DEPARTMENT OF COMPUTER APPLICATIONS, MIT Manipal
M.C.A (MASTER OF COMPUTER APPLICATIONS)
Course Structure (Applicable to 2023 admission onwards)

Year	First Semester						Second Semester					
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
I	MAT 4111	Computational Mathematics	4	0	0	4	MCA 4221	Object Oriented Programming - II	3	1	0	4
	MCA 4121	Object Oriented Programming - I	3	1	0	4	MCA 4222	Data Structures and Algorithms	3	1	0	4
	MCA 4122	Database Management System	3	1	0	4	MCA 4223	Operating Systems	4	0	0	4
	MCA 4123	Web Technologies	3	1	0	4	MCA 4224	Data Analytics	4	0	0	4
	HUM 5051	Research Methodology and Technical Communication	1	0	3	-	HUM 5051	Research Methodology and Technical Communication	-	-	-	2
							MCA ****	Program Elective I	3	0	0	3
	MCA 4141	Database Management System Lab	0	0	3	1	MCA 4241	Object Oriented Programming Lab - II	0	0	3	1
	MCA 4142	Object Oriented Programming Lab - I	0	0	3	1	MCA 4242	Data Structures and Algorithms Lab	0	0	3	2
	MCA 4143	Web Technologies Lab	0	0	3	1	MCA 4243	Linux Programming Lab	0	0	3	1
		Total	**14**	**3**	**12**	**19**			**17**	**2**	**9**	**25**
II	Third and Fourth Semesters											
	Sub Code	Subject Name	L	T	P	C	Sub Code	Subject Name	L	T	P	C
	MCA 5121	Machine Learning	4	0	0	4	MCA 5291	**Project Work**	**0**	**0**	**0**	**12**
	MCA 5122	Computer Networks	4	0	0	4						
	MCA ****	Program Elective II	3	0	0	3						
	MCA ****	Program Elective III	3	0	0	3						
	MCA 5123	Software Engineering	4	0	0	4						
	MCA 5141	Machine Learning Lab	0	0	3	2						
	MCA 5142	Mobile Application Development Lab	0	1	3	2						
	MCA 5143	Network Lab	0	1	3	2						
		Total	**18**	**2**	**9**	**24**		**Total**	**0**	**0**	**0**	**12**
								Total Credits				**80**

*TAUGHT IN BOTH SEMESTERS AND EVALUATED AND CREDITED IN THE SECOND SEMESTER

Program Electives				
	Program Electives - I			Program Electives - II & III
Code	Subject Name	Code		Subject Name
MCA 4051	Computational Intelligence	MCA 5051		Big Data Analytics
MCA 4052	Computer Organization and Architecture	MCA 5052		Cloud Computing
MCA 4053	Internet of Things	MCA 5053		Cyber Forensics
MCA 4054	Management Information Systems	MCA 5054		Design and Analysis of Algorithms
MCA 4055	NoSQL Database Systems	MCA 5055		Game Programming
MCA 4056	Object Oriented Analysis and Design	MCA 5056		Human Resource Management
		MCA 5057		Information and Network Security
		MCA 5058		Information Storage and Management
		MCA 5059		Optimization Techniques
		MCA 5060		Pattern Recognition Techniques and Applications
		MCA 5061		Semantic Web
		MCA 5062		Service Oriented Architecture
		MCA 5063		Software Project Management
		HUM 5050		Ethical Hacking

FIRST SEMESTER

MAT 4111   COMPUTATIONAL MATHEMATICS   [4 0 0 4]

Mathematical Logic: Statement (Proposition), Logical Connectives, Conditional, Bi-conditional, Converse, Inverse, Contra positive, Exclusive OR, NAND, NOR, Tautology, Contradiction, Satisfiable, Duality Law, Algebra of propositions, Applications. Set Theory: Sets, Types of sets, Cardinality of a set, Subset and superset, Comparability of sets, Power set, Operations on sets, disjoint sets, application of set theory, Group theory: Groups, Subgroups, Cyclic groups, Symmetric groups, Addition and multiplication modulo n over $\mathbb{Z}$ with examples, Graph theory: Graphs, Computer Representations of Graphs, Isomorphic Graphs, Paths, Cycles and Circuits, Eulerian and Hamiltonian Graphs, Planar Graphs, Digraphs, Directed acyclic graphs, Weighted Diagraphs, Trees, Spanning trees, Minimal Spanning Trees, Rooted Trees, Binary Trees, Binary Search Trees, Combinatorics and Probability: The Fundamental Counting Principles, Permutations, Combinations, Permutations and Combinations with Repetitions, Conditional probability, Independent events, Bayes' theorem, One-dimensional random variable, Cdf, Mean, Variance, Problems.

REFERENCES
1. Thomas Koshy, *Discrete Mathematics with Applications*, Academic Press, Reprint 2005.
2. C. L. Liu, *Elements of Discrete Mathematics*, Mc Graw Hill, 1986.
3. J.P. Trembaly and R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*, Mc Graw Hill, 1987.
4. P.L. Meyer, *Introduction to Probability and Statistical Applications*, Second Edition, Oxford and IBH Publishing, Delhi, 1980.
5. D.P. Acharjya, Sreekumar, *Fundamental Approach to Discrete Mathematics*, New Age International (P) Limited, 2005.
6. Kenneth H Rosen, *Discrete Mathematics & its Applications with Combinatorics and Graph Theory*, 6th Edition, McGraw Hill, 2007.
7. Martin Aigne, *Discrete Mathematics*, American Mathematical Society, USA, 2007.

MCA 4121   OBJECT ORIENTED PROGRAMMING - I   [3 1 0 4]

Introduction: Object Oriented paradigm, Procedural vs. Object Oriented Paradigm. Programming Basics: Type conversion, Loops and Decision, Structures, Enumerated Data Types. Simple functions, passing arguments to functions, Returning values from the functions, Reference arguments, Overloaded functions, Inline functions, Default arguments, variables and storage classes, Returning by reference. Elements of Object-Oriented Programming: Object, Classes, Encapsulation & data abstraction, Array fundamentals, Arrays as class member data, Arrays of objects, Inheritance, Polymorphism. String handling, Addresses and pointers, Pointers and arrays, Pointers and functions, Pointers and strings, function pointer, void pointer, Memory management using new and delete, Pointers to objects, Pointers to pointers. Operator Overloading, Data conversion, Virtual Functions & run-time Polymorphism in Inheritance, Friend functions, Static functions, this pointer. Files and Streams: Streams, String I/O,

Character I/O, Object I/O, File pointers. Generic programming: Templates, Exception Handling , STL: An overview, containers, vectors, lists, iterators, maps, algorithms.

SDL: STL: An overview, containers, vectors, lists, iterators, maps, algorithms

References:

1. Herbert Schildt, *The Complete Reference C++*, 4th Edition, Tata McGraw Hill, 2017.
2. Robert Lafore, *Object Oriented Programming in C++*, 4th Edition, Pearson Education, 2008.
3. Bjarne Stroustrup, *A Tour of C++*, 2nd Edition, Pearson Education, 2018.
4. Bjarne Stroustrup, *The C++ Programming Language*, 3rd Edition, Pearson, 2002.

MCA 4122   DATABASE MANAGEMENT SYSTEM   [3 1 0 4]

Database System Applications, Advantages, View of data, Database languages, Design, Data storage and Querying, Architecture, SQL, Basic structure of SQL queries, Basic operations, Set operations, Nested subqueries, Intermediate SQL, Join, Views, Integrity Constraints, Data types and schemas, Advanced SQL, PL/SQL, Cursors, Stored Programs, Triggers, Entity-Relationship Model, Basic Concepts, Design of ER database schema, Reduction of ER to schema, Relational model structure, Keys, Schema Diagram, Relational Database design, Functional dependencies, Normal forms, Closure, Canonical cover, Lossless joins , dependency preserving decomposition, File structure, File organization, Organization of records in files, indices, Query Processing, Overview, Measure of query cost, Join operation, Evaluation of expressions, Query Optimization, Estimating statistics of expression results, Transactions, Concepts, Simple transaction model, Schedules-serial, concurrent, serializability. Concurrency Control, Lock based protocols, Deadlock handling, Unstructured database

SDL: Unstructured database

References:
1. Abraham Silberschatz, Henry Korth, S. Sudarshan *"Database System Concepts "*, 7th Edition, McGraw Hill, 2019.
2. Ramez Elmasri, Shamkant Navathe *"Fundamentals of Database System"*, 6th Edition, Addison Wesley Publications Co., 2010
3. Raghu Ramakrishnan, Johannes Gehrke, *"Database Management System"*, 3rd Edition, WCB/McGraw Hill Publisher, 2007
4. Shashank Tiwari*," Professional NOSQL"*, Wiley, 2015.
5. Ivan Bayross, *"SQL, PL/SQL-The Programming Language of ORACLE"*, 4th Edition, BPB Publications, 2010.
6. Benjamin Rosenzweig, Elen Silvestrova, *"Oracle Pl/Sql By Example"*,4th Edition, Addion-Wesley,2009.

MCA 4123   **WEB TECHNOLOGIES**   **[3 1 0 4]**

Introduction to HTML, Structure of HTML Document, Semantics of HTML Elements and Attributes, HTML Tables and Forms, Introduction to CSS, Types of Styles, Selectors, Style Cascade, The Box Model, Text Styling, Background Styling, Table Styling, Box Styling, Normal Flow of Elements, Positioning and Layering Elements, Floating Elements, Approaches to CSS Layout, Responsive Design, Introduction to Client-Side Programming with Javascript, Basics of Programming, Data Types and Objects, Javascript Events, Form Validation, Introduction to Server-Side Programming with PHP, What is Server-Side Development, PHP Controls, PHP Functions, PHP Arrays, Superglobal Arrays, File Uploading, Server-Side Validation, PHP Error and Exception Handling, State Management using Cookies and Sessions, JSON, Database Operations with PHP, Introduction to AJAX, Angular: Fundamental Architecture, Set-Up and Deployment, Components, Templates, Binding, Forms and Web API.

SDL: Frameworks on Web development projects

References:
1. Randy Connolly, Ricardo Hoar, *Fundamentals of Web Development*, 1st Edition, Pearson Education India, 2015.
2. Luke Welling, Laura Thomson, *PHP and MySQL Web Development*, 5th Edition, Pearson Education, 2016.
3. Nicholas C Zakas, *Professional JavaScript for Web Developers*, 3rd Edition, Wrox/Wiley India, 2012.
4. John Kocer, *"Angular 7: By Example (Part One Book 1)"*, 2019.
5. Nate Murray, Felipe Coury, Ari Lerner, Carlos Taborda, *ng-book- The Complete Book on Angular*, 2019.

HUM 5051   **RESEARCH METHODOLOGY & TECHNICAL COMMUNICATION**

[1 0 3 2]

Research Methodology: Basic concepts: Types of research, Significance of research, Research framework. Sources of data, Methods of data collection. Research formulation: Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Research hypothesis: Criterion for hypothesis construction, Nature of hypothesis, Characteristics and Types of hypothesis, Elements of research design, Introduction to various sampling methods Sources of data, Collection of data, Research reports, references styles, Effective Presentation techniques, Research Ethics.

References:
1. Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. John Wiley & Sons.

2. Zikmund, W. G., Babin, B. J., Carr, J. C., & Griffin, M. (2013). *Business research methods*. Cengage Learning.
3. Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.
4. Donald R Cooper & Pamela S Schindler, *Business Research Methods*, McGraw Hill International, 2018.

MCA 4141   DATABASE MANAGEMENT SYSTEM LAB   [0 0 3 1]

Exercises related to implementation/realization of database concepts such as SQL, Queries, Join, Views, Advanced SQL, PL/SQL, Cursors, Functions and Procedures, Triggers

References:

1. Ivan Bayross, SQL, PL/SQL-*The Programming Language of ORACLE*, 4th Edition, BPB Publications, 2010.
2. Satish Asnani, *Oracle Database 11g*, PHI, 2010.
3. Scott Ullman, Ron Hardman and Michael Mclaughlin, *Oracle Database 10g PL/SQL Programming*, Oracle Press, McGraw-Hill Education.

MCA 4142   OBJECT ORIENTED PROGRAMMING LAB - I [0 0 3 1]

Apply algorithms/ flow charts to develop programs using C++ programs on decision making, looping and switch conditions. Write programs to implement concept of structures, classes and objects, construction and destruction of objects, compile-time polymorphism with function and operator overloading. Develop programs for array of objects, manipulation using pointers, dynamic memory allocation. Write and execute C++ programs to implement different types of inheritance, dynamic binding, virtual functions, file I/O and exception handling.

References:

1. Herbert Schildt, *The Complete Reference C++*, 4th Edition, Tata McGraw Hill, 2017.
2. Robert Lafore, *Object Oriented Programming in C++*, 4th Edition, Pearson Education, 2008.
3. Bjarne Stroustrup, *A Tour of C++*, 2nd Edition, Pearson Education, 2018.
4. Bjarne Stroustrup, *The C++ Programming Language*, 3rd Edition, Pearson, 2002.

MCA 4143   WEB TECHNOLOGIES LAB   [0 0 3 1]

The students are required to implement and realize web page development. The static web page development using HTML elements including text, images, links and tables. The web forms are modeled and designed using necessary form-based elements. Responsive web layouts are

implemented using media elements and advanced CSS. Dynamic HTML concepts are realized through DOM implementation using client-side JavaScript. The data-driven server-side applications are implemented on server-side environment using PHP and Angular JS.

References:
1. Randy Connolly, Ricardo Hoar, *Fundamentals of Web Development*, 1st Edition, Pearson Education India, 2015.
2. Luke Welling, Laura Thomson, *PHP and MySQL Web Development*, 5th Edition, Pearson Education, 2016.
3. Nicholas C Zakas, *Professional JavaScript for Web Developers*, 3rd Edition, Wrox/Wiley India, 2012. 4. John Kocer, "Angular 7: By Example (Part One Book 1)", 2019.
4. Nate Murray, Felipe Coury, Ari Lerner, *Carlos Taborda, ng-book-* The Complete Book on Angular, 2019.

SECOND SEMESTER

MCA 4221   OBJECT ORIENTED PROGRAMMING - II   [3 1 0 4]

Java Development Kit (JDK), Java Run Time Environment (JRE), Java Virtual Machine (JVM), Bytecode. Java datatypes, keywords, operators, Type conversion, Arrays, Ragged arrays. The Scanner class, The String Class, Classes & Objects, Access specifiers, Constructors, Inner classes, Static fields and methods, Inheritance, Dynamic method dispatch, Abstract class, The Object class, Wrapper classes, Autoboxing and Unboxing. Enumeration, Annotation. Packages, creating and importing packages, Interfaces, partial implementations, Object cloning, Cloneable interface. Exception handling, Exception types, User-defined exceptions. Multithreaded programming, The Java thread model, The Thread class and runnable interface, creating multiple threads, Synchronization, Inter-thread communication. Garbage collection. Streams and Files. The stream classes, The Byte Streams, The Character streams. Event handling, event sources, event listeners, event classes. The Collection classes, lambda expressions, generic programming, defining a generic class, creating a generic method, Database programming - JDBC packages.

SDL: Swings: creating GUI applications, Components, containers, Event handling, event sources, event listeners, event classes. Database programming - JDBC packages.

References:

1. Herbert Schildt, *Java The Complete Reference*, 12th Edition, McGraw Hill, 2021.
2. Cay S. Horstmann. *Core Java: Volume I - Fundamentals*. 11th Edition, Pearson Education, 2018.
3. Cay S.Horstmann, *Core Java: Volume II – Advanced Features*, 11th Edition, Pearson Education, 2019.
4. Herbert Schildt and Dale Skrien, *Java Fundamentals*, Tata McGraw-Hill Education, 2015.

MCA 4222   DATA STRUCTURES AND ALGORITHMS   [3 1 0 4]

Basic Concepts: Pseudocode, The Abstract Data Type, Model for an Abstract Data Type, ADT Implementation, Algorithm Efficiency, Time and Space Complexities, Asymptotic Notations. Recursion: Factorial – A Case Study, Designing Recursive Algorithms, Recursive Examples. Stacks: Basic Stack Operations, Stack ADT, Stack Applications. Queues: Queue Operations, Queue ADT, Queue Applications. General Linear Lists: Basic Operations, List ADT, Singly-Linked List, Doubly Linked List, Circular Linked List. Introduction to Trees: Basic Concepts, Binary Trees. Binary Search Trees: Basic Concepts, BST Operations, BST Applications, AVL

Search Trees: Basic Concepts, Balance Factor, Applications. Heaps: Basic Concepts, Heap Implementation, Heap Applications. Multiway Trees: M-way Search Trees, B-Trees, Simplified B-Trees, B-Tree Variations, Lexical Search Trees. Graphs: Basic Concepts, Operations, Graph Storage Structure, Graph ADT, Graph Algorithms – BFS and DFS. Sorting: Sort Concepts, Selection Sorts, Insertion Sorts, Exchange Sorts, External Sorts. Searching: List Searches, Hashed List Searches, Collision Resolution.

SDL: Searching and Sorting , Shortest Path Algorithms , Dijkstra's Algorithm, Bellman Ford Algorithm

References:

1. Richard F. Gilberg and Behrouz A. Forouzan, *Data Structures – A Pseudocode Approach with C*, Second Edition, Cenage Learning, 2009.
2. S. Sridhar, *Design and Analysis of Algorithms*, Oxford University Press, 2015.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, *"Fundamentals of Algorithms*, 2nd Edition, Universities Press, 2010.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *"Introduction to Algorithms*, 3rd Edition, PHI Publications, 2009.

MCA 4223   OPERATING SYSTEMS   [4 0 0 4]

Introduction: Simple, multi-programmed batch systems, distributed systems, time-sharing & real time systems, hardware protection; CPU Scheduling: Process concept, process state transitions, process control block, operations on processes, inter-process communication, scheduling algorithms, multilevel feedback queues; Concurrent Process: Mutual exclusion, Precedence graphs, critical section, Dekker's algorithm, hardware solution to mutual exclusion, semaphores, process synchronization with semaphores; Deadlocks: Deadlock characterization, resource allocation graph, deadlock prevention, avoidance, detection, Bankers algorithm and recovery from deadlock; Memory management: Address binding, dynamic loading, dynamic linking, Overlays, swapping, contiguous allocation, paging, segmentation, segmentation with paging; Virtual Memory: Demand paging, page replacement algorithms, thrashing; File Systems: Free space management, allocation methods, Directory structure, Disk scheduling methods.

SDL: File Systems: Free space management, allocation methods, Directory structure, Disk scheduling methods.

References:

1. A Silberschartz, Peter B. Galvin and Greg Gagne, *"Operating Systems Concepts",* 10th Edition, John Wiley & Sons, 2018.
2. Andrew S. Tanenbaum and Herbert Bos, *"Modern Operating Systems",* 4th Edition, Pearson, 2015.

3. H. M. Deitel, *An Introduction to Operating Systems*, 3rd Edition, Addison Wesley, 2004.
4. Milan Milankovic, *Operating Systems Concepts and Design*, 7th Edition, Tata McGraw Hill, 2004

MCA 4224   DATA ANALYTICS   [4 0 0 4]

Introduction: Data science, Need for analytics, Sources of Data, Process for making sense of data, Describing Data- Observations and variables, Types of variables, Central Tendency, Distribution of data, Preparing Data Tables, Understanding Relationships: Visualizing relationships, Calculating Metrics, Identifying and Understanding Groups: Clustering, Association Rules, Learning decision trees from data, Building models from data: Linear, Logistic Regression, K-Nearest Neighbours, Classification and Regression Trees, Other Approaches, Ensemble methods, Anomaly Detection, Forecasting models, Applications in Data Analytics: Case studies.

SDL: Applications in Data Analytics: Case studies

References:
1. Glenn J. Myatt, Wayne P. Johnson, *Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining*, 2nd Edition, John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, *Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications*, John Wiley & Sons Publication, 2009.
3. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, *Data Mining for Business Intelligence,* John Wiley and Sons, 2014.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, *Data Mining: Practical Machine Learning Tools and Techniques*, Morgan Kaufmann, 2011.
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, *Introduction to Data Mining*, Pearson Addison Wesley, 2005.

MCA 4241   OBJECT ORIENTED PROGRAMMING LAB - II [0 0 3 1]

Exercises related to implementation/realization of concepts that include: basic Java Programming, Arrays, Strings, Inheritance, Exception handling, Packages, Multithreaded programming, Collections, File handling and JDBC.

References:
1. Herbert Schildt, *Java The Complete Reference*, 12th Edition, McGraw Hill, 2021.

2. Cay S. Horstmann. *Core Java: Volume I - Fundamentals*. 11th Edition, Pearson Education, 2018.
3. Cay S.Horstmann, *Core Java: Volume II – Advanced Features*, 11th Edition, Pearson Education, 2019.
4. Herbert Schildt and Dale Skrien, *Java Fundamentals*, Tata McGraw-Hill Education, 2015.

MCA 4242   DATA STRUCTURES AND ALGORITHMS LAB [0 0 3 1]

Exercises related to implementation/realization of concepts discussed in the theory class. The concepts included are Searching and Sorting algorithms, Stacks and Queues, Conversion of mathematical expressions, Evaluation of mathematical expressions, Singly- and doubly-linked lists, Trees, Graph algorithms.

References:

1. Richard F. Gilberg and Behrouz A. Forouzan, *Data Structures – A Pseudocode Approach with C*, Second Edition, Cenage Learning, 2009.
2. S. Sridhar, *Design and Analysis of Algorithms*, Oxford University Press, 2015.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, *"Fundamentals of Algorithms*, 2nd Edition, Universities Press, 2010.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *"Introduction to Algorithms*, 3rd Edition, PHI Publications, 2009.

MCA 4243   LINUX PROGRAMMING LAB   [0 0 3 1]

Exercises related to implementation/realization of concepts discussed in the theory class. Also an addition Basic Linux Commands, the vi Editor and Simple Shell Programs, file-related commands and Shell Programs, Additional Linux Commands and Shell Programs, Processes, Process Scheduling, Process Synchronization and Deadlocks, Page replacement, File Handling, Disk Scheduling.

References:
1. Richard Blum and Christine Bresnahan, *Linux Command Line Shell Scripting Bible*, 3rd Edition, Wiley, 2015.
2. Mark Sobel. *A Practical Guide to Linux commands Editor and shell programming*, Prentice Hall, 2nd Edition, 2010.
3. A Silberschartz, Peter B. Galvin and Greg Gagne, *Operating Systems Concepts*, 8th Edition, John Wiley & Sons, 2012.

THIRD SEMESTER

MCA 5121   **MACHINE LEARNING**   **[4 0 0 4]**

Types of Learning - Supervised, Unsupervised, Semi-Supervised, Reinforcement, & Deep Learning; Parametric and Non-Parametric Regression and Classification Models; Cross-Validation, Modeling Data, Univariate and Multivariate Models, Bayesian Learning, Bias and Variance, Regularizers, Data Distributions: Guassian, Bernoulli and Poisson Distributions; Preprocessing Techniques, Dimensionality Reduction Techniques, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA); Types of Regression - Univariate and Multivariate Linear Regression, Logistic Regression, Gradient Descent; Analysis via Linear Models, Parameter Estimation, Model Selection and Prediction, Cross-Validation and Predictive Residual Sum of Squares, Nonlinear Regression Models, Generalized Linear Models: ML and MAP estimation, Bayesian inference; Regression Vs Classification; Classification based Model Selection and Accuracy Metrics; Distance Measures: Cosine Similarity, Jaccard; Classification Methods: K-Nearest Neighbors, Naive Bayes', Decision Trees, Support Vector Machines, Kernel Functions; Basics of Neural Networks: Artificial Neurons; Applications of ANN; Single and Multi Layer Feed forward and Feedback Neural Networks; Clustering: K-Means Clustering, Hierarchical Clustering - Agglomerative and Divisive Clustering.

SDL: Parametric and Non-Parametric Regression and Classification Models, Generalized Linear Models, Kernel Functions, Guassian, Bernoulli and Poisson Distributions.

References:

1. Ethem Alpaydin, *Introduction to Machine Learning*, 3rd Edition, PHI Learning Private Limited, 2018.
2. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.
3. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, *Foundations of Machine Learning*, MIT Press, 2012.
4. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2007.
5. Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman *, Data Science and Machine Learning - Mathematical and Statistical Methods*; 25th November 2020.

MCA 5122   COMPUTER NETWORKS   [4 0 0 4]

Introduction to Computer Networks: Definition, Network Layer, Network Layer services, Interfacing - Bridges, IP addressing, Subnetting, IPv6 addressing, Delivery Forwarding, and Routing of IP Packets, Internet Protocol - Datagram, Fragmentation, Options, Checksum, Introduction to Routing Protocols, Interior and Exterior routing, Dynamic IP Routing Protocols - RIP, OSPF, Routing between peers – BGP, ARP, Internet Control Message Protocol, User Datagram Protocol, Transmission Control Protocol and Introduction to application layer, Domain Name System (DNS), and DHCP

SDL: Introduction to application layer, Domain Name System (DNS), and DHCP.

References:
1. Forouzan B. A., *TCP/IP Protocol Suite (4e),* Tata McGraw Hill 2017.
2. Tanenbaum A. S., *Computer Network (5e),* Prentice Hall of India Pvt Ltd 2013.
3. Forouzan B. A., *Data Communications and Networking (6e),* Tata McGraw Hill 2022.
4. Garcia L., Widjala, *Communication Networks (2e),* Tata McGraw Hill 2004.

MCA 5123   SOFTWARE ENGINEERING   [4 0 0 4]

Software Product, Process models and SRS: Various Process models, Development approaches and team structures, Requirements Functional and non-Functional, Software Document, Requirement Engineering Process, Feasibility Studies, Software Prototyping, Functional models, Structured Analysis, Design Concepts and Principles: Coupling, Cohesion, Span of control, Systems Engineering, Analysis Concepts, Design Process And Concepts, Modular Design, Monitoring And Control System, Cyclomatic complexity and good coding practices, Testing: Taxonomy Of Software Testing, Types Of S/W Test, Software Implementation Techniques,Software Validation, Static and Dynamic Analysis, Symbolic Equation, Mutation Analysis, Dynamic Testing, Unit Testing, White-box and Black-box Testing, Test Case Generation, Integration Testing, Bottom-up and Top-down Testing, System Testing, Function Testing, Performance Testing, Acceptance Testing, Installation Testing, Regression testing, Theoretical Foundation of Testing, Project scheduling and tracking techniques like WBS or Gnatt charts, Regression Testing and shadow paging, UML case designs using Canva/Figma, Writing code based on test data driven development(TDD).

SDL: Online automated test tools familiarization, Selenium and Postman, online test automation tools, Sample case studies to test code using system and integration testing an Agile approach

References:
1. Ian Sommerville, *"Software engineering",* 9th Edition, Pearson Education Asia, 2011.
2. Roger S. Pressman, *"Software Engineering – A practitioner's Approach",* 8th Edition, McGraw-Hill International Edition, 2014.

3. Richard Fairley, *"Software Engineering Concepts*", 9th Edition, McGraw-Hill Inc NewYork, 2017 Amazon first edition.
4. Pankaj Jalote, *"Software Project Management in Practice",* 7th Edition, Addison, Wesley, 2014.
5. Waman S Jawadekar*,"Software Enginnering Principles and Practice",* 3rd Edition, Tata McGraw- Hill,2010

MCA 5141   MACHINE LEARNING LAB   [0 1 3 2]

Exercises related to implementation/realization of concepts discussed in the theory class. The concepts included are Probability-based problems, Dimensionality reduction, Supervised Learning, Regression, Ensemble methods – classifiers and clusters and Unsupervised Learning.

References:
1. Ethem Alpaydin, *Introduction to Machine Learning*, 3rd Edition, PHI Learning Private Limited, 2018.
2. Kevin P. Murphy, Machine *Learning: A Probabilistic Perspective*, MIT Press, 2012.
3. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, *"Foundations of Machine Learning*, MIT Press, 2012.
4. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2007.

MCA 5142   MOBILE APPLICATION DEVELOPMENT LAB   [0 1 3 2]

Exercises related to implementation/realization of concepts discussed in the theory class. Also, an additional tutorial class will be conducted as per the prerogative of the faculty who is handling the lab.

MCA 5143   NETWORK LAB   [0 1 2 2]

Exercises related to implementation/realization of inter-process communication, socket programming concepts and simulate using a Network simulator tool. Interposes-process communication constructs are in Unix are used in the exercises to demonstrate process-to-process communication. Socket programming exercises based on UDP and TCP transport layer protocols. Network simulating tool is used to configure a network topology and simulate routing protocols.

References:

1. W. Richard Stevens, Bill Fenner and Andrew M. Rudoff, *Unix Network Programming*, The *Sockets networking API, Volume-1,* 3rd Edition, Prentice Hall of India EE Edition, 2010.
2. W. Richard Stevens, Bill Fenner and Andrew M. Rudoff, *Unix Network Programming, Inter process communication, Volume-2*, 2nd Edition, Prentice Hall of India, 2004.
3. CISCO packet tracer version tool

PROGRAM ELECTIVES – I

MCA 4051   COMPUTATIONAL INTELLIGENCE   [3 0 0 3]

Artificial Neural Networks: The Artificial Neuron, Activation Functions, Artificial Neuron Geometry, Artificial Neuron Learning; Supervised Learning, Neural Network Types, Supervised Learning Rules; Unsupervised Learning, Hebbian Learning Rule, Principal Component Learning Rule, Self-Organizing Feature Maps; Reinforcement Learning, Learning through Awards, Model-Free Reinforcement Learning Model, Neural Networks and Reinforcement Learning; Performance Issues, Performance Measures, Analysis of Performance, Performance Factors. Evolutionary Computation: Generic Evolutionary Algorithm, Representation-the Chromosome, Initial Population, Fitness Function, Selection, Reproduction Operators, Stopping Conditions, Evolutionary Computation Versus Classical Optimization, Genetic Algorithms, Genetic Programming, Evolution Strategies. Swarm Intelligence: Basic Particle Swarm Optimization, Social Network Structures, Basic Variations, Basic PSO Parameters, Single- Solution Particle Swarm Optimization, Ant Colony Optimization; Fuzzy Systems: Fuzzy Sets, Fuzzy Logic and Reasoning, Fuzzy Inferencing, Fuzzy Controllers, Mamdani Fuzzy Controller, Takagi-Sugeno Controller, Rough Sets.

References:

1. Andries P. Engelbrecht, *Computational Intelligence*, 2nd Edition, Wiley Publications, 2007.
2. Russell Eberhart and Yuhui Shi, *Computational Intelligence: Concepts to Implementations*, Morgan Kaufmann Publishers, 2009.
3. Janusz Kacprzyk, Witold Pedrycz, *Springer Handbook of Computational Intelligence*, Springer, Heidelberg, 2015.
4. Lakhmi Jain, Philippe De Wilde, *Practical Applications of Computational Intelligence Techniques*, Springer, New York, 2001.

MCA 4052 COMPUTER ORGANISATION AND ARCHITECTURE [3 0 0 3]

Number Systems and Conversions, Boolean Algebra and Simplifications, Minimization of Boolean Functions, Karnaugh Map, Quine McClusky Method. Logic Gates: NAND NOR implementation. Design of Circuits: Adder / Subtracter , Encoder, Decoder, MUX /DEMUX – Comparators, Flip flops, Triggering, Master: Slave Flip Flop, State Diagram and Minimization, Counters, Registers Functional Units, Basic Operational Concepts: Bus structures, Performance and Metrics, instruction and instruction sequencing, Hardware Software Interface, Addressing modes, Instruction Sets, RISC and CISC, ALU Design, Fixed point and Floating point Processor basics, CPU Organization, Data Path Design, Control Design, Basic concepts, Hardwired control, Micro Programmed control, Pipe control, Hazards super scale operations Memory technology, Memory Systems: Virtual Memory, Caches, Design Methods, Associative memories, Input /output system, Programmed I/O, DMA and interrupts, I/O devices and Interfaces, Fundamental of Parallel Processing: Introduction, parallelism in conventional computers, general classification of computer architecture, Array processors: systolic arrays and wave front array processors, processing: Basic concepts, Arithmetic, pipelines, multiprocessors: Single bus, Multi-bus, cross bar, multiport memory.

References:
1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, *Computer Organization and Embedded Systems*, 6th Edition, TataMcGraw Hill, 2012.
2. David A. Patterson and John L. Hennessy, *Computer Organization and Design: The Hardware/Software Interface*, Morgan Kaufmann, 2010.
3. Morris Mano, *Digital Design*, 5th Edition, Prentice Hall of India, 2013.
4. John P. Hayes, *Computer Architecture and Organization*, 3rd Edition, Tata McGraw Hill, 2012.
5. William Stallings, *Computer Organization & Architecture – Designing for Performance,* 10th Edition, Pearson Education, 2016.

MCA 4053   INTERNET OF THINGS   [3 0 0 3]

Internet of Things, Physical Design, Logical Design, IoT Enabling Technologies, IoT Levels & Deployment Templates, Domain Specific IoT Applications. IoT Network Architecture and Design: Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack. Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. IP as the IoT Network Layer, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods. Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data

Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics. Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, Formal Risk Analysis Structures. Prototyping Endpoints - Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black, IoT Use Cases - Industrial Automation, Smart Home, Smart City, Commercial Building Automation.

SDL: Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics

References:
1. 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).
2. Arshdeep Bahga, Vijay Madisetti, *Internet of Things – A hands-on approach*, Universities Press, 2015.
3. Adrian McEwen, Hakim Cassimally, *"Designing the Internet of Things",* Wiley, 2014.
4. Holler J., "*From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*", Academic Press, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi, *The Internet of Things – Key applications and Protocols*, Wiley, 2012.

MCA 4054   MANAGEMENT INFORMATION SYSTEM   [3 0 0 3]

System Concepts, Definitions, Computer based user machine system, Open and Close Systems, Integrated system, Need for a database, Utilizat ion of models, Evolution, Subsystems, Organizational subsystems, Activities subsystems, Organizational Structure, Basic model, Hierarchica l, Specialization, Formalization, Centralization, Modifications of basic organizational structure, Project organization, Lateral relations, Matrix organization, Organizational culture and power organizational change, Structure of MIS, Operating elements, Physical components, Processing functions, Outputs, MIS support for decision making, Structured programmable decisions, Unstructured non-programmable decisions, MIS structure based on management activity and organizational functions, MIS pyramid structure, Synthesis of MIS structure, Development and Management, A contingency approach to choosing an application, Developing strategy, Lifecycle definition stage, Lifecycle development stage, Lifecycle installation and operation stage.

References:
1. Gordan B Davis, Margrethe H. Olson, *Management Information Systems: Conceptual foundations, Structure and development*, 5th Edition,Tata-Mc Graw Hill International Book Company, 2012.

2. E.Wainright Martin, Carol V. Brown, Denial W. DeHayes, Jeffrey A. Hoffer, William C Perkins, *Managing Information Technology*, 7th Edition, Prentice Hall International, 2011.
3. A.K. Gupta, *Management Information Systems*, 4th Edition, S. Chand and Company Ltd., 2010.

MCA 4055 NOSQL DATABASE SYSTEMS [3 0 0 3]

The significance of Relational databases, Impedance mismatch, the emergence of NoSQL, definition and history, Aggregate model, Four Types of NoSQL Database, scheme less databases, materialized Distribution models-single server, Sharding, Master-Slave replication, Peer-to-Peer Replication, combinations, relaxation consistency, Brewer's cap theorem, Document Databases, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, CRUD operations using Mongo DB, Column- oriented NoSQL databases HBASE, a, Architecture of HBASE, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, CRUD operations using HBase/Cassandra. NoSQL Key/Value databases Redis, Key-Value Databases, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, CRUD operations using Redis, Graph Databases, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, CRUD operations using Neo4j, Schema migrations, schema changes in RDBMS, schema changes in NoSQL, Incremental migration, migration in Graph Databases, Case Study-Document Database MongoDB.

SDL : Migration in Graph Databases, Case Study-Document Database MongoDB, Suitable Use Cases, Event Logging, Content Management, Expiring Usage, Graph Database. Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases

References:
1. Pramod J Sadalage, Martin Fowler, *NoSQL Distilled*, Addison-Wesley, 1st Edition, 2012.
2. Shashank Tiwari, *Professional NOSQL*, John Wiley & Sons Inc., 1st Edition, 2011.
3. Kyle Banker, Peter Bakkum, Shaun Yerch, Douglas Garrett, Tim Hawkins, *MongoDB in Action*, 2nd Edition, Manning Publications, 2016.
4. Lans George, *HBase: The Definitive Guide*, 1st Edition, O'Reilly Media, Inc., 2011.
5. Ian Robinson, Jim Webber and Emil Eifrem, *Graph Databases*, 2nd Edition, O'Reilly Media, Inc., 2015.

MCA 4056 OBJECT ORIENTED ANALYSIS AND DESIGN [3 0 0 3]

Complexity: Structure, Five Attributes of a complex system, The Object Model: Evolution, Foundations, Elements and Applications, Classes and Objects: Nature and relationship between objects, Nature and relationship between classes. Importance of classification, Notation: Unified modelling language, Class diagram, Use case diagram, Sequence diagrams, Activity diagram, Object Diagrams, Component diagram, Deployme nt diagram and Package diagrams, The Process: First Principles, The Macro Process: The Software Development Lifecycle, The Micro Process: The Analysis & Design Process, Pragmatics: Management & Planning, Staffing, Release Management, Reuse, Quality Assurance and Metrics, Documentation, Tools and special tools, Risks of Object Oriented Development, Applications: System Architecture: Satellite Based Navigat io n, Control System: Traffic Management, Artificial Intelligence: Crptyanalysis, Web Application: Vacation Tracking System.

References:

1. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen and Kelli A. Houston, *Object-Oriented Analysis And Design With Applications,* 3rd Edition, Pearson Education Inc., 2007.
2. Grady Booch,, *Object-Oriented Analysis And Design With Applications,* 2nd Edition, Pearson Education Inc., 2007.
3. Michael Blaha and James R Rumbaugh, *Object-Oriented Modeling And Design with UML 2.0,* 2nd Edition, Pearson Education, India, 2007.
4. Brahma Dathan, Sarnath Ramnath, *Object-Oriented Analysis, Design and Implementation*, Universities Press, 2013.
5. Grady Booch, James Rumbaugh, Ivar Jacobson, *The Unified Modeling Language Reference Manual*, 2nd Edition, Addison Wesley, 2004.

PROGRAM ELECTIVES – II & III

MCA 5051   BIG DATA ANALYTICS   [3 0 0 3]

Introduction to Big Data: evolution, structuring, elements, big data analytics, distributed and parallel computing for big data, Hadoop, Cloud computing and big data, in-memory computing technology for big data, Big Data Stack, Virtualization and Big Data, Hadoop: ecosystem, Hadoop Distributed File System (HDFS), MapReduce: MapReduce Framework, optimizing MapReduce jobs, MapReduce Applications, Understand ing YARN architecture, HBase, Exploring Hive, Analyzing data with Pig, Using Oozie, Introduction to Mahout, role of HBase in Big Data Processing, RHadoop: Data Analysis Using the MapReduce Technique in RHadoop,

Spark: Core Concepts, Spark's Python and Scala shells, Programming with RDD: RDD Operations, Passing Functions to Spark, Common Transformations and Actions, Mining Data Streams: Streams Concepts, stream Data Model and Architecture, stream computing, filtering Streams, estimating Moments, decaying window, Real time Analytics Platform (RTAP) Applications, Case studies: Real Time Sentiment Analysis, Stock Market Predictions.

References:

1. Vignesh Prajapathi, *Big Data Analytics with R and Hadoop*, Packt Publishing, 2013.
2. Holden Karau, Andy Konwinski , Patrick Wendell, Matei Zaharia, *Learning Spark: Lightning-Fast Big Data Analysis,* 1st Editio n,O'Reilley Media Inc, 2015.
3. Michael Minnelli, Michele Chambers, *Big Data Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses* ,Wiley India Pvt. Ltd., 2013.
4. Arvind Sathi, *Big Data Analytics*, MC Press, LLC, 2012.

MCA 5052   CLOUD COMPUTING   [3 0 0 3]

Cloud Computing Overview: Definition and evolution of Cloud Computing Enabling Technologies, Service and Deployment Models, Popular Cloud Stacks and Use Cases Benefits, Risks, and Challenges of Cloud Computing, Virtualization: Introduction, Characteristics of Virtualized Environment, Types of Virtualization, Implementation Levels of Virtualization, Taxonomy of Virtualization Techniques, Tools and Mechanisms, Pros and Cons of Virtualization. Programming Model: Parallel and Distributed Programming Paradigms, Cloud Platforms in Industry: Amazon Web Services, Google App Engine, Microsoft Azure, Service level agreements; Data in the cloud, MapReduce and extensions, Security In The Cloud: Security Overview, Cloud Security Challenges and Risks, Software-as-a-Service Security, Security Governance, Risk Management, Security Monitoring, Security Architecture Design, Data Security, Application Security , Virtual Machine Security, Identity Management and Access Control, Autonomic Security.

SDL: Cloud Platforms in Industry: Amazon Web Services, Google App Engine, Microsoft Azure, Virtualization Tools and Mechanisms.

References:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, *Mastering cloud computing: foundations and applications programming"*, Elsevier Inc, 2013.
2. Gautam Shroff, *ENTERPRISE CLOUD COMPUTING: Technology, Architecture, Applications,* Cambridge University Press, 2010
3. Barrie Sosinsky, *"Cloud Computing Bible"*, Wiley India Edition, 2013.
4. Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah, *"Cloud computing black Book"*, Dream Tech Press, 2014.

5. Velte Anthony T, Toby J. Velte and Robert E., *"Cloud Computing: A Practical Approach"*, Tata McGraw Hill, 2013.

MCA 5053   CYBER FORENSICS   [3 0 0 3]

Understanding the Digital Forensics Profession and Investigations: - An Overview of Digital Forensics, Preparing for Digital Investigations, Procedures for Private-Sector High-Tech Investigations. The Investigator's Office and Laboratory:- Understanding Forensics Lab Accreditation Requirements, Data Acquisition, Validating Data Acquisitions Processing Crime and Incident Scenes, Current digital forensics tools, Network Forensics and email investigation, Exploring the Role of E-mail in Investigations, Exploring the Roles of the Client and Server in E-mail, Investigating E-mail Crimes and Violations, Understanding E-mail Servers, Using Specialized E-mail Forensics Tools. Report Writing for High-Tech Investigations, Expert Testimony in Digital Investigations and ethics, Understanding the Importance of Reports, Guidelines for Writing Reports, Generating Report Findings with Forensics Software Tools, Preparing for Testimony, Testifying in Court, Preparing for a Deposition or Hearing, Preparing Forensics Evidence for Testimony, Applying Ethics and Codes to Expert Witnesses.

References:

1. Bill Nelson, Amelia Phillips, *Guide to Computer Forensics and Investigations: Processing Digital Evidence*, Fifth Edition, CENGAGE Learning, 2015.
2. John R. Vacca, *Computer Forensics, Computer Crime Scene Investigation*, 3rd Revised Edition, Jones and Bartlett Publishers, Inc., 2019.
3. Keith J. Jones, Richard Bejtiich, Curtis W. Rose, *Real Digital Forensics*, Addison Wesley Pearson Education, 2006.

MCA 5054   DESIGN AND ANALYSIS OF ALGORITHMS [3 0 0 3]

Introduction: Need for Algorithmic Thinking, Need for Algorithm Efficiency, Fundamental Stages of Problem Solving, Classification of Algorithms. Basics of Algorithm Analysis: Basics of Algorithm Complexity, Introduction to Time Complexity, Analysis of Iterative Algorithms, Rate of Growth, Asymptotic Analysis and Space Complexity Analysis. Mathematical Analysis of Recursive Algorithms, Divide-and-conquer Recurrences. Brute Force Approaches: Introduction, Computational Geometry Problems, Exhaustive Searching. Divide-and-conquer Approach, Merge Sort, Quick Sort, Closest-pair Problem. Greedy Algorithms, Suitability of Greedy Approach, Coin Change Problem, Scheduling Problems, Knapsack Problem, Optimal Graph Problems. Dynamic Programming, Fibonacci Problem, Computing Binomial

Coefficients, Floyd-Warshall All Pairs Shortest-path problem, Bellman-Ford Algorithm, Traveling Salesperson Problem, Knapsack Problem. Backtracking, N-queen Problem, Sum of subsets, Vertex Coloring Problem, Hamiltonian Circuit Problem. Branch-and-Bound technique, Traveling Salesperson Problem, Knapsack Problem. Basics of Computational Complexity, Algorithmic Complexity, Complexity Classes, Theory of NP-complete Problems, Example Problems for Proving NP-completeness.

References:
1. S. Sridhar, *Design and Analysis of Algorithms*, 1st Edition, Oxford University Press, 2015.
2. Richard F. Gilberg and Behrouz A. Forouzan, *Data Structures – A Pseudocode Approach with C*, 2nd Edition, Cenage Learning, 2009.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, *Fundamentals of Algorithms*, 2nd Edition, Universities Press, 2010.
4. Thomas H. Cormen, Charles, E. Leiserson, Ronald L. Rivest and Clifford Stein *Introduction to Algorithms*, 3rd Edition, PHI Publications, 2009.

MCA 5055   GAME PROGRAMMING   [3 0 0 3]

3D Graphics for game programming: Coordinate Systems, Ray Tracing, Modeling in Game Production, Vertex Processing, Rasterization, Fragment Processing and Output Merging, 3D Transformations, Quaternions, 3D Modeling and Rendering, Ray Tracing, Shader Models, Lighting, Color, Texturing, Camera and Projections, Culling and Clipping, Character Animation, Physics-based Simulation, Scene Graphs. Game engine design: Game engine architecture, Engine support systems, Resources and File systems, Renderers, Software Rendering, Hardware Rendering, and Controller based animation, Spatial Sorting, Level of detail, collision detection, standard objects, and physics, Human Interface devices, Collision and rigid body dynamics, Game Programming: Application layer, Game logic, Game views, managing memory, controlling the main loop, loading and caching game data, User Interface management, Game event management, Introduction to Games development tools: Milk Shape - 3D, Unity – 3D, Light wave 3D.

References:
1. Mike Mc Shaffrfy and David Graham, *Game Coding Complete*, 4th Edition, Cengage Learning, PTR, 2012.
2. Jason Gregory, *Game Engine Architecture*, CRC Press / A K Peters, 2009.
3. Kenneth C. Finney, *Advanced 3D Game Programming All in One*, Premier Press, 2011.
4. Mike McShaffry, David Rez Graham, *Game Coding Complete*, Course Technology PTR, 2012.
5. Joseph Hocking, *Unity in Action: Multiplatform Game Development in C# with Unity 5,* 2nd Edition, Manning Publications, 2018.

MCA 5056   HUMAN RESOURCE MANAGEMENT   [3 0 0 3]

HRM- HR and HRM, Role in organization, HR in Technical and Knowledge domain, Acquisition of HR, HR Planning, HRM vs Personal Management, Development of HR, Motivation and Maintenance of HR Leadership-Technical Leadership, Leader's Goal, Conviction, Leader's Vision, Transformational and Transactional Leadership, Commitment and Professionalism, Importance of Professionalism, Manager's Role in Professionalism, Respect. Managing Technical & Professional people- Goals of Engineers and Scientists, Work Assignment and Need for Influence, Professional Career and Goals, Career Risks, Technical Competence, Training and Survival of Best fit, Performance and Motivation, Role of PMS evaluation, Professional Discipline, Manager's Role in Professional Discipline. Identification & Development of Talented people –Talented Professionals, Importance of Talent, Assessment and Recognizing Talent, Developing Technical Talent, Developing Managerial Talent, Development Needs, Planning and Counseling. Innovation- Importance of Innovation, Risk of Failure, Creativity from Imagination, Need of Creative Teams. Team environment and recognition – Team Dynamics, Innovative team Environment, Managing Innovative Teams, Manager's Responsibility in Innovation, Team's Personal Needs, Political versus Technical Solutions, Rewards and Recognition. Case studies in Indian Organizations. Case studies on HRM Interview questions with mock sessions and Case studies on different HRM challenges with role play.

References:

1. Jim Collins, *"Good to Great"*, Harper Collins Publishers, Volume 2, 2011.
2. Armstrong, *"Handbook of Human Resource Management Practice",* Emerald group Publishing limited, 2009.
3. K. Aswathappa, *"Human Resource and Personnel Management text and cases",* Tata Mc-Graw Hill publishing Co. Ltd., 2002.
4. Wiseman and Grey*,"Multipliers How the Best leaders make everyone smarter",*Harper Business Publishers edition 1,2010

MCA 5057   INFORMATION AND NETWORK SECURITY   [3 0 0 3]

Introduction: The OSI Security Architecture, Security Attacks, Services and Mechanisms, Model for Network Security, Number theory Cryptographic Hash Functions, Digital Signatures, System Security, Symmetric Encryption and Message Confidentiality, Substitution ciphers, Stream ciphers, Public-key cryptography and Message Authentication, Key Distribution and Authentication, Transport Layer Security, Wireless Network Security, E-mail Security, IP Security, Security Management Systems, Need for IT Security, Intrusion Prevention and Detection Systems, Cyber Security.

References:
1. William Stallings, *Cryptography and Network Security: Principles and Practice*, 7th Edition, Pearson Education, 2017.
2. William Stallings, *Network Security Essentials: Applications and Standards*, 6th Edition, Pearson Education, 2014.
3. Atul Kahate, *Cryptography and Network Security*, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, 2013.
4. Bruce Schneier, *Applied Cryptography: Protocols, Algorithms and Source Code in C*, 2nd Edition, Wiley Publications, 2007.
5. V. K. Pachghare, *Cryptography and Information Security Paperback*, 2nd Edition, PHI Publications, 2015.

MCA 5058 INFORMATION STORAGE AND MANAGEMENT [3 0 0 3]

Information storage, evolution of storage architecture, ILM. Storage System Environment: Disk components and performance measurement. Data Protection RAID: techniques, types, Intelligent storage system. Block: based Storage System: Components of block: based storage system. Storage provisioning and storage tiering, File-based Storage System: NAS, file sharing methods, File-level virtualization, Object-based and Unified Storage: Key features of OSD, Content addressed storage (CAS), unified storage architecture, Software-defined Storage: architecture of software-defined storage, Fibre Channel SAN: components and architecture, Internet Protocol SAN, iSCSI protocol, network components, and connectivity, link and switch aggregation, and VLAN, Fibre Channel over Ethernet SAN: FCoE SAN, FCoE SAN connectivity. Introduction to Business Continuity, Backup and Archive, Replication, Storage virtualization: forms of virtualization, EMC Products and tools: A Case study CLARiiON Architecture, Snap view, Mirror view, Power path and SANCOPY.

References:
1. Marc F. Osborne, *Building Storage Networks*, 2nd Edition, Tata McGraw Hill, 2001.
2. Marc Farley, *Storage Networking Fundamentals*, 1st Edition, CISCO Press, 2004.
3. Robert Spalding, *Storage Networks: The Complete Reference*, Tata McGraw Hill, 2003.
4. G. Somasundaram, A. Shrivastava, *EMC Corporation, Information Storage and Management*, 2nd Edition, Wiley Publication, 2012.

MCA 5059   OPTIMIZATION TECHNIQUES   [3 0 0 3]

Linear Programming: Problem Formulation, Linear Programming (LP) in standard form, Graphical Solution, Simplex Method, Big M Method. Transportation and Assignment Model: Transportation problem formulation, optimal solution, unbalanced transportation problem, degeneracy, Assignment problem, Hungarian Problem. Network Analysis: Graphs, Network and Flows, Minimum cost flow Models, Sources, Sinks Max Flow - Min Cut Theorem, CPM and PERT Networks. Inventory: Introduction, Single Item, Deterministic model, Purchase

Inventory model with one price, break and multiple price breaks. Dynamic Programming: Introduction, Forward and backward recursions, Bellman's Principle of Optimality. Equipment Replacement Model, Allocation Problem, Inventory Models. Decision Theory: Decision under certainty: Analytic Hierarchy Process (AHP), decision under risk: decision trees, expected value criterion, Variations of the Expected value criterion, decision under uncertainty: Laplace, MinMax, Savage, Hurwicz method. Game Theory: Introduction, Minmax – Maxmin pure strategies, Optimal solution of two person zero sum games, solution of mixed strategy games, 2 x 2 games, 2 x n games, m x 2 games. Heuristics and approximation algorithms: approximation algorithms for Travelling Salesman Problem (TSP), Vertex cover problem.

References:

1. Taha H, *Operation Research: An Introduction*, 10th Edition, McMillan, 2017.
2. Rardin, Ronald L., *Optimization in Operations Research*, Pearson Education (2005)
3. Ravindra K. Ahuja, Thomas L. Magnanti, James B. Orlin, *Network Flows: Theory, Algorithms, and Applications*, Pearson New International Edition, 2014.
4. Teofilo F. Gonzalez, *Handbook of Approximation Algorithms and Metaheuristics*, Chapman & Hall/CRC Computer and Information Science Series, 1st Edition, 2007.
5. S.S. Rao, *Engineering Optimization: Theory and Practice*, New Age International Pvt. Ltd., New Delhi, 2013.

MCA 5060 PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS [3 0 0 3]

Introduction: Definitions of data sets for Pattern Recognition (PR), Different paradigms of PR, Representations of Patterns and Classes, Metric and Non-metric proximity measures, Applications of PR, Feature extraction and feature selection: Feature extraction, different approaches to feature selection, Feature ranking. Statistical Decision Making: Introduction, Bayes theorem, multiple features, conditionally independent features, decision boundaries, the leaving-one-out technique, characteristic curves, estimating the composition of populations. Naïve Bayes classifier, Bayesian Belief Networks, Supervised and unsupervised Classification: Introduction to supervised and unsupervised classifications, Classification in High dimension, Random forests, SVM classifications. Introduction to clustering, clustering large datasets and combination of classifiers.

References:
1. Devi V. S, Murthy M. N, *Pattern Recognition: An Introduction*, Universities Press, Hyderabad. 2011.
2. Earl Gose, Richard Johnsonbaugh and Steve Jost, *Pattern Recognition and Image Analysis*, Prentice Hall of India, 2003.
3. R.D. Duda, P.E. Hart and D.G. Stork, *Pattern Classification*, 2nd Edition, John Wiley Inc., 2001.

MCA 5061   **SEMANTIC WEB**   **[3 0 0 3]**

Semantic Web Vision: technologies, layered approach, Structured Web Documents: XML, Describing Web Resources: RDF-data model, syntaxes, RDFS-adding semantics, RDF schema, RDF and RDF schema in RDFS, Axiomatic schematics for RDF and RDF schema, Direct inference system for RDF and RDFS, querying in SPARQL, Web Ontology Language: OWL and RDF/RDFS, Requirement of ontology language,   Compatibili ty of OWL2 features, Logic and Inference: Rules, monotonic rules, OWL2 RL, Rule interchange format (RIF), Description Logic Programs (DLP), Semantic Web Rules Language(SWRL) , Rule Markup Language (RuleML), Ontology Engineering: constructing ontologies, reusing existing ontologies, semiautomatic ontology acquisition, Ontology Mapping, On-To-Knowledge Semantic Web Architecture.

References:

1. Grigoris Antoniou, Paul Groth, Frank van Harmelen, Rinke Hoekstra, *A Semantic Web Primer*, MIT Press, 2012.
2. Michael C. Daconta, Leo J. Obrst and Kevin T. Smith, *The Semantic Web: A Guide to the Future of XML, Web Services, and KnowledgeManagement*, Wiley, 2003.
3. Jorge Cardoso, Martin Hepp and Miltiadis D. Lytras, *The Semantic Web: Real-World Applications from Industry*, Springer, 2008.

MCA 5062   **SERVICE ORIENTED ARCHITECTURE**   **[3 0 0 3]**

Fundamental SOA, Common Characteristics, misperception, tangible benefits and pitfalls of adopting; SOA timeline, The continuing evolution of SOA, roots of SOA, Comparing SOA to past architecture, Web Services and Primitives: The web service framework, Service roles, Service models, Service descriptions, Messaging with SOAP, Planning and Analysis: SOA delivery lifecycle phases, The top down strategy, The bottom up strategy, The agile strategy, Service oriented analysis: Objectives and process of SOA, Service modelling and its guidelines, Classifying service model logic, Technology and Design: Service Oriented Design: Introduction to service oriented design, WSDL and related XML schema, SOAP language basics, Service interface design tools, SOA Composition: Steps to composing SOA, Choosing service layers, Considerations for positioning core SOA standards, Considerations for choosing SOA extensions, SOA Service design: Entity centric business service design, Task centric business service design, Application service design, Service design guidelines, Business process design: Service oriented business process design, SOA Platforms: Basics, SOA support in J2EE, SOA support in .net.

References:

1. Thomas Erl, *Service Oriented Architecture (SOA): Concepts, Technology and Design*, Pearson Education, 2016.
2. Eric Newcomer and Lomow, *Understanding SOA with Web Services*, Pearson Education, 2009.
3. Sandeep Chatterjee and James Webber, *Developing Enterprise Web Services*, Pearson Education, 2007.

MCA 5063   SOFTWARE PROJECT MANAGEMENT   [3 0 0 3]

Managing Software Projects: Processes and Project Management, Process Planning: Case Study Example, Requirement Change Management: Change Management Process, Effort Estimation and Scheduling: Estimation and Scheduling Concepts, Effort Estimation: Bottom-up & Top-down Estimation, Use case Points, Effectiveness, Example, Scheduling: Overall, Effectiveness, Detailed, Quality Planning: Concepts, Quantitat ive Quality Management Planning, Example, Risk Management: Concepts, Assessment, Control, Example of Configuration Management, Measurement and Tracking Planning: Concepts, Measurements, The Project Management Plan: Process Database, Process Capability Baseline, Process Assets and Body of Knowledge System, The Project Management Plan, Team Management, Project Monitoring and Control: Tracking, Milestone Analysis, Defect Analysis and Prevention, Process Monitoring and Audit, Project Closure: Analysis, Report.

References:

1. Pankaj Jalote, *Software Project Management in Practice*, 1st Edition, Addison, Wesley, 2014.
2. Bob Hughes, Mike Cotterell, Rajib Mall, *Software Project Management*, 6th Edition McGraw Hill Education, 2017.
3. Roger S. Pressman, *Software Engineering: A Practitioner's Approach*, 8th Edition, McGraw Hill Publication, 2014.
4. Normal E Fenton, Shari Lawrence, *Software Metrics,* 5th Edition, Pfleeger Thompson, 2010.

MCA 5050   ETHICAL HACKING   [3 0 0 3]

Introduction to Ethical Hacking: Important Terminologies, Penetration Testing and Tools: Phases involved in Ethical Hacking, Types of Hackers. Foundations of Information Security, Network Security: Introduction, Protocols, IP Security, SSL/TLS, DNS, Firewalls, Intrusion Detection, Linux Basics: File structure, permissions, scheduler, users, backtrack, Footprinting and reconnaissance, Social Engineering, Trojans, backdoors, viruses and worms, Web Hacking,

Attacking the authentication, Brute force and dictionary attacks, types of authentication, Sniffers, Introduction, Types of sniffing, MITM attacks, ARP attacks, DOS attacks, SQL injection and Buffer overflows.

References:
1. Harper Allen, *Gray Hat Hacking: The Ethical Hackers HandBook,* 3rd Edition, McGraw Hill, 2011.
2. Rafay Baloch, *Ethical Hacking and Penetration Testing Guide,* Auerbach Publications, 2014.
3. Himanshu Sharma, *Kali Linux - An Ethical Hacker's Cookbook*, Packt Publishing Limited, 2017.
4. Dafydd Stuttard and Marcus Pinto, *The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws*, 2nd Edition, 2011.