO5 Understand the concepts of OOPs, array, string, abstract class, interface
CO6 Learn how to extend Java classes with inheritance and dynamic binding
CO7 Learn how to read and write files in Java
CO8 Learn how to use exception handling in Java applications
CO9 Understand how to design applications with threads in Java.
CO10 Learn Java generics and how to use the Java Collections API
CO11 Understand how to design JDBC applications
CO12 Describe the JAVA 8 Features

Unit I	**Introduction to Object Oriented Concepts** Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism, Types of Languages (Object Oriented, Procedure Oriented, Scripting)
Unit II	**Introduction to the Java Technology** The Java Platform, API, JVM, Java Compiler, Byte Code, Java Editions, Difference between JDK, JRE & JVM
Unit III	**Basics of Java** Introduction to Java, Writing & Compiling Java Programs- The main Method, Command Line Arguments, String Class, Primitive Data Types, Variables, and Assignment, Javadoc Comments, UNICODE System, Naming Convention, Expressions, Data Conversion, Boolean Data Type and Expressions { if, switch } Statements,{for,while,do}Statements, for-each loop, Methods, Parameter Passing, Returning Values, Overloading Methods, Scope of Variables, Varargs
Unit IV	**Arrays** Defining and Initializing Arrays, new Operator, Using Arrays, Passing Arrays to Methods, Returning Arrays from Methods, Command-Line Arguments, Dimensional Arrays
Unit V	**Objects and Classes** Defining Class, Creating Object, Strong Reference vs Weak Reference, Packages (Concept of package, package and import keywords, Use of predefined packages), Visibility Modifiers(public, private, protected, default), Object, Members and Class Members (static), Arrays of Objects, this Keyword, Wrapper Classes, Types of Classes (Inner Class, Anonymous Class), Static block , Scanner Class
Unit VI	**String Handling** What is a String? Immutable Strings, Substring, Methods of String Class, toString() Method, StringBuffer Class, StringBuilder Class, StringBuffer vs StringBuilder

Unit VII	**Inheritance and Polymorphism** Inheritance (IS-A), Aggregation/Composition (HAS-A), Superclass and Subclass – extends Keyword, super Keyword, Overriding Members, Protected Data Members- Object Class and its toString() Method, Final Classes, Methods and Variables, instanceof Operator, Dynamic Binding, Casting Objects
Unit VIII	**Abstract Classes & Interfaces** Concept of Interfaces, Implementing Interfaces, when to use which? Programming to Interface Concept
Unit IX	**Exceptions and Exception handling** Exception Handling: What and Why? try and catch Block, Multiple catch Block, Nested try, finally Block, throw Keyword, Exception Propagation, throws Keyword, Checked & Unchecked Exceptions, Custom Exception, final vs finally
Unit X	**File Handling** FileOutputStream & FileInputStream, BufferedOutputStream & BufferedInputStream, FileWriter & FileReader, Using Scanner Class to Read from File, PrintWriter, StreamTokenizer, ObjectInputStream & ObjectOutputStream, Serialization & Deserialization, transient Keyword
Unit XI	**Multithreading** Multithreading: What and Why? Life Cycle of a Thread, Creating Thread (Extending Thread Class/ Implementing Runnable Interface), Thread Priority, what is a Daemon Thread? Thread synchronization, Inter-Thread Communication Methods (wait() &notify ())
Unit XII	**Introduction to Collection Framework** Collection Framework, ArrayList Class, LinkedList Class, HashSet Class, TreeSet Class, Hashtable Class, HashMap Class, TreeMap Class, Comparable and Comparator Interfaces
Unit XIII	**JDBC** JDBC Driver (Type4), Connectivity with MySQL, DriverManager, Connection interface, Statement interface, ResultSet interface, PreparedStatement, ResultSetMetaData, DatabaseMetaData
Unit XIV	**JAVA 8 Features** Lambda expression, Functional Interfaces, Method References, Default Method, forEach () method, StringJoiner class, Annotations, Type Annotations (@NonNull, @NonNegative, @Encrypted, @Open, @ZeroDivisor)
Unit XV	**Introduction to Web Application** What is a web application? HTTP Request, HTTP Response, Client UI (HTML/CSS, JAVAScript) & Server (Servlet/JSP), Tomcat Web Server, "Hello World" Web App Demo using Servlet &JSP

Reference Books:

1) Java: How to Program, Deitel & Deitel, PrenticeHall
2) Core Java 2: Volume I – Fundamentals, Cay S. Horstmann and Gary Cornell; Prentice-Hall 2002. ISBN 0130471771
3) Core Java 2: Volume II – Advanced Features, Cay S. Horstmann and Gary Cornell; Prentice-Hall 2001. ISBN0130927384
4) Java: The Complete Reference, Herbert Schildt. Fifth Edition

Important URLs:

http://java.sun.com/reference/docs/

MTS5409 : Experiential Training Course on Python Programming [Credits – 4]

Course Outcomes After learning this course student will be able to: CO1 Use an integrated development environment to write, compile, run, and test simple Python programs CO2 Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in python CO3 Express different decision-making statements and functions CO4 Interpret Object oriented programming in python CO5 Understand and summarize different File handling operations in Python CO6 Explain how to design GUI Applications in python and evaluate different database operations in python CO7 Understand how to make python code robust by handling errors and exceptions properly CO8 Describe different methods to create threads and learn to implement synchronization for thread-safe operations CO9 Understand how to explore python built-in libraries to solve a problem in context without writing your own code	
Unit I	**Python Introduction** What is Python?, Features, History, Version, Applications, Install Python, Python Path, Python Example, Execute Python, Variables, Keywords, Identifiers, Literals, Operators, Comments
Unit II	**Control Statement** if, if-else if, nested if, for loop, while loop, do-while, break, continue, pass
Unit III	**Python Strings** Accessing Strings, Basic Operators, Membership Operators, Relational Operators, Slice Notation, String functions and Methods
Unit IV	**Python Data Structures** Python List - Accessing Lists, List Operations, Functions and Methods of Lists Python Tuple - Accessing Tuple, Tuple Operations, Functions and methods of Tuples, Why use Tuple? Python Dictionary- Accessing Values, Functions & Methods
Unit V	**Python Functions** Built-in Functions, User defined Functions, Inoking a Function, return Statement, Argument and Parameter, Positional Argument (Required Argument), Default Argument, Keyword Argument, Anonymous Function, Difference between Normal Functions and Anonymous Function, Scope of a Variable
Unit VI	**Python OOPs** OOPs Concepts, Object Class, Constructors, __str__() and __repr__() methods, Inheritance, Multilevel Inheritance, Multiple Inheritance
Unit VII	**Python Files I/O** Input from Keyboard, File Handling, Attributes of File, Modes of File, File Handling Methods

Unit VIII	**Python Modules** What is a Module? Importing a Module, Built in Modules in Python, Package
Unit IX	**Exception Handling** Hierarchy of Exception, except with no Exception, Declaring Multiple Exceptions, Finally Block, Raise an Exception, Custom Exception
Unit X	**Multithreading** The Threading Module, Thread class, Creating a New Thread, Starting a New Thread, Thread Class Methods, Thread Synchronization.
Unit XI	**Python-MySQL Connectivity** Establishing a Connection, CRUD (Create, Read, Update, Delete) Operations.
Unit XII	**Python GUI Programming** Tkinter module, Tkinter Programming, Tkinter Widgets (Frame, Canvas, Label, Button, Listbox, Radiobutton, Checkbutton, MessageBox).
Unit XIII	**Mathematical Application Development using Python** Explore Any Two Python Packages

Reference Books:

1) Beginning-Python, Second Edition by Magnus LieHetland
2) The Complete Reference Python by Martin C.Brown
3) Head First Python by PatrickBarry
4) Learning Python, O'Reilly by MarkLutz
5) Python in a Nutshell, O'Reilly by AlexMartelli

Important URL:
https://www.python.org

MTS5410 : Experiential Training Course on Web UI &UX [Credits – 4]

Course Outcomes

After learning this course student will be able to:

CO1 Use an integrated development environment to write, compile, run, and test simple web pages.

CO2 Write valid and concise code for webpages

CO3 Discover how does web works really, what makes web sites work

CO4 Learn how to improve the user experience while designing websites

CO5 Learn how to design web pages using HTML & CSS

CO6 Understand how to use Bootstrap classes to make use of readymade CSS to design User Interface

CO7 Describe how to achieve client-side validation using JavaScript

CO8 Describe how to use jQuery, a light-weight JavaScript library

CO9 Interpret how to give Ajax calls

CO10 Understand how to design interactive UIs for single-page applications using ReactJS

Unit I	**HTML** What is HTML? Tags, Heading, paragraph, anchor, image, table, Lists (ordered, unordered, description), form, label, input, button, br, hr, script (simple JavaScript code) **HTML5** Audio, Video, Progress, Datalist Tag, Header Tag, Footer Tag, Article Tag, Aside Tag, Canvas, SVG, Google Maps, Geolocation, Web Storage
Unit II	**UX Design Overview** Introduction to UX design, UX fundamentals – Behavior, Strategy, Usability and Validation, Basics of Usability, UXD Process and Workflow, UX Research Phase, UX Design Phase, Validation and Implementation Phase
Unit III	**CSS** What is CSS? CSS Syntax, CSS Selector, How to add CSS? CSS types, CSS comments **CSS Properties** Background, colors, Border, Margin, Padding, Height/Width, Box Model, Outline, Text, Fonts, Icons, Links, Lists, Tables, Display, Max-width, Position, Overflow, Inline-block, Align, Combinators, Pseudo-classes (link, visited, hover, active, focus), Pseudo- elements(first-line, first-letter, before, after), Opacity, Tooltips, Image Gallery, Image Sprites, Attr Selectors, Forms, **CSS3** –Rounded Corners, Backgrounds, Colors, Shadows, Text, Fonts, Animations, Images, Buttons, Multiple Columns, User Interface, Box Sizing, Flexbox, Media Queries, MQ Examples
Unit IV	**JavaScript** Introduction, Syntax, Statements, JavaScript BOM, Comments, Variables, Operators, Data Types, Functions, Objects, Scope, Events (onclick, onchange, onmouseover, onmouseout, onkeydown, onload), Strings, String Methods (indexOf(), lastIndexOf(), search(), slice(), substring(),substr()),

	Numbers, Number Methods (toString(), toExponential(), toFixed(), toPrecision(), valueOf()), Math (min(), max(), pow(), random(), sqrt(), ceil(), floor() methods), Array, Array methods (toString(), join(), pop(), push(), shift(), unshift(), splice(), concat()), Date & its methods, Booleans, Comparisons, Conditions, Switch, for loop, while loop, break, Type Conversion, Debugging, JS Objects, Object Properties, Object Methods, Object Prototypes.
Unit V	**Bootstrap 4.0** What is Bootstrap, Container, Jumbotron, Button, Grid, Table, Form, Alert, Badges, Cards, Pagination, Image, Carousel, Progress Bar, List Group, Dropdown, Collapse, Tabs/Pills, Navbar, Input Types (check box, radio button), Modals,Popover, Flex
Unit VI	**jQuery & AJAX** Introduction, Syntax, Selectors, Attributes, Effects, hide/show, toggle, fade, slide, animate, delay, callbacks, html(), CSS manipulation, Traversing, DOM, Filtering, Events – (click(), bind(), blur(), focus(), select(), change(), submit(), keydown(), keypress(), keyup(), mouseenter(), mouseleave(), hover(), mousedown(), mouseup(), mouseover(), load(), unload()) , AJAX, GET, POST
Unit VII	**Introduction to ReactJS** Overview, Virtual DOM, JSX, Components, State, Props, Lifecycle, Forms, Events, CSS, Router, React Flux, Introduction to Redux

Reference Books:

1) Beginning HTML5 and CSS3 By Christopher Murphy, Divya Manian, Oliver Studholme and Richard W. Clark (APress)
2) Beginning JavaScript By Jeremy McPeak and Paul Wilton(Wrox)
3) Beginning JQuery By Jack Franklin (APress)
4) Bootstrap by Jake Spurlock (O'Reilly)
5) Head First HTML5 Programming, Building Web Apps with JavaScript By Eric Freeman, Elisabeth Robson (O'Reilly)
6) Head First JavaScript Programming By Eric T. Freeman, Elisabeth Robson (O'Reilly)
7) Head First Ajax By Rebecca M. Riordan (O'Reilly)
8) Head First jQuery, A Brain-Friendly Guide By Ryan Benedetti, Ronan Cranley (O'Reilly)

Important URLs:

1) https://www.w3schools.com/
2) https://getbootstrap.com/