GANGADHAR MEHER UNIVERSITY
AMRUTA VIHAR, SAMBALPUR, ODISHA

DEPARTMENT OF MCA

Syllabus for

MASTER OF COMPUTER APPLICATIONS

(2-Year Programme)

Course Effective from Academic Year 2025-2026

DEPARTMENT OF MCA

Vision

To create globally competent undergraduates and postgraduates in Computer Science by imparting training in emerging technologies and collaborative research through a conducive and disciplined academic environment, and orient them towards serving the society.

Mission Statements

M1: To provide high quality professional training at the undergraduate and postgraduate level with an emphasis on basic principles of computer science and applications.

M2: To empower the students with the required skills to solve the complex technological problems of modern society and also provide them with a framework for promoting collaborative and multidisciplinary research.

M3: To strengthen the Industry-Academia interface by interacting with the industry, educational & research organizations and alumni that will help the students to emerge as leaders in academics or in entrepreneurship.

M4: To impart moral and ethical values, and interpersonal skills to the students for betterment of the society.

PROGRAM OUTCOMES(POs):

PO1. **Knowledge and Understanding**: Develop an ability to understand the theoretical foundations of computer science for designing efficient methodologies along with the knowledge of limitations of computing.

PO2. **General, Technical and Professional Skills:** An ability to function effectively as an individual with diversified skills or as a part of a multi-disciplinary team setting to accomplish defined goals.

PO3. **Application of Knowledge and Skills**: Developing problem analysis skills and knowledge and applying the same in real life situation.

PO4. **Research Skills:** Explore research based knowledge and carry out academic investigations on the cutting edge technologies in allied subjects of Computer Science.

PO5. **General Learning Outcomes:** Create, select and apply advanced techniques and tools including modelling complex activities related to Computer Science.

PO6. **Constitutional, Humanistic, Ethical and Moral Values:** Design, develop and evaluate new system components or processes of computer science that meet the desired needs with appropriate considerations of industry, society, public health, safety, culture, environment and sustainable development sticking on to the ethics and values.

PO7: **Employability Job Skills and Entrepreneur Skills:** Prepare the students to take up a career as versatile contributors in industry, academia, research and development or entrepreneurship employing their expertise to advance personal growth while making meaningful contributions to societal progress

PROGRAM SPECIFIC OUTCOMES(PSOs):

PSO1. To shield students from the rapid obsolescence of computer technology, the program focuses on imparting foundational knowledge, fostering critical thinking skills, and cultivating technical expertise.

PSO2. Analyze, design, and develop software applications with latest computing tools and technologies.

PSO3. Empowering the students to pursue careers in IT industry/ consultancy/ research and development, teaching and allied areas related to computer science.

MCA
Programme Structure

Year	Semesters	
First Year	Semester I	Semester II
Second Year	Semester III	Semester IV

Part-I: Semester-I

Papers		Duration (Hrs)	Credit
Paper No	Title		
MCA101	Programming and Data Structure	4	4
MCA102	Data Communication and Networks	4	4
MCA103	Operating Systems	4	4
MCA104	Mathematical Foundations of Computer Science	4	4
MCA105	Lab I (Data Structure and Operating System)	6	4
Total			**20**

Part-I: Semester-II

Papers		Duration (Hrs)	Credit
Paper No	Title		
MCA201	Object Oriented Programming using JAVA	4	4
MCA202	Computer Organization and Architecture	4	4
MCA203	Database Management Systems	4	4
MCA204	Formal Language and Automata Theory	4	4
MCA205	Lab II (OOP using Java and DBMS)	6	4
	DSE-I Papers		
MCA206 A	**Data Warehousing and Mining**	4	4
MCA206 B	**Ecommerce**	4	4
MCA206 C	**Internet of Things**	4	4
MCA206D	**Mobile Application Development**	4	4
MCA206E	**Optimization Techniques**	4	4
MCA206F	**Real Time System**	4	4
Total			**24**

Part-II: Semester-III

Papers		Duration(Hrs)	Credit
Paper No	Title		
MCA301	Artificial Intelligence	4	4
MCA302	Web Technology	4	4
MCA303	Design and Analysis of Algorithms	4	4
	DSE-II Papers		
MCA304A	**Data Science**	4	4
MCA304B	**Compiler Construction**	4	4
MCA304C	**Information Security**	4	4
MCA304D	**Digital Image Processing**	4	4
MCA304E	**Soft Computing**	4	4
MCA304F	**Simulation Modelling**	4	4
MCA305	Lab III (Web Technology and Artificial Intelligence using Python)	6	4
IDSE Papers			
MCA306A	**Network and Internet Technologies**	4	4
MCA306B	**Data Analytics using R Programming**	4	4
MCA306C	**Object-Oriented Programming using C++**	4	4
MCA306D	**Data Analytics and Visualization with Excel**	4	4
Total			**24**

Part-II: Semester-IV

Papers		Duration(Hrs)	Credit
Paper No	Title		
MCA401	Machine Learning	4	4
MCA402	Software Engineering and OOAD	4	4
MCA403	Project Work and VIVA VOCE		12
	MOOCs-1		6*
	MOOCs-2		
Total			**20**
	Grand Total		**88+6***

Value Added Course offered beyond the prescribed syllabus

Subject	Duration(Hrs)	Credit
Web Designing	40	4

***Non-Divisional Credits**

SEMESTERWISECREDITDISTRIBUTION					
Semester	**I**	**II**	**III**	**IV**	**TOTAL**
Total Credit	**20**	**24**	**24**	**20**	**88+6***

NB:

- The students are encouraged to take two extra MOOC courses to earn a maximum of 6 Credits.
- Each theory paper consists of 100 marks (Mid Sem 30, End Sem70).
- Lab Exam will be of 100marks.

Semester-I

Course Code	**MCA101**
Course Name	**PROGRAMMING AND DATA STRUCTURE**
Category	Programme Core Course
Prerequisite	Computer fundamentals

Paper-MCA101

Programming and Data Structure

UNIT-I: **10hrs**

Introduction to Programming Language, Introduction to C Programming, Lexical Elements, Input and Output Operations, Compilation and pre-processing, Data types: Different data types, Data types qualifier, modifiers, Memory representation, size and range, Operators: Operators (Arithmetic, Relational, Logical, Bitwise, Assignment & compound assignment, Increment & Decrement, Conditional), Operator types (unary, binary, ternary). Expressions, Order of expression (Precedence and associativity), Decision Making and Branching statements (Simple IF, IF…ELSE, Nested IF… ELSE, ELSE … IF ladder), Selection control structure (Switch Statement). Looping statements (FOR, WHILE, DO…WHILE), break, continue, and GOTO statements

UNIT-II: **10hrs**

Preprocessor directives (#define, #include), Storage classes (auto, static, extern, register), Concept of Array, Array Declaration, types of array (one and multiple dimensions), Character Arrays and Strings, limitations of arrays. Structures, Unions, Functions, Recursive functions, Use of Pointers, Pointers to an Array, Array of Pointers, Dynamic memory allocation using malloc( ) and calloc( ), File Handling (fopen, fclose, fprintf, fscanf, fread, fwrite), Command-line arguments

UNIT-III: **10hrs**

Data Structure, Basic Terminology, Basic Data Structures and Operations, Algorithm Complexity and Time-Space Trade-off.

Stacks: Representation and Implementation of Stacks, Operations on Stacks: Create, Push, Pop, Stack Overflow and Stack Underflow, Applications of Stacks: Infix to Postfix Conversion and Evaluation of Postfix Expression.

Queues: Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, D-queues and Priority Queues.

Linked list: Representation and Implementation of Singly Linked Lists, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, Doubly Linked List, Polynomial Representation and Addition, Garbage Collection and Compaction.

UNIT-IV: **10hrs**

Trees: Basic Terminology, Binary Trees, Binary Tree Representation, Algebraic Expressions, Complete Binary Tree, Extended Binary Tree, Representation of Binary Trees, Binary Tree Traversals: Pre-Order, In-Order and Post-Order traversals, Binary Search Tree (BST), Insertion and Deletion in BST, Height Balanced Trees (AVL Trees).

Graphs: Terminology and Representation, Directed Graphs, Sequential Representation of Graphs, Adjacency Matrix, Adjacency List, Graph Traversals: Breadth First Search (BFS) and Depth First Search (DFS).

Searching: Linear Search, Binary search

Sorting: Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort

Text Books:
1. E. Balagurusamy, Programming in Ansi C, 6th Edition, McGraw-Hill, 2012. 2. Reema Thareja, Data Structures Using C, 2nd Edition, Oxford University Press, 2014. 3. Horowitz and Sahani, "Fundamentals of data Structures", Galgotia 4. J. P. Tremblay and P. G. Sorenson, An Introduction To Data Structures With Applications, 2nd Edition, McGraw Hill, 1983. 5. Ellis Horowitz, SartajSahni, Susan, Derson-Freed, Fundamentals of Data Structures in C, 2nd Edition, Universities Press, 1982.
Reference Books:
1. B. Kernighan and D. Ritche, The C Programming Language, 2nd Edition, Pearson, 1988. 2. Amiya kumar Rath, Data Structures Using C, 2nd Edition, Scitech Publications India Pvt. Ltd, 2011.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Explain Linear data structure and their Linked Representation.
CO2	Perform operation on tree data structure and their operation.
CO3	Analyse performance of different Sorting Techniques.
CO4	Explain and represent B tree and AVL tree along with their operations.
CO5	Use both Linear and Nonlinear Data structure in Real time Application through Coding.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	3	3	2		1	1		
CO2	1	2	3	3	2		1	2	1	1
CO3	1	2	3	2	2		1	1	1	1
CO4	1	3	3	3	2		2	3	2	1
CO5	2	2	3	3	2		2	2	1	1

Course Code	**MCA102**
Course Name	**DATA COMMUNICATION AND NETWORKS**
Category	Programme Core Course
Prerequisite	Basics of Computer

Paper-MCA102

Data Communication and Networks

UNIT :I **12hrs**

Overview of Data Communication and Networking. **Physical Layer:** Analog and Digital, Analog Signals, Digital signals, Analog versus Digital, Data Rate Limits, Transmission Impairment, More about signals, **Digital Transmission:** Line coding, Block coding, Sampling, Transmission mode, Analog Transmission : Modulation of Digital Data; Telephone modems, modulation of Analog signals, Multiplexing : FDM, WDM, TDM, Transmission media: Guided media, unguided media (wireless), Circuit switching and Telephone Network: Circuit switching, Telephone network.

UNIT:II **14hrs**

Data Link Layer: Error Detection and Correction: Types of errors, Detection, Error correction, Data Link control and Protocols: Flow and Error control, Stop-and-Wait ARQ, Go-Back-N ARQ, Selective Repeat ARQ, HDLC, Point-to-Point Protocol, Multiple Access, Random Access, Controlled Access, Channelization. Local area Network: Ethernet, Traditional Ethernet, Fast Ethernet, Gigabit Ethernet, Wireless LANs: IEEE 802.11, Bluetooth virtual circuits: Frame Relay and ATM.

UNIT:III **10hrs**

Network Layer: Host- to –Host Delivery: Internetworking, Addressing, Routing, Network Layer Protocols: ARP, RARP, NAT, BOOTP, DHCP, IPV4, IPV6, ICMP, ICMPV6 and Unicast Routing protocols, Transport Layer: Process to Process Delivery: UDP, TCP, congestion control and Quality of Service.

UNIT: IV **04hrs**

Application Layer: Client Server Model, Peer to Peer network, Domain Network System (DNS), Electronic Mail (SMTP), and file transfer (FTP), HTTP and WWW.

Text Book:

1. B.A. Forouzan, Data Communication And Networking, 4th Edition, Tata McGraw Hill, 2007.
2. Peter Lars Dordal, An Introduction to Computer Networks, 2nd Edition, Loyola University of Chicago, 2014.

Reference Books:

1. A. S. Tenenbaum, Computer Network, 5thEdition, PHI, 2011.

2. James F. Kurose & Keith W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition, Pearson Education India, 2013.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Identify the networks with their related concepts.
CO2	Memorize the protocols at different layers of the network.
CO3	Compare the same concepts with different dimension.
CO4	Practice the numerical problems of the related concept.
CO5	Explain the signals with their differences.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	3	2	1	2	2	1	3	1
CO2	1	3	3	3	1	2	1	2	2	1
CO3	1	2	3	2	1	2	2	1	2	1
CO4	1	2	3	3	1	1	2	1	2	1
CO5	1	2	3	2	1	1	2	2	1	1

Course Code	**MCA103**
Course Name	**OPERATING SYSTEMS**
Category	Programme Core Course
Prerequisite	Computer Programming and Data Structures

Paper-MCA103

Operating Systems

UNIT-I: 10 hrs

Operating System Overview: -Introduction, The Need of Operating Systems, Evolution of Operating Systems, Types of Operating Systems, Simple Batch, Multi-programmed, Time-shared, Personal Computer, Parallel, Distributed Systems, Real-Time Systems, System components, Operating System services, System Calls, Virtual Machines, System Design and Implementation.
Process Management – Process concepts, Life cycle, PCB, Schedulers, Process Scheduling, Threads, Scheduling Levels, CPU Scheduling: Scheduling-Criteria, Algorithms, Algorithm Evaluation.

UNIT-II: 10hrs

Concurrency: Process synchronization, The Critical-Section Problem, Peterson's Solution, synchronization Hardware, Semaphores, Classic problems of synchronization, Monitors.
Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock detection, deadlock prevention, deadlock avoidance, Recovery from deadlock.

UNIT-III: 10hrs

Memory Management: Main Memory, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table.
Virtual Memory: Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files

UNIT-IV: 10hrs

Mass-Storage Structure: Overview, Disk Structure, Disk scheduling algorithms, disk management, Swap-space management, RAID structure.
File Systems: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, Protection. File- System Structure and Implementation, Directory Implementation, Allocation Methods, Free-Space Management.

Text Book:

1.A. Silberchatz, P. B. Galvin, G. Gagne, Operating System Concepts, 8th Edition, Wiley India, 2010.

Reference Books:

1. Charles Crowley, Operating Systems: A Design-Oriented Approach, 1st Edition, McGraw-Hill, 1996.
2. A. S. Tanenbaum and H. Bos, Modern Operating Systems, 4th Edition, Pearson, 2015.
3. W. Stallings, Operating Systems – Internals And Design Principles, 9thEdition, Prentice Hall, 2017.
4. D. M. Dhandhere, Operating Systems-A Concept Based Approach, 2ndEdition, McGraw-Hill, 2006.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Explain the different types of Operating systems
CO2	Describe the lifecycle of a process and its attributes with its scheduling algorithms
CO3	Analyze the concept of Deadlock
CO4	Apply segmentation and paging techniques
CO5	Explain the structure and organization of the file systems and I/O systems

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1			1	1		1	1		
CO2	2	2	3	3	1		2	2	2	
CO3	1	2	3	2	2		1	2	2	1
CO4	1	2	3	3			2	1		1
CO5	1	3	3	3	1		1	2	2	1

Course Code	**MCA104**
Course Name	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**
Category	Programme Core Course
Prerequisite	Basics of set theory and combinatory

Paper-MCA104

Mathematical Foundations of Computer Science

UNIT-I: 14hrs

Fundamentals of Logic: Propositional Logic, Propositional Equivalences, Predicate and Quantifiers, nested Quantifiers, Rules of Inference.

Set Theory: Sets, Set Operations.

Introduction to proofs: proof by Induction, proof by contradiction, proof by cases with examples.

Mathematical Induction: Introduction to Induction, strong Induction, Recursion.

Relations: Relations and their properties, n-ary Relations and their applications, Representing relations, Closures of relations, Equivalence relations, and Partial Orderings, lattices, partial order set, properties of lattices.

Functions: Types of Functions, Composition of Functions, Invertible Functions, Recursive Functions, Pigeon-hole principle.

UNIT-II: 06hrs

Discrete Numeric functions and Generating Functions: Discrete Numeric Functions, Generating Functions, Recurrence relations and recursive algorithms, Linear recurrence relations, Solving Recurrence Relations by Generating Functions.

UNIT-III: 10hrs

Graphs: Graphs, Graph models, special types of graphs, Representing graphs, Graph Isomorphism, connectivity, Euler and Hamilton paths, Planar graphs, Graph Coloring, Matching problem.

Trees: Introduction to Trees, Applications of Trees, Binary Trees, n-ary Trees, Tree Traversal, Spanning Trees

UNIT-IV: 10hrs

Algebraic Structures: Group, Semi groups , monoids, subgroup, homomorphism, co-sets, normal subgroup, Lagrange's theorem, algebraic system of two binary operation, Boolean algebra, Boolean function and simplification, group codes, parity check, single error correcting code,

Text Books:

1. C.L.Liu, D. P. Mohapatra, Elements of Discrete Mathematics: A Computer Oriented Approach, 4th Edition, McGraw-Hill, 2016.
2. K. H. Rosen, Discrete Mathematics & Its Applications (with Combinatorics and Graph Theory), 6thEdition, McGraw-Hill, 2007.

Reference Books:
1. J.P. Tremblay, R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill, 1997.
2. R. L. Graham, D. E. Knuth, O. Patashnik, Concrete Mathematics: A Foundation for Computer Science, 2nd Edition, Pearson Education, 2007.
3. D. B. West, Introduction to Graph Theory, 2nd Edition, PHI Learning, 2009.
4. A. Brualdi, Introductory Combinatorics, 4th Edition, Pearson, 2004.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Able to use logical notation to define and reason about fundamental mathematical concepts such as sets, relations, and functions.
CO2	To apply mathematical foundations, algorithmic principles, and computer science theory to the modelling and design of computer based systems.
CO3	Able to construct simple mathematical proofs and possess the ability to verify them.
CO4	Model problems in Computer Science using graphs and trees methods.
CO5	To Understand and prove fundamental results and solve algebraic problems using appropriate techniques

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	1	1		1	1		1
CO2	1	2	1	1	1		1	1		1
CO3	1	2	1	1	1		1	2	1	1
CO4	2	3	1	2	2		2	2	1	1
CO5	2	2	3	2	1		1	2	1	1

Paper-MCA105

Lab I: Data Structure and Operating System

C PROGRAMS:

1. Simple Programs using C: Find Area, Perimeter of Square & Rectangle, Find max. Among 3 nos, Check leap year

2. Programs using Loop :Factorial of Number, Prime Number, Perfect Number, Armstrong Number, Floyd's Triangle

3. Function Programs : Simple Function Problems, Function with call by reference, Recursion function e.g. sum of digit, reverse of digit, Fibonacci Series, Inter conversion of Decimal, Binary & Hexadecimal no, LCM & GCD of numbers

4. Array & Structure Operations: Insert & Delete an element at given location in array, Transpose of matrices, Multiplication of matrices, Display upper & lower diagonal of matrices

Array of Structure e.g. student result, Employee pay slip , Phone bill

DATA STRUCTURE PROGRAMS:

1. Implementation of sparse matrix
2. Implementation of linear search, binary search, bubble sort, insertion sort, selection sort
3. Implementation of single linked list and its operations
4. Design a doubly linked list to hold strings and use it for organizing a sequence of cities
5. Repeat Q4 using doubly circular linked list
6. Create a polynomial using single linked list and perform addition operation of two polynomials
7. Implement a stack, use stack for conversion of infix to postfix and evaluation of postfix expression.
8. Implementations of circular queue (using array) with menu options like insert, delete, display and exit.
9. Implementation of a priority queue and use it to organize student records prioritized by marks.
10. Recursive implementation of quick sort and merge sort. Generate 10 random integers in a given range and apply sorting mechanisms.
11. Implement linear search and binary search to find out whether a given element is present or not in the array. Compare two search mechanisms based on number of comparisons required for a successful as well as unsuccessful search.
12. Implementation of a binary search tree with menu options: Construct a tree, insert a node, delete anode, traverse and display preorder, in order and post order sequence of its nodes.
13. Implementation of Heap Sort.
14. Implementation of digraphs using adjacency matrix and find the transitive closure using Warshall's algorithm.
15. Implementation of a weighted graph and find minimal cost spanning tree usingPrim's algorithm.

Paper-MCA105

OPERATING SYSTEM PROGRAMS:

1. Implementation of FCFS Scheduling.
2. Implementation of Round Robin Scheduling.
3. Implementation of Shortest Job First Scheduling (Non Pre-emptive).
4. Implementation of Shortest Job First Scheduling (Pre-emptive).
5. Implementation of Priority Based Scheduling.
6. Implementation of Deadlock detection
7. Implementation of simple Thread and Multi-Threading.
8. Implementation of Paging techniques of Memory Management(FIFO,LRU,OPTIMAL)
9. Implementation of Semaphore.
10. Implementation of Peterson's Solution in Process Synchronization.

Semester-II

Course Code	**MCA201**
Course Name	**OBJECT-ORIENTED PROGRAMMING USING JAVA**
Category	Programme Core Course
Prerequisite	Basic procedural programming Language (like C-Programming)

Paper-MCA201

Object Oriented Programming using JAVA

UNIT-I: **08hrs**

Java Evolution and Environment: Java evolution, overview of java language, java history, features of java, how java differs from C and C++, java and World Wide Web, web browser.
Java Environment: Java Development Kit(JDK), Application Programming Interface(API), java programming structure, java tokens, constants, variables, expressions, decision making statements and looping, java statements, overview of arrays and strings, machine neutral, Java Virtual Machine(JVM), Command Line Arguments.

UNIT-II: **12 hrs**

Classes, Objects and Methods: Introduction, defining a class, creating objects, accessing class members, constructors, method overloading, static members. Inheritance: Defining a sub-class, sub-class constructor, multi-level variables, and final classes and finalize methods, abstract methods and classes, visibilitycontrol.**Arrays and Strings:** One-dimensional arrays, creating an array, declaration of arrays, initialization of arrays, two-dimensional arrays, string arrays, string methods, string buffer class, vectors, wrapper classes, Basic I/O Streams: Scanner, buffered reader, Collection classes.**Managing Errors and Exceptions**: Introduction, types of errors: compile time and run-time errors, exceptions, types of exceptions, syntax of exception handling code, multiple catch statements, using finally statement, throwing our own exceptions.

UNIT-III: **10 hrs**

Interfaces, Package and Multi-threaded Programming: Introduction, defining interfaces, extended interfaces, implementing interfaces.**Package:** Creation, importing a package and user-defined package.**Threads:** Introduction to threads, creating threads, extending the thread class, implementing the 'runnable' interface, life-cycle of a thread, priority of a thread, synchronization, and deadlock.

UNIT-IV: **10 hrs**

Applet programming: Introduction, how applets differ from applications, building applet code, applet life cycle, about HTML, designing a web page, passing parameters to applets, getting input from the user.**Graphics Programming:** Introduction, abstract window toolkit class hierarchy, frames, event-driven programming, layout managers, panels, canvases, drawing geometric figures.**Introduction to Swings:** Introduction to Swings, overview of Swing components: Jbutton, JCheckBox, JRadioButton, JLabel, JTextField, JTextArea, JList.

Text Book:

1. H. Schildt, Java The Complete References, 11th Edition, Tata McGraw Hill, 2019.

Reference Books:
1. Y. Daniel Liang, An Introduction to JAVA Programming, 10th Edition, Pearson.
2. K. Sierra, Head First Java, 2nd Edition, O'Reilly Media, Inc,, 2003.
3. E. Balaguruswamy, Programming with JAVA, 6th Edition, Tata McGraw Hill, 2014.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to
CO1	Explain the basic principles of object-oriented programming along with its strength and weakness
CO2	Identify Java standard libraries and classes
CO3	Apply the object-oriented programming techniques in developing small to medium-sized application programs
CO4	Identify Java code utilities in applets, Java packages, and classes
CO5	Design simple Graphical User Interface applications

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2		3	2	3		3	2	1	1
CO2	3	1	3	3		1	2	2	2	3
CO3	3	3	3	3	2	2	3	3	3	3
CO4	2	2	3	3	2	2	3	3	3	3
CO5	3	2	3	3	2	1	2	3	3	3

Course Code	**MCA202**
Course Name	**COMPUTER ORGANIZATION AND ARCHITECTURE**
Category	Programme Core Course
Prerequisite	Digital Logic

Paper-MCA202

Computer Organization and Architecture

UNIT :I **10hrs**

Introduction: Basic Organization of Computers, Classification Micro, Mini, Mainframe and Super Computer. System Bus and Interconnection: Single and multi-bus, Computer Function Von-Neumann M/c: Structure of IAS.

Computer Arithmetic: Data Representation: Fixed Point Representation, Floating Point Representation. Addition and Subtraction, Multiplication (Booth Algorithm), Division Algorithm, Floating Point Arithmetic Operation, Decimal Arithmetic Operation

UNIT:II **10hrs**

Instruction Set Architecture: Instruction Format: Three Address, Two Address, One Address and Zero Address Instruction, Addressing Modes: Types of Addressing modes, Numerical Examples, Program Relocation, Compaction, Data Transfer & Manipulation: Data transfer, Data Manipulation, Arithmetic, Logical & Bit Manipulation Instruction, Program Control: Conditional Branch Instruction.

CPU Organization: Fundamental Concepts: Instruction-cycle, Fetching and storing a word in Memory, Register Transfer, Performing an Arithmetic & Logic Operation, Branching. Control word, Stack Organisation, Register Stack, Memory Stack, RPN, Evaluation of Arithmetic Expression using RPN, Subroutine, Control Unit Operation: Hardware Control & Micro Programmed Control.

UNIT:III **10hrs**

Memory Organization:

Computers Memory System Overview, Characteristics of Memory System, The Memory Hierarchy, Semi Conductor Main Memory types, Organisation, Memory cell Operation. Cache Memory: Cache Principles, Elements of Cache Design, Cache Size, Cache Mapping function, Replacement Algorithm, LRU, FIFO, LFU, Write policy. Number of Caches: Single versus two level caches, Pentium Cache Organisation. Associative Memory: Hardware Organisation, Match Logic. Read Operation, Write Operation, Auxiliary Memory: Magnetic Disks, Magnetic Tape. Virtual Memory: Paging, Paging h/w, Address Mapping using pages, Segmentation h/w, Demand Paging, Memory Management h/w.

UNIT: IV **10hrs**

Input/Output Organization: Peripheral Devices, Input – output Interface, I/O Bus, Interface Module, Asynchronous Data Transfer, Strobe Control, Handshaking, Asynchronous Serial Transfer, Asynchronous Communication Interface, Modes of Transfer: Programmed I/O, Interrupt Driven I/O, Direct Memory Access (DMA), DMA Controller, I/O Channel & Processor.

Interrupt: Class of interrupt, Priority Interrupt: Daisy Chaining Priority, Parallel Priority Interrupt. Program Interrupt, Types of Interrupt, RISC & CISC Characteristic. Parallel Processing: Flynn's Classification, Introduction to Pipelining and hazards, Speedup, Efficiency, Throughput

Text Book:
1. William Stalling, Computer Organization and Architecture, 8th Edition, PHI, 2010.
Reference Books:
1. Rajiv Chopra, Computer Architecture and Organization, 1st Edition, S. Chand Publication, 2013.
2. Carl Hamacher, Zvonkoranesic, and SafwatZaky**,** Computer Organization, 5th Edition, McGraw-Hill Education India, 2002.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Analyze the designing process of combinational and sequential circuits.
CO2	Identify the addressing modes used in macro instructions.
CO3	Describe the memory organization with the virtual memory concept along with the mapping and replacement technique.
CO4	Describe the input / output organization technique with its implementation.
CO5	Identify the interrupt of the system and characteristics of types of systems.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	3	1		1	1	1	1
CO2	2	1	1	2	1		2	2	2	2
CO3	3	2	2	2	1		1	1	1	1
CO4	3	2	3	3	1		1	1	1	1
CO5	3	2	3	2	1		1	1	1	1

Course Code	**MCA203**
Course Name	**DATA BASE MANAGEMENT SYSTEMS**
Category	Programme Core Course
Prerequisite	Basic Understanding of Algorithms and Data Structures

Paper-MCA203

Database Management Systems

UNIT-I: 10hrs

Introduction to DBMS: Characteristics, Purpose, Application of the Database approach, Advantages of using DBMS approach upon file structure, Three-schema Architecture, Data Abstraction, Data Independence, Data base languages, DBMS Architecture, Data Models overview, Introduction to ER model and Relational data model.
Relational Query Language: Relational algebra, Tuple and Domain Relational Calculus, SQL.

UNIT-II: 12hrs

Database Design and ER model: Overview of Design Process, Entities, Attributes, Constraints, Weak Entities, ER diagram, Extended ER Features, Reduction to Relational Schemas.
Relational Database Design: Feature of Good Relational Design, Atomic Domain and First Normal Form, Functional Dependency Theory, Decomposition of Schemas, Properties of Relational Decompositions, Normal forms and Normalization, 2NF, 3NF, BCNF, Multi-valued Dependencies & 4NF. Performance tuning and De-normalization

UNIT-III: 8hrs

Query Processing and Optimization: Evaluation of Relational Algebra Expression, QueryEquivalence, Join strategy, Query optimization algorithms. **Storage Strategies:** Indices, B+Trees, Hashing

UNIT-IV: 10hrs

Transaction Processing: Transaction Concept, ACID Properties of Transaction, Serializability, Recoverability.
Concurrency Control: Overview, Lock-based Protocol, Timestamp ordering protocol, Multi version and Optimistic concurrency control techniques.
Recovery Systems: Database Failure and Recovery, Log based Recovery to preserve Atomicity and Durability

Text Book:

1.A. Silberschatz, F. H. Korth, Database System Concepts, 6thEdition, Mc Graw Hill, 2010.

Reference Books:

1.R. Elmasri, Fundamental of Database Systems, 7thEdition, Pearson Education, 2016.
2.B. Desai, An Introduction to Database System, 2ndEdition, Galgotia publication, 2012.
3.C.J. Date, An Introduction to Database Systems, 8thEdition, Pearson Education, 2004.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to
CO1	Define the basics of databases, database management systems, architecture of database systems, and the role of database users. Explain effectively the features of database management systems and data models.
CO2	Construct formal queries using relational algebra and relational calculus and structured query languages to perform database operations.
CO3	Identify the attributes to code a real world entity and create E-R models for designing databases for real-world applications. Examine the database design to check for improvement using normalization.
CO4	Describe various indexing techniques and explain the basics of query evaluation mechanisms.
CO5	Recognize the state of a database instance. Apply concurrency control and recovery mechanisms to maintain the correctness and consistency in the database.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	1	3	1	2	2		2	1	2	1
CO2	2	3	1	2	2		1	2	3	1
CO3	1	2	1	2	3		2	1	3	1
CO4	1	2	1	1	2		1	1	3	1
CO5	2	3	2	2	2		2	2	2	2

Course Code	**MCA204**
Course Name:	**FORMAL LANGUAGE AND AUTOMATA THEORY**
Category:	Programme Core Course
Prerequisite:	Basics of computer programming

Paper-MCA204

Formal Language and Automata Theory

UNIT-I: **10hrs**

Introduction: Automata theory, Computability theory, Complexity theory, Mathematical notations & terminology, Alphabet, String, Languages &operations on strings; Finite Automata (Deterministic): Formal definition, Transition function, Extended transition function, Language of DFA, Design of DFA; Finite Automata (Non-deterministic): Formal definition, Language of NFA, Equivalence of DFA & NFA; NFA with Epsilon Transition: Eliminating "-transitions from NFA, Conversion from Epsilon-NFA to DFA, Minimization of DFA.

UNIT-II: **10hrs**

Moore machines, Mealy machines; Regular expressions: Regular operators and their precedence, Building regular expressions, DFA to Regular expressions, Regular expressions to DFA, Arden's theorem, Pumping Lemma for Regular languages, Closure properties of Regular languages.

UNIT-III: **10hrs**

Introduction to Grammars: Definition, Derivation of string, Left and right linear grammars, Regular grammars; Context Free Grammars (CFG): Definition,Derivation of string, Language of CFG, Parse Tree, Ambiguity in grammar,Elimination of ambiguity, Normal forms of CFG: Chomsky and Greibachnormal forms, Converting CFG to CNF & GNF, Closure properties of context free languages (CFL).

UNIT-IV: **10hrs**

Push Down Automata(PDA): PDA Components, Moves of a PDA, Design of a PDA, PDA to CFG and CFG to PDA conversion, Pumping lemma for CFL;
Turing Machines (TM): Design of a TM, Variation of TM, Recursively Enumerable Languages and undecidable problems.Church Turing hypothesis, Recursive and recursively enumerable sets, Chomsky's hierarchy of languages. Ackermann's function, Godel numbering; NP Completeness: P and NP, NP complete andNP Hard problems.

Text Books:

1.J. 1.E. Hopcroft, R. Motwani, and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, 3rd Edition, Pearson Education, 2007.
2.P. Linz, An Introduction to Formal Languages and Automata, 4th Edition, Jones & Bartlett Learning, 2006.

Reference Books:

1.M. 1.Sipser, Introduction to the Theory of Computation, 3rd Edition, Cengage Learning, 2012.
2.J. 2.C. Martin, Introduction to Languages and the Theory of Computation, 4th Edition, Tata McGraw-Hill, 2010.
3.K. 3.L. P. Mishra, and N. Chandrasekaran, Theory of Computer Science: Automata, Languages and Computation, 3rd Edition, PHI, 2012.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Develop and implement mathematical models with DFA, NFA for regular languages.
CO2	Design regular expression for regular sets.
CO3	Design and implement grammar and PDA for context free languages and demonstrate their properties. Construct Turing machines for context sensitive and un-restricted languages.
CO4	Describe the Chomsky hierarchy of Formal Languages and Grammar.
CO5	Explain the concept of decidability & recursive enumerability, and classify a given language to the P, NP or NPC complexity classes.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	3	1		2	2	3	2
CO2	3	2	1	2	2			2	3	2
CO3	3	3	2	2	2			2	3	2
CO4	2	2	2	3	1		1		2	
CO5	2	3	2	3	3		2	1	3	3

Paper -MCA205

Lab II: OOP using Java and DBMS

JAVA PROGRAMS:

1. Programs to illustrate class and objects
2. Programs to illustrate Overloading & Overriding methods in Java
3. Programs on Constructers
4. Programs Illustrate the Implementation of Various forms of Inheritance. (Ex. Single, Hierarchical, Multilevel inheritance….)
5. Program which illustrates the implementation of multiple Inheritance using interfaces in Java.
6. Program to illustrate the implementation of abstract class.
7. Programs to illustrate Exception handling
8. Programs to create packages in Java.
9. Program to Create Multiple Threads in Java.
10. Program to Implement Producer/Consumer problem using synchronization
11. Developing a simple paint like program using applet
12. Developing programs on JButtons, JTextBox, JTextButton etc.

DBMS PROGRAMS:

1. Creation of a tables using create command and writing SQL queries to retrieve information from the tables.
2. Implement data definition languages (Create, Alter, Drop, Truncate, and Rename) &data manipulation languages (Insert, Update, and Delete) for updating and viewing records.
3. Implement SELECT command with different clauses (where clause, having clause, group by clause, order by clause).
4. Implement Single Row function (character, numeric, data functions).
5. To implement Group function (AVG, MIN, MAX, SUM).
6. Implement various types of integrity constraints (NOT NULL Constraint, DEFAULT Constraint, UNIQUE Constraint, PRIMARY Key, FOREIGN Key, CHECK Constraint).
7. Creation of Views, Synonyms, Sequence, Indexes, Save point.
8. Creating relationship between tables.
9. Implementation of PL/SQL block.
10. Write a PL/SQL block to satisfy some conditions by accepting input from the user.
11. Write a PL/SQL block that handles all types of exceptions.

Course Code	**MCA206A**
Course Name	**DATA WAREHOUSING AND MINING**
Category	Program Elective Course
Prerequisite	Data Structure and Algorithm, Linear Algebra, Basics of Web programming

DSE Paper – MCA206A

Data Warehousing and Mining

UNIT-I: **10hrs**

Decision Support Systems, Introduction to Data warehouse, Applications of Data Warehouse, Components of Data Warehouse, Data Warehouse and DBMS, OLAP vs OLTP, Data Marts, Metadata, Multidimensional Data Model, Concept Hierarchy, OLAP operations, Data Cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations.

UNIT-II: **10hrs**

Types of OLAP servers, 3–Tier Data Warehouse Architecture, Distributed and Virtual Data Warehouses, Data Staging, ETL, Introduction to Business Intelligence, KDD, Data Mining, Stages of the Data Mining, Integration of a Data Mining System with a Data Warehouse, Data Pre-processing, Data Cleaning, Outliers Analysis, Correlation, Covariance, Data Transformation, Feature Selection, Feature Extraction, Feature Reduction, Dimensionality Reduction, Discretization.

UNIT-III: **10hrs**

Regression, Multiple Linear Regression, Classification, Decision Tree, Bayesian Classification, Rule Based Classification, KNN Classifier, Neural Network, Back Propagation, Support Vector Machine, Associative Classification, Association, Lazy Learners, Performance Measures of Regression and Classification

UNIT-IV: **10hrs**

Clustering, Similarity and Dissimilarity Measures (Euclidean, Manhattan, Cosine, etc), Types of Clustering, K-Means Clustering, K-Medoid Clustering, Agglomerative Clustering, Divisible Clustering, DBSCAN Clustering, Introduction to Text Mining, Applications of Data Mining in Business, Bioinformatics, Healthcare, and Scientific Research.

Text Books:

1.Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publishers, ,2011.
2.Alex Berson and Stephen J. Smith, " Data Warehousing, Data Mining & OLAP",10thEdition,TataMcGraw Hill Edition, ,2007.
3.G. K. Gupta, "Introduction to Data Min Data Mining with Case Studies", Easter EconomyEdition, Prentice Hall of India, 2006

Reference Books:

1.Mehmedkantardzic,Datamining:Concepts,Models,Methods and Algorithms,Wiley,Interscience, 2003.
2.Ian Witten, Eibe Frank, Data Mining; Practical Machine Learning Tools and Techniques, 3rd Edition, Morgan Kaufmann, 2011.
3.George M Marakas, Modern Data Warehousing, Mining and Visualization, Prentice Hall,2003.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Describe the requirement of a data warehouse and its components.
CO2	Explain the data warehouse life cycle.
CO3	Explain the concepts of data mining and data pre-processing.
CO4	Analyze different classification algorithms and apply the same to real life problems.
CO5	Apply different clustering algorithms for solving problems in various domains.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1		2		3	2			1	2	1
CO2	1	2		2	2	2		1	2	1
CO3	1	2		3	2	2	1	2	2	
CO4	1	1	2	3	3	2	2	2	2	2
CO5	1	2	2	3	3	3	3	2	2	2

Course Code	**MCA206B**
Course Name	**ECOMMERCE**
Category	Programme Elective Course
Prerequisite	Basic Business Knowledge

DSE Paper – MCA206B

E Commerce

UNIT-I: **8hrs**

Computer Systems in Electronic Business: Motivation, brief history of e-commerce, Advantages and Disadvantages, Benefits to Organization, Benefits to society, Forces behind E commerce industry framework, Architectural framework.

Traditional Commerce v/s E- Commerce: Traditional business commerce, Rules for traditional commerce, Main difference between e-commerce and traditional commerce, Technical & non-technical limitations, Enterprise Data Interchange.

UNIT-II: **10hrs**

E- Commerce Models: Business - to - Business (B2B), Business - to - Consumer (B2C), Consumer - to - Consumer (C2C), Consumer - to - Business (C2B), Business - to - Government (B2G), Government - to - Business (G2B), Government - to - Citizen (G2C), Intra organizational ecommerce and Inter organization ecommerce.

Network infrastructure for ecommerce: Infrastructure for ecommerce, Meaning of I-Way, Market forces behind I-way, Market Drivers of I-Way, Component of I-way access equipment, The I-way Infrastructure and Strategic Alliances, Understanding the requirement and demands, Global information distributed network, Broadband Telecommunication.

UNIT-III: **10hrs**

Mobile Commerce: Introduction to mobile commerce, Advantage of M-Commerce, History of M-Commerce, M-Commerce Versus E-Commerce, Mobile computing application, Wireless application protocols, WAP Architecture, WAP Technology, Mobile information devices.

Electronic Payment System: Overview of Electronics Payments, Types of Electronic Payment Systems, Digital Token-Based Electronic Payment Systems, Smarts Cards, Credit Card, Debit Card Emerging financial Instruments, Home Banking, Online Banking, Wallet.

UNIT-IV: **12hrs**

Security in E-Commerce: Client-Server network, Emerging client server security threats, Threats to Servers, Trust-Based Security, Security Through Obscurity(STO), Password Schemes, Biometric Systems, Software Agents and Malicious code Threat, Trojan horses, Malwares, Worms, Viruses, Introduction to Cryptography.

Legal Issues related to E-commerce in India: E- Governance of India, Cyber Law in India, Computer Crime, Types of Crimes, Introduction to Ethics, Cyber laws, Types of Cyber Crimes, Characteristics of Cyber crimes, Purpose of Cyber law, Legal Framework in India, IT Acts in India, Amendments.

Text Book:

1. P.T. Joseph, S.J., E-commerce & Managerial Perspective, 3rd Edition, PHI, 2008.

Reference Books:

1. Janice Raynolds, The Complete E-commerce Book, 2nd Edition, Taylor & Francis Group, 2017.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Explain the need of e-commerce and its impact on society.
CO2	Describe the types of e-commerce and its related network infrastructure.
CO3	Analyse the mobile-commerce with e-commerce.
CO4	Explain different payment systems used in e-commerce.
CO5	Describe the security and security related threats in e-commerce.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		2	3	2		3				
CO2		2	3	2		3				
CO3		2	2							
CO4	2	2		3			2		3	
CO5		3		3		3	2	2	2	3

Course Code	**MCA206C**
Course Name	**INTERNET OF THINGS**
Category	Programme Elective Course
Prerequisite	Basic Idea of Computer Networks

DSE Paper –MCA206C

Internet of Things

UNIT-I: 10hrs

Introduction to IoT, Basic requirements for building an IoT system, IoT reference framework, IoT network level – performance criteria.

IoT devices: Sensors, Types of sensors and their functions: temperature, pressure, air pollution, proximity, infrared, moisture & humidity, flow, level, noise, and speed sensors. Characteristics of sensors. Use of RFID

Actuators, Types of actuators and their functions: electrical, mechanical, and hydraulic actuators, controlling IoT devices

UNIT-II: 10hrs

IoT requirements for networking protocols, device addressing, credential management, wireless spectrum, determinism, security and privacy, application interoperability, semantic interoperability. IoT Protocol Stack: layered view.

Link layer: IEEE 802.15.4 technology, LoRaWAN end-to-end architecture, Time-Sensitive Networking

Internet Layer: Routing Protocol for Low-Power and Lossy Networks.

UNIT-III: 10hrs

Application Protocols Layer: Data Serialization Formats, Communication Paradigms: Request/Response Versus Publish/Subscribe, Blocking Versus Non-blocking, QoS: Resource Utilization, Data Timeliness, Data Availability, Data Delivery

IoT Application Protocols: CoAP, XMPP, MQTT, AMQP, SIP, IEEE 1888, and DDS RTPS.

Application Services Layer: ETSI M2M network architecture, oneM2M standards.

IoT Services Platform: Functions and Requirements, IoT Platform Manager, Discovery, Communication Manager, Data Management, Management of IoT Devices, Configuration and Fault Management, Performance Management and measures

UNIT-IV: 10hrs

IoT security and Privacy: challenges, requirements, IoT Three-Domain Architecture, Attacks and Countermeasures for each domain.

Applications of IoT in areas like Smart home, Agriculture, Healthcare, Industry, Transportation, Retail, Oil and Gas, Energy etc. IoT Service Model: Anything as a Service, IoT Connected Ecosystems Models

Text Book:

1. A. Rayes and S. Salam, Internet of Things from Hype to Reality: The Road to Digitization, 2nd Edition, Springer,2019.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Describe basic concepts of IoT, its architecture and system design.
CO2	Employ the communication mechanisms between sensors and systems using various protocols and network models.
CO3	Explain IoT with respect to machine to machine and design IoT systems with data synchronization and resource manipulation. Explore various application protocols.
CO4	Discuss and describe different security issues and challenges.
CO5	Identify real world applications of IoT in multidisciplinary domains.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	1	3	2	1	2	3	2	1
CO2	1	2	1	2	3	1		3	2	
CO3	2	2		1	2	1	1	2	1	1
CO4	2	1		1	1	1	2	2	2	
CO5	2	2	1	3	2	1	2		1	1

Course Code	**MCA206D**
Course Name	**MOBILE APPLICATION DEVELOPMENT**
Category	Programme Elective Course
Prerequisite	Data Communication and Computer Networks

DSE Paper-MCA206D

Mobile Application Development

UNIT-I: 10hrs

Introduction to Android Operating System:

Android OS design and Features – Android development framework, SDK features, Installing and running applications on Android Studio, Creating AVDs, Types of Android applications, Best practices in Android programming, Android tools

Android application components – Android Manifest file, Externalizing resources like values, themes, layouts, Menus etc, Resources for different devices and languages, Runtime Configuration Changes Android Application Lifecycle – Activities, Activity lifecycle, activity states, monitoring state changes

UNIT-II: 10hrs

Android User Interfaces:

Measurements – Device and pixel density independent measuring UNIT - s Layouts – Linear, Relative, Grid and Table Layouts

User Interface (UI) Components – Editable and non-editable TextViews, Buttons, Radio and Toggle Buttons, Checkboxes, Spinners, Dialog and pickers

Event Handling – Handling clicks or changes of various UI components

Fragments – Creating fragments, Lifecycle of fragments, Fragment states, Adding fragments to Activity, adding, removing and replacing fragments with fragment transactions, interfacing between fragments and Activities, Multi-screen Activities

UNIT-III: 10hrs

Intents and Broadcasts:

Intent – Using intents to launch Activities, Explicitly starting new Activity, Implicit Intents, Passing data to Intents, Getting results from Activities, Native Actions, using Intent to dial a number or to send SMS

Broadcast Receivers – Using Intent filters to service implicit Intents, Resolving Intent filters, finding and using Intents received within an Activity

Notifications – Creating and Displaying notifications, Displaying Toasts

UNIT-IV:	10hrs

Persistent Storage and Database

Files – Using application specific folders and files, creating files, reading data from files, listing contents of a directory Shared Preferences – Creating shared preferences, saving and retrieving data using Shared Preference

Introduction to SQLite database, creating and opening a database, creating tables, inserting retrieving and etindelg data, Registering Content Providers, Using content Providers (insert, delete, retrieve and update)

Text Books:

Google Developer Training, Android Developer Fundamentals Course – Concept Reference, Google Developer Training Team, 2017.
James C Sheusi, Android Application Development for Java Programmers, Cengage Learning, 2013.

Reference Books:

1. Erik Hellman, Android Programming – Pushing the Limits, 1st Edition, Wiley India Pvt Ltd, 2014.
2. J F DiMarzio, Beginning Android Programming with Android Studio, 4th Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126565580
3. Anubhav Pradhan, Anil V Deshpande, Composing Mobile Apps using Android, 1st Edition, Wiley, 2014
4. https://www.gitbook.com/book/google-developer-training/android-developerfundamentals-course-concepts/details.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Create, test and debug Android application by setting up Android development environment.
CO2	Implement adaptive, responsive user interfaces that work across a wide range of devices.
CO3	Infer long running tasks and background work in Android applications.
CO4	Demonstrate methods in storing, sharing and retrieving data in Android applications.
CO5	Describe the steps involved in publishing Android application to share with the world.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1		2	2	1	1	2	3
CO2	1	1	1	1	2		2	2	2	3
CO3		1				2	2	1	2	3
CO4	1		1		2	1	1	1	2	3
CO5			1	3		2	3	2	3	3

Course Code	**MCA206E**
Course Name	**OPTIMIZATION TECHNIQUES**
Category	Programme Elective Course
Prerequisite	Basic knowledge of Mathematics

DSE Paper-MCA206E

Optimization Techniques

UNIT-I: **10hrs**

Introduction to Optimization: Introduction to Classical Methods & Linear Programming Problems Terminology, Design Variables, Constraints, Objective Function, Problem Formulation. Calculus method, Kuhn-Tucker conditions, Method of Multipliers, **Linear Programming Problem**: Linear Programming Problem, Simplex method, Two-phase method, Big-M method, duality, Integer linear Programming, Dynamic Programming, Sensitivity analysis.

UNIT-II: **10hrs**

Single Variable Optimization: Problems, Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method. Gradient-Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic search method.

UNIT-III: **10hrs**

Multivariable and Constrained Optimization Techniques: Multi Multi-Variable and Constrained Optimization Technique, Optimality criteria , Direct search Method, Simplex search methods, Hooke-Jeeve‘s pattern search method, Powell‘s conjugate direction method, Gradient based method, Cauchy‘s Steepest descent method, Newton‘s method, Conjugate gradient method. Kuhn - Tucker conditions, Penalty Function, Concept of Lagrangian multiplier, Complex search method, Random search method

UNIT-IV: **10hrs**

Intelligent Optimization Techniques: Introduction to Intelligent Optimization, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO), Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP

Text Books:

1. S. S. Rao, Engineering Optimisation: Theory and Practice , Wiley, 2008.
2. K. Deb, Optimization for Engineering design algorithms and Examples , Prentice Hall, 2 nd edition 2012.

Reference Books:

1. C.J. Ray, Optimum Design of Mechanical Elements, Wiley, 2007
2. R. Saravanan, Manufacturing Optimization through Intelligent Techniques, Taylor & F
3. D. E. Goldberg, Genetic algorithms in Search, Optimization, and Machine Learning, Addison-Wesley L

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Comprehend the techniques and applications of Engineering optimization.
CO2	Analyze characteristics of a general linear programming problem
CO3	Apply basic concepts of mathematics to formulate an optimization problem
CO4	Analyse various methods of solving the unconstrained minimization problem
CO5	Analyze and appreciate variety of performance measures for various optimization problems

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2		2	2	3	2
CO2	3	2	1	2	1		1	2	3	1
CO3	3	2	1	1	2		2	3	3	2
CO4	3	2	1	1	2		1	3	3	2
CO5	3	1	1	2	1		1	1	3	3

Course Code	**MCA206F**
Course Name	**REAL TIME SYSTEM**
Category	Programme Elective Course
Prerequisite	Operating System

DSE Paper-MCA206F

Real Time System

UNIT-I: **10hrs**

Introduction: What is real time, Applications of Real-Time systems, A basic model of Real-time system, Characteistics of Real-time system, Safety and Reliability, Types of Real-time tasks, timing constraints, Modelling timing constraints Real-Time Task Scheduling: Some important concepts, Types of Real-time tasks and their characteristics, Task scheduling, Clock-Driven scheduling, Hybrid schedulers, Event-Driven scheduling, Earliest Deadline First (EDF) scheduling, Rate monotonic algorithm (RMA). Some issues Associated with RMA. Issues in using RMA practical situations.

UNIT-II: **10hrs**

Handling Resource Sharing and dependencies among Real-time Tasks: Resource sharing among real-time tasks. Priority inversion. Priority Inheritance Protocol (PIP), Highest Locker Protocol (HLP). Priority Ceiling Protocol (PCP). Different types of priority inversions under PCP.Important features of PCP. Some issues in using a resource sharing protocol. Handling task dependencies. Scheduling Real-time tasks in multiprocessor and distributed systems: Multiprocessor task allocation, Dynamic allocation of tasks. Fault tolerant scheduling of tasks. Clock in distributed Real-time systems, Centralized clock synchronization

UNIT-III: **10hrs**

Commercial Real-time operating systems: Time services, Features of a Real-time operating system, Unix as a Real-time operating system, Unix-based Real-time operating systems, Windows as a Real-time operating system, POSIX-RT, A survey of contemporary Real-time operating systems. Benchmarking real-time systems.

UNIT-IV: **10hrs**

Real-time Databases: Example applications of Real-time databases. Review of basic database concepts, Real-time databases, Characteristics of temporal data. Concurrency control in real-time databases. Commercial real-time databases. Realtime Communication: Basic concepts, Examples of applications, Real-time communication in a LAN and Real-time communication over packet switched networks.

Text Books:

1. Real-time Systems Theory and Practice by Rajib Mall, Pearson Publication, 2008.

Reference Books:

2. Jane W. S. Liu, Real-Time Systems, Pearson Education, 2000.
3. C.M. Krishna and K.G. Shin, Real-Time Systems, TMH.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Explain the concepts of Real Time Systems.
CO2	Able to schedule the jobs in RTOS.
CO3	Handle allocation of resources.
CO4	Real-time scheduling and schedulability analysis.
CO5	Real-time communication.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	2		2	2	1	1
CO2	2	1	1	2	1		1	2	1	2
CO3	2	2	1	1	2		1	2	1	1
CO4	2	1	2	2	2		1	2	1	2
CO5	2	1	1	2	1		1	1	1	2

Semester-III

Course Code	**MCA301**
Course Name	**ARTIFICIAL INTELLIGENCE**
Category	Programme Core Course
Prerequisite	Linear Algebra, Programming Language

Paper-MCA301

Artificial Intelligence

UNIT-I: **10 hrs**

Introduction to Artificial Intelligence, AI Problems, AI Techniques,Problems ,Problem Space and Search, Defining the problem as a state space search, Production system, Problem characteristics, Heuristic search Technologies: Generate and Test, Hill Climbing, Best First Search, Problem Reduction, means end-analysis, optimal and A*,AND-OR Graphs, AO* Algorithms.

UNIT-II: **08hrs**

Representation Knowledge using Predicate Logic, Representing simple facts in logic, Representing Instance and ISA relationships, Computable functions and Predicates, Resolution, Representing Knowledge using Rules, Forward Vs Backward Reasoning, Matching , Control Knowledge, Weak slot and Filter structures, Semantic nets, Frames

UNIT-III: **10hrs**

Strong slot and Filter structures, Conceptual Dependencies, Scripts. Introduction to Non monotonic reasoning ,Logics for Non monotonic reasoning, Implementation : Depth First Search, Dependency Directed Back Tracking, Justification based Truth Maintenance Logic based Truth Maintenance systems,Statistical Reasoning, Probability and Bayes Theorem,Certainty factors, Rule based Systems, Beyesian Networks, Dempster-Shaffer Theory

UNIT-IV: **12hrs**

Minmax search, alpha-beta cutoffs, Planning system, Goal stack planning, Hierarchical Planning, Natural Language Processing., Syntactic Analysis, Semantic Analysis, Discuses and Pragmatic Processing. Introduction and Fundamentals of Artificial Neural Networks, Biological Prototype, Artificial Neuron, Single Layer Artificial Neural Networks, Multilayer Artificial Neural Networks, Training of Artificial Neural Networks, Genetic Algorithms

Text Books:

1. Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence,3rd Edition, McGraw-Hill,2009.
2. Waserman , Neural Computing: Theory and Practice.

Reference Books:

1. George F. Lugar, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson Education
2. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, PearsonEducation,2010.
3. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI.
4. Simon Haykin, Neural Networks: A Comprehensive Foundation,2nd Edition, Pearson Education.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Explore agents, environments, and search goal state using uninformed techniques in a state space.
CO2	Interpret logic, inference rules for decision making, and represent knowledge using semantic nets & frames.
CO3	Apply planning and reasoning to handle uncertainty in real life problems.
CO4	Design expert systems. to solve complex real-life problems.
CO5	Apply neural network and genetic algorithm to solve various mathematical and engineering problems.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	1	2	1	3	1	2	2
CO2	2	1	2	1	2	1	2	1	2	1
CO3	2	2	2	1	1	1	2	1	1	1
CO4	3	2	2	1	2	1	2	1	2	3
CO5	2	2	2	1	2	1	2	2	2	2

Course Code	**MCA302**
Course Name	**WEB TECHNOLOGY**
Category	Programme Core Course
Prerequisite	Knowledge of Internet basics, Database and object oriented programming

Paper-MCA302

Web Technology

UNIT-I: **8hrs**

Web Essentials: Clients, Servers, and Communication. The Internet-Basic Internet Protocols - The World Wide Web-HTTP request message-response message-Web Clients Web Servers-Case Study. **Markup Languages: XHTML**. An Introduction to HTML History-Versions-Basic XHTML Syntax and Semantics-Some Fundamental HTML Elements-Relative URLs-Lists-tables-Frames-Forms-XML Creating HTML Documents-Case Study.

UNIT-II: **8hrs**

Style Sheets: CSS-Introduction to Cascading Style Sheets-Features-Core Syntax-Style Sheets and HTML Style Rule Cascading and Inheritance-Text Properties-Box Model-Normal Flow Box Layout-Beyond the Normal Flow-Other Properties-Case Study. **Client-Side Programming:** The JavaScript Language-History and Versions Introduction to JavaScript in Perspective-Syntax-Variables and Data Types-Statements-Operators-Literals-Functions-Objects-Arrays-Built-in Objects-JavaScript Debuggers.

UNIT-III: **12hrs**

PHP: Introducing PHP, PHP Language Basics–Using variables, Understanding Data Types, Operators and Expressions, Constants. Decisions and Loops–Making Decisions, Doing Repetitive Tasks with Looping, Mixing Decisions and Looping with HTML. **Strings**–Creating and Accessing Strings, Searching Strings, Replacing Text with strings, Dealing with Upper and Lowercase, Formatting Strings. **Arrays**–Creating Arrays, Accessing Array Elements, Looping Through Arrays with for-each, Working with Multidimensional Arrays, Manipulating Arrays. **Functions**, writing your own Functions, Working with References, Writing Recursive Functions.
Objects–Introduction OOP Concepts, Creating Classes and Objects in PHP, Creating and using Properties, Working with Methods.

UNIT-IV: **12hrs**

PHP MySQL: Handling HTML Forms with PHP–How HTML form works, Capturing Form Data with PHP, Dealing with Multi-Value Fields, Generating Web Forms with PHP, Storing PHP Variables in Forms, Creating File Upload Forms, Redirecting After a Form Submission. **Introducing Databases and SQL**–Deciding How to Store Data, Understanding Relational Databases, Setting Up MySQL, A Quick Play with MySQL, Connecting MySQL from PHP. **Retrieving Data from MySQL with PHP**–Setting Up the Book Club Database, Retrieving Data with SELECT, Creating a Member Record Viewer. Manipulating MySQL Data with PHP–Inserting, Updating, and Deleting Records.

Text Books:

1. M. Doyle, Beginning PHP 5.3, 1st Edition, John Wiley & Sons,2011.
2. J. Duckett, Beginning HTML, XTML, CSS and JavaScript, 1st Edition, John Wiley & Sons,2011.

Reference Book:

1. L. Welling, L. Thomson, PHP and My-SQL Web Development, 1st Edition, Sams Publishing,2003.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Identify basic HTML elements, XML elements and develop static web-pages.
CO2	Describe different styles in web page design. Apply style sheets and java script to prepare elegant web-pages with client side validations.
CO3	Implement server side business logic into dynamic web pages using PHP.
CO4	Use PHP to design user interactive forms for data entry with proper validation.
CO5	Develop aesthetic web applications with database connectivity using PHP.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	1	3	1	1	3		1	2	1	1
CO2	2	3	2	2	1				1	1
CO3	2	3	1	2	1		1	1	2	2
CO4	2	3	2	3	2		1	1	2	2
CO5	2	3	2	3	2		1	1	1	2

Course Code	**MCA303**
Course Name	**DESIGN AND ANALYSIS OF ALGORITHMS**
Category	Programme Core Course
Prerequisite	Data Structure

Paper-MCA303

Design and Analysis of Algorithms

UNIT-I: **10hrs**

Introduction to Design and analysis of algorithms, Growth of Functions (Asymptotic notations), Recurrences, Solution of Recurrences by substitution, Recursion tree method, Master Method, Analysis of Searching and Sorting Techniques: Brute Force Technique, Selection sort, Bubble sort.

UNIT-II: **10hrs**

Divide and Conquer: Merge sort, Quick sort, Time complexity analysis for Merge and Quick sort.

Transform and Conquer: Balanced search tree, Heaps and Heap sort. Dynamic Programming algorithms: Matrix Chain Multiplication, Elements of Dynamic Programming, Longest Common Subsequence, 0/1 Knapsack problem.

UNIT-III: **10hrs**

Greedy Algorithms: Activity Selection Problem, Elements of Greedy Strategy, Fractional Knapsack Problem, Huffman Codes. Graph Algorithm - BFS and DFS, Minimum Spanning Trees, Kruskal's algorithm, Prim's Algorithm, Single Source Shortest paths, Bellmen Ford Algorithm, Dijkstra's Algorithm.

UNIT-IV: **10hrs**

String matching, Rabin-Karp Algorithm, KMP Algorithms. Theory of NP-completeness: Complexity classes of P, NP, NP-Hard, NP complete. Polynomial reduction, Cook's theorem, discussion on SAT, CNF-SAT, Min vertex cover, max clique, Graph coloring.

Text Book:

1. T.H.Coreman et.al, Introduction to Algorithms, 3rd Edition, MIT press Cambridge,2010.

Reference Books:

1. M. R. Kabat, Design and Analysis of Algorithms, 1st Edition, PHI,2013.
2. S. Sridhar, Design and Analysis of Algorithms, 1st Edition, Oxford University Press,2015.
3. E. Horowitz, S. Sahni, Fundamentals of Computer Algorithms, 2nd Edition, Computer Science press,2010.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to
CO1	Describe asymptotic notation, its properties and use it in measuring algorithm behaviour
CO2	Apply mathematical principles in analysis of algorithms
CO3	Analyze and apply the complexities of various algorithms and select the best
CO4	Know the different strategies that are known to be useful in finding efficient algorithms to solve problems and to be able to apply them
CO5	Choose appropriate data structures and algorithms and use it to design algorithms for a specific problem

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2		2	3	2	1	3	3	3
CO2	2	2	3	2	3	2	1	2	2	2
CO3	2	2	3	3	2	1	2	3	3	3
CO4	2	3	3	3	2	3	2	2	2	3
CO5	2	3	2	3	2	3	2	3	3	3

Course Code	**MCA304A**
Course Name	**DATA SCIENCE**
Category	Programme Elective Course
Prerequisite	Statistics, Mathematics, Programming Knowledge

Paper-MCA304A

Data Science

UNIT-I: 8hrs

Brief Introduction to Data Science. Descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, hypothesis testing

UNIT-II: 8hrs

Introduction to Machine Learning: Supervised Learning, Decision Tree Induction, Naïve Bayes Classification, Rule based Classification, K-Nearest Neighbour, Unsupervised Machine learning, Clustering, K-Means, Association rule mining, Apriori, FP-Tree.

UNIT-III: 12hrs

Attribute-oriented analysis: Attribute generalization, Attribute relevance, Class comparison, Statistical measures, Data pre-processing: Data cleaning, Data transformation, Data reduction. Predictive Modelling: Regression, Decision Tree, SVM.

UNIT-IV: 12hrs

Feature selection (Filters; Wrappers), Dimensionality reduction: PCA and LDA.
Ensemble Learning, Bagging, Boosting, Gradient Boosting (Random Forest, Adaptive Boosting)
Time Series Data Analysis: Introduction to Time Series, Correlation, Forecasting (Univariate): Autoregressive Moving Average (ARMA) models, Autoregressive Integrated Moving Average (ARIMA) models, Introduction to Deep Learning

Text Books:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly. 2014.
2. James, G., Witten, D., Hastie, T., Tibshirani, R. An introduction to statistical learning with applications in R. Springer, 2013.Joel Grus, Data Science from Scratch: First Principles with Python. 1st Edition.
3. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson.
4. Laura Igual and Santi Seguí, Introduction to Data Science, Springer.

Reference Books:

1.Han, J., Kamber, M., Pei, J. Data mining concepts and techniques. Morgan Kaufmann, 2011.
2. “Practical Data Science with R”. Nina Zumel, John Mount. Manning, 2014.
3. Davy Cielin, Arno Meysman, Mohamed Ali, Introducing Data Science, Manning
4. Andreas, Practical Data Science, Apress

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Develop in depth understanding of the key technologies in data science and business analytics: data mining, machine learning, visualization techniques, predictive modelling, and statistics.
CO2	Practice problem analysis and decision-making.
CO3	Gain practical, hands-on experience with statistical programming languages and tools through coursework and applied research experiences.
CO4	Analyze and interpret data using an ethically responsible approach.
CO5	Apply data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	1	1			1	1	3
CO2	3	1	1	1	1			1	1	3
CO3	3	1	2	1	1			1	1	3
CO4	1	3	1	2	1			1	1	3
CO5	1	3	3	3	1			1	1	3

Course Code:	**MCA304B**
Course Name:	**COMPILER CONSTRUCTION**
Category:	Programme Core Course
Prerequisite:	Theory of Computation / Automata theory

Paper-MCA304B

Compiler Construction

UNIT-I: 12 hrs

Introduction: Overview and Phases of compilation. Lexical Analysis: Non-Deterministic and Deterministic Finite Automata (NFA & DFA), Regular grammar, Regular expressions and Regular languages, Design of a Lexical Analyzer as a DFA, Lexical Analyzer generator, Lex.

UNIT-II: 14 hrs

Syntax Analysis: Context free grammars and Context free languages, Parse trees and derivations, Ambiguous grammar. Parser, Top down Parsing: Recursive descent parsing, LL (1) grammars, Non-recursive Predictive Parsing, Error reporting and Recovery.

Bottom Up Parsing: Handle pruning and shift reduces Parsing, SLR parsers and construction or SLR parsing tables, LR(1) parsers and construction of LR(1) parsing tables, LALR parsers and construction of efficient LALR parsing tables, Parsing using Ambiguous grammars, Error detection, Parser generator.

UNIT-III: 08 hrs

Syntax Directed Translation – Syntax Directed Definitions. Evaluation Orders for SDDs. Applications of Syntax Directed Translation. Symbol Table Organization - Structure of Symbol table, Symbol Table organization, Data Structures of symbol Table.

Intermediate code generation: Intermediate code (IC), IC for various constructs in programming language.

UNIT-IV: 06 hrs

Machine code generation, Issues in the design of a code Generator, Machine code generation scheme. Elements of code optimization, Peephole Optimization, Elimination of redundant loads and stores, Elimination of unreachable code, Elimination of jump over jumps, Elimination of local common sub-expressions, Basics of flow of control optimization.

Text Book:

1. A. V. Aho, M. S. Lam, R. Sethi and J. D. Ullman, Compilers: Principles, Techniques &Tools , 2nd Edition, Pearson Education, 2007.

Reference Book:

1. K. D. Cooper and L. Tarezon T. Munakata, Engineering a Compiler, 2nd Edition, Elsevier, 2011.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Identify phases of a compiler, process of designing lexical analyzer, and apply LEX tool.
CO2	Construct parsing tables and implement parser using BISON tool.
CO3	Understand use of symbol table and design SDT as semantic analyzer for a language.
CO4	Generate intermediate code using lexical analyzer, parser and semantic analyzer.
CO5	Translate intermediate code to machine code, handle run-time environment, and apply code optimization techniques.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	1			2	3	1
CO2	3	3	2	1	1			2	3	1
CO3	3	3	2	1	2			3	3	2
CO4	3	2	2	1	2			3	3	2
CO5	3	3	1		1			1	3	3

Course Code	**MCA304C**
Course Name	**INFORMATION SECURITY**
Category	Programme Elective Course
Prerequisite	Computer Network

Paper-MCA304C

Information Security

UNIT-I: 8hrs

Attacks on Computers and Computer Security: Introduction, The need for security, Security goals, Security attacks(Attack on Confidentiality,Integrity,Availability)Security Services and Mechanisms, Techniques(Cryptography,Steganography).

Introduction to plain text and cipher text, encryption and decryption. substitution techniques, transposition techniques, symmetric and asymmetric key cryptography, steganography, possible types of cryptanalysis attacks.

UNIT-II: 12hrs

Symmetric key Ciphers: Block Cipher principles &Algorithms(DES, AES, Blowfish), Differential and Linear Cryptanalysis, Block cipher modes of operation, Stream ciphers RC4,Location and placement of encryption function.

Introduction to number theory-Prime numbers,Euler's Phi-Function,Fermat's and Euler's theorem, Chinese Remainder Theorem,Generating Primes(MersennePrime,Fermat Prime),Primality testing(Deterministic algorithms,Probalistic algorithms)

Asymmetric key Ciphers: Principles of public key cryptosystems, Algorithms(RSA, Diffie-Hellman), Key Distribution.

UNIT-III: 10hrs

Message Authentication Algorithms and Hash Functions: Message authentication (MDC,MAC)Nested MAC,HMAC,CMAC,Whirlpool. Hash functions: MD5 Message Digest algorithm,SHA-1. Digital signatures, Authentication Applications: Kerberos, X.509 Authentication Service, Public — Key Infrastructure, Biometric Authentication.

UNIT-IV: 10hrs

E-Mail Security: Pretty Good Privacy, S/MIME IP **Security:IP** Security overview, IP Security architecture, Authentication Header, Encapsulating security payload, Combining security associations, key management.

Web Security: Web security considerations, Secure Socket Layer and Transport Layer Security, Secure electronic transaction. Intrusion Detection System(types, techniques).

Intruders, Virus and Firewalls: Intruders, Intrusion detection, password management, Virus and related threats, Countermeasures, Firewall design principles, Types of firewalls.

Text Book:

1. B. A. Forouzan,D.Mukhopadhyay,Cryptography and Network Security, 2nd Edition, McGraw Hill, 2008.

Reference Books:

1. A. Kahate, Network Security, 2nd Edition, McGraw Hill, 2008.
2. W. Stalling, Cryptography and Network Security, 7th Edition, Pearson Education

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Analyze the working of various Symmetric and Asymmetric key cryptographic algorithms for information security purpose
CO2	Identify the basic categories of threats in a networks
CO3	Able to demonstrate the design and use of hash functions, digital signatures, and key distribution with a wide range of key types
CO4	Discuss about Web security and Firewalls
CO5	Discuss about Intrusion Detection system.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	1	1			2	3	3
CO2	2	1	2	1	1			2	3	3
CO3	2	2	2		3			2	1	2
CO4	2	2	1	1	1			2	2	3
CO5	2	2	1		1			2	2	3

Course Code	**MCA 304D**
Course Name	**DIGITAL IMAGE PROCESSING**
Category	Program Elective Course
Prerequisite	Basics of Digital Electronics and Basic understanding of calculus

Paper-MCA304D

Digital Image Processing

UNIT-I: **08hrs**

Digital Image Fundamentals and Transforms: Elements of visual perception: Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Image sampling and quantization Basic relationship between pixels: Basic geometric transformations-Introduction to Fourier Transform and DFT : Properties of 2D Fourier Transform , FFT, Separable Image Transforms ,Walsh – Hadamard – Discrete Cosine Transform, Haar, Slant – Karhunen – Loevetransforms.Perspective Projection, Spatial Domain Filtering, sampling and quantization

UNIT-II: **08hrs**

Image Enhancement Techniques: Spatial Domain methods: Basic grey level transformation, Histogram equalization, Image subtraction, Image averaging, Spatial filtering: Smoothing, sharpening filters,Laplacian filters, Frequency domain filters : Smoothing, Sharpening filters,Homomorphic filtering.

UNIT-III: **16hrs**

Image Restoration and Image Compression: Model of Image Degradation/restoration process: Noise models, inverse filtering, least mean square filtering, constrained least mean square filtering, blind image restoration, Pseudo inverse, Singular value decomposition.

Lossless compression: Variable length coding: LZW coding, Bit plane coding- predictive coding, DPCM.

Lossy Compression: Transform coding – Wavelet coding – Basics of Image compression standards: JPEG, MPEG, Basics of Vector quantization

UNIT-IV: **08hrs**

Image Segmentation and Representation: Edge detection: Thresholding, Region Based segmentation, Boundary representation: chair codes, Polygonal approximation, Boundary segments: boundary descriptors: Simple descriptors, Fourier descriptors, Regional descriptors, Simple descriptors, Texture.

Text Books:

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, 4th Edition, Pearson Education.

Reference Books:

1. Anil K Jain, Fundamentals of Digital Image Processing, Pearson, 1989.
2. William K Pratt, John Willey ,Digital Image Processing, 4th Edition, CRC Press,2001.
3. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing Analysis and Machine Vision, 4th Edition.
4. B. Chanda, D. DuttaMagundar ,Digital Image Processing and Analysis, 2nd Edition, Prentice Hall of India, 2000.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Understand the need for image transforms different types of image transforms and their properties
CO2	Develop any image processing application.
CO3	Understand the rapid advances in Machine vision
CO4	Learn different techniques employed for the enhancement of images
CO5	Understand a digital image and different processing techniques for the better analysis of an image

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2			1	1		2	3	3	3
CO2	3	3	2	2	2	1	3	2		
CO3	2	3	1	3	2	1	2		2	3
CO4	2			3	3	1	3		2	3
CO5	2	1	3	3	3	3	3	2	3	3

Course Code	**MCA304E**
Course Name	**SOFT COMPUTING**
Category	Programme Elective Course
Prerequisite	Basic Mathematics

Paper-MCA304E

Soft Computing

UNIT-I: **8hrs**

Fuzzy Logic: Basic definition and terminology of fuzzy set, set theoretic operations, T-norm, T-conorm, Membership function formulation and parameterization, Extension Principle, Fuzzy relations, Linguistic variables, fuzzy if then rules, Compositional rule of inference, fuzzy reasoning, fuzzy inference systems, Mamdani fuzzy model.

UNIT-II: **8hrs**

Neural Network: Evolution of Artificial Neural Network (ANN), McP neural network, Perceptron, Perceptron convergence theorem, Perceptron learning, Multilayer perceptron, Back-propagation algorithm, Radial Basis Function, Radial Basis Function Network.

UNIT-III: **12hrs**

Genetic Algorithm: Introduction to Genetic Algorithm (GA), Working cycle of a GA, Binary coded GA, GA-parameter setting, Constraint handling, Advantages and disadvantages of GA.

UNIT-IV: **12hrs**

Simulated Annealing, Ant-Colony Optimization, Particle Swarm Optimization, Multi-objective optimization techniques and evolutionary computing.

Text Books:

1. J. Shing, R. Jang, C. T. Sun, and E. Mizutani, Neuro Fuzzy And Soft Computing - A Computational Approach to Learning and Machine Intelligence, 3rd Edition, Pearson Education, 2008.
2. D. K. Pratihar, Soft Computing, 2nd Edition, Narosa Publishing House, 2009.
3. S. Haykin, Neural Network - A Comprehensive Foundation, 2nd Edition, Pearson Education, 2006.

Reference Books:
1. T. Munakata, Fundamentals of the New Artificial Intelligence - Neural, Evolutionary, Fuzzy and More, 2nd Edition, Springer, 2014. 2. F. O. Karray and C. De Silva, Soft Computing and Intelligent System Design - Theory, Tools and Applications, 1st Edition, Pearson Education, 2009.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to
CO1	Apply fuzzy logic and fuzzy inference system concept to design automation system for real life problems
CO2	Apply the concepts of genetic algorithm to solve engineering optimization problems.
CO3	Train the Artificial Neural Network for decision making in real life environment.
CO4	Use the concepts of Artificial Neural Network (ANN) to solve real life engineering and societal problems.
CO5	Apply the concepts of Simulated Annealing, Ant-Colony Optimization, Particle Swarm Optimization, Multi-objective optimization techniques to solve engineering optimization problems.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1			2	2	2	2		1	3	
CO2			2	3	2	2	1	2	3	2
CO3			3	1		2	3		3	3
CO4	2		3	3	2	3	3	2	3	2
CO5	2		3	3	2	2	3	2	3	2

Course Code	**MCA304F**
Course Name	**SIMULATION MODELING**
Category	Programme Elective Course
Prerequisite	Basic knowledge of Computer Fundamentals, Mathematics, Probability and Statistics.

MCA-304F

Simulation Modeling

UNIT-I: **08hrs**

System Model: System definition and components, System Environment, Stochastic Activities, Continuous and Discrete Systems, System Modeling, Types of models, Static and Dynamic Physical Models, Static and Dynamic Mathematical Models, Principles used in Modelling, System Studies, Types of system study.

UNIT-II: **10hrs**

System simulation: why & when to simulate, nature and techniques of simulation, Monte Carlo Method, Comparison of simulation and analytical methods, Types of system simulation, Numerical Computation Technique for Continuous Models, Numerical Computation Technique for Discrete Models, Single-server queuing system, Distributed Lag models, Cobweb model, Progress of a Simulation study.

UNIT-III: **10hrs**

Continuous System Simulation and Probability Concept: Continuous System Simulation, Analog vs. Digital Simulation, Hybrid Computers, Continuous System Simulation Languages (CSSLs), CSMP-III, Hybrid Simulation, water reservoir system, simulation of an autopilot, Real time Simulation. Discrete system simulation, fixed time-step , generation of random numbers, Simulation of a telephone System, Simulation Programming Tasks, test for randomness, Discrete simulation languages.

UNIT-IV: **12hrs**

System Dyanamic, GPSS AND SIMSCRIPT: System dynamics, exponential growth models, exponential decay models, modified exponential growth models, logistic curves, generalization of growth models, system dynamic diagrams. Introduction to GPSS, simulation of Manufacture Shop, Gathering Statistics,Data structure in GPPS, Evaluation of Simulation Algorithm in GPSS. Introduction to SIMSCRIPT:Program, system concepts, origination, and statements, defining the telephone system model, Data structure in SIMSCRIPT, Evaluation of Simulation Algorithm in SIMSCRIPT.

Text Book:

1. Geoftrey Gordon, " System Simulation",2/e, PHI

Reference Books:

1. Jerry Banks, John S. C Barry L. Nelson David M. Nicol, "Discrete Event System Simulation", Pearson Education.
2. NarsinghDeo, System Simulation with Digital Computer, PHI.
3. V P Singh, "System Modeling and simulation", New Age International.
4. Averill M. Law, W. David Kelton, "System Modeling and simulation and Analysis", TMH.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Remember and understand the basic concepts/Principles of SIMULATION MODELING
CO2	Analyze the Various Concepts to understand them through case studies
CO3	Apply the knowledge in understanding practical problems
CO4	Execute/Create the Project or field assignment as per the knowledge gained in the course
CO5	Build tools to view and control simulations and their results

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	1	3	1	2	2	1	1
CO2	2	2	2	1	3	1	2	2	2	2
CO3	3	3	3	1	3	1	3	2	3	2
CO4	3	2	1	1	3	1	2	2	2	1
CO5	3	2	3	2	2	1	2	2	2	2

Paper-MCA305

Lab III: Web Technology and Artificial Intelligence using Python

WEB TECHNOLOGY PROGRAMS:

1. Design a web page for your college containing a description of courses, departments, faculties using different HTML elements.
2. Customize the HTML page using CSS.
3. Create a login form which will check for username and password. If login successful then goto next form(Student registration form) that contains form with fields Name, Email, Mobile No ,Gender and a button .write a JavaScript code to validate data of above form.
4. Develop simple calculator for addition, subtraction, and multiplicationanddivisionoperation using JavaScript.
5. Design a web page to create your resume usecolor, textcolor, an Image, font etc. You may use CSS to format web page.
6. Create user Student registrationform (use textbox, checkbox, radiobutton, select box etc.)
7. Design an examination registration form using HTML. Sore the required data in a database (create it using MySQL) using PHP and also display message regarding status of registration (Success or Unsuccess).
8. Create a database through PHP and MySQL, and create, delete and modify data on database.
9. Store the data from a HTML form designed for registering a webinar and using PHP and MySQL, store, and update the data. Display the database data in HTML form.
10. Create anapplication using HTML, PHP. Create login form using HTML and checkusername and password using PHP, if login successful it will go on next HTML page and if failure again goesback to login page

ARTIFICIAL INTELLIGENCE PROGRAMS:

1. Write a Python program to implement a state-space search for solving the 8-puzzle problem using Breadth First Search (BFS).
2. Write a Python program to implement hill climbing to find the maximum value of a mathematical function.
3. Write a Python program to implement A search* for a shortest path problem (e.g., from one city to another in a graph).
4. Write a Python program to demonstrate a simple production system for diagnosing whether a student passes or fails based on marks.
5. Write a Python program to represent facts using predicate logic and perform simple inference (e.g., “Socrates is a man → Man is mortal → Socrates is mortal”).
6. Write a Python program to implement forward chaining and backward chaining on a small rule-based knowledge system.
7. Write a Python program to calculate Bayesian probability given prior and conditional probabilities.
8. Write a Python program to implement the Minimax algorithm with Alpha-Beta pruning for Tic-Tac-Toe.
9. Write a Python program to implement a simple Perceptron model for the AND gate.
10. Write a Python program to implement a Genetic Algorithm (GA) to optimize the function $f(x) = x^2$.

IDSE PAPERS:

Course Code	**MCA306A**
Course Name	**NETWORK AND INTERNET TECHNOLOGIES**
Category	IDSE course
Prerequisite	Basic Mathematics

IDSE-Paper-MCA306A

Network and Internet Technologies

UNIT-I: 10hrs

Computer Networks: Introduction to computer network, data communication, components of data communication, data transmission mode, data communication measurement, LAN, MAN, WAN, wireless LAN, internet, intranet, extranet.
Network Models: Client/ server network and Peer-to-peer network, OSI, TCP/IP, layers and functionalities.

UNIT-II: 10hrs

Transmission Media: Introduction, Guided Media: Twisted pair, Coaxial cable, Optical fibre. Unguided media: Microwave, Radio frequency propagation, Satellite. **LAN Topologies:** Ring, bus, star, mesh and tree topologies. **Network Devices:** NIC, repeaters, hub, bridge, switch, gateway and router. **Internet Terms:** Web page, Home page, website, internet browsers, URL, Hypertext, ISP, Web server, download and upload, online and offline.

UNIT-III: 10hrs

Introduction to Web Design: Introduction to hypertext mark-up language (html) Document type definition, creating web pages, lists, hyperlinks, tables, web forms, inserting images, frames, hosting options and domain name registration.

UNIT-IV: 10hrs

Style Sheets: CSS-Introduction to Cascading Style Sheets-Features-Core Syntax-Style Sheets and HTML Style Rule Cascading and Inheritance-Text Properties-Box Model-Normal Flow Box Layout-Beyond the Normal Flow-Other Properties-Case Study. **Client-Side Programming:** The JavaScript Language-History and Versions Introduction to JavaScript in Perspective-Syntax-Variables and Data Types-Statements-Operators-Literals-Functions-Objects-Arrays-Built-in Objects-JavaScript Debuggers.

Text Book:

1. J. A. Ramalho, Learn Advanced HTML 4.0 with DHTML, 1st Edition, BPB Publications, 2007.

Reference Books:

1. B. A. Forouzan, Data Communication and Networking, 5th Edition, Tata McGrawHill, 2008.
2. D.R. Brooks, An Introduction to HTML and JavaScript for Scientists and Engineers, 1st Edition, Springer, 2007.
3. Wendy Willard,HTML A Beginner's Guide, 4th Edition, Tata McGraw-Hill Education, 2009.
4. J. A. Ramalho, Learn Advanced HTML 4.0 with DHTML, 1st Edition, BPB Publications, 2007.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Understand the fundamental concepts of Computer networks with architecture.
CO2	Basic Concept of various Network Devices
CO3	Understand the basic concept of transmission media, LAN topology.
CO4	Understand Fundamentals of Web Design
CO5	Develop Web Applications using Web Technologies

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	1	3	2	2	2		1			1
CO2	1	2	1			1		1	1	1
CO3	1	2	1			1		1	1	1
CO4	1	3	1	3	3	3	1	1	2	1
CO5	2	3	2	3	3	3	1		2	1

Course Code	**MCA306B**
Course Name	**DATA ANALYTICS USING R PROGRAMMING**
Category	IDSE course
Prerequisite	Basic knowledge of programming (C/Python), databases, Fundamentals of Statistics & Probability.

IDSE Paper- MCA 306B

Data Analytics Using R Programming

UNIT-I: **10hrs**

Introduction to R and Data Handling- Introduction to R and RStudio, Installing and using R packages , Data types, variables, operators, expressions, Data structures: vectors, lists, matrices, arrays, data frames, Importing and exporting data (CSV, Excel, SQL databases), Basic data manipulation and indexing.

UNIT-II: **10hrs**

Data Wrangling and Visualization- Data cleaning, preprocessing, handling missing values & outliers, Data manipulation using dplyr, tidyr, Data summarization and grouping, Introduction to visualization, Data visualization using ggplot2 (bar, line, scatter, histogram, boxplot, pie chart), Exploratory Data Analysis (EDA).

UNIT-III: **12hrs**

Statistical Analysis and Machine Learning Basics- Descriptive statistics (mean, median, mode, variance, standard deviation, correlation), Probability distributions in R (normal, binomial, Poisson), Hypothesis testing: t-test, chi-square test, ANOVA, Regression: Simple & Multiple Linear Regression, Basics of classification: Logistic Regression, Decision Trees, Introduction to clustering: k-Means, Hierarchical Clustering.

UNIT-IV: **08hrs**

Applications of Data Analytics- Time series analysis (trend, seasonality, forecasting using ARIMA basics), Introduction to text mining and sentiment analysis, Case studies: Healthcare, Finance, Social Media analytics, Mini Project: Apply R to a real-world dataset (end-to-end analytics pipeline), Current and future trends in data analytics.

Text Books:

1. Garrett Grolemund & Hadley Wickham – R for Data Science, O'Reilly Media, 2017.
2. Norman Matloff – The Art of R Programming, No Starch Press.
3. Jure Leskovec, Anand Rajaraman, Jeffrey Ullman – Mining of Massive Datasets, Cambridge University Press.

Reference Books:

1. Mark Gardener – Beginning R: The Statistical Programming Language, Wiley.
2. Peter Dalgaard – Introductory Statistics with R, Springer.
3. Roger D. Peng – Exploratory Data Analysis with R, Leanpub.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman – The Elements of Statistical Learning, Springer.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Apply fundamental concepts of R programming to perform data manipulation, visualization, and statistical analysis.
CO2	Demonstrate proficiency in importing, cleaning, and preprocessing datasets using R for real-world analytical tasks.
CO3	Develop analytical models using descriptive, predictive, and inferential statistical techniques in R.
CO4	Implement machine learning algorithms in R to solve classification, clustering, and regression problems.
CO5	Analyze and interpret results from R-based data analytics solutions to support decision-making in practical scenarios.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	1	1			1	1	3
CO2	3	1	1	1	2			2	2	3
CO3	3	1	2	1	2			1	1	3
CO4	1	3	1	2	1			1	1	3
CO5	1	3	3	3	1			1	1	3

Course Code	**MCA306C**
Course Name	**OBJECT ORIENTED PROGRAMMING USING C++**
Category	IDSE course
Prerequisite	Basic Programming knowledge

IDSE Paper-MCA306C

Object Oriented Programming using C++

UNIT-I: 10hrs

Principles of Object Oriented Programming (OOP), Software Evaluation, A Look at Procedure-Oriented Programming, OOP Paradigm, Basic Concepts of OOP, Benefits of OPP, Application of OOP. **Introduction to C++**: What is C++, A simple C++ Program, More C++ statements, Structure of C++ Program. Tokens, Expression and controls Structures, Tokens , Keywords, Identifiers and Constants, C++ data types, Variables: Declaration, Dynamic initialization of variables, Reference variables, Operators in C++ : Scope resolution operator, Member deferencing Operators, Memory Management Operators, Manipulators, Type cast operators, Expressions and Control Structures. **Functions**: The main() function, Function Prototyping, Call by reference, Return by reference, Inline function, Function Overloading.

UNIT-II: 10hrs

Classes and Objects: Introduction, Specifying a Class, Defining member Functions, C++ Program with Class, Nesting of Member functions, Private member functions, Memory Allocation for Objects, Static Data members, Static Member Functions, Arrays within a Class, Arrays of Objects, Objects as Function Arguments, Friendly Functions, Returning Objects. **Pointers:** Declaration and initializing, Manipulation of pointers, pointers Expression and Pointer Arithmetic, Pointer with Arrays, Arrays of Pointers, Pointers to objects, this pointers, Arrays of Pointers to Objects, **Constructors and Destructors:** Constructors, Parameterized Constructors, Multiple Constructors in a class, Copy constructor, Destructors. **Operator overloading:** Defining Operator Overloading, Overloading Unary Operators, Overloading Binary Operators, Type Conversions.

UNIT-III: 12hrs

Inheritance and Polymorphisms: Introduction, Defining Derived Classes, Single inheritance, Multiple inheritance, Hierarchical inheritance, Multilevel inheritance, Hybrid inheritance, Virtual Base Classes, Polymorphism, static and dynamic binding, Constructor in Derived Classes, Pointers to Derived Classes, Virtual Functions, Pure Virtual Functions**.**

UNIT-IV: 08hrs

I/O Operations and Files: C++ Stream Classes, Unformatted I/O Operations, Formatted I/O operations, Classes for File Streams, Opening and Closing a File : open() and close() functions, Manipulators of File Pointers : seekg(), seekp(), tellg(), tellp() functions, Sequential Input and output Operations : put (), get(), write(), read() functions, Error handling File Operations : eof(), fail(), bad(), good() .

Text Book:

1. E. Balagurusamy - Object Oriented Programming with C++ - TMH.

Reference Books:

1.Robert Lafore - Object Oriented Programming in Microsoft C++ - Galgotia.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	**Explain** the fundamental principles of Object-Oriented Programming, its benefits, and applications, along with the basic structure and features of C++.
CO2	**Apply** concepts of tokens, data types, operators, expressions, control structures, and functions (including overloading and inline functions) to solve computational problems in C++.
CO3	**Develop** C++ programs using classes, objects, constructors, destructors, pointers, and operator overloading for efficient problem-solving.
CO4	**Analyze** inheritance and polymorphism techniques, including multiple inheritance, virtual functions, and dynamic binding, to build reusable and extensible software systems.
CO5	**Implement** file handling and I/O operations in C++ to manage persistent data storage and retrieval effectively.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	2	2		2	2	2	2
CO2	2	2	1	2	2		1	2	1	2
CO3	2	2	1	2	2		1	2	1	2
CO4	1	2	2	2	1		1	2	2	2
CO5	2	2	2	1	2		1	2	2	1

Course Code	**MCA306D**
Course Name	**DATA ANALYTICS AND VISUALIZATION WITH EXCEL**
Category	IDSE course
Prerequisite	Basic Computing Skills

IDSE Paper-MCA306D

Data Analytics and Visualization with Excel

UNIT-I: 10hrs

Fundamental of Data and Excel : Data, Information, and Knowledge: definitions & examples, Types of Data: Structured vs. Unstructured, Levels of Measurement: Nominal, Ordinal, Interval, Ratio, Introduction to Data Analytics: descriptive, diagnostic, predictive, prescriptive, Importance of data quality in decision-making

Excel interface, sheets, and basic operations, Cell references: relative, absolute, mixed, Importing datasets (CSV, TXT, external sources), Sorting, filtering, and conditional formatting, Basic formulas (SUM, AVERAGE, COUNT, IF, VLOOKUP, HLOOKUP)

UNIT-II: 10hrs

Data Summarization and Visualization : Principles of data visualization (clarity, accuracy, simplicity), Types of charts and their use cases, Importance of Exploratory Data Analysis (EDA), Storytelling with data: presenting insights effectively.

Creating and customizing charts (bar, line, scatter, pie, combo), PivotTables and PivotCharts for summarization, Conditional formatting with icons, color scales, and data bars, Interactive dashboards with slicers and timelines, Case study: Building a sales or student performance dashboard

UNIT-III: 10hrs

Practical Analytics and Data Cleaning : Descriptive statistics: mean, median, mode, variance, standard deviation, Correlation and Regression (concepts only, simple application), Data Cleaning & Quality: Missing values, duplicates, inconsistent data, Role of clean data in business and research.

Data Analysis ToolPak: descriptive statistics, correlation, regression, Cleaning datasets: TRIM, CLEAN, PROPER, remove duplicates, find/replace, Splitting and merging data (Text-to-Columns, CONCATENATE), Sampling and randomization, Case study: Cleaning and analyzing a student survey dataset

UNIT-IV: 10hrs

Advanced Analytics and Forecasting : Introduction to Forecasting and Predictive Analytics, Basics of Optimization and Decision Support, Limitations of Excel for big data and advanced analytics, Transition to advanced tools (Python, R, Power BI)

Forecasting using trendlines and exponential smoothing, What-if analysis: Scenario Manager, Goal Seek, Data Tables, Optimization using Solver (resource allocation problems), Introduction to automation with Macros (basic VBA), Case study: Forecasting sales or attendance trends

Text Book:

1. Alexander, M. Excel 2021 for Data Analysis (Wiley, 2021).

Reference Books:

1. Winston, W. L. Microsoft Excel Data Analysis and Business Modeling (Microsoft Press, 2019)

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Explain the fundamental concepts of data, data analytics, and visualization, and the role of Excel in multidisciplinary problem-solving.
CO2	Apply Excel functions, formulas, sorting, filtering, and PivotTables to organize and summarize datasets
CO3	Create effective data visualizations and dashboards using Excel charts, conditional formatting, and interactivity tools.
CO4	Perform practical analytics such as descriptive statistics, correlation, regression, forecasting, and optimization using Excel ToolPak, Solver, and What-if Analysis.
CO5	Analyse real-world datasets by cleaning, preparing, and presenting data insights in a structured and meaningful way for decision-making.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	2	1	3	2	2	2
CO2	2	2	3	2	2	2	3	2	2	2
CO3	2	2	3	3	2	2	3	2	2	2
CO4	2	2	3	3	2	2	3	2	2	2
CO5	2	2	3	3	2	2	2	2	2	1

Semester-IV

Course Code	**MCA401**
Course Name	**MACHINE LEARNING**
Category	Programme Core Course
Prerequisite	Basic knowledge of Mathematics

Paper-MCA401

Machine Learning

UNIT-I: **10hrs**

Introduction to machine Learning: (Supervised, Unsupervised and Reinforcement learning), Learning Models (Classification, Regression, Clustering). Cluster Analysis, Partitioning Methods (k-Means, k-Medoids), Hierarchical Methods, Density Based Methods, Evaluation of Clustering.

UNIT-II: **10hrs**

Conditional Probability, Bayes' Theorem, Naïve Bayes Classifier, K-nearest neighbour, Multiple linear regression, Shrinkage method, Ridge regression, Logistic regression, Linear Discriminant Analysis.

UNIT-III: **12hrs**

Neural Networks - Introduction, McP Neural Network, Perceptron Learning, Neural Networks - Backpropagation, Neural Networks - Initialization, Training & Validation. Decision Tree, Decision Tree Induction, Attribute Selection Measures, Information Gain, Gain Ratio, ID3, C4.5, Gini Index, CART.

UNIT-IV: **08hrs**

Support Vector Machine for linearly separable data, Kernel function, Support Vector Machine for linearly non-separable data. Dimensionality reduction, Feature selection, Feature extraction, Principal Component 10hrs Text Books: Analysis.Model Cross- validation, Performance of Classification algorithms (Confusion Matrix, Precision and Recall).

Text Book:

1. T. Hastie, R. Tibshirani,and J. Friedman , The Elements of Statistical Learning-Data Mining, Inference, and Prediction, 2nd Edition, Springer Verlag, 2009.
2. S. Haykin, Neural Networks and Learning Machines, 3rdEdition,Pearson Education, 2009.

Reference Books:

1. Y. G. James, D. Witten, T. Hastieand R. Tibshirani, An introduction to Statistical learning with Applications in R, Springer, 2013.
2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Explain the concepts of supervised machine learning and its functionalities.
CO2	Perform classification using Bayes classifier, SVM, Decision Tree, and Random Forest.
CO3	Reduce dimension of feature space using feature selection and feature extraction.
CO4	Explain the concepts of unsupervised machine learning and its functionalities.
CO5	Apply supervised and unsupervised machine learning methods to solve real life problems.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1		1	1			2	3	1
CO2	3	1		1	1			2	3	1
CO3	3	2		1	2			3	3	2
CO4	3	2		1	2			3	3	2
CO5	3	1	1		1			1	3	3

Course Code	**MCA402**
Course Name	**SOFTWARE ENGINEERING AND OOAD**
Category	Programme Core Course
Prerequisite	Knowledge of software, object oriented concept and databases

Paper-MCA402

Software Engineering and OOAD

UNIT-I: **10hrs**

Introduction to Software and Software Engineering: Basic concepts about software and program, the nature of software, Evolution of Software Engineering, Stakeholders in software engineering, Software quality, Software engineering projects, Activities common to software projects, Basic concepts on process and life cycle models. Models: Waterfall, Prototype, Evolutionary, Incremental, Spiral, Agile, V-model

UNIT-II: **10hrs**

Requirement Analysis: System and software requirements, Types of software requirements, Functional and non-functional requirements, Domain requirements, User requirement Elicitation and analysis of requirements, Overview of requirement techniques, Viewpoints, Interviewing, Scenario, Requirement validation, Requirement specification, Software requirement Specification (SRS)Structure and contents, SRS format.

UNIT-III: **12hrs**

Introduction to Object Oriented Technology: Development and OO Modelling History, Modelling Concepts. Object Oriented Analysis: Identifying Use-Cases, Complexity in Object Oriented Analysis, Business Process Modelling and Business Object Analysis, Use-Case Driven Object-Oriented Analysis, Use-Case Model. Class Modelling: Object and class concepts, link and association, Generalization and Inheritance, Advanced class modelling- aggregation, state diagram, state diagram behaviour, Relation of Class and State models. Interaction Modelling: Sequence models, Activity Diagrams.

UNIT-IV: **08hrs**

Software Project Management: Overview of Project Management, Responsibilities of Project Manager, Project Planning, Metrics for Project Size Estimation, Factors Influencing Project Management, Project Estimation Techniques, COCOMO Model, Scheduling, Work Breakdown Structures (WBS), Activity Network, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), GANTT Chart, Risk Management.
Software Testing: Testing overview, concepts, Scope of Testing, Testing Constraints, Testing Life Cycle, Levels of Testing, System Testing, Blackbox Testing, Whitebox Testing, Integration Testing, Acceptance Testing, Performance Testing (Load testing, Stress testing, Scalability Test ing, Stability Testing, Volume Testing, Smoke Testing). Basic Concepts of Regression Test ing(Need of Regression Testing, How to perform Regression Testing, Testing Tools).

Text Book:

1.R. Mall, Fundamentals of Software Engineering, 5th Edition, PHI, 2019.
2. R.S. Pressman, Software Engineering, A Practitioner's Approach, 7th Edition, McGraw-Hill, 2009
3. Timothy C. Lethbridge, Robert Laganière, Object-Oriented Software Engineering Practical Software Development Using UML and Java,2nd Edition, McGraw-Hill.

Reference Books:
1. Sommerville, Software Engineering, 9th Edition, Addison-Wesley.

	COURSE OUTCOMES: After completion of this course successfully, the students will be able to-
CO1	Define software terminologies, and generic view of the software engineering process.
CO2	Describe the SDLC phases and apply suitable life-cycle model in building of software products based on their characteristics.
CO3	Apply object oriented analysis and design to build a software system.
CO4	Explain the scheduling, project management tasks and design artefacts.
CO5	Summarize different testing strategies and implement them appropriately.

Mapping of COs to POs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	2	1	1	2		1	1	2	2
CO2	1	1	1	2	2	2	1	2	1	1
CO3	2	1	1	1	1		1	1	1	1
CO4	1	1	2	1	1	1	2	1	1	1
CO5	1	1	1	1	1	1	1	1	2	1

MCA403

Project Work

Students are required to complete a software development or research project under the supervision of a faculty member from the School.

At the end of the 4th Semester the student shall submit a project report and give a power point presentation before the faculty members with external Examiner(s) outside the university in the relevant fields.

The award of Marks for the Project Work:

Internal Project evaluation by Supervisor of School=100 Marks

Project Evaluation by External Examiner (outside university) =100 Marks

Project Report=50 Marks

Presentation & Viva =50 Marks

Total=300 Marks

MOOCs-1/MOOCs-2

Students are required to complete any **two** of the following MOOCs courses to earn a minimum of 6 credits duration anytime during his/her entire two years of MCA. From**https://swayam.gov.in**. or from**https://nptel.ac.in**.The course completion certificate of MOOCs courses need to be submitted in the final year at the time of Project Viva.

1. Quantum Algorithms and Cryptography	2.Big Data Computing
3. Computer Graphics	4. Natural Language Processing
5.Programming with Generative AI	6.Google Cloud Computing Foundations
7. Data Analytics with Python	8.Privacy and Security in Online Social Media
9. Linux Operating System	10.Computer Application in Business
11.Peer to Peer Networks	12.Animations
13. Embedded System Design	14.Data Science for Engineers
15.Pattern Recognition	16. Introduction to Internet of Things
17.Blockchain and its Applications	18.Advanced Graph Theory
19.Deep Learning	20.Software Testing
21.Ethical Hacking	22.Android app using Kotlin
23.Introduction to Haskell programming	24. User Centric Computing for Human-Computer Interaction
25.Arduino	26. Reinforcement Learning
27.Introduction to Soft Computing	28.Computer Vision and Image Processing
29.Matlab Programming for Numerical Computation	30.Cloud Computing and Distributed Systems

Apart from the above courses if any student wishes to do any course from https://swayam.gov.in. or fromhttps://nptel.ac.in(but it should not be in their course curriculum of 1st, 2nd and 3rd Semesters) they are allowed to do so with a prior approval from Head, Computer Science.

Value Added Course

Program: Certificate		Session: 2025-2026

Course Code	**GMU-MCA-VAC-WD**
Course Title	**Web Designing**
Course Type	**Value Added Course (VAC)**
Pre-requisite (if any)	Open for All
Course Learning outcomes (CLO)	After studying this Course the student will be able to — Code a handful of useful HTML & CSS examples Build semantic, HTML & CSS web page Write basic scripts Use Names, Objects, and Methods Add Interactivity to a Web Page Create Dynamic Web Pages using Java Script in HTML forms.
Expected Job Role / Career opportunities	Job Role - Web Designer / Front End Developer/ Creative Ad Designer Job Description — Web designers develop functional and appealing web pages, websites, web applications, online advertisements for individuals, businesses and government agencies to establish their online presence. They use knowledge of computer programming and graphic design to create websites that meet client needs. Career Opportunities — Typical employers of web designers are — Software companies • IT consultancies Specialist web design companies •3 Large corporate organisations Any organisation that uses computer systems •3 Self-employment/freelance work is often possible for individuals with appropriate experience. Vacancies are advertised online, by career services and by recruitment agencies.
Credit Value	**4 (Theory — 2 Practical — 2)**

Part B- Content of the Course		
Total No. of Lectures + Practical (in hours per week): L-2 Hrs / P-2 Hrs		
Total No. of Lectures/ Practical: L-30hrs/P-30hrs		
Module	Topics	Hours
I	Introduction to Internet- World Wide Web, Internet Addressing, Browser, URL, Web server, website, homepage, Domain Name. Basic concepts. Softwares for Web Designing - Notepad/Notepad+, Dreamweaver, Blue Griffon, Net beans, Sea Monkey, Word press, Sublime. Introduction to HTML: HTML Tags and Attributes, HTML Basic Tags, Formatting Tags, HTML Color Coding, Div and Span Tags for Grouping. Lists: Unordered Lists, Ordered Lists, Definition list. Images: Image and Image Mapping Hyperlink: URL - Uniform Resource Locator, URL Encoding. Table: <table>, <th>, <tr>, <td>, <caption>, <thead>, <tbody>, <tfoot>, <colgroup>, <col>. Attributes Using Iframe as the Target Form: <input>, <textarea>, <button>, <select>, <label> Headers: Title, Base, Link, Styles, Script HTML Meta Ta , XHTML, HTML Deprecated Tags & Attributes	10
11	CSS: Introduction, Features and benefits of CSS, CSS Syntax, External Style Sheet using <link>, Multiple Style Sheets, Value Lengths and Percentages. Selectors: ID Selectors, Class Selectors, Grouping Selectors, Universal Selector, Descendant / Child Selectors, Attribute Selectors, CSS — Pseudo Classes. Color Background Cursor: background-image, background-repeat, backgroundposition, CSS Cursor Text Fonts: color, background-color, text-decoration, text-align, vertical-align, text-indent, text-transform, white-space, letter-spacing, word-spacing, line-height, font-family, font-size, font-style, font-variant, font-weight. Lists Tables: list-style-type, list-style-position, list-style-image, list-style, CSS Tables (border, width & height, text-align, vertical-align, padding, color) Box Model: Borders & Outline, Margin & Padding, Height and width, CSS Dimensions. Display Positioning: CSS Visibility, CSS Display, CSS Scrollbars, CSS Positioning (Static Positioning, Fixed Positioning, Relative Positioning, Absolute Positioning), CSS Layers with Z-lndex.	10

III	The JavaScript: Nature of JavaScript, Script Writing Basics, Enhancing HTML Documents with JavaScript, The Building Blocks. Introduction to JavaScript, JavaScript Engines, Values, Variables and Operators, Variable Mutation, Basic Operators, Operator Precedence, JavaScript Types, Types Definition, Types in JavaScript, Objects, Type Conversion and Coercion, Static vs Dynamic Type Checking. JavaScript Conditionals: Introduction to Conditionals, Conditionals in JavaScript, Ternary Operators and Conditionals. Conditional Ladder & Switch statement. JavaScript Arrays: Introduction to Arrays, Declaring and Mutating Arrays, Array Methods and Properties, Replication with Array Methods, Multi-dimensional Arrays.	10
IV	JavaScript Loops: Introduction to Loops, Loops in JavaScript, While and Do/While Loops, For Loops, Break and Continue in Loops, Iterating Arrays, Iterating Objects. JavaScript Functions: Introduction to Functions, Functions in JavaScript, Nested Functions in JavaScript, Arrow Functions in JavaScript, Function as an Argument, Function as the Returned Object, JavaScript Scope: Scope Introduction, Scope in JavaScript, Lexical Scope, Module Scope. Method of Adding Interactivity to a Web Page, Creating Dynamic Web Pages; Concept of Java Scripting the Forms. Java Scripting the Forms, Basic Script Construction, Talking to the Form Objects, Organizing the Objects and Scripts, Field-Level Validation, Check Required Fields like Validating Zip Code, Automated Formatting, Format Phone, Format Money, Automatic Calculation, Calculate Expiration Date, Calculate Amount etc	10

	Practicals	
	1. Design a home page which displays information about your college department using headings, HTML entitites and paragraphs. 2. Implement different type of list tags in the college department homepage. 3. Create a webpage for any clinic using marquee and HTML formatting tags. 4. Create 3 Hyperlinks in home page connecting it to 3 different pages. 5. Create 3 hyperlinks in a page, which jumps to 3 different headings on same page. 6. Insert image(s) and iframe in a webpage. 7. Design a page with image of block diagram of computer, mapping each component as area with specifië co-ordinates which when clicked may give their detail. 8. Create a web page having two frames, Frame 1 containing links and another with contents of the link. When link is clicked appropriate contents should be displayed on Frame 2. 9. Design a timetable and display it in tabular format. 10. Demonstrate difference between "get" and "post" method of form tag in a form with name and password text fields. 11. Design an admission form for any course in your college with text, password fields, drop-down list, check-boxes, radio buttons, submit and reset button etc. 12. Create a website for online book store with Home, Login, Catalogue, Registration page with links to all these pages in a menu on top of every page. Embed heading, paragraph, images, video, iframe, form controls, table, list in this website. 13. Write a CSS style specification rule that would make all unordered lists (tags) have square bullets and a purple background. 14. Create a HTML form with the use of cascading style sheets. 15. Design a web page of your Home town with a attractive background color, text color, an image, font face by using Inline CSS formatting. 16. Create a catalog for an online shopping company that sells music records using style sheets. 17. Create a sample code to illustrate the Inline style sheet for your web page. 18. Create a sample code to illustrate the External style sheet for your web page 19. Design a web page by using different CSS border styles. 20. Demonstrate the use of CSS Box Model. 21. Change the color of all elements with the class "colortext" to "Blue" 22. Set different margins for all four sides of paragraph.	15

	1. Write a JavaScript program to display the current day and time . 2. Write a JavaScript program to remove a character at the specified position of a given string and return the new string. 3. Write a JavaScript program to get the current date. 4. Write a JavaScript program to find the area of a triangle. 5. Write a JavaScript program to determine whether a given year is a leap year. 6. Write a JavaScript program to calculate multiplication and division of two numbers. 7. Write a JavaScript program to convert temperatures to and from Celsius, Fahrenheit. 8. Write a JavaScript program to check whether a given positive number is a multiple of 3. 9. Write a JavaScript program to change the case of a string.(i.e upper case to lower case and vice-versa). 10. Write a JavaScript program to compute the sum of elements of given array of integers. 11. Develop and demonstrate a HTML file that includes JavaScript script for taking a number n as input using prompt and display first n Fibonacci numbers in a paragraph. 12. Develop and demonstrate a HTML file that includes JavaScript script for taking full name in a text field and display first, middle, last name in 3 different labels. Middle and last name may be optional, thus message like "NA" should be displayed in corresponding labels. If input contains 2 words, then they should be considered as first and last name. 13. Develop and demonstrate a HTML file that includes JavaScript script for switching an image source for a image on click of "change" and "original"	15

button.

14. Design HTML form for keeping student record, apply JavaScript validation in it for restriction of mandatory fields, numeric field, email-address field, specific value in a field etc.

15. Write a JavaScript code that displays text "Bigger Text" with increasing font size in the interval of .10ms in red color, when the font size reaches 50pt it displays "Smaller Text" in green color. Then the font size should decrease to 5pt and then stop.

Part C-Learning Resources

Text Books, Reference Books, Other resources

1. Suggested Readings:

Jon Duckett, HTML And CSS: Design And Build Websites, Wiley º Jon Duckett, JavaScript And Jquery: Interactive Front-End Web Development, Wiley º Jennifer Niederst Robbins, Learning Web Design: A Beginner's Guide To HTML, CSS, JavaScript, And Web Graphics, O'reilly

Steven M. Schafer, Html, XHTML, And CSS Bible, Wiley

Felke-Morris, Basics Of Web Design: Htm15 & Css3, 5th Edition, Pearson Education, 2019. Felke-Morris, Web Development & Design Foundations With Htm15, 10th Edition, AddisonWesley, 2020.

º Ian Pouncey, Richard York, Beginning CSS: Cascading Style Sheets For Web Design, Wiley India.

Thomas A Powell, The Complete Reference To Html

Lee Anne Philips, Using Html, PHI

C. Xavier, World Wide Web Design With Html,

Xavier C, Web Technology And Design, New Age International

Laura Lemay, Mastering Html, CSS & JavaScript Web Publishing

Dt Editorial Sewicés, Html 5 Black Book - Covers CSS 3, JavaScript, XML, XHTML, AJAX, PHP and Jquery, DreamTech Press Publication

2. Suggestive digital platforms web links:

- https://www.w3schools.com/
- https://spoken-tutorial.org/
- https://www.doc-developpement-durable.org/file/Projets-informatiques/cours-&-manuelsinformatiques/htm-html-xml-

  200ne.pdf (PDF: 608 pages)
- http://www.nematrian.com/Pages/HTMLCSSJSCombined.pdf (PDF: 514 pages)
- https://www.daoudisamir.com/references/vs ebooks/htm15 css3.pdf DF: 681 pages

Suggested equivalent online courses:

https://nptel.ac.in/courses/106/105/106105084/ (NPTEL Course: Internet Technology — Part of the Course) https://onlinecourses.swayam2.ac.in/aic20_spl_l/preview (HTML and CSS) https://www.coursera.org/learn/html-css-javascript-for-web-developers#syllabus (HTML, CSS, and JavaScript for Web Developers) https://www.classcentral.com/course/html-css-javascript-for-web-developers-4270 (HTML, CSS, and JavaScript for Web Developers) https://www.classcentral.com/course/duke-programming-web-4256 https://www.coursera.org/learn/duke-programming-web (Programming Foundations with JavaScript, HTML and CSS)