Guru Nanak Institute of Technology

Department of Computer Applications

Course Structure

&

Syllabus

for

Master of Computer Applications (MCA)

Regulation – 20

(Under Autonomy)

GURU NANAK INSTITUTE OF TECHNOLOGY

157/F, Nilgunj Road, Sodepur, Kolkata-114

Affiliated to -

Maulana Abul Kalam Azad University of Technology (Formerly known as WBUT)

Guru Nanak Institute of Technology

Department of Computer Applications

Program Structure							
SEMESTER	**THEORY**		**PRACTICAL**		**SESSIONAL**		**Semester Credits [A+B+C]**
	Courses	**Credits [A]**	**Courses**	**Credits [B]**	**Courses**	**Credits [C]**	
I	4(C) + 1(E)	19	3	6	-	-	25
II	4(C) + 1(E)	19	3	6	-	-	25
III	3(C) + 2(E)	18	1	2	1	5	25
IV	1(O)	3	-	-	2	22	25
TOTAL CREDIT→							**100**

*** C → Compulsory Courses**
*** E → Elective Courses**
*** O → Open Elective Courses**

Guru Nanak Institute of Technology

Department of Computer Applications

CURRICULUM							
Semester – I							
Sl. No.	Course Code	Course Name	Contact Hours / Week				Credit
			L	T	P	Total	
THEORY							
1	MCA20-101	Programming in Python	3	1	-	4	4
2	MCA20-102	Relational Database Management Systems	3	1	-	4	4
3	MCA20-103	Computer Organization and Architecture	3	1	-	4	4
4	MCA20-104	Discrete Mathematics and Graph Theory	3	1	-	4	4
5	**Elective I**		3	-	-	3	3
	MCA20-E105A	Environment and Ecology					
	MCA20-E105B	Management and Accountancy					
	MCA20-E105C	Constitution of India					
	MCA20-E105D	Stress Management through Yoga					
	MCA20-E105E	Values and Ethics in Profession					
	MCA20-E105F	Managerial Economics					
PRACTICAL							
1	MCA20-190	Soft Skills and Interpersonal Development	-	-	4	4	2
2	MCA20-191	Python Programming Lab	-	-	4	4	2
3	MCA20-192	Relational Database Management Systems Lab	-	-	4	4	2
		Total Weekly Contact Hours and Credit				**31**	**25**

CURRICULUM

Semester – II

Sl. No.	Course Code	Course Name	Contact Hours / Week				Credit
			L	T	P	Total	
THEORY							
1	MCA20-201	Data Structures	3	1	-	4	4
2	MCA20-202	Operating Systems	3	1	-	4	4
3	MCA20-203	Object Oriented Programming with JAVA	3	1	-	4	4
4	MCA20-204	Data Communication & Computer Networks	3	1	-	4	4
5	**Elective II**		3	-	-	3	3
	MCA20-E205A	Numerical and Statistical Analysis					
	MCA20-E205B	Computer Graphics					
	MCA20-E205C	Probability and Statistics					
	MCA20-E205D	Introduction to Cyber Security					
	MCA20-E205E	Introduction to Internet of Things (IoT)					
	MCA20-E205F	Automata Theory & Computational Complexity					
PRACTICAL							
1	MCA20-291	Data Structures Lab	-	-	4	4	2
2	MCA20-292	Operating Systems Lab (Unix)	-	-	4	4	2
3	MCA20-293	Object Oriented Programming Lab using JAVA	-	-	4	4	2
		Total Weekly Contact Hours and Credit				**31**	**25**

Guru Nanak Institute of Technology

Department of Computer Applications

CURRICULUM							
Semester – III							
Sl. No.	Course Code	Course Name	Contact Hours / Week				Credit
			L	T	P	Total	
THEORY							
1	MCA20-301	Software Engineering	3	1	-	4	4
2	MCA20-302	Artificial Intelligence	3	1	-	4	4
3	MCA20-303	Design and Analysis of Algorithms	3	1	-	4	4
4	**Elective III**		3	-	-	3	3
	MCA20-E304A	Image Processing					
	MCA20-E304B	Web Enabled JAVA Programming					
	MCA20-E304C	Cloud Computing					
	MCA20-E304D	Web Technology					
	MCA20-E304E	Android Application Development					
	MCA20-E304F	Basic Data Science					
5	**Elective IV**		3	-	-	3	3
	MCA20-E305A	Information Retrieval					
	MCA20-E305B	Data Warehousing and Data Mining					
	MCA20-E305C	Introduction to Big Data Analytics					
	MCA20-E305D	Cryptography					
	MCA20-E305E	Operations Research and Optimization Techniques					
	MCA20-E305F	Pattern Recognition					
	MCA20-E305G	Machine Learning					
PRACTICAL							
1	MCA20-E394 (A/B/C/D/E/F)	Elective III Lab	-	-	4	4	2
SESSIONAL							
1	MCA20-381	Minor Project and Viva-voce	-	-	8	8	5
		Total Weekly Contact Hours and Credit				**30**	**25**

CURRICULUM

Semester – IV

Sl. No.	Course Code	Course Name	Contact Hours / Week				Credit
			L	T	P	Total	
THEORY							
1	**Open Elective *+**		-	-	-	-	3
	MCA20-O401A	Business Analytics					
	MCA20-O401B	Robotics					
	MCA20-O401C	Bioinformatics					
	MCA20-O401D	Information Theory & Coding					
	MCA20-O401E	Automation in VLSI Design					
	MCA20-O401F	Intelligent Control					
	MCA20-O401G	Design of Embedded Systems					
	MCA20-O401H	Machine Learning					
	MCA20-O401I	Soft Computing					
	MCA20-O401J	Information Retrieval					
	MCA20-O401K	Multimedia					
	MCA20-O401L	Distributed System					
	MCA20-O401M	Big Data Analytics					
	MCA20-O401N	Cryptography					
	MCA20-O401O	Social Networks					
	**While opting for a domain for pursuing the Open Elective course, a student needs to ensure that the domain was not covered in previous semesters of the program.*						
	+ will abide by the rules of MAKAUT						
SESSIONAL							
1	MCA20-481	Grand Viva	-	-	-	-	2
2	MCA20-482	Major Project and Viva-voce	-	-	28	28	20
		Total Weekly Contact Hours and Credit				**28**	**25**

SYLLABUS

Semester – I

Course Code	**MCA20-101**
Course Name	**Programming in Python**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. To acquire programming skills in core Python.
2. To understand why Python is a useful scripting language for developers.
3. To learn how to design and program Python applications.
4. To learn how to use lists, tuples, and dictionaries in Python programs.
5. To learn how to identify Python object types.

Course Outcome:

After successful completion of this course, students will be able to:

1. Learn, understand and comprehend the concept of programming.
2. Design algorithm to solve simple programming problem.
3. Understand and remember syntax and semantics of Python.
4. Create application using secondary storage.
5. Understand and apply library for data analysis.
6. Apply Python to implement different solutions for the same problem and analyze why onesolution is better than the other.
7. To write program for real life problems.

MODULE NUMBER	COURSE CONTENT
1	**Fundamentals of Computers (6L)** History of Computers, Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. Basic Concepts of Assembly language, High level language, Compiler and Assembler. Number systems (decimal, octal and hexadecimal) with signed and unsigned numbers (using 1's and 2's complement) - their representation, conversion and arithmetic operations. Packed and unpacked BCD system, ASCII. IEEE-754 floating point representation (half- 16 bit, full- 32 bit, double- 64 bit).
2	**Programming Basics (2L)** Problem analysis, Flowchart, algorithms, Pseudo codes, structured programming, Example of Flowchart and Algorithm representation
3	**Variable and Expression (4L)** Variables as names for values; expressions (arithmetic and logical) and their evaluation (operators, associativity, precedence). Assignment operation; difference between left hand side and right hand side of assignment, Console input/output: taking input from user and printing user information.
4	**Control Statement and Iteration (5L)** If statement, else-if statement, multiple statements within if, multiple if statement. While Loop, For Loop, Nesting Loops, Controlling Loops using Break and Continue, Else Statement, Range Statement and Pass Statement in Loop.
5	**Collections (2L)** Strings, List, Tuples, Dictionary, Set, Selection sort, Bubble sort
6	**Function (2L)** Built in function, user defined function, function passing values, function returning values, default parameter values, Recursive function
7	**File Management (4L)** Operations on files (opening, modes, attributes, encoding, closing), read() & write() methods, tell() & seek() methods, renaming & deleting files and directories
8	**Errors and Exception Handling** Dealing with syntax errors, Exceptions, Handling exceptions with try/except, Cleaning up with finally

9	**Classes and Objects (5L)** Create a Class, Create Object, Init() Function, Methods, Self Parameter, Modification and Deletion of Object Parameter, Deletion of Object, Pass Statement, Inheritance and Polymorphism, Scope, Module, Built-In Math Function, Math Module, Module date time and Date Objects, RegEx Module and RegEx Functions, Exception Handling.
10	**Modules & Packages (2L)** Importing a module, Creating module, Function aliases, packages
11	**Numpy (6L)** ndArray, Pandas: reading files, exploratory data analysis, data preparation and processing, , Matplotlib : Scatterplot, Line plot, Bar plot, Histogram, Box plot, Pair plot

Reference Books:

1. N.S. Gill, Handbook of Computer Fundamentals, Khanna Publishing House
2. Dr. Jeeva Jose-Taming Python by Programming, Khanna Publishing
3. Martin C. Brown – The Complete Reference Python, Mc Graw Hill
4. A. Martelli, A. Ravenscroft, S. Holden, Python in a Nutshell, ORElLLY.
5. Jason Rees-Python Programming: Practical introduction to Python Programming for total beginners,
6. Anthony Brun – Python Programming: A Step By Step Guide From Beginner To Expert (Beginner, Intermediate & Advanced)
7. Mark Pilgrim-Diva into Python, Springer-Verlag Berlin and Heidelberg GmbH & Co.KG
8. Summerfield Mark- Programming in Python 3,Pearson Education India

SYLLABUS

Semester – I

Course Code	**MCA20-102**
Course Name	**Relational Database Management Systems**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

The students will learn

1. Fundamental Concepts Of Database Management System
2. Data Models
3. Different Database Languages

Course Outcome:

After successful completion of this course, students will be able to:

1. Identify the need for a database over the file system.
2. Understand and implement the process of data insertion, retrieval, and manipulation.
3. Implement SQL concept for a database transaction.
4. Understand and analyze the functional dependencies among attributes of the entity set andnormalization between the relations.
5. Evaluate the relational tables, PL/SQL programs, triggers, database files, indexing of RDBMS.
6. Understand and Implement the Transaction control and concurrency control management.
7. Understanding the concept of distributed & object-oriented database.

MODULE NUMBER	COURSE CONTENT
1	**Basic Concept (5L)** Database Management System, File based system, Advantages of DBMS over file based system, Database Approach, Logical DBMS Architecture, Three level architecture of DBMS or logical DBMS architecture, Need for three level architecture, Physical DBMS Architecture, Database Administrator (DBA) Functions & Role, Data files indices and Data Dictionary Types of Database, Relational and ER Models: Data Models, Relational Model, Domains, Tuple and Relation, Super keys, Candidate keys, Primary keys and foreign key for the Relations, Relational Constraints, Domain Constraint, Key Constraint, Integrity Constraint, - Update Operations and Dealing with Constraint Violations, Relational Operations **Entity Relationship (ER) Model:** Entities, Attributes, Relationships, More about Entities and Relationships, Defining Relationship for College Database, Conversion of E-R Diagram to Relational Database.
2	**Database Integrity and Normalization (7L)** Relational Database Integrity, The Keys, Referential Integrity, Entity Integrity, Redundancy and Associated Problems, Single Valued Dependencies, Normalization, Rules of Data Normalization, The First Normal Form, The Second Normal Form, The Third Normal Form, Boyce CODD Normal Form, The Fourth Normal Form, The Fifth Normal Form, Multi-valued Functional Dependency, Attribute Preservation, Lossless join Decomposition, Dependency Preservation.
3	**File Organization (4L)** Physical Database Design Issues, Storage of Database on Hard Disks, File Organization and Its Types, Heap files (Unordered files), Sequential File Organization, Indexed (Indexed Sequential) File Organization, Hashed File Organization, Types of Indexes, Index and Tree Structure, Multi-key File Organization, Need for Multiple Access Paths, Multi-list File Organization, Inverted File Organization.
4	**Structured Query Language(SQL) (6L)** Meaning, SQL commands, Data Definition Language, Data Manipulation Language, Data Control Language, Transaction Control Language, Queries using Order by, Where, Group by, Nested Queries. Joins, Views, Sequences, Indexes and Synonyms, Table Handling.
5	**Transaction and Concurrency Management (8L)** Transactions, Concurrent Transactions, Locking Protocol, Serializable Schedules, Locks Two Phase Locking (2PL), Deadlock and its Prevention, Optimistic& Pessimistic Concurrency Control. Database Recovery and Security: Database Recovery meaning, Kinds of failures, Failure controlling methods, Database errors, Backup & Recovery Techniques, Security & Integrity, Database Security Authorization.

6	**PL/SQL (6L)** Introduction to PL/SQL, Variables & Data types, Basic blocks, Conditional & branching statement, Handling of Cursor, Trigger, Function, Procedure, Package and Exception.
7	**Distributed & Object-Oriented Databases (4L)** Centralized Versus Non-Centralized Databases, Heterogeneous and Homogeneous Distributed Databases Reference Architecture of DDBMS, Distributed Database Design Query Processing, Distributed Concurrency Control: Serializability, Locking Protocols, Timestamp Protocols, Distributed Deadlock Management, Distributed Commit Protocols: Two-Phase Commit (2PC) & Three-Phase Commit (3PC). Basic Concept, Limitation of Relational Databases and Need for Object Oriented Databases.

Reference Books:

1. Silverchatz, Korth & Sudarshan-Data Base System Concepts, MH.
2. Elmasri, Navathe- Fundamentals of Database Systems, Pearson
3. C J date-An Introduction to Database, Addison-Wesley Publishing Company
4. Majumder & Bhattacharyya-Data Base Management Systems, TMH
5. Feuerstein-Oracle PL/SQL Programming, SPD/O'REILLY
6. Leon-Data Base Management Systems, VIKAS
7. Kroenke-Data Base Processing: Fundamentals, Design & Implementation, PHI
8. P.S Deshpande -SQL PL/SQL for Oracle 8 & 8i, Wiley Dreamtech
9. P. Bhatia, S. Bhatia, G. Singh- Concepts of Database Management System, Kalyani Publishers

SYLLABUS

Semester – I

Course Code	**MCA20-103**
Course Name	**Computer Organization and Architecture**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

The students will learn

1. The organization of a computer and its principal components, viz, ALU, Control, Memory and Input/output, etc.
2. The design components of a digital subsystem that required realizing various components such as ALU, Control, etc.

Course Outcome:

After successful completion of this course, students will be able to:

1. Describe the merits and pitfalls in computer performance measurements and analyze the impact of instruction set architecture on cost-performance of computer design
2. Explain Digital Logic Circuits, Data Representation, Register and Processor level Design and Instruction Set architecture
3. Solve problems related to computer arithmetic and Determine which hardware blocks and control lines are used for specific instructions
4. Design a pipeline for consistent execution of instructions with minimum hazards
5. Explain memory organization, I/O organization and its impact on computer cost/performance.

MODULE NUMBER	COURSE CONTENT
1	**Data and numbers [4L]** Data and number representation- binary-complement representation, BCD-ASCII, conversion of numbers from one Number system to the other, (r-1)'s & r's complement representation. Weightedand Unweighted Codes – Gray Code, Excess 3 Code, Binary Arithmetic, Floating Point Numbers.
2	**Boolean Algebra and Logic Gates [4L]** Fundamentals of Boolean Algebra, Logic gates (AND, OR, NOT, XOR, NAND, NOR) MINTERM, MAXTERM, truth table, Boolean expression, simplification, Boolean Algebra, K-map up-to 4 variable, Canonical Forms.
3	**Module 3: Combinational Circuits [6L]** Adder, subtractor, BCD adder, multiplexer, De-multiplexer, encoder, decoder
4	**Module 4: Sequential Circuits [8L]** Flip-Flop (SR, JK, D, T, Master-slave), Application of flip-flop-- Asynchronous counter up-to 4-bit, decade counter, mod-n-counter, Synchronous counter—ring counter, Johnson's count, Up down counter, Register.
5	**Module 5: Memory Organization [4L]** Types of memory RAM ROM, EPROM, DRAM, SRAM, Addressing Modes, Associative memory, main memory, virtual memory, Memory Hierarchy, Cache memory, secondary memory
6	**Module 6: I/O Interface [4L]** I/O: I/O interface, polling, interrupts, DMA, mode of data transfer
7	**Module 7: CPU Organization & Pipelining [6L]** CPU organization, instruction format, addressing mode, RISC, CISC, Von- Neumann-ArchitecturePipeline & vector processing, Pipeline structure, speedup, efficiency, throughput and bottlenecks. Data dependencies, branch delays. Arithmetic pipeline and Instruction pipeline.

8	**Module 8: Computer Arithmetic [4L]** Computer arithmetic: addition, subtraction, multiplication & division. Booth's algorithm. Dual core,C2D, I3, I5.

Reference Books:

1. Computer Organization and Embedded Systems, 6th Edition, Hamacher Carl,et.al, TataMcGrawHill,New Delhi,2011.
2. Computer Organization and Design: The Hardware Software / Interface, 5thEdition, 1994, PattersonDavid A.
3. Computer System Architecture, Revised 3rdEdition, Mano M. Morris, Pearson Education

SYLLABUS

Semester – I

Course Code	**MCA20-104**
Course Name	**Discrete Mathematics and Graph Theory**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

The students will learn

1. Fundamental concepts of Basics of Discrete Mathematics, Algebraic Structures.
2. Mathematical Logic
3. Set theory and algebraic structures
4. Graph Theory and its applications

Course Outcome:

After successful completion of this course, students will be able to:

1. Interpret the problems that can be formulated in terms of graphs and trees.
2. Explain network phenomena by using the concepts of connectivity, independent sets, cliques, matching, graph coloring etc.
3. Achieve the ability to think and reason abstract mathematical definitions and ideas relating to integers through concepts of well-ordering principle, division algorithm, greatest common divisors and congruence.
4. Apply counting techniques and the crucial concept of recurrence to comprehend the combinatorial aspects of algorithms.
5. Analyze the logical fundamentals of basic computational concepts.
6. Compare the notions of converse, contrapositive, inverse etc. in order to consolidate the comprehension of the logical subtleties involved in computational mathematics.

MODULE NUMBER	COURSE CONTENT
1	**Mathematical Logic [4L]** Mathematical Logic: Statements and Notation, Connectives, Normal Forms, Predicate Calculus.
2	**Set Theory [8L]** Sets, Relation and Function: Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem. Fuzzy set, Basic properties of fuzzy set.
3	**Mathematical Induction [2L]** The Well-Ordering Principle, Recursive definition, The Division Algorithm : Prime Numbers, GCD : Euclidian Algorithm, The fundamental theorem of Arithmetic, Mathematical Induction, Problem solving using method of Mathematical Induction
4	**Counting Principle[8L]** Counting: Factorial Notation, Binomial Coefficients, Permutation and Combinations, PigeonholePrinciple, Principle of Inclusion-Exclusion.
5	**Algebraic Structure [6L]** Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Algebraic Structures with two Binary Operations, Rings, Integral domains, Fields.
6	**Graph Theory[12L]** Basic concepts; Complete, Regular and Bipartite Graphs; Subgraphs and Isomorphism; Paths and connectivity; Trees and Planar graphs; Euler and Hamiltonian Graphs; Graph Algorithms. Spanning Tree, minimal Spanning Tree, Shortest path and algorithms. Graph colouring, colouring maps, colouring vertices and edges, perfect graph.

Reference Books:

1. Kandel & Baker- Discrete Mathematics for Comp. Scientists & Mathematicians, Mott, PHI
2. C.L.Liu- Discrete Mathematical Structure, C.L.Liu, TMH
3. G.S.RAO- Discrete Mathematical Structure, New Age International
4. Deo Narsingh - Graph Theory With Applications To Engineering And Computer Science, PHI Learning
5. Arumugam, Ramachandran- Invitation to Graph Theory, Scitech Publications(India)

SYLLABUS

Semester – I

Course Code	**MCA20-E105A**
Course Name	**Environment and Ecology**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

The students will learn

1. Environment concerns.
2. Students will learn about environment, factors affecting the environment
3. Environmental ethics and its protection
4. Save our nature
5. Presentations, documentaries and field visits

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the natural environment and its relationships with human activities.
2. Apply the fundamental knowledge of science and engineering to assess environmental and health risk.
3. Understand environmental laws and regulations to develop guidelines and procedures for health and safety issues
4. Solve scientific problem-solving to air, water, noise and land pollutions.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (4L)** Basic ideas of environment and interrelationship among man society and environment. Environmental problems and issues, Segments of environments, Natural Cycles of environments Mathematics of population growth and its associated problems, Logistic population growth
2	**Elements of Ecology (3L)** Open and closed system ecology, species, population, community, definition of ecosystem-components types and functions, Environmental perspectives, Montreal protocol
3	**Pollutants and Contaminants (3L)** Definition of primary and secondary pollutants and contaminants. Source and effects of different air pollutants suspended particulate matter, oxides of carbon, nitrogen, sulphur particulate
4	**Air Pollution (5L)** Structures of the atmosphere, global temperature models, Greenhouse effect, global warming; acid rain: causes, effects and control. Lapse rate and atmospheric stability; pollutants and contaminants; smog; depletion of ozone layer; standards and control measures of air pollution.
5	**Water Pollution (5L)** Hydrosphere; pollutants of water: origin and effects; oxygen demanding waste; thermal pollution; pesticides; salts. Biochemical effects of heavy metals; eutrophication: source, effect and control. Waterquality parameters: DO, BOD, COD. Water treatment: surface water and wastewater.
6	**Land Pollution (5L)** Land pollution: sources and control; solid waste: classification, recovery, recycling, treatment and disposal.
7	**Noise Pollution (5L)** Noise: definition and classification; noise frequency, noise pressure, noise intensity, loudness of noise, noise threshold limit value; noise pollution effects and control.

Reference Books:

1. Basic Environmental Engineering and Elementary Biology, Gour Krishna Das Mahapatra, VikasPublishing House P. Ltd.
2. Environmental Chemistry, A. K. De, New Age International.
3. Environmental Engineering, G.M. Masters, Tata Mc Graw Hills
4. Environmental Chemistry with Green Chemistry, A. K. Das, Books and Allied P. Ltd.
5. Fundamentals of Environment & Ecology, D. De, D. De, S. Chand & Company Ltd.

SYLLABUS

Semester – I

Course Code	**MCA20-E105B**
Course Name	**Management and Accountancy**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

The students will learn -

1. To develop cognizance of the importance of accounting in organization and financial statements
2. To describe how people analyze the corporate financial under different conditions
3. To understand why people describe the financial statements in different manner.
4. To analyze specific characteristics of Logistics Management Accounting
5. To analyze future action for expenses and income
6. To synthesize related information and evaluate options for most logical and optimal solutions

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the basic concepts related to Business.
2. Demonstrate the roles, skills and functions of different discipline of business management.
3. Disseminate knowledge among the students inculcate with theoretical structures about banking system
4. Record basic accounting transactions and prepare annual financial statements; and analyse, interpret andcommunicate the information contained in basic financial statements
5. Analyse and provide recommendations to improve the operations of Organisations through the application of Cost and Management accounting techniques
6. Equip students with in-depth and expert knowledge of Tally ERP with GST.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (3L)** Basics of management; Planning, scheduling, organizing, staffing, directing, controlling
2	**Management (3L)** Marketing Management, Financial management, Operation management, Human resource management, Management information System
3	**Strategy (3L)** Firm and its environment, strategies and resources, industry structure and analysis, corporate strategies and its evaluation, strategies for growth and diversification, strategic planning
4	**Business Trade and Banking (3L)** Business: Types of business, Sole Proprietorship, Partnership, Limited company and cooperativesociety – their characteristics. Banking: role of commercial banks; credit creation and its importance in industrial functioning. Role of central bank: Reserve Bank of India. International Business or Trade Environment.
5	**Financial Accounting (7L)** Journals, Ledgers, Trial Balance, Profit & Loss Account, Balance Sheet, Financial Reporting Financial Statement Analysis and Interpretation (Financial Ratio and Cash Flow analysis)
6	**Cost Accounting (7L)** Concepts and Classification of costs, Cost Sheet Break Even Analysis, Variance Analysis, Cost-volume profit (CVP) relationship, Cash Budgeting
7	**Packages (4L)** Financial accounting computer package (Tally ERP with GST)

Reference Books:

1. Financial Accounting- A Managerial Perspective, R. Narayanswami, Prentice-Hall of India PrivateLimited. New Delhi
2. Fundamentals of Financial Management, Horne, James C Van, Prentice-Hall of India Private Limited,New Delhi
3. Modern Economic Theory, H. L. Ahuja., S. Chand. New Delhi.
4. Management Accounting, Khan & Jain, TMH
5. Management Accounting, M.E.Thukaram Rao, New Age International

SYLLABUS

Semester – I

Course Code	**MCA20-E105C**
Course Name	**Constitution of India**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

The students will learn

1. The importance of constitution
2. The structure of executive, legislature and judiciary
3. Philosophy of fundamental rights and duties
4. Autonomous nature of constitutional bodies like Supreme Court and high court, controller and auditorgeneral of India and election commission of India.
5. Central and state relation, financial and administrative bodies

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role andentitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917and its impact on the initial drafting of the Indian Constitution.

MODULE NUMBER	COURSE CONTENT
1	**History of Making of the Indian Constitution (5L)** History Drafting Committee, (Composition & Working)
2	**Philosophy of the Indian Constitution (5L)** Preamble Salient Features
3	**Contours of Constitutional Rights & Duties (5L)** Fundamental Rights, Right to Equality, Right to Freedom ,Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
4	**Organs of Governance (5L)** Parliament , Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications,Powers and Functions
5	**Local Administration (5L)** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass rootdemocracy
6	**Election Commission (5L)** Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Reference Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

SYLLABUS	
Semester – I	
Course Code	**MCA20-E105D**
Course Name	**Stress Management through Yoga**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

The students will learn

1. To identify and understand the signs and symptoms of stress.
2. Distinguish methods to control and/or reduce stress in their daily life.
3. Develop coping skills that will enable the student to control his/her level of stress.
4. Apply stress management techniques.

Course Outcome:

After successful completion of this course, students will be able to:

1. To achieve overall health of body and mind
2. To overcome stress.

MODULE NUMBER	COURSE CONTENT
1	**Astanga (8L)** Definitions of Eight parts of Yoga (Ashtanga)
2	**Yam and Niyam (8L)** Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan
3	**Asan and Pranayam (8L)** i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects- Typesof pranayama
4	**Meditation Techniques (6L)**

Reference Books:

- Janardan Swami Yogabhyasi Mandal- Yogic Asanas for Group Tarining-Part-I, Nagpur
- Swami Vivekananda- Rajayoga or conquering the Internal Nature, Advaita Ashrama (Publication Department), Kolkata

SYLLABUS

Semester – I

Course Code	**MCA20-E105E**
Course Name	**Values and Ethics in Profession**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

The students will learn -

1. Creating awareness among technical students about the importance of professional ethics
2. The effect of technology on the societal issues
3. How to develop technologies that do not disturb the psychological wellbeing of the society

Course Outcome:

After successful completion of this course, students will be able to:

1. Earn about morals, values & work ethics, Learn to respect others and develop civic virtue.
2. Learn about the ethical responsibilities of the engineers; create awareness about the customs and religions, Install Moral and Social Values and Loyalty and to appreciate the rights of others.
3. Demonstrate knowledge to become a social experimenter, Provide depth knowledge on framing of the problem and determining the facts.
4. Create awareness about safety, risk & risk benefit analysis, Provide knowledge on Intellectual Property Rights.
5. Develop knowledge about global issues, Create awareness on computer and environmental ethics, Analyze ethical problems in research.

MODULE NUMBER	COURSE CONTENT
1	**Human Values (6L)** Morals, Values and Ethics-Integrity-Work Ethic-Service learning, Civic Virtue, Respect for others, Living Peacefully, Caring, Sharing, Honesty, Courage-Cooperation, Commitment, Empathy, Self Confidence Character.
2	**Professional Ethics (6L)** Senses of 'Professional Ethics-Variety of moral issued, Types of inquiry, Moral dilemmas, Moral autonomy, Kohlberg's theory-Gilligan's theory, Consensus and controversy, Models of professional roles, Theories about right action, Self-interest, Customs and religion.
3	**Professional As Social Experimentation (6L)** Profession As Social Experimentation, Framing the problem, Determining the facts, Codes of Ethics, Clarifying Concepts, Application issues, Common Ground, General Principles, Utilitarian thinking respect for persons.
4	**Safety, Responsibilities And Rights in Profession (6L)** Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination
5	**Global Issues (6L)** Globalization, Cross culture issues-Environmental Ethics, Computer Ethics –Computers as the instrument of Unethical behavior, Computers as the object of Unethical acts, Autonomous Computers, Computer codes of Ethics, Moral Leadership, Code of Conduct, Corporate Social Responsibility. Ethics and Research, Analyzing Ethical Problems in research.

Reference Books:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi.
2. A. R. Aryasri, Dharanikota Suyodhana "Professional Ethics and Morals" Maruthi Publications.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi.
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi.

SYLLABUS

Semester – I

Course Code	**MCA20-E105F**
Course Name	**Managerial Economics**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

The students will learn

1. To get familiarized with the basic concept of microeconomics.
2. To understand the demand and supply analysis in business applications
3. To get familiarized with the production and cost structure under different stages of production.
4. The pricing and output decisions under various market structures.
5. To understand and apply the various decision tools to understand the market structure.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand applications of managerial economics.
2. Understand and interpret demand function,
3. Assess the relationships between short-run and long-run costs.
4. Analyze perfectly competitive markets including substitution.
5. Explain uniform pricing and how it relates to price discrimination and total revenue.
6. Analyze the causes and consequences of different market conditions.
7. Integrate the concept of price and output decisions of firms under various market structures.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (2L)** Introduction to Managerial Economics, Basic problems of an economic system; Goals of managerial decision making; Resource allocation using PPC
2	**Demand Analysis (6L)** A. Demand Functions - Law of Demand, Explaining the law of demand, Violations of the Law of Demand, Shifts in Demand; Elasticity of Demand: Price Elasticity (at a point and over and interval), Factors affecting price elasticity, Price elasticity and Change in Total Revenue, AR, MR and Price elasticity, Range of Values of Price Elasticity; Income Elasticity, Inferior, Superior and Normal goods, Income Elasticity and Share in Total Expenditure; Cross- Price Elasticity, Substitutes and Complements Indifference curves, budget line and consumer equilibrium Introduction to methods of demandestimation (concepts only)
3	**Production and Cost Analysis (10L)** Production Function, Short Run and Long Run, Production with One Variable Input, Total Product, Average and Marginal Products, Law of Variable proportions, Relationship between TP, AP and MP. Short Run Costs of Production, Fixed and Variable Costs, Short Run Total, Average and MarginalCost and Relationship between them, Short Run Cost Curves, Relationship between AVC, MC, AP and MP; Long run cost curves, Relationship between LAC and SAC, Economies of Scale and Scope. Production with Two Variable Inputs, Isoquants – Characteristics, Marginal Rate of Technical Substitution, Laws of Returns to Scale, Isocost Curves, Finding the Optimal Combination of Inputs, Production of a given output at Minimum Cost, Production of Maximum Output with a given level of Cost, Expansion Path, Finding the Long Run Cost Schedules from the Production Function
4	**Alternate Goals of Managerial Firms (2 L)** Profit maximization; Revenue maximization; Managerial utility maximization
5	**Managerial Decision Making under Alternative Market Structures (6 L)** Characteristics of Perfect Competition, #Profit Maximization in Competitive Markets, Output Decision in the Short Run, Shut Down Point, Short Run Supply for the Firm and Industry; Output Decision in the Long Run, Break Even Point, Long Run Supply for the Perfectly Competitive Industry. Price and output decision under different market structure – Monopoly, Monopolistic Competition, Oligopoly – cartel, price leadership.

6	**Pricing Decisions [4 L]** Price Discrimination under Monopoly, Transfer Pricing. Market Failure Game theory &Asymmetric information

Reference Books:

1. Damodaran, Suma – Managerial Economics – Oxford University Press
2. Lipsey & Chrystal – Economics – Oxford University Press
3. Peterson & Lewis – Managerial Economics – Pearson Education.
4. Pindyck and Rubenfeld - Micro Economics – Pearson Education
5. H.L. Ahuza- Managerial Economics, S. Chand
6. D.N. Dwivedi- Managerial Economics, Prentice Hall.

SYLLABUS	
Semester – I	
Course Code	**MCA20-190**
Course Name	**Soft Skills and Interpersonal Development**
Lecture (per week)	**0**
Practical (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

The students will learn

1. Understand the communication concepts.
2. Practically apply various components of business communication
3. Identify and analyze essentials of communication
4. Understand the concept of effective communication in a corporate world

Course Outcome:

After successful completion of this course, students will be able to:

1. Effectively communicate through verbal/oral communication and improve the listening skills
2. Able to be self-confident with positive vibes
3. Actively participate in group discussion / meetings / interviews and prepare & deliver presentations
4. Become more effective individual through goal/target setting, self-motivation and practicing creative thinking. through the knowledge of team work,
5. Function effectively in multi-disciplinary and heterogeneous teams personal relationships, conflict management and leadership quality.
6. Inter- personal relationships, conflict management and leadership quality

MODULE NUMBER	COURSE CONTENT
1	**Soft Skills & Interpersonal Communication** An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development. Inter personal relations; communication models, process and barriers; team communication; developing interpersonal relationships through effective communication; listening skills; essential formal writing skills; corporate communication styles –assertion, persuasion, negotiation.
2	**SWOT & Creative Thinking** Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue. Developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels.
3	**Corporate Communication** **Public Speaking:** Skills, Methods, Strategies and Essential tips for effective public speaking. **Group Discussion:** Importance, Planning, Elements, Skills assessed; Effectively disagreeing, Initiating, Summarizing and Attaining the Objective. **Interview& Presentation Skills:** Interviewer and Interviewee– in-depth perspectives. Before, During and After the Interview. **Tips for Success:** Types, Content, Audience Analysis, Essential Tips – Before, During and After,Overcoming Nervousness.
4	**Non-Verbal Communication & Personality Development** Importance and Elements; Body Language. Concept, Essentials, Tipsc Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.
5	**Business Etiquette & Team Work** Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills. Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.

Reference Books:

1. Managing Soft Skills for Personality Development – edited by B.N. Ghosh, McGraw Hill India, 2012.
2. Effective Communication and Soft Skills, Nitin Bhatnagar, Pearson Education India, 2011
3. English and Soft Skills – S.P. Dhanavel, Orient Blackswan India, 2010.

SYLLABUS

Semester – I

Course Code	**MCA20-191**
Course Name	**Python Programming Lab**
Lecture (per week)	**0**
Practical (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

The students will learn

1. Interpret the use of procedural statements like assignments, conditional statements, loops and function calls.
2. Infer the supported data structures like lists, dictionaries and tuples in Python.
3. Illustrate the application of matrices and regular expressions in building the Python programs.
4. Discover the use of external modules in creating excel files and navigating the file systems.
5. Describe the need for Object-oriented programming concepts in Python

Course Outcome:

After successful completion of this course, students will be able to:

1. Write simple programs relating to different logical problems.
2. Be able to interpret, understand and debug syntax errors reported by the compiler.
3. Understand and implement the native data types (Python in this course)
4. Implement conditional branching, iteration.
5. Decompose a problem into functions.
6. Be able to create, read from and write into simple text files.
7. Understand the basic concept of OOPs
8. Understand and implement Python Numpy Array operations

MODULE NUMBER	COURSE CONTENT
1	**Python Basics:** Installing Python, Setting up Path and Environment Variables, Running Python, First Python Program
2	**Python Data Types & Input/output:** Keywords, Identifiers, Python Statement, Indentation, Documentation, Variables, Multiple Assignment, Understanding Data Type, Data Type Conversion, Python Input and Output Functions, Import command.
3	**Operators and Expressions:** Operators in Python, Expressions, Precedence, Associativity of Operators, Non Associative Operators.
4	**Control Structures:** Decision making statements, Python loops, Python control statements.
5	**Python Native Data Types:** Numbers, Lists, Tuples, Sets, Dictionary, Functions & Methods of Dictionary, Strings(in detail with their methods and operations).
6	**Python Functions:** Built-in Functions, User defined functions, Anonymous functions, Pass by value, Pass by Reference, Recursion
7	**Exception Handling:** Exceptions, Built-in exceptions, Exception handling, User defined exceptions in Python.
8	**File Management in Python:** Operations on files (opening, modes, attributes, encoding, closing), read() & write() methods, tell() & seek() methods, Renaming & deleting files in Python, directories in Python.

9	**Python OOPs** Python OOPs Concepts, Object Class, Constructors, Inheritance
10	**Python Numpy** Numpy data types, Operations on Numpy Array (indexing, slicing, shape/reshape, iteration, join, split, search, sort, filter)

SYLLABUS

Semester – I

Course Code	**MCA20-192**
Course Name	**Relational Database Management Systems Lab**
Lecture (per week)	**0**
Practical (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

The students will learn

1. To describe the fundamental elements of relational database management systems
2. To explain the basic concepts of relational data model, ER model, relational database design
3. Relational algebra and SQL
4. To design ER-models to represent simple database application scenarios
5. To convert the ER-model to relational tables, populate relational database
6. Formulate SQL queries on data, Database normalization
7. Basic database storage structures and access techniques: file and page organizations, indexing methods

Course Outcome:

After successful completion of this course, students will be able to:

1. Learn to use Entity Relationship Diagram (ERD) model as a blueprint to develop the corresponding relational model in a RDBMS system like Oracle DBMS.
2. Apply DDL component of Structured query language (SQL) to create a relational database from scratch through implementation of various constraints in Oracle RDBMS system.
3. Apply DML component of structured query language (SQL) for storing and modification of data in Oracle RDBMS system.
4. Apply DQL component of structured query language (SQL) to construct complex queries for efficient retrieval of data from existing database as per the user requirement specifications.

5. Conceptualize and apply various P/L SQL concepts like cursor, trigger in creating database programs.
6. Develop a fully-fledged database backend system using SQL and P/L SQL programming to establish overall integrity of the database system.
7. Implement PL/SQL function, Procedure and Package and Apply Exception.

MODULE NUMBER	COURSE CONTENT
1	**Creation of a database based on given ERD Model:** SQL Data Definition Language (DDL) Create (and Alter) table structure, Apply (and Alter) constraints on columns/tables viz., primary key, foreign key, unique, not null, check. Verify/ Review the table structure (along with applied constraints) using appropriate data dictionary tables like user_constraints, user_cons_columns,etc. Create view, materialized view using one or more table. SQL Data Manipulation Language (DML) Insert into rows (once at a time/ and in bulk) from a table, Update existing rows of a table, Deleterows (a few or all rows) from a table.
2	**Data Query Language (DQL)** Basic select-from-where structure - Usage of Top, Distinct, Null keywords in query, Using String and Arithmetic Expressions, Exploring Where Clause with various Operators and logical combination of various conditions, Sorting data using Order By clause. Usage of IN, LIKE, ALLkeywords. Introduction to Joins, Natural Joins, equi-join, non-equi-join, Self-Join, Inner Join, Outer (left, right) Join. Set operations: Unions, Intersect, minus set operations on table data using SQL. Using single row functions in Queries NVL function (to handle ambiguity of null data), upper, lower, to_date, to_char functions, etc. Using group/multiple row functions in Queries like Count, Sum, Min, Max, Avg, etc, using Group By and Having Clause, Using Group By with Rollup and Cube. Sub-query - Working with various nested structure of Sub Queries - use in from or where clause with more than one level of nesting, correlated sub-query- Ranking table data using correlated sub-query.
3	**PL/SQL** Stored Procedures and Functions- Basic programming constructs of PL / SQL like if, else, else-if,loop, while, for structure Populate stored procedure variables with the data fetched from table using SQL command. Working with Cursors - Creating Cursors, parameterized cursor, Locks on cursors, Exploring advantages of cursors. Introduction to triggers - Constraints Vs Triggers, Creating, Altering, Dropping triggers, use of for/ after/ instead of triggers, Using trigger to validate/ rollback a Transaction, Automatically populate integer data based primary key columns (e.g., Id.) using trigger. Handling Function, Procedure & Package – Create Function, Create Procedure and Create Package. Exception Handling.

SYLLABUS

Semester – II

Course Code	**MCA20-201**
Course Name	**Data Structures**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. To introduce the concepts of Abstract data Type, data structure, performance measurement, time and space complexities of algorithms.
2. To discuss the implementation linear data structures such as stacks, queues and lists and their applications.
3. To discuss the implementation of different non-linear data structures such as trees and graphs.
4. To introduce various search data structures such as hashing, binary search trees, red black trees, splay trees and b-trees.
5. To introduce various internal sorting techniques and analyze their time complexities.

Course Outcome:

After successful completion of this course, students will be able to:

1. Use different kinds of data structures which are suited to different kinds of applications and some are highly specialized to specific tasks.
2. Manage large amounts of data efficiently, such as large databases and internet indexing services.
3. Use efficient data structures which are a key to designing efficient algorithms.
4. Use some formal design methods and programming languages which emphasize on data structures, rather than algorithms, as the key organizing factor in software design.
5. Store and retrieve data stored in both main memory and in secondary memory.

MODULE NUMBER	COURSE CONTENT
1	**Linear Data Structure Introduction (8L)** Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – order notations. Different representations – row major, column major. Sparse matrix - its implementation and usage. Array representation of polynomials. Linked List : Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.
2	**Linear Data Structure [Stack and Queue] (7L)** Stack and its implementations (using array, using linked list), applications. Queue, circular queue, dequeue. Implementation of queue- both linear and circular (using array, using linked list), applications. Recursion: Principles of recursion – use of stack, differences between recursion and iteration, tail recursion.
3	**Nonlinear Data structures [Trees and Graph] (15L)** Basic terminologies, forest, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), threaded binary tree (left, right, full) - non-recursive traversal algorithms using threaded binary tree, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). B- Trees – operations (insertion, deletion with examples only). Huffman tree. Graph definitions and Graph representations/storage implementations – adjacency matrix, adjacency list, adjacency multi-list. Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS), concepts of edges used in DFS and BFS (tree-edge, back-edge, cross edge, forward-edge), applications. Minimal spanning tree – Prim's and Kruskal's algorithm
4	**Searching and Sorting (10L)** Sequential search, binary search, interpolation search. Internal sorting and external sorting Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap), radix sort. Tree Sort technique. Hashing functions, collision resolution techniques etc. .

Reference Books :

1. Fundamentals of Data Structures in C, E. Horowitz, Sartaj Sahni and Susan Anderson, W. H. Freeman and Company
2. Data Structure Using C & C++, Tanenbaum, PHI
3. Data Structures & Program Design in C, 2nd Ed, Kruse, Tondo & Leung, PHI
4. Mastering Algorithms with C. Loudon, SPD/O'REILLY
5. Data Structures and Algorithm, R. S. Salaria, Khanna Publishing

SYLLABUS

Semester – II

Course Code	**MCA20-202**
Course Name	**Operating Systems**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. Describe the main components of OS and their working
2. Explain the concepts of process and thread and their scheduling policies
3. Explain the concepts of Memory management
4. Explain the concepts of File management, Disk management
5. Explain the concepts of Network management, I/O management

Course Outcome:

After successful completion of this course, students will be able to:

1. Describe the main components of OS and their working
2. Explain the concepts of process and thread and their scheduling policies
3. Compare the different techniques for managing memory, I/O, disk and files
4. Explain the concepts of Network management, I/O management
5. Acquire a detailed understanding of one aspect (the scheduler) of the Linux kernel

MODULE NUMBER	COURSE CONTENT
1	**Introduction (6L)** Generations Concept of Operating systems, Systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Real Time Operating Systems, Distributed Operating Systems, Multiprocessor Operating System. Case Study: Architecture of Unix and Windows Operating Systems
2	**Process Management (14L)** Processes and Threads: Process model and scheduling, Operations on processes, Inter-process communication, Threads overview, Benefits of threads, User and kernel threads, Race condition. CPU Scheduling: Scheduling criteria, Preemptive & non-preemptive scheduling, Starvation. Scheduling algorithms (FCFS, SJF, RR, Priority, Multi-level queue, Multi-level feedback queue), Comparative study of the algorithms, Multi- processor scheduling. Process Synchronization: Background, Critical section problem, Software solution – Peterson and Bakery algorithm, Synchronization hardware, Semaphores, Monitor. Classical problems of synchronization. Deadlocks: System model, Deadlock characterization, Livelock. Methods for handling Deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock. Case Study: Scheduling on Unix /Linux Operating Systems
3	**Memory Management (9L)** Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation– Fixed and variable partition– Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation Hardware support for paging, Protection and sharing, Disadvantages of paging. Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacementalgorithms(Optimal, FIFO, SC, NRU and LRU), Thrashing. Case Study: Unix /Linux Virtual Memory.

4	**File Systems and I/O Management (7L)** File concept, Fundamental File System Organization and Access Methods, Directory structure, File system structure, Allocation methods (Contiguous, Linked, Indexed), Free-space management (Bit vector, Linked list, Grouping), Directory Implementation (Linear list, Hash table), Efficiency and Performance. Common File system-FAT, FAT-32, NTFS, HTTS, EXT-4, etc. PC Bus Structure, I/O connections, Data transfer techniques (Programmed, Interrupt driven, DMA), Bus arbitration (Daisy chain, Polling, Independent request), Blocking and non-blocking I/O, Kernel I/O subsystem (Scheduling, Buffering, Caching, Spooling and device reservation, Error handling). Case Study: Unix/Linux File System.
5	**Security and Protection (4L)** Overview of Security and Protection, Goals of Security and Protection, Security Attacks, Formal and Practical aspects of Security, Encryption, Authentication and Password Security, Access Descriptors and the Access Control Matrix, Protection Structures, Capabilities, Case Study: Unix /Linux Security.

Reference Books :

1. Operating System Concepts Essentials, 10th Edition by Avi Silberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
3. Operating System Concepts, Ekta Walia, Khanna Publishing House
4. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
5. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, Addison- Wesley
6. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India
7. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

SYLLABUS

Semester – II

Course Code	**MCA20-203**
Course Name	**Object Oriented Programming with JAVA**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. To introduce fundamental object oriented concepts of java programming such as classes, inheritance, packages and interfaces.
2. To introduce concepts of exception handling and multi-threading.
3. Analyze various activities of different string handling functions with various I/O operations
4. To use various classes and interfaces in java collection framework and utility classes.
5. To introduce GUI programming using AWT controls, I/O streams and serialization

Course Outcome:

After successful completion of this course, students will be able to:

1. Design the process of interaction between Objects, classes & methods w.r.t. Object Oriented Programming.
2. Acquire a basic knowledge of Object Orientation with different properties as well as different features of Java.
3. Analyze various activities of different string handling functions with various I/O operations.
4. Discuss basic code reusability feature w.r.t. Inheritance, Package and Interface.
5. Implement Exception handling, Multithreading and Applet (Web program in java) programming concept in Java.

MODULE NUMBER	COURSE CONTENT
1	**Object-Oriented Languages (10L)** Java's history, creation of Java, Internet & Java, Byte-code, Its Features, Java Program Structure and Java's Class Library, Data Types, Variables, and Operators, Operator Precedence; Selection Statements, Scope of Variable, Iterative Statement; Defining Classes & Methods, Creating Objects of a Class, Defining and Using a Class, Automatic Garbage Collection. Arrays and Strings: Arrays, Arrays of Characters, String Handling Using String Class, Operations on String Handling Using String Buffer Class.
2	**Classes and Inheritance (10L)** Using Existing Classes, Class Inheritance, Choosing Base Class, Multiple Levels of Inheritance, Abstraction through Abstract Classes, Using Final Modifier, Packages: Understanding Packages, Defining a Package, Packaging up Your Classes, Adding Classes from a Package to Your Program, Understanding CLASSPATH, Standard Packages, Access Protection in Packages, Concept of Interface. Exception Handling: The concept of Exceptions, Types of Exceptions, Dealing with Exceptions, Exception Objects, Defining Your Own Exceptions.
3	**Multithreading Programming (10L)** The Java Thread Model, Understanding Threads, The Main Thread, creating a Thread, Creating Multiple Threads, Thread Priorities, Synchronization. Input / Output in Java: I/O Basic, Byte and Character Structures, I/O Classes, Reading Console Input, Writing Console Output, Reading and Writing on Files, Random Access Files, Storing and Retrieving Objects from File, Stream Benefits. Creating Applets in Java: Applet Basics, Applet Architecture, Applet Life Cycle, Simple Applet Display Methods, The HTML Applet Tag Passing Parameters to Applets.
4	**Working with Windows (10L)** AWT Classes, Window Fundamentals, Working with Frame, Creating a Frame Window in an Applet; Displaying Information within a Window. Working with Graphics and Texts: Working with Graphics, Working with Color, Setting the Paint Mode, Working with Fonts, Managing Text Output; Using Font Metrics, Exploring Text and Graphics, Working with AWT Controls, Layout Managers and Menus.

Reference Books :

1. The Complete Reference JAVA, Herbert Schildt, TMH Publication.
2. JAVA and Object-Oriented Programming Paradigm, Debasish Jana, Prentice Hall of India
3. Beginning JAVA, Ivor Horton, WROX Publication.
4. JAVA 2 UNLEASHED, Tech Media Publications.JAVA 2(1.3) API Documentations.

SYLLABUS

Semester – II

Course Code	**MCA20-204**
Course Name	**Data Communication & Computer Networks**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. To be familiar with the basics of data communication
2. To be familiar with various types of computer networks
3. To have experience in designing communication protocols
4. To be exposed to the TCP/IP protocol suite

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the purpose of network layered models, network communication using the layered concept and able to compare and contrast OSI and TCP/IP model.
2. Differentiate among and discuss the four level of address (physical, logical, port and URL) used by the internet TCP/IP protocols.
3. Understand the routing principals and algorithm such as distance vector routing and link state.
4. Judge the efficiency of the connection oriented and connectionless protocol.
5. Familiar with the routing techniques and network security aspects, protocols and quality of service.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (4L)** Direction of data flow (simplex, half duplex, full duplex), Network topology, categories of network (LAN, MAN, WAN).
2	**Protocol and Standard (4L)** Layered Task, The OSI model, TCP/IP protocol suite, Comparison of models, Addressing.
3	**Internetworking (10L)** Internetworking concept, IPv4 and IPv6 Addressing, IPv4 protocol, IPv6 protocol, transition from IPV4 to IPV6, transition from IPv4 to IPv6, Address Mapping, Error Reporting, Multicasting, Unicast Routing Protocols, Distance Vector routing, Link state routing, Path vector routing, Multicasting Routing Protocols, Transmission Control Protocol (TCP), User Datagram Protocol(UDP).
4	**Quality of Service (6L)** Data traffic, Congestion, Principle of congestion control, Quality of service, Techniques to improve QoS, Integrated services, Differentiated service, QoS in Frame Relay, QoS in ATM.
5	**DNS and Web (8L)** Name Space, Domain Name System, Distribution of Name Space, Remote Logging, Electronic Mail and File Transfer, WWW, Web document and HTTP, Network Management, Simple Network Management Protocol (SNMP).
6	**Network Security (8L)** Symmetric Key Cryptography, DES, AES, Asymmetric Key Cryptography, RSA, Diffie-Hellman, Security Services, Digital Signature, Key Management, IP Security, SSL/TLS, PGP, Firewalls.

Reference Books :

1. Computer Networks, Andrew S. Tanenbaum, Pearson Education, Fourth edition.
2. Data and Computer Communication, William Stallings, Prentice hall, Seventh edition.
3. High speed Networks and Internets, William Stallings, Pearson education, Second edition.
4. Behrouz A Forouzan, - Data communication & Networking , TMH
5. Behrouz A Forouzan, - TCP/IP Protocol Suite , TMH
6. Kelvin R Fall, W. Richard Stevens- TCP/IP Illustrated Volume 1, Addison Wesley

SYLLABUS

Semester – II

Course Code	**MCA20-E205A**
Course Name	**Numerical and Statistical Analysis**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. Provide basic understanding of the derivation and the use of the numerical methods.
2. Along with the knowledge of finite precision arithmetic and fundamental concepts of statistics and probability.
3. Provide basic understanding of different interpolation techniques.
4. Provide basic understanding of integration techniques.
5. To understand and implement solutions for linear and algebraic and differential equations.

Course Outcome:

After successful completion of this course, students will be able to:

1. Recall the distinctive principles of numerical analysis and the associated error measures.
2. Understand the theoretical workings of numerical techniques.
3. Apply numerical methods used to obtain approximate solutions to intractable mathematical problems such as interpolation, integration, the solution of linear and nonlinear equations, and the solution of ordinary differential equations.
4. Select appropriate numerical methods to apply to various types of problems in engineering and science in consideration of the mathematical operations involved, accuracy requirements, and available computational resources.
5. Interpret complex statistical findings using the understanding of inferential statistics.

MODULE NUMBER	COURSE CONTENT
1	**Approximation in numerical computation (2L)** Truncation and rounding errors, Fixed and floating point arithmetic, Propagation of errors.
2	**Interpolation (3L)** Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation
3	**Numerical integration (3L)** Trapezoidal rule, Simpson's1/3 rule, Romberg's Integration, Expression for correspondingerror terms**.**
4	**Numerical solution of Linear equations (3L)** Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method
5	**Numerical solution of Algebraic equation (5L)** Bisection method, Regula-Falsi method, Newton-Raphson method, Iteration Method, SecantMethod.
6	**Numerical solution of ordinary differential equation (4L)** Euler's method, Runge-Kutta methods, Taylor's series, Predictor Corrector methods and Finite Difference method.(4L)
7	**Least Square Curve fitting (2L)** Linear & non-linear curve fitting
8	**Introduction to Statistics& Probability (8L)** Basic Statistics-measure of central tendency, dispersion. Probability, distribution introduction to mass function, density function, distribution function (Binomial, Poisson, Normal).

Reference Books:

1. Shishir Gupta & S.Dey, Numerical Methods, Mc. Grawhill Education Pvt. Ltd.
2. C.Xavier: C Language and Numerical Methods, New age International Publisher.
3. Dutta& Jana: Introductory Numerical Analysis. PHI Learning
4. J.B.Scarborough: Numerical Mathematical Analysis. Oxford and IBH Publishing
5. Jain, M. K., Iyengar, S. R. K. and Jain, R. K. Numerical Methods (Problems and Solution). New ageInternational Publisher.
6. Prasun Nayek: Numerical Analysis, Asian Books
7. N. G. Das: Statistical Methods, TMH.
8. Sancheti , D. S. & Kapoor ,V.K. : Statistics Theory , Method & Application, Sultan chand & sons, NewDelhi
9. Balagurusamy, E. Numerical Methods, Scitech. TMH.
10. Dutta, N. Computer Programming & Numerical Analysis, Universities Press.
11. Guha, S. and Srivastava, R. Numerical Methods, Oxford Universities Press.
12. Shastri, S. S. Numerical Analysis, PHI.
13. Mollah, S. A. Numerical Analysis, New Central Book Agency.
14. Numerical Methods for Mathematics, Science & Engg. , Mathews, PHI.
15. Rao, G. S. Numerical Analysis, New Age International.
16. Rao, G.S, Programmed Statistics (Questions – Answers), New Age International

SYLLABUS

Semester – II

Course Code	**MCA20-E205B**
Course Name	**Computer Graphics**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them.
2. To learn the basic principles of 2D and 3D computer graphics.
3. To provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
4. To provide an understanding of mapping from a world coordinates to device coordinates clipping, and projections.
5. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.

Course Outcome:

After successful completion of this course, students will be able to:

1. Identify the basic terminologies of Computer Graphics and interpret the mathematical foundation of the concepts of computer graphics.
2. Apply mathematics to draw basic primitives.
3. Illustrate the concepts of windowing and clipping and apply various algorithms to fill and clip polygons.
4. Understand and apply the core concepts of computer graphics, including transformation in two and three dimensions, viewing and projection.
5. Create effective programs using concepts of curves.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (6L)** Overview of computer graphics, representing pictures, preparing, presenting & interacting with pictures for presentations; Visualization & image processing; RGB color model, direct coding, lookup table; storage tube graphics display, Raster scan display, 3D viewing devices, Plotters, printers, digitizers, Light pens etc.; Active & Passive graphics devices; Computer graphics software.
2	**Graphics Primitives (6L)** Points, Lines and Circles as primitives, Scan conversion algorithms for primitives, Fill area primitives including scan-line polygon filling, inside-outside test, Boundary and Flood-fill, Character generation, line attributes, area-fill.
3	**2D Transformation and Viewing (6L)** Transformations (translation, rotation, scaling), matrix representation, homogeneous coordinates, composite transformations, reflection and shearing, viewing pipeline and coordinates system, window-to-viewport transformation, clipping including point clipping, line clipping (Cohen-Sutherland, Liang-Bersky), Polygon clipping.
4	**3D Transformations (4L)** Translation, rotation, scaling & other transformations. Rotation about an arbitrary axis in space, Reflection through an arbitrary plane; General parallel projection transformation; clipping, viewport clipping, 3D viewing.
5	**Curve (3L)** Curve representation, surfaces, designs, Bezier curves, B-spline curves, end conditions for periodic B-spline curves, rational B-spline curves.
6	**Hidden surfaces (3L)** Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, The Painter'salgorithm, scan-line algorithm; Hidden line elimination.
7	**Color & shading models (2L)** Light &Color Model; Interpolative Shading Models; Texture.

Reference Books :

1. D.Rogers,J.Adams,MathematicalElementsforComputerGraphics,TataMcGraw Hill Publication
2. Schaum's outlines Computer Graphics (2nd Ed.)by Ray A. Plastock, Gordon Kalley, McGrawHill Inc.

SYLLABUS	
Semester – II	
Course Code	**MCA20-E205C**
Course Name	**Probability and Statistics**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. Provide basic understanding of the derivation and the use of the numerical methods.
2. Provide basic understanding of probability.
3. Along with the knowledge of finite precision arithmetic and fundamental concepts of statistics and probability distribution.
4. Provide basic understanding of expectation, standard deviation and moments

Course Outcome:

After successful completion of this course, students will be able to:

1. Explain the concept of probability and its feature in terms of random event, sample space, favorable event.
2. Describe the idea of random variable and the probability distribution.
3. Calculate the expectation, standard deviation and moments.
4. Critically evaluate the underlying assumptions of analysis tools.

MODULE NUMBER	COURSE CONTENT
1	**Probability(3L)** Sample Space, Probability Axioms, Combinatorics: probability of finite sample space, Conditional probability and Bayes Theorem, Independence of Events.
2	**Random Variables(5L)** Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median and quartiles, Markov inequality, Chebyshev's inequality, problems
3	**Special Distributions(6L)** Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Pareto, beta, normal
4	**Joint Distributions(3L)** Joint, marginal and conditional distributions, product moments, correlation and regression,independence of random variables, bivariate normal distribution, problems.
5	**Sampling Distributions(2L)** The Central Limit Theorem, distributions of the sample mean and the sample variance for anormal population, Chi-Square, t and F distributions, problems.
6	**Descriptive Statistics(2L)** Graphical representation, measures of locations and variability
7	**Estimation(3L)** Unbiasedness, consistency, the method of moments and the method of maximum likelihoodestimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.
8	**Testing of Hypotheses(6L)** Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications, problems.

Reference Books :

1. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh- An Introduction To probability And statistics, John Wiley & Sons.
2. V.K. Rohatgi & A.K. Md. E. Saleh - An Introduction to Probability and Statistics
3. J.S. Milton &J.C. Arnold- Introduction to Probability and Statistics
4. H.J. Larson -Introduction to Probability Theory and Statistical Inference.
5. S.M. Ross - Introduction to Probability and Statistics for Engineers and Scientists

SYLLABUS	
Semester – II	
Course Code	**MCA20-E205D**
Course Name	**Introduction to Cyber Security**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. Exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an Organization.
2. Practice with an expertise in academics to design and implement security solutions.
3. Understand key terms and concepts in Cryptography, Governance and Compliance.
4. Develop cyber security strategies and policies
5. Understand principles of web security and to guarantee a secure network by monitoring and analyzing the nature of attacks through cyber/computer forensics software/tools.

Course Outcome:

After successful completion of this course, students will be able to:

1. Know Fundamental knowledge in Cyber Security
2. Understand the security challenges as well as the best practices that are essential to protect one from becoming the victims of cybercrimes.
3. Understand the current status of cyber world.
4. To safe-guard the individual, society, organization and the government from the dangers of cyber frauds, scams, threats and attacks.
5. Able to further exploration in Cyber Security Domain.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (2L)** Introduction to Cyber Space, Information Systems, Need for Cyber Security
2	**Cyber Attacks (3L)** Introduction to Cyber Attacks, Classification of Cyber Attacks, Classification of Malware, Threats
3	**Intrusion Detection and Prevention (2L)** Vulnerability Assessment Intrusion Detection Systems Intrusion Prevention Systems
4	**Authentication Methods (2L)** Introduction to User Authentication Methods Biometric Authentication Methods, Biometric Systems
5	**Security Models (3L)** Different Security Models and Security Mechanisms Information Security and Network Security Operating System Security
6	**Online Security (2L)** Web Security Email Security, Mobile Device Security, Cloud Security
7	**IoT & Social Media Security (3L)** IoT Security, Cyber Physical System Security Social Media Security
8	**Security and Virtual Currency (3L)** Virtual Currency, Block Chain Technology Security Auditing
9	**Cyber Crimes (4L)** Introduction, Different Types of Cyber Crimes, Scams and Frauds, Analysis of Crimes, Human Behavior, Stylometry, Incident Handling, Investigation Methods, Criminal Profiling, Cyber Trails
10	**Digital Forensics (3L)** Digital Forensics, History, Challenges, Branches of Digital Forensics, Digital Forensic Investigation Methods, Reporting, Management of Evidence
11	**Cyber Law(3L)** Cyber laws, Cyber terrorism, Information Technology Act 2000 and Amendments, Evidentiary value of Email/SMS, Cybercrimes and Offenses dealt with IPC, RBI Act and IPR Act in India, Jurisdiction of Cyber Crime, Cyber Security Awareness Tips

Reference Books :

1. Fundamentals of Cyber Security By Mayank Bhushan, BPB Publications
2. https://heimdalsecurity.com/pdf/cyber_security_for_beginners_ebook.pdf
3. Information Security & Cyber Laws, Gupta & Gupta, Khanna Publishing House
4. Certified Ethical Hacker Certification Exam by William Manning
5. Data communication and Networking by Behrouz A. Forouzan, McGraw Hill Education (India) Pvt. Ltd.

SYLLABUS	
Semester – II	
Course Code	**MCA20-E205E**
Course Name	**Introduction to Internet of Things (IoT)**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To introduce the concept and vision of IoT.
2. Understand IoT Market perspectives.
3. Data & Knowledge Management and uses of Devices in IoT Technology.
4. Understand the State-of-the-Art IoT Architectures
5. Real World IoT applications: Industrial Automation, Building Automation, Agriculture, Healthcare& Environment, etc.

Course Outcome:

After successful completion of this course, students will be able to:

1. Explain what Internet of Things is
2. Describe key technologies in Internet of Things.
3. Understand wireless sensor network architecture and its framework along with WSN applications.
4. Explain resource management in the Internet of Things.
5. Understand business models for the Internet of Things.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (6L)** What is the Internet of Things? : History of IoT, About IoT, Overview and Motivations, Examples of Applications, Internet of Things Definitions and Frameworks : IoT Definitions, IoT Architecture, General Observations, ITU-T Views, Working Definition, IoT Frameworks, Basic Nodal Capabilities
2	**Fundamental IoT Mechanisms And Key Technologies (6L)** Identification of IoT Objects and Services, Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture, Key IoT Technologies, Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology, Satellite Technology
3	**Radio Frequency Identification Technology(6L)** RFID: Introduction, Principle of RFID, Components of an RFID system, Issues EPC Global Architecture Framework: EPCIS & ONS, Design issues, Technological challenges, Security challenges, IP for IoT, Web of Things. Wireless Sensor Networks: History and context, WSN Architecture, the node, Connecting nodes, Networking Nodes, Securing Communication WSN specific IoT applications, challenges: Security, QoS, Configuration, Various integration approaches, Data link layer protocols, routing protocols and infrastructure establishment.
4	**Resource Management In The Internet Of Things (6L)** Clustering, Software Agents, Clustering Principles in an Internet of Things, Architecture, Design Guidelines, and Software Agents for Object Representation, Data Synchronization. Identity portrayal, Identity management, various identity management models: Local, Network, Federated and global web identity, user- centric identity management, device centric identity management and hybrid-identity management, Identity and trust.
5	**Internet Of Things Privacy, Security And Governance (6L)** Vulnerabilities of IoT, Security requirements, Threat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT.

Reference Books :

1. Pethuru Raj and Anupama C Raman, The Internet of Things – Enabling Technologies, Platforms,and use cases, CRC Press, Taylor and Francis
2. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press.
3. Yasuura, H., Kyung, C.M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing.
4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, 1stEdition, Pearson Education (Cisco Press Indian Reprint).
5. Srinivasa K G, Internet of Things, CENGAGE Leaning India

SYLLABUS	
Semester – II	
Course Code	**MCA20-E205F**
Course Name	**Automata Theory and Computational Complexity**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. The goal of this course is to teach you to formulate, analyze, and solve mathematical models that represent real-world problems.
2. To learn linear programming, network flow problems, integer programs, nonlinear programs, dynamic programming and queuing models.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the formal notation for strings, languages and machines.
2. Design and Implement Finite automata to accept a string of a language and determine whether the given language is regular or not.
3. Design context free grammars to generate strings of context free language.
4. Determine equivalence of languages accepted by Push Down Automata and languages generated by context free grammars
5. Understand and analyze the hierarchy of formal languages, grammars and machines.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (2L)** Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchyof languages.
2	**Regular languages and finite automata (6L)** Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata
3	**Context-free languages and pushdown automata (6L)** Context-free grammars (CFG) and languages (CFL), Chomsky and Greatbatch normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic push down automata, closure properties of CFLs.
4	**Turing machines (8L)** The basic model for Turing machines (TM), Turing recognizable(recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators. Context Sensitive Language, The model of Linear Bounded Automaton, relation between LBA and context sensitive language
5	**Decidability (4L)** Decidability, decidable language and undecidable language, Halting problem of TM, Halting problem of TM
6	**Complexity (4L)** Growth rate of functions, The classes P and NP, Polynomial time reduction and NP completeness, SAT is NP complete, Cook's theorem, Church-Turing Thesis

Reference Books :

1. Introduction to Automata Theory, Languages, and Computation, John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Pearson Education Asia.
2. Elements of the Theory of Computation, Harry R. Lewis and Christos H. Papadimitriou, Pearson Education Asia.
3. Theory of Computer Science, Automata Languages and computation, Mishra and Chandra Shekaran, 2nd edition, PHI.
4. Automata and Computability, Dexter C. Kozen, Undergraduate Texts in Computer Science, Springer.
5. Introduction to the Theory of Computation, Michael Sipser, PWS Publishing.

SYLLABUS	
Semester – II	
Course Code	**MCA20-291**
Course Name	**Data Structures Lab**
Lecture (per week)	**0**
Practical (per week)	**4**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

1. Write program using different data structure.
2. To understand linear and non-linear data structures.
3. To understand different types of sorting and searching techniques.
4. To know how to create an application specific data structure.
5. To solve the faults / errors that may appear due to wrong choice of data structure.

Course Outcome:

After successful completion of this course, students will be able to:

1. Write program using different data structure.
2. To understand linear and non-linear data structures.
3. To understand different types of sorting and searching techniques.
4. To know how to create an application specific data structure.
5. To solve the faults / errors that may appear due to wrong choice of data structure.

MODULE NUMBER	COURSE CONTENT
1	**Array** Implementation of data structure operations (Insertion, deletion, traversing, searching) onarray. Linear search, Binary search.
2	**Stack and Queue** Implementation of stack, queue operation using array, Tower of Hanoi, Pop, Push, Implementation of circular queue, Infix to postfix conversion, postfix expression evaluation.
3	**Linked List** Implementation of linked lists: Single linked list, circular linked list, double linked list, doubly circular linked list. Implementation of stack and queue using linked list. Merging two linked list, Linked list representation of a polynomial and related operations.
4	**Tree** Creating Binary Search tree, recursive and non-recursive traversal of BST, deletion in BST, calculating height of a BST, building AVL tree.
5	**Sorting techniques** Bubble sort, selection sort, insertion sort, merge sort, quick sort, heap sort, implementationof priority queue.
6	**Graph** Representation, searching, BFS, DFS.

Reference Books :

1. Data Structures using C, R. Thareja, 2nd Edition, Oxford University Press.
2. Data Structures Using C E. Balagurusamy, Mcgraw Hill
3. Data Structures in C by Aaron M. Tenenbaum, 1st Edition, Pearson
4. Data Structures Through 'C' Language by Samiran Chattopadhyay, Debabrata Ghosh Dastidar, Matangini Chattopadhyay, Edition: 2001, BPB Publications
5. Data structures using C, A.K.Sharma, 2nd Edition, Pearson
6. Fundamentals of Data Structures of C by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed 2nd Edition, Universities Press

SYLLABUS	
Semester – II	
Course Code	**MCA20-292**
Course Name	**Operating Systems Lab**
Lecture (per week)	**0**
Practical (per week)	**4**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

1. To familiarize the students with the Operating System.
2. To demonstrate the process, memory, file and directory management issues under the UNIX/LINUX operating system.
3. To introduce LINUX basic commands.
4. To make students how to make simple programs in LINUX and administrative task of LINUX.

Course Outcome:

After successful completion of this course, students will be able to:

1. Do the use of basic UNIX Commands from the command line, and create Shell Scripts to customize their UNIX Working Environment.
2. Organize and manage their processes and files within UNIX through system calls.
3. Provide a mechanism for handling asynchronous events through signals (Software Interrupt).
4. Implement the Inter-process communication using FIFOs, Message Queues, Semaphores, and Shared Memory.
5. Explain Socket programming to design Client-Server Environment.

MODULE NUMBER	COURSE CONTENT
1	**Shell programming** Creating a script, making a script executable, shell syntax (variables, Conditions, control structures,functions and commands).
2	**Process** Starting new process, replacing a process image, duplicating a process image, waiting for a process, Zombie Process, Orphan Process
3	**File Handling** Programming on files using create(), open(), read(), write(), close(), lseek(), dup().
4	**Signal** Signal Handling, Blocking, Suspending, Delivering Signals, Various Signal Related Functions
5	**Inter-process communication** Pipes (use functions pipe(), popen(), pclose()), Named Pipes (FIFOs, accessing FIFO), Message Queues (use functions msgget(), msgsnd(), msgrcv(), msgctl()), Semaphores (use functions semctl(), semget(), semop(), Shared Memory (use functions shmget(), shmat(), shmdt(), shmctl().
6	**Sockets** TCP Sockets, UDP Sockets, Socket Options, Client /Server Example, Name and Address Conversions
7	**POSIX Threads** Programming with pthread functions viz. pthread_create(), pthread_join(), pthread_exit(), pthread_attr_init(), pthread_cancel()

Reference Books :

1. Yashavant P. Kanetkar, UNIX Shell Programming, 1st edition, BPB Publications Beej's Guide to Unix IPC
2. W. Richard Stevens, UNIX Network Programming, 2nd edition, Prentice Hall

SYLLABUS	
Semester – II	
Course Code	**MCA20-293**
Course Name	**Object Oriented Programming Lab Using JAVA**
Lecture (per week)	**0**
Practical (per week)	**4**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

1. It demonstrates that how can you change the implementation of an object without affecting any other code by increasing data security and protecting unwanted data access. (Encapsulation).
2. It allows you to have many different functions, all with the same name, all doing the same job, but depending upon different data. (Polymorphism).
3. It guides you to write generic code: which will work with a range of data, so you don't have to write basic stuff over, and over again. (Generics).
4. It lets you write a set of functions, then expand them in different direction without changing or
5. Copying them in any way. (Inheritance).

Course Outcome:

After successful completion of this course, students will be able to:

1. Create the procedure of communication between Objects, classes & methods.
2. Understand the elementary facts of Object Orientation with various characteristics as well as several aspects of Java.
3. Analyze distinct features of different string handling functions with various I/O operations.
4. Discuss simple Code Reusability notion w.r.t. Inheritance, Package and Interface.
5. Apply Exception handling, Multithreading and Applet (Web program in java) programming concept in Java.

MODULE NUMBER	COURSE CONTENT
1	**Java Basics:** Simple Java programming using operators, control statements & loops, array. Programming on class, object, and method, access specifier. Programming on constructor, method/constructor overloading. Programming on this keyword, call by value & call by reference, static variables & methods,inner classes.
2	**Basic String handling & I/O:** Programming to show the use of String class methods - charAt(), compareTo(), equals(), equalsIgnoreCase(), indexOf(), length() , substring(), toCharArray(), toLowerCase(), toString(), toUpperCase(), trim(), valueOf() methods. Programming to show the use of StringBuffer class methods - append(), capacity(), charAt(), delete(), deleteCharAt(),ensureCapacity(), getChars(), indexOf(), insert(), length(), setCharAt(), setLength(), substring(), toString() methods. Programming on Command line arguments. Programming using keyboard input by implementing BufferedReader & Scanner classes.
3	**Inheritance, Interface and Java Packages** Programming on Simple Inheritance, super and final keywords, super() method. Programming on method overriding, dynamic method dispatch, abstract classes & methods, multiple inheritance by using interface. Programming on importing system package, creating user-defined package, importing user defined package, using protected access specifier, subclassing an imported class of a package, using same names for classes of different packages, adding multiple public classes to a package.

4	**Exception handling, Multithreading and Applet Programming** Programming on exception handling using try-catch block, implementing throw and throwskeywords, using finally block, creating user-defined exception. Programming on creating child threads i) by extending thread class ii) by implementingrunnable interface, creating child threads by assigning thread priorities. Programming on creating simple applet to display some message, creating applet two add 2integers, creating applet to do GUI based programming.

Reference Books :

1. Herbert Schildt – "Java: The Complete Reference " – 9th Ed. – TMH
2. E. Balagurusamy – " Programming With Java: A Primer " – 3rd Ed. – TMH.
3. R.K Das – " Core Java for Beginners " – VIKAS PUBLISHING. Rambaugh, James Michael, Blaha – "Object Oriented Modeling and Design " – Prentice Hall, India

SYLLABUS	
Semester – III	
Course Code	**MCA20-301**
Course Name	**Software Engineering**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. It aims to develop a broad understanding of Software Engineering.
2. To learn software development life cycle for Object-Oriented solutions for Real-World Problem.
3. To understand the concept of Testing.

Course Outcome:

After successful completion of this course, students will be able to:

1. Analyze the problem scenario and identify classes/objects and their properties, relationships in- class model.
2. Learn software development life cycle for Object-Oriented solutions for Real-World Problems.
3. Apply the concepts of object-oriented methodologies to analyze requirements and design to the point where it is ready for implementation.
4. Demonstrate the concept of Testing to measure the quality of software.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to Software Engineering, Object-Oriented Concept, Modeling (7L)** What is Software Engineering? Software Engineering Concepts, Software Engineering Development Activities, Managing Software Development. Object-Oriented Principals and Concepts: Classes and Object, Modularity, Abstraction and Encapsulation; Object Relationship like Association, Aggregation and Composition; Inheritance, Polymorphism and Dynamic Binding Interfaces Model: Importance of Modeling, Object Oriented Modeling Identifying the Elements of an Object Model: Identifying classes and objects, Specifying the attributes Defining operations, Finalizing the object definition.
2	**Introduction to UML, Basic and Advanced Structural Modeling (10L)** Overview of UML, Conceptual Model of UML, Architecture, S/W Development Life Cycle. Classes Relationship, Common mechanism, Diagrams, Class Diagram, Advanced classes, Advanced Relationship, Interface, Types and Roles, Packages, Object Diagram.
3	**Basic and Advanced Behavioral Modeling and Architectural Modeling (10L)** Interactions, Use cases, Use Case Diagram, Sequence Diagram, Collaboration Diagram, Interaction Diagram, Activity Diagram, State Chart Diagram. Artifacts, Artifact Diagram, Implementation Diagram, Deployment Diagram.
4	**Object-Oriented Design and Analysis (9L)** Generic components of Object-Oriented Design model, System Design process, Partitioning the Analysis Model, Concurrency and subsystem Allocation, Task Management component, Data Management Component, Resource Management Component, Inter Sub-system Communication. Iterative Development, Unified process & its Phases: Inception, Elaboration, Construction, Transition, Understanding requirements.
5	**Object-Oriented Testing (4L)** Overview of Testing and object-oriented Testing, Types of Testing, Object-oriented Testing strategies, Test case design for Object-Oriented software, Inter class test case design.

Reference Book :

1. The Unified Modeling Language User Guide, Grady Booch, James Raumbaugh, Ivar Jacobson, Second Edition, The (Addison-Wesley Object Technology Series).
2. Object Oriented Software Engineering, Ivar Jacobson, ACM Press, Third Edition.
3. Applying UML and Patterns, Craig Larman Motilal Uk Books of India, Third Edition.
4. Object-Oriented Software Engineering: Using UML, Patterns, and Java, Bernd Bruegge, Allen Dutoit, Pearson, Third Edition.
5. Software Engineering – A Practitioner's Approach, Roger. S. Pressman and Bruce R. Maxim, McGraw Hill, Eighth Edition.

SYLLABUS

Semester – III

Course Code	**MCA20-302**
Course Name	**Artificial Intelligence**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. To understand the assumption of philosophy of the logical sequences of the real-life problem.
2. To apply State Space Search behind the limitation of the non-solving method of the conventional computational approach.
3. To understand heuristic search and game-playing strategy.
4. To learn various strategies of representation of knowledge.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the assumption of philosophy of the logical sequences of real-life problem by applying State Space Search behind the limitation of the non-solving method of the conventional computational approach.
2. Incorporating heuristic search technique on Game Playing.
3. Apply various strategies with decision-making algorithms. Creation of substantial domain knowledge base with metadata and representation issues using Prolog/LISP.
4. Recognize the adoption of a new system through learning by an Intelligent System and processing of Natural Language.
5. Apply machine learning techniques to solve real-world problems and how Expert Systems can be carried out with the help of learning, analyzing by applying various search techniques and resolute to provide solutions.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to Intelligent Systems (8L)** Overview of Artificial intelligence, Problems of AI, AI techniques, Tic - Tac - Toe problem.
2	**Search Techniques (10L)** Problems, Problem Space & search. Heuristic Search Techniques, Game planning, Minimax search procedure, adding alpha beta cut-off's, Iterative Deepening.
3	**Knowledge Representation Issues (7L)** Representing knowledge using rules, Weak slot & filler structures, Strong slot & filler structures, Implementation of Knowledge with Prolog Programs, Basic knowledge of programming languages like Prolog & Lisp.
4	**Adoption of New Knowledge (10L)** Introduction to Neural Networks, Convolution of New Knowledge, Introduction to Natural Language Processing, Learning – induction & explanation-based learning.
5	**Expert Systems (5L)** Introduction to Expert System, Expert System Shells, knowledge acquisition.

Reference Books :

1. Artificial Intelligence: A Modern Approach, Stuart Russell & Peter Norvig, Pearson Education. Third Edition.
2. Artificial Intelligence, Rich & Knight, TMH. Third Edition.
3. Artificial Intelligence for Students, Subhasree Bhattacharjee, Shroff Publishers & Distributors Pvt. Ltd. 1st Edition.
4. Artificial Intelligence & Intelligent Systems, N.P Padhy, Oxford University Press. Illustrated Edition.
5. Introduction to Artificial Intelligence & Expert Systems, Dan W. Patterson, PHI.
6. Artificial Intelligence: A new Synthesis, Nils J. Nilsson, Morgan Kaufmann Publishers, International student edition.
7. M.C. Trivedi, Artificial Intelligence, Khanna Publishing House, Second Edition.

SYLLABUS	
Semester – III	
Course Code	**MCA20-303**
Course Name	**Design and Analysis of Algorithm**
Lecture (per week)	**3**
Tutorial (per week)	**1**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**4**

Course Objective:

1. To understand the running times of algorithms based on asymptotic analysis and justify the correctness of algorithms.
2. To understand and implement the greedy paradigm for a given problem.
3. To learn the implementation of Back Tracking and Branch-&-Bound problem.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand and analyze the running times of algorithms based on asymptotic analysis and justify the correctness of algorithms.
2. Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it.
3. Understand and implement the greedy paradigm for a given problem.
4. Design the dynamic programming paradigm and implement it.
5. Understand and implement the Back Tracking and Branch-&-Bound problem.
6. Explain the ways to analyze randomized algorithms (expected running time, probability of error).

MODULE NUMBER	COURSE CONTENT
1	**Introduction (8L)** Characteristics of the algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters' theorem.
2	**Divide-&-Conquer and Greedy Method (8L)** Divide & Conquer: General Method, Finding maximum and minimum, Merge sort, Quicksort, Selection, Strassen's matrix multiplication. Greedy Method: General Method, knapsack problem, Tree vertex splitting, Job sequencing with deadlines, optimal storage on tapes.
3	**Dynamic Programming (8L)** Multistage graphs, all-pairs shortest paths, single-source shortest paths. String Editing: 0/1 knapsack. Search techniques for graphs: DFS-BFS-connected components, biconnected components.
4	**Back Tracking and Branch-&-Bound (8L)** Back Tracking: 8-queens, Sum of subsets, Graph Coloring, Hamiltonian cycles. Branch and Bound: Traveling Salesperson problem.
5	**Lower Bound Theory (8L)** Comparison trees, Oracles and advisory arguments, Lower bounds through reduction, Basic Concepts of P-NP, NP-Hard and NP-Complete problems.

Reference Books :

1. E. Horowitz, S. Sahni and S. Rajasekaran, 2008, Computer Algorithms, Second Edition, Universities Press, India.
2. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, 4th Edition, MIT Press/McGraw-Hill.
3. A.V. Aho, J.E. Hopcroft, J.D. Ullmann, 1974, The Design and Analysis of Computer Algorithms, Addison Wesley, Boston.
4. The Art of Computer Programming: Fundamental Algorithms v. 1: Volume 3 by Donald E. Knuth.

SYLLABUS	
Semester – III	
Course Code	**MCA20-E304A**
Course Name	**Image Processing**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To understand the fundamental concept of the digital image processing system.
2. To learn different feature extraction techniques for image analysis and recognition.
3. To learn various compression techniques.
4. To learn the evaluation of the techniques for image enhancement and restoration.

Course Outcome:

After successful completion of this course, students will be able to:

1. Describe the fundamental concept of the digital image processing system.
2. Experiment with the images in the frequency domain and spatial domain using various transforms.
3. Evaluate the techniques for image enhancement and restoration.
4. Explain different feature extraction techniques for image analysis.
5. Categorize various compression techniques.
6. Develop any image processing application.

MODULE NUMBER	COURSE CONTENT
1	**Introduction (4L)** Background, Digital Image Representation (Grey & Colour), Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display, Basics of image compression.
2	**Digital Image Formation (4L)** A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization - Uniform & Non-uniform.
3	**Image Preliminaries (7L)** Neighbor of pixels, Connectivity, Relations, Equivalence & Transitive Closure, Distance Measures, Arithmetic/Logic Operations, Fourier and Wavelet Transformation, Properties of The Two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform.
4	**Image Enhancement (5L)** Spatial Domain Method, Frequency Domain Method, Contrast Enhancement, Linear & Nonlinear Stretching, Histogram Processing, Smoothing - Image Averaging, Mean Filter, Low-pass Filtering, Image Sharpening. High-pass Filtering, High-boost Filtering, Derivative Filtering, Homomorphic Filtering, Enhancement in the frequency domain - Low pass filtering, High pass filtering.
5	**Image Restoration (4L)** Degradation Model, Discrete Formulation, Algebraic Approach to Restoration-Unconstrained & Constrained, Constrained Least Square Restoration, Restoration by Homomorphic Filtering, Geometric Transformation, Spatial Transformation, Gray Level Interpolation.
6	**Image Segmentation (6L)** Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection – Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding; Region Oriented Segmentation - Basic Formulation, Region Growing by Pixel Aggregation, Region Splitting & Merging**.**

Reference Books :

1. Digital Image Processing, Rafael C. Gonzalez & Richard E. Woods, Pearson, Fourth Edition.
2. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education-2003, First Edition.
3. Digital Image Processing, Jahne, Springer India.
4. Digital Image Processing & Analysis, Chanda & Dutta Majumder, PHI Fundamentals of Digital Image Processing, Jain, PHI, Third Edition.

SYLLABUS

Semester – III

Course Code	**MCA20-E304B**
Course Name	**Web Enabled JAVA Programming**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To understand the basic working methodology of JSP, servlet and JSF Frameworks.
2. To learn the creation of dynamic web applications using JSP and servlet and database.
3. To learn the design and development of a Web site using AJAX.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the basic working methodology of JSP, servlet and JSF Frameworks.
2. Create dynamic web applications using JSP and servlet and database.
3. Design and develop a Web site using AJAX.
4. Apply concepts to Debug the Programs and error handling techniques.

MODULE NUMBER	COURSE CONTENT
1	**Core Java Overview (4L)** Object-oriented concepts, Exception Handling, Multi-Threading Introduction to JDBC: Overview of JDBC API, The Java.sql package, JDBC Drivers, Executing SQL commands using JDBC Drivers, static and dynamic Execution of SQL statements, Execution of Stored Procedures using JDBC. Introduction to Transactions and Transaction Methods. Introduction to JNDI, Introduction to Data Source and Connection pooling, Introduction to Web Applications, Web Servers Overview of J2EE Technologies.
2	**Introduction to Java Servlets (6L)** Static and Dynamic contents, Servlet life Cycle and Life cycle methods, Servlet Request and Response Model, Deploying a Servlet, Servlet State Transitions, Servlet Config and Servlet Context, Servlet Redirection and Request Dispatch, Servlet Synchronization and Thread Model. Maintaining Client State: Cookies, URL rewriting, Hidden form fields, Session Tracking.
3	**Introduction to JSP (6L)** JSP & Servlet as Web Components, Servlets vs. JSP, JSP Lifecycle, JSP Page Lifecycle Phases, General Rules of Syntax, JSP syntactic elements, JSP element syntax, Template content. JSP elements-directives, declarations, expressions, scriptlets, actions. JSP Standard Actions: jsp:useBean, jsp:getPreoperty, jsp:setProperty, jsp:include, jsp:forward, jsp:plugin, jsp:param, Java Server Pages Standard Tag Library (JSTL).
4	**Introduction to JSF Frameworks (8L)** A Simple Example, Sample Application Analysis, Development Environments for JSF, A Sample Application, Bean Scopes Configuring Beans, Navigation, Static Navigation, Dynamic Navigation, Standard JSF tags, Data tables, conversion and validation Overview of the Conversion and Validation Process, Using Standard Converters. Life Cycle Events, Value Change Events, Action Events, Event Listener Tags, Immediate Components, Passing Data from the UI to the Server, Custom Components, Classes for Implementing Custom components, Tags and Components, The Custom Component Developer's Toolbox, Generating Markup, Processing Request Values, Using Converters, Implementing Custom Component Tags, The TLD File, The Tag Handler Class, Defining Tag Handlers in JSF 1.1.
5	**AJAX (6L)** Ajax Fundamentals, JavaScript Libraries, The Prototype Library, The Fade Anything Technique Library, Form Completion. Realtime Validation, Propagating Client-Side View State Direct Web Remoting, Ajax Components, Hybrid Components, Keeping JavaScript Out of Renderers, Transmitting JSP Tag Attributes to JavaScript Code, Ajax4jsf, Implementing Form Completion with Ajax4jsf, Implementing Real-time Validation with Ajax4jsf. Introduction to Java Web Services.

Reference Books :

1. Professional Java Server Programming- J2EE 1.3 Edition- Subrahmanyam Allamaraju and Cedric Buest- Apress publication, 2007.
2. Core JavaServer Faces-Second Edition-David Geary, Cay Horstmann-Prentice Hall-2007.

SYLLABUS	
Semester – III	
Course Code	**MCA20-E304C**
Course Name	**Cloud Computing**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To learn the cloud computing fundamentals.
2. To learn the architectures.
3. To learn services, implementation and deployment techniques.
4. To learn programming concept.
5. To learn security & risk management.
6. To know research trends.

Course Outcome:

After successful completion of this course, students will be able to:

1. Compare the strengths and limitations of cloud computing.
2. Identify the architecture, infrastructure and delivery models of cloud computing.
3. Apply a suitable virtualization concept and choose the appropriate Programming approach.
4. Understand risk involvement.
5. Able to find current research areas.

MODULE NUMBER	COURSE CONTENT
1	**Basics of Cloud Computing (4L)** Defining a Cloud, Cloud Types - NIST Cloud Reference Model, Cloud Cube Model, Deployment Models (Public, Private, Hybrid and Community Clouds), Service Models - IaaS, PaaS, SaaS, Benefits and Advantages of Cloud Computing.
2	**Concepts of Abstraction and Virtualization (4L)** Taxonomy of Virtualization, Reference model for Virtualization.
3	**Services and Applications by Type (5L)** IaaS - Basic Concept, Workload, Partitioning of Virtual Private Server Instances, Pods, Aggregations, Silos PaaS – Basic Concept, Tools and Development Environment with examples, SaaS - Basic Concept and Characteristics, Open SaaS, examples of SaaS Platform, Identity as a Service (IDaaS), Compliance as a Service (CaaS).
4	**Concepts of Service Oriented Architecture (SOA) and Web Service (WS) (2L)** Service-Oriented Architecture - Basics, Terminologies, Components, Standards and Technologies, Benefits and Challenges. Web Services - Basics, Characteristics, Terminologies, Characteristics and Scope, Business Models.
5	**Cloud-based Storage and Security (7L)** Cloud File Systems, including GFS and HDFS. Cloud security concerns, security boundary, security service boundary, Overview of security mapping. Security of data - cloud storage access, storage location, tenancy, encryption, auditing, compliance, Identity management (awareness of identity protocol standards), Risk Management and Compliance, Research Trends in Cloud Computing.
6	**Introduction to Various Web Services and Cloud Federation (8L)** Amazon Web Services, Google Web Services, Microsoft Cloud Services. Definition, different scenario description, replaceability and negotiation mechanism.

Reference Books:

1. Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education.
2. Cloud Computing Bible by Barrie Sosinsky, Wiley India Pvt. Ltd.
3. Cloud Computing: A Practical Approach by Anthony T. Velte, Tata McGraw-Hill, First Edition.
4. Building Applications in Cloud: Concept, Patterns and Projects by Moyer, Pearson.
5. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley-India, First Edition.

SYLLABUS	
Semester – III	
Course Code	**MCA20-E304D**
Course Name	**Web Technology**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To understand the basic working methodology of HTML, CSS, JavaScript.
2. To learn how to create user-defined functions of JavaScript for form validation.
3. To learn how to develop a dynamic webpage by the use of JavaScript and DHTML.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the basic working methodology of HTML, CSS, JavaScript.
2. Apply In-Built functions and Create User-defined functions of JavaScript for form validation.
3. Develop a dynamic webpage by the use of JavaScript and DHTML.
4. Apply concepts to Debug the Programs and error handling techniques.

MODULE NUMBER	COURSE CONTENT
1	**Understanding of Internet (5L)** www, client-server, DNS, IP Protocol, HTTP, URL, Browser working principle, Web Hosting, W3C standard, Cloud Development.
2	**Fundamental of Web Design (10L)** Introduction to HTML, Editor(VS Code/ Sublime), Element, Attribute, Head, Heading, Paragraph, Style, Formatting, Quotation, Comment, Color, CSS, Link, Image, Table, List, Block & Inline, Class, ID, Iframe, Script, File path, Layout, Code, Entity, Symbol, Emoji, Charset, Forms, Form Attributes, Elements, Input types, Input Attributes. Introduction to CSS, Selector, External-Internal-Inline CSS, Comments, Color, Background, Border, Margin, Padding, Height, Width, Box model, Outline, Text, Font, Icon, Link, List, Table, Display, Max width, Position, Overflow, Float, Inline-bock, Align, Pseudo-class, Pseudo element, Opacity, Navigation Bar, Dropdowns, Image gallery, Image sprites, Attr Selector, Form, Counter, Units, Rounded corner, Border image, Gradient, Shadow, Text Effect, Web Fonts, Transition, Animation, Tooltip, Style Image, Button, Pagination, Multiple columns, Media Query, Flexbox.
3	**Advance Web Design: CSS Responsive Design (3L)** Introduction to CSS Responsive Design, Viewport, Grid view, Media queries, Responsive image, Responsive video.
4	**Advance Web Design: Bootstrap (6L)** Introduction to Bootstrap, Container, Grid, Typography, Color, tables, Images, jumbotron, Alerts, Button, Button group, Badges, Progress bar, Spinner, Pagination, List group, Card, Dropdown, Collapse, Navs, Navbar, Forms, Input, Input group, Carousel, Modal, Tooltip, Popover, Toast, Scrollspy, Flex, Media object.
5	**Advance Web Design: JavaScript (6L)** Introduction to JavaScript, output, variables, operator, Datatype, Function, Object, Event, String, String method, Number method, Array, Array method, Array iteration, Date & Date format, Date method, Math, Random, Comparison, Condition, keyword (for, while, break, this), Function, Arrow function, Form validation, HTML DOM – Documents, Elements, HTML, CSS, Animation, Event, Even listener, Navigation, Nodes, Collection, Node list.

Reference Books :

1. The Joy of PHP Programming: A Beginner's Guide to Programming Interactive Web Applications with PHP and MySQL. Alan Forbes, Fifth Edition, Plum Island.
2. Beginning Web Programming, Jon Duckett, WROX, Second Edition.
3. Open Source for the Enterprise: Managing Risks, Reaping Rewards, Dan Woods and Gautam Guliani, O'Reilly, Shroff Publishers and Distributors, 2005.

SYLLABUS	
Semester – III	
Course Code	**MCA20-E304E**
Course Name	**Android Application Development**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To understand mobile application development trends and the Android platform.
2. To learn SMS, email service, binding and deploying APKs.
3. To learn how to develop, deploy and maintain the Android Applications.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand mobile application development trends and Android platforms.
2. Analyze the need for simple applications, game development, Location map-based services.
3. Familiar with SMS, email, service, binding and deploying APKs.
4. Develop, deploy and maintain the Android Applications.

MODULE NUMBER	COURSE CONTENT
1	**Android Fundamentals (6L)** Mobile Application development and trends, Android overview and Versions, Android open stack, features, Setting up Android environment (Eclipse, SDK, AVD), Simple Android application development,– Anatomy of Android applications – Activity and Life cycle – Intents, services and Content Providers.
2	**Android User Interface (6L)** Layouts - Linear, Absolute, Table, Relative, Frame, Scroll View, Resize and reposition, Screen orientation - Views: Text view, Edit Text, Button, Image Button, Checkbox, Toggle Button, Radio Button, Radio Group, Progress Bar, Autocomplete Text, Picker, List views and Web view, Displaying pictures with views - Gallery and Image View, Image Switcher, Grid view, Displaying Menus - Helper methods, Option and Context.
3	**Data Persistence (6L)** File Handling: File system, System partition, SD card partition, user partition, security, Internal and External Storage - Managing data using SQLite -User-defined content providers.
4	**Messaging, Networking and Services (6L)** SMS Messaging - Sending and Receiving, sending email and networking, Downloading binary and text data files, Access Web services, Developing android services: create own services, performing long-running tasks in service-performing repeated tasks in a service.
5	**Location Access and Publish Android Application (6L)** Location-based services - Display map, zoom control, view and change, Marking, Geocoding, get location, Publish Android applications and Deployment.

Reference Books :

1. Beginning Android Application Development, Wei Meng Lee, (2012) Wrox Publications (John Wiley, New York).
2. Hello Android: Introducing Google's Mobile Development Platform, Ed Burnette (2010), The Pragmatic Publishers, Third edition, North Carolina, USA.
3. Professional Android 4 Application Development, Reto Meier (2012), Wrox Publications (John Wiley, New York).
4. Programming Android: Java Programming for the New Generation of Mobile Devices, Zigurd Mednieks, Laird Dornin, Blake Meike G, Masumi Nakamura (2011), O" Reilly Media, USA.

SYLLABUS	
Semester – III	
Course Code	**MCA20-E304F**
Course Name	**Basic Data Science**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

To make students able to

1. Learn the fundamental concepts of data science.
2. Know fundamentals of statistics.
3. Learn the mechanics of regression analysis.

Course Outcome:

After completion of this course successfully the students will be able to:

1. Understand the fundamental knowledge of Data Science and the task of Data Science people.
2. Understand the fundamental of statistics and calculate the correlation, covariance, central tendency.
3. Estimate confidence interval and perform hypothesis testing.
4. Understand the mechanics of regression analysis and classification using kNN, decision tree.
5. Use clustering method to cluster records.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to Data Science and (2L)** Define Data Science, why data science, data science in business.
2	**Descriptive Statistics and Inferential Statistics (8L)** Matrix, Matrix operations, Sample, Population, Descriptive statistics, Central tendency, outlier detection. Basics of probability, probability distribution, Central Limit theorem.
3	**Hypothesis testing (6L)** Null and Alternate Hypothesis, Making a Decision, and Critical Value Method, p-Value Method and Types of Errors, Two-Sample Mean and Proportion Test.
4	**Regression Analysis (4L)** Fundamentals of Regression analysis, assumption of regression analysis, accuracy, validity, Dealing with categorical data.
5	**Classification and Clustering (6L)** Introduction, Logistic regression, Multiple Linear Regression, Least square gradient descent, Linear Classification, model building and evaluation. Introduction to clustering, k-means clustering, hierarchical clustering.
6	**Decision tree and kNN (4L)** Introduction to a decision tree, regression tree, truncation & pruning, random forest, kNN for regression, classification, weighted kNN

Reference Books :

1. Introducing Data Science; Davy Cielen, Arno D Meysman and Mohamed Ali; Dreamtech Press.
2. Practical Statistics for Data Scientists; Peter Bruce and Andrew Bruce; O‟ Reilly Media Inc.
3. Doing Data Science; Cathy O‟ Neil and Rachel Schutt; O‟ Reilly Media Inc.
4. Mining of Massive Datasets; Jure Leskovek, Anand Rajaraman and Jeffrey Ullman; Cambridge University Press, First Edition.

SYLLABUS

Semester – III

Course Code	**MCA20-E305A**
Course Name	**Information Retrieval**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. Learn the information retrieval models.
2. Be familiar with Web Search Engine.
3. Be exposed to Link Analysis.
4. Understand Hadoop and Map Reduce.
5. Learn document text mining techniques.

Course Outcome:

Upon completion of the course, students will be able to :

1. Apply information retrieval models.
2. Design Web Search Engine.
3. Use Link Analysis and Specialized Search.
4. Use Hadoop and Map Reduce.
5. Apply document text mining techniques.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to IR (6L)** Introduction - History of IR, Components of IR, Issues, Open source Search engine Frameworks, The impact of the web on IR, The role of artificial intelligence (AI) in IR, IR Versus Web Search, Components of a Search engine, Characterizing the web.
2	**Information Retrieval (6L)** Boolean and vector-space retrieval models, Term weighting, TF-IDF weighting, cosine similarity, Preprocessing, Inverted indices, efficient processing with sparse vectors, Language Model-based IR, Probabilistic IR, Latent Semantic Indexing, Relevance feedback and query expansion.
3	**Web Search Engine – Introduction And Crawling (6L)** Web search overview, web structure, the user, paid placement, search engine optimization/ spam. Web size measurement, search engine optimization/spam, Web Search Architectures, crawling, meta-crawlers, Focused Crawling, web indexes, Near-duplicate detection, Index Compression, XML retrieval.
4	**Web Search - Link Analysis And Specialized Search (6L)** Link Analysis - hubs and authorities, Page Rank and HITS algorithms, Searching and Ranking, Relevance Scoring and ranking for Web, Similarity, Hadoop & Map Reduce, Evaluation. Personalized search - Collaborative filtering and content-based recommendation of documents and products, handling “invisible” Web, Snippet generation, Summarization, Question Answering, Cross-Lingual Retrieval.
5	**Document Text Mining (6L)** Information filtering; organization and relevance feedback, Text Mining, Text classification and clustering, Categorization algorithms: naive Bayes; decision trees; and nearest neighbor, Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM).

Reference Books :

1. Manning, P. Raghavan, and H. Schütze, "Introduction to Information Retrieval", Cambridge University Press.
2. Ricardo Baeza -Yates and Berthier Ribeiro - Neto, "Modern Information Retrieval: The Concepts and Technology behind Search", ACM Press Books.
3. Bruce Croft, Donald Metzler and Trevor Strohman, "Search Engines: Information Retrieval in Practice", Addison Wesley.
4. Mark Levene, "An Introduction to Search Engines and Web Navigation", Edition Wiley.
5. Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines", The MIT Press.
6. Ophir Frieder "Information Retrieval: Algorithms and Heuristics: The Information Retrieval Series", Springer.

SYLLABUS

Semester – III

Course Code	**MCA20-E305B**
Course Name	**Data Warehousing and Data Mining**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To learn different sequential pattern algorithms.
2. To learn the technique to extract patterns from time-series data and its application in thereal world.
3. To understand Graph mining algorithms to Web mining.

Course Outcome:

After successful completion of this course, students will be able to:

1. Know the different sequential pattern algorithms.
2. Learn the technique to extract patterns from time-series data and its application in the real world.
3. Apply the Graph mining algorithms to Web mining.
4. Identify the computing framework for Big Data.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to Data Warehousing (6L)** The need for data warehousing, Operational and informational Datastores, Data warehouse definition and characteristics, Data warehouse architecture, Data warehouse Database, Sourcing, Acquisition, Cleanup and transformation tools, Metadata, Access tools, Data marts, Data warehousing administration and management.
2	**Online Analytical Processing (OLAP) (4L)** Need for OLAP, Multidimensional data model, OLAP guidelines, Multidimensional vs. Multi-relational (OLAP), Categorization of OLAP tools, OLAP tools internet.
3	**Introduction to Data Mining (6L)** The motivation, Learning from past mistakes, Data mining, Measuring data mining effectiveness, Embedded data mining into business process, What is decision tree, Business scorecard, Where to use decision tree, The general idea, How the decision tree works.
4	**Classification and Prediction (5L)** Cluster Analysis - Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns.
5	**Time Series Analysis (4L)** Time-series Data, Periodicity Analysis for time-related sequence data, Trend analysis, Similarity search in Time-series analysis.
6	**Web Mining (5L)** Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.

Reference Books :

1. Data warehousing, Data mining and OLAP by Alex Berson & Stephon J. Smith, Tata McGraw Hill.2003.
2. Data Warehousing Fundamentals for IT Professionals, Second Edition by Paulraj Ponniah, Wiley India.
3. Principles and Implementation of Data Warehousing, Rajeev Parida Fire Wall Media, Lakshmi Publications. 2006.

SYLLABUS

Semester – III

Course Code	**MCA20-E305C**
Course Name	**Introduction to Big Data Analytics**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. Introduce students to the concept and challenge of big data (3 V's: volume, velocity, and variety).
2. To get hands-on experience on large-scale analytics tools to solve big data problems using Hadoop.
3. Teach students in applying skills and tools to manage and analyze big data.

Course Outcome:

After successful completion of this course, students will be able to:

1. Understand the concept and challenge of big data and why existing technology is inadequate to analyze big data.
2. Collect, manage, store, query, and analyze the various form of big data.
3. Gain hands-on experience on large-scale analytics tools to solve big data problems using Hadoop.
4. Understand the impact of big data on business decisions and strategy.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to Big Data (4L)** Introduction to Big Data Platform, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs Reporting.
2	**Mining Data Streams (6L)** Introduction To Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real-time Analytics Platform (RTAP) Applications, Case Studies - Real-Time Sentiment Analysis, Stock Market Predictions.
3	**Hadoop (8L)** History of Hadoop, Hadoop Distributed File System, Components of Hadoop, Analyzing the Data with Hadoop, Scaling Out, Hadoop Streaming, Design of HDFS, Java interfaces to HDFS Basics, Developing a Map-Reduce Application, How Map Reduce Works, Anatomy of a Map, Reduce Job run, Failures, Job Scheduling, Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features Hadoop environment.
4	**Frameworks (6L)** Applications on Big Data Using Pig and Hive, Data processing operators in Pig, Hive services, HiveQL, Querying Data in Hive, fundamentals of HBase and ZooKeeper, IBM InfoSphere BigInsights and Streams.
5	**Predictive Analytics (6L)** Simple Linear Regression, Multiple Linear Regression, Interpretation of regression coefficients, Visual data analysis techniques, interaction techniques, systems and applications.

Reference Books :

1. Hadoop: The Definitive Guide, Tom White Third Edition, O'Reilly Media, 2012.
2. Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, Chris Eaton, Dirk De Roos, Tom Deutsch, George Lapis, Paul Zikopoulos, McGraw Hill Publishing, 2012.
3. Mining of Massive Datasets, Anand Rajaraman and Jeffrey David Ullman, CUP, 2012.
4. Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Bill Franks, John Wiley& sons, 2012.
5. Making Sense of Data, Glenn J. Myatt, John Wiley & Sons, 2007.

SYLLABUS

Semester – III

Course Code	**MCA20-E305D**
Course Name	**Cryptography**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To know the methods of conventional encryption.
2. To understand the concepts of public-key encryption and number theory.
3. To know the network security tools and applications.
4. To understand the system-level security practices.

Course Outcome:

After successful completion of this course, students will be able to:

1. Learn about different methods of conventional encryption.
2. Know about the concepts of public-key encryption and number theory.
3. Acquire knowledge about authentication functions, message authentication codes and different hash algorithms.
4. Acquire knowledge about network security tools and authentication applications.

MODULE NUMBER	COURSE CONTENT
1	**Computer Attack & Security (5L)** Attacks on Computers & Computer Security Introduction, Need for Security, Security approaches, Principles of Security, Types of attack.
2	**Cryptography (5L)** Introduction to Cryptography Concepts & Techniques, Plaintext & Ciphertext, Substitution Techniques, Transposition Techniques, Encryption & Decryption, Symmetric & Asymmetric key Cryptography, Key Range & Key Size.
3	**Symmetric Key Algorithm (6L)** Introduction to Symmetric Key Algorithm, Algorithm types & Modes, Overview of Symmetric Key Cryptography, DES(Data Encryption Standard) algorithm, IDEA (International Data Encryption Algorithm) algorithm, RC5 (Rivest Cipher 5) algorithm.
4	**Asymmetric Key Algorithm (6L)** Introduction to Asymmetric Key Algorithm, Digital Signature and RSA Introduction, Overview of Asymmetric Key Cryptography, RSA algorithm, Symmetric & Asymmetric key Cryptography together, Digital Signature, Basic concepts of Message-Digest and Hash Function (Algorithms on Message-Digest and Hash function not required).
5	**Security Protocols (4L)** Internet Security Protocols, User Authentication Basic Concepts, SSL protocol, Authentication Basics, Password, Authentication Token, Certificate-based Authentication, Biometric Authentication.
6	**Mail Security & Firewall (4L)** Electronic Mail Security Basics of mail security, Pretty Good Privacy, S/MIME. Firewall Introduction, Types of the firewall.

Reference Books :

1. Introduction to Cryptography Principles and Applications, Hans Delfs, Helmut Knebl, Springer, Third Edition
2. Cryptography and Information Security, V. K. Pechghare, PHI, Third Edition

SYLLABUS	
Semester – III	
Course Code	**MCA20-E305E**
Course Name	**Operation Research and Optimization Techniques**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. Learn Fundamental Concepts of optimization.
2. Learn Linear Programming Problems and their solution techniques.
3. Knowledge about Transportation and Assignment problems.

Course Outcome:

After successful completion of this course, students will be able to:

1. Describe the way of writing mathematical models for real-world optimization problems.
2. Identify Linear Programming Problems and their solution techniques.
3. Categorize Transportation and Assignment problems.
4. Apply Game-Theoretic Models to a variety of real-world scenarios in economics and other areas.
5. Convert practical situations into non-linear programming problems.
6. Solve unconstrained and constrained programming problems using analytical techniques.

MODULE NUMBER	COURSE CONTENT
1	**Linear Programming Problem (LPP)-I (8L)** Formulation of an LPP; Graphical Method of solution of an LPP; Convex Combination and Convex Set; Convex Hull and Convex Polyhedron; Canonical and Standard form of an LPP; Basic Solution of a system of linear equations; Simplex Method; Big-M Method; Concept of Duality; Mathematical formulation of duals.
2	**Linear Programming Problem (LPP)-II (8L)** Introduction to Transportation Problems (TP), Representation of Transportation Problems as LPP, Methods of finding initial basic feasible solution of TP, North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method, Optimality test of the basic feasible solution, Assignment Problems, Hungarian Method.
3	**Game Theory (7L)** Introduction, Strategies, The Minimax and Maximin Criterion, Existence of Saddle Point - Two-person zero some Games, Games with saddle Point, Pure Strategies, Games without a Saddle Point - Mixed Strategies, Symmetric Games, Dominance Principle, Graphical Method of Solution, Algebraic Method of Solution.
4	**Non-Linear Programming Problem (NLPP) (7L)** Single-variable Optimization. Multivariate Optimization with no constraints: Semi-definite Case, Saddle Point; Multivariate Optimization with Equality Constraints: Method of Lagrange Multipliers; Multivariable Optimization with inequality constraints: Kuhn-Tucker Conditions.

Reference Books :

1. Linear Programming and Game Theory by J. G. Chakraborty and P. R. Ghosh, Moulik Library.
2. Operations Research by Kanti Swarup, P. K. Gupta and Man Mohan, S. Chand and Sons.
3. Engineering Optimization by S. S. Rao, New Age Techno-Press.
4. Operations Research by J K Sharma, Macmillan India Ltd.

SYLLABUS

Semester – III

Course Code	**MCA20-E305F**
Course Name	**Pattern Recognition**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

1. To learn the fundamental algorithms for pattern recognition.
2. To understand mathematical and statistical techniques commonly used in pattern recognition.
3. To know how to design a pattern recognition system.

Course Outcome:

After successful completion of this course, students will be able to:

1. Identify where, when and how pattern recognition can be applied.
2. Equipped with basic mathematical and statistical techniques commonly used in pattern recognition.
3. Understand a variety of pattern recognition algorithms.
4. Apply machine learning concepts in real-life problems.
5. Design and develop a pattern recognition system for the specific application.
6. Evaluate the quality of the solution of the pattern recognition system.

MODULE NUMBER	COURSE CONTENT
1	**Basics of Probability, Random Processes and Linear Algebra (4L)** Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. Inner product, outer product, inverses, eigenvalues, eigenvectors, singular values, singular vectors.
2	**Bayes Decision Theory (4L)** Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features.
3	**Parameter Estimation Methods (8L)** Maximum-Likelihood estimation - Gaussian case. Maximum a Posteriori estimation. Bayesian estimation - Gaussian case. Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. K-Nearest Neighbor method.
4	**Dimensionality Reduction and Non-Metric Methods for Pattern Classification (8L)** Principle component analysis - it relationship to eigen analysis. Fisher discriminant analysis - Generalized eigen analysis. Eigenvectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning methods. Non negative matrix factorization - a dictionary learning method. Non-numeric data or nominal data, Decision trees, Classification and Regression Trees (CART). K-Nearest Neighbor method.
5	**Linear Discriminant Functions and (2L)** Gradient descent procedures, Perceptron, Support vector machines - a brief introduction.
6	**Artificial Neural Networks (4L)** Multilayer perceptron - feedforward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks.

References Books :

1. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2/E, Wiley Interscience, 2000.
2. Christopher M. Bishop :, "Pattern Recognition And Machine Learning (Information Science and Statistics)", 1/E, Springer, January 2008.
3. T. Hastie , R. Tibshirani, J. H. Friedman:, "The Elements of Statistical Learning", 1/E, Springer, Reprint 3/E, 2003.
4. Christopher M. Bishop ; "Pattern Recognition and Machine Learning", Springer, 2006 Shigeo Abe, "Advances in Pattern Recognition", Springer, 2005.

SYLLABUS

Semester – III

Course Code	**MCA20-E305G**
Course Name	**Machine Learning**
Lecture (per week)	**3**
Tutorial (per week)	**0**
Contact Hours (per week)	**3**
Total Contact Hours	**30**
Credit	**3**

Course Objective:

To make the students able to

1. Learn the fundamental concepts of machine learning.
2. Know the various machine learning models for the performance parameters.
3. Learn supervised, unsupervised learning.
4. Learn different machine learning algorithms.

Course Outcome:

After completion of this course successfully the students will be able to:

1. Understand the concept of machine learning.
2. Identify the regression and classification problem.
3. Relate the supervised, unsupervised learning into the real-life problem.
4. Evaluate the machine learning models for the performance parameters.
5. Design and implement various machine learning algorithms in the range of real-world problems.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to Machine Learning (2L)** Introduction to Artificial Intelligence, Machine Learning, Deep Learning, Types of Machine Learning, Application of Machine Learning.
2	**Linear Algebra, Regression and Classification (6L)** Scalar, Vector, Matrix, Matrix Operation, Norms, Probability, Joint Distribution, Bayes Theorem, Expectation, Covariance. Simple Linear Regression, Multiple Linear Regression, Least square gradient descent, Linear Classification, Logistic Regression.
3	**Decision Tree and Ensemble Learning (4L)** Representing concepts like decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Overfitting, noisy data, and pruning**.** Bagging, boosting, and DECORATE. Active learning with ensembles.
4	**Artificial Neural Networks (4L)** Neurons and biological motivation. Linear threshold units. Perceptrons - representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks, Introduction to Deep Learning.
5	**Support Vector Machines and Bayesian Learning (8L)** Maximum margin linear separators. Quadratic programming solution to finding maximum margin separators. Kernels for learning non-linear functions. Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies.
6	**Clustering and Unsupervised Learning and Dimensionality Reduction (6L)** Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. k-means partitional clustering, Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabeled data. Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Feature selection, Feature manipulation and normalization

Reference Books :

1. Pattern Recognition and Machine Learning- Christopher M. Bishop, Springer.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction - Trevor Hastie, Robert Tibshirani, and Jerome Friedman, Springer.
3. Machine Learning for Absolute Beginners: A Plain English Introduction - Oliver Theobald, Scatterplot Press, First Edition.
4. Machine Learning -Tom M. Mitchell, Mc Graw Hill.

SYLLABUS

Semester – III

Course Code	**MCA20-E394A**
Course Name	**Image Processing Lab**
Lecture (per week)	**0**
Tutorial (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

1. Implement and apply operations like Convolution, Correlation, DFT and FFT on DT signals
2. Implement spatial domain Image enhancement techniques.
3. Implement Edge detection techniques using first-order derivative filters.

Course Outcome:

After completion of this course successfully the students will be able to:

1. Identify the sample and reconstruct the signal.
2. Implement and apply operations like Convolution, Correlation, DFT and FFT on DT signals.
3. Implement spatial domain Image enhancement techniques.
4. Implement Edge detection techniques using first-order derivative filters.

MODULE NUMBER	COURSE CONTENT
1	**Introduction** Sampling and Reconstruction.
2	**Discrete Correlation and Discrete Convolution** To perform Discrete Correlation. To perform Discrete Convolution.
3	**Discrete Fourier Transform** To perform Discrete Fourier Transform.
4	**Fast Fourier Transform** To perform Fast Fourier Transform.
5	**Histogram Processing** Implementation of Image negative, Gray level Slicing and Thresholding. Implementation of Contrast Stretching, Dynamic range compression & Bit plane Slicing. Implementation of Histogram Processing.
6	**Implementation of Image operations** Implementation of Image smoothing/ Image sharpening. Implementation of Edge detection using Sobel and Previtt masks.

Reference Books :

1. Digital Image Processing, Rafael C. Gonzalez& Richard E. Woods, Pearson.
2. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education-2003.
3. Digital Image Processing, Jahne, Springer India.
4. Digital Image Processing & Analysis, Chanda & Majumder, PHI.
5. Fundamentals of Digital Image Processing, Jain, PHI.

SYLLABUS

Semester – III

Course Code	**MCA20-E394B**
Course Name	**Web Enabled JAVA Programming Lab**
Lecture (per week)	**0**
Tutorial (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

1. Do hands-on Java programming language.
2. Create Java programs that leverage the object-oriented features of the Java language, such as
   encapsulation
   inheritance
   polymorphism
3. Use of data types, arrays and other data collections
4. Implement I/O functionality to read from and write to text files

Course Outcome:

After completion of this course successfully the students will be able to:

1. Create dynamic Website/ Web based Applications.
2. Create Java programs that leverage the object-oriented features of the Java language.
3. Implementation of I/O functionality.

MODULE NUMBER	COURSE CONTENT
1	**Introduction** HTML to Servlet Applications, Applet to Servlet Communication.
2	**Uses of JSP** Designing online applications with JSP, Creating JSP program using JavaBeans.
3	**Enterprise JavaBeans** Working with Enterprise JavaBeans.
4	**Java Database Connectivity** Performing Java Database Connectivity.
5	**Building web applications** Creating and Sending Email with Java, Building web applications.

Reference Books :

1. Programming with Java: A Primer, 5th Edition, E Balagurusamy, TMH.
2. Object Oriented Programming with JAVA: Wu, TMH.
3. Core Java, Volume I & II: Cays Horstmann, Gary Cornell, Pearson Publication, 7th Edition. Complete Reference for JAVA: Herbert Schildt. 7th Edition.

SYLLABUS

Semester – III

Course Code	**MCA20-E394C**
Course Name	**Cloud Computing Lab**
Lecture (per week)	**0**
Tutorial (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

1. To develop web applications in the cloud.
2. To learn the design and development process involved in creating a cloud-based application.
3. To learn to implement and use parallel programming using Hadoop.

Course Outcome:

After completion of this course successfully the students will be able to:

1. Configure various virtualization tools such as Virtual Box, VMware workstation.
2. Design and deploy a web application in a PaaS environment.
3. Learn how to simulate a cloud environment to implement new schedulers.
4. Install and use a generic cloud environment that can be used as a private cloud.
5. Manipulate large data sets in a parallel environment.

MODULE NUMBER	COURSE CONTENT
1	**Introduction** Install Virtual box/VMware Workstation with different flavors of Linux or Windows OS on top of Windows7 or 8. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs.
2	**Installation of Google App Engine** Install Google App Engine. Create hello world app and other simple web applications using python/java.
3	**Launching of the web applications** Use GAE launcher to launch the web applications.
4	**Simulation using CloudSim** Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
5	**Transferring Files** Find a procedure to transfer the files from one virtual machine to another virtual machine, Find a procedure to launch virtual machine using trystack (Online Openstack Demo Version). Install Hadoop single node cluster and run simple applications like word count.

Reference Books :

1. Cloud Computing, by Rajib Chopra, 1st Edition, New Age International Publishers.
2. Cloud Computing: A Hands-on Approach, Arshdeep Bahga & Vijay Madisetti, Universities Press.
3. Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS & IaaS), Michael J. Kavis, Wiley.
4. Cloud Computing, M N Rao, Prentice Hall India.

SYLLABUS

Semester – III

Course Code	**MCA20-E394D**
Course Name	**Web Technology Lab**
Lecture (per week)	**0**
Tutorial (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

To make students able to

1. Know how HTML forms are submitted with PHP Server
2. Know HTML forms are submitted with PHP Server
3. Know strategy to connect with MYSQL Server

Course Outcome:

After completion of this course successfully the students will be able to:

1. Understand the underlying assumption of defining variables, constants, operators, expressions, HTML Form creation and submissions. POST & GET Method & Implementation of Decision, Loops, Functions, Array and Exception Handling concepts.
2. How HTML forms are submitted with PHP Server.
3. Strategy to connect with MYSQL Server.
4. Ability to check validation using JavaScript & JQuery.
5. Connecting Forms using AJAX Concept

MODULE NUMBER	COURSE CONTENT
1	**Introduction** Introduction to Web Technology & implementation of PHP Programs &Knowing about Connection Strings and Functions. Implementing basic PHP programs with Form, Loop, Functions Array and Strings.
2	**Handling Html Form With PHP** Capturing Form. Data Dealing with Multi-value files. Generating File uploaded form. Redirecting a form after submission.
3	**Database Connectivity with MySql** Programs implementing displaying data from MYSQL to HTML forms using PHP. Programs implementing updating data from MYSQL to HTML forms using PHP. Programs implementing deleting data from MYSQL to HTML forms using PHP.
4	**Java Script & JQuery** Validating forms using JAVASCRIPT.
5	**Connecting Forms using AJAX Concept** Fetching data from one form to another form using AZAX.

Reference Books :

1. The Joy of PHP Programming: A Beginner's Guide to Programming Interactive Web Applications with PHP and MySQL. Alan Forbes, Fifth Edition, Plum Island.
2. Beginning Web Programming, Jon Duckett, WROX, Second Edition.
3. Open Source for the Enterprise: Managing Risks, Reaping Rewards, Dan Woods and Gautam Guliani, O'Reilly, Shroff Publishers and Distributors, 2005.

SYLLABUS	
Semester – III	
Course Code	**MCA20-E394E**
Course Name	**Android Application Development Lab**
Lecture (per week)	**0**
Tutorial (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

To make students able to

1. Learn to use Android Application development platform
2. Develop the various simple android application
3. To understand and implement various designing components of Android user interfaces

Course Outcome:

After completion of this course successfully the students will be able to:

1. Learn to use the Android Application development platform.
2. Create a simple android application
3. Understand and implement various designing components of Android user interfaces
4. Design the application's main navigation screen
5. Understand and designing Android Notification (including push notifications)
6. Develop the android application to the database for data insertion and retrieval.

MODULE NUMBER	COURSE CONTENT
1	**Writing First Application** Creating Android Project, Android Virtual Device Creation, Set up debugging environment, Workspace set up for development, Launching emulator, debugging on mobile devices.
2	**Basic and Advanced UI design** Basics about Views, Layouts, Resources, Input controls, Input Events, Toasts**.** Layouts design GridView and ListView, Action bar, Adapters, Menus: Option-menu, context menu, sub-menu, Pickers - Date and Time, Spinners.
3	**Activity and Fragment and Intents** Activity, Fragment, Activity Lifecycle and Fragment Lifecycle. Implicit Intents, Explicit intents, communicating data among Activities.
4	**Navigation Drawer** Panel that displays the app's main navigation screens on the left edge of the screen
5	**Android Notifications** Toast, Dialogs (TimePicker, DatePicker, Progress, Alert), Notification Manager and Push Notification
6	**Introducing SQLite** SQLite Open Helper and creating a database - Opening and closing a database, Working with cursors Inserts, updates, and deletes

Reference Books :

1. Beginning Android Application Development, Wei Meng Lee, (2012) Wrox Publications (John Wiley, New York)
2. Hello Android: Introducing Google's Mobile Development Platform, Ed Burnette (2010), The Pragmatic Publishers, 3rd edition, North Carolina, USA.
3. Professional Android 4 Application Development, Reto Meier (2012), Wrox Publications (John Wiley, New York).
4. Programming Android: Java Programming for the New Generation of Mobile Devices, Zigurd Mednieks, Laird Dornin, Blake Meike G, Masumi Nakamura (2011), O'Reilly Media, USA.

SYLLABUS	
Semester – III	
Course Code	**MCA20-E394F**
Course Name	**Basic Data Science Lab**
Lecture (per week)	**0**
Tutorial (per week)	**0**
Contact Hours (per week)	**4**
Total Contact Hours	**40**
Credit	**2**

Course Objective:

1. Learn the fundamental concepts of data science.
2. Know the various domain and vertices of data science.
3. Learn the usage and application of data science.

Course Outcome:

After completion of this course successfully the students will be able to:

1. Learn the key difference between various areas of data science.
2. Understand the fundamental concepts of tools and techniques available in data science.
3. Build the fundamental algorithms available in Artificial Intelligence.
4. Implement the key algorithms available in data mining and machine learning.

MODULE NUMBER	COURSE CONTENT
1	**Introduction to Python** Introduction to Python Libraries - Numpy, Pandas, Matplotlib, Scikit. Perform Data exploration and preprocessing in Python
2	**Implementation of Regression** Implement regularized Linear regression, Implement Naive Bayes classifier for dataset stored as CSV file, Implement regularized logistic regression.
3	**Building models using different techniques** Build models using different Assembling techniques, Build models using Decision trees.
4	**Building model using SVM** Build model using SVM with different kernels, Implement K-NN algorithm to classify a dataset.
5	**Building model to perform Clustering** Build model to perform Clustering using K-means after applying PCA and determining the value of K using Elbow method.

Reference Books :

1. Rachel Schutt, Cathy O'Neil, "Doing Data Science: Straight Talk from the Frontline" by Schroff/ O'Reilly, 2013.
2. S. Russell and P. Norvig, Artificial Intelligence A Modern Approach, 2nd Edition. Pearson Education, 2007.
3. John W. Foreman, "Data Smart: Using data Science to Transform Information into Insight" by John Wiley & Sons, 2013.
4. Ian Ayres, "Super Crunchers: Why Thinking-by-Numbers Is the New Way to Be Smart" Ist Edition by Bantam, 2007.
5. Eric Seigel, "Predictive Analytics: The Power to Predict who Will Click, Buy, Lie, or Die", 1st Edition, by Wiley, 2013.

SYLLABUS

Semester – III

Course Code	**MCA20-381**
Course Name	**Minor Project and Viva-voce**
Lecture (per week)	**0**
Tutorial (per week)	**0**
Contact Hours (per week)	**8**
Total Contact Hours	**80**
Credit	**5**

Course Objective:

To make students able to

1. To give the students Hands-on experience of system development life cycle.
2. To make the students apply in real life the technologies during the course.
3. To expose the students to real-life project development environments involving deadlines and teamwork.
4. To make the students learn new upcoming technologies not covered during the course while applying in projects.

Course Outcome:

After completion of this course successfully the students will be able to:

1. Use technologies in the hands-on experience in the system development life cycle.
2. Apply the technologies during the course in real-life projects.
3. Implement work in real-life project development environments involving deadlines and teamwork.
4. Apply upcoming technologies in project development not covered during the course.

Guidelines:

1. Students may be offered software/hardware development or research-oriented projects.
2. Faculty members may offer project proposals from their side and students may choose from them.
3. Students may also submit project proposals not covered in the faculty provided list, which may be guided by the interested faculty members.
4. Same project ideas may be submitted by more than one student group but maybe unique at the implementation level.
5. Students may be encouraged to take up more innovative projects involving contemporary technologies, leading to the research paper and/or patent publications.