

**SCHEME FOR MASTER OF COMPUTER APPLICATIONS (MCA) NEW COURSE**  
**SEMESTER - III of MCA, Applicable from July 2019 onwards**

			TEACHING SCHEME			EXAMINATION SCHEME							
Sr. No.	SUBJECT NO.	NAME OF THE SUBJECT	THEORY Hr	TUTO Hr.	PRACT. Hr.	SESSIONAL M. Hr.		THEORY M. Hr	PRACT. M H	T.W. MARKS		TOTAL	
1	MCA 211	DATA STRUCTURES	4	-	3	25	2	50	3	50	3	25	150
2	MCA 212	OPERATING SYSTEMS	3	1	3	25	2	50	3	50	3	25	150
3	MCA 213	SYSTEM SOFTWARE	4	-	3	25	2	50	3	50	3	25	150
4	MCA 214	CORE JAVA PROGRAMMING	4	-	3	25	2	50	3	50	3	25	150
5	MCA 215	COMPUTER ORIENTED STATISTICAL METHODS	3	1	-	25	2	50	3	-	-	25	100
	TOTAL		18	2	12	125	-	250	-	200	-	125	700

**Gujarat University**  
**Syllabus**  
**Master of Computer Applications – III**

**Course Name: Data Structures**

**Course Code: MCA 211**

**Objectives:**

At the end of the course, student will be able to

- Develop proficiency in the specification, representation, and implementation of Data types and Data Structures
- Carry out the Analysis of various Algorithms for mainly Time and Space Complexity
- Get a good understanding of applications of Data Structures
- Develop a base for advanced computer science study

**Prerequisites:**

Any programming language like C, C++

**Contents:**

**1. Introduction**

Data types , ADT, data structure: Definition & classification, Analysis of algorithms (recursive and non-recursive) with emphasis on best case, average case and worst case

**2. Linear Data structures with applications**

Array data structure: storage, mapping, applications (sparse matrix, polynomial representation, strings), *List*: Introduction, implementation using array & linked list (singly, doubly, circular, multi-list), Applications: Polynomial representation, Sparse matrix, *Stack*: Introduction, implementation using array & linked list, *Applications*: Function call, Recursion, balancing of parenthesis, *Polish Notation*: infix to postfix conversion and evaluation of postfix expression, *Queue*: Introduction (queue, circular queue, deque, priority queue), implementation using array & linked list, *Applications*: Job Scheduling

**3. Non Linear data structures**

*Tree*: Introduction and representation, Forest, Tree traversal, Binary Tree representation using array and links), Binary tree traversal (recursive & non-recursive implementation), Expression tree, *Graph*: Introduction, representations, Traversal(BFS,

DFS), *Applications*: Shortest path (Single source-all destinations), Minimal spanning tree (Prim's algorithm, Kruskal's algorithm)

#### 4. Searching and Sorting

Linear Search, Binary Search, Transpose sequential search, Binary search tree, Heap tree (application in priority queue and sorting), AVL tree, Splay tree, M-way search tree, B tree (insertion), B+ tree (Definition and introduction), B\* tree (Definition and introduction), Tries, Application of B tree and B+ tree in File Structures, *Hash Tables*: Introduction, hash functions and hash keys, Collisions, Resolving collisions, Rehashing, Sorting with algorithm analysis (best case, worst case, average): Bubble, Selection, Insertion, Shell, Merge, Quick, Heap, Radix

#### 5. NP-Completeness and the P & NP Classes

Introduction, Polynomial Time & Verification, NP - Completeness and Reducibility, The Vertex Cover Problem, The Traveling Salesman Problem, The Set Covering Problem

### Main Reference Books:

1. Data Structures and Algorithm Analysis in C, Mark Allen Weiss, 2<sup>nd</sup> edition (2003), Pearson Education,
2. Data structures and algorithms, concepts, Techniques and Applications, G. A.V. PAI, 1<sup>st</sup> Edition (2008), TMH
3. Fundamentals of Data Structures in C, Horowitz, Sahni, Anderson-Freed, 2<sup>nd</sup> edition -2007, University Press
4. An Introduction to Data Structures with Applications, Jean-Paul Tremblay, Paul G. Sorenson, , 2<sup>nd</sup> Edition - 2007, Tata McGraw-Hill
5. Introduction to Algorithm, Cormen, Leiserson, Rivest, Stein, 2<sup>nd</sup> Edition - 2003, PHI
6. Data Structures: A Pseudo-code Approach with C, Gilberg & Forouzan, Thomson Learning
7. Design and Analysis of Algorithms, Parag Dave & Himanshu Dave, edition – 2008, Pearson Education
8. Data Structures Using C & C++, Tanenbaum, PHI
9. Algorithm design-foundation, analysis & internet examples, Michel Goodrich, Roberto Tamassia, Wiley
10. Data Structures & Algorithms, A V Aho, J E Hopcroft, J D Ullman, edition - 1983, Addison-Wesley Publishing
11. Data Structures Via C++: Objects by Evolution, Michael Berman, edition - 2004 Oxford University Press

12. Sorting & Searching - The Art of Computer Programming, Vol. 3, D E Knuth, edition - 1973, Addison- Wesley Publishing

**Accomplishments of the student after completing the Course:**

- Ability to decide the appropriate data type and data structure for a given problem
- Ability to select the best algorithm to solve a problem by considering various problem characteristics, such as the data size, the type of operations, etc.
- The algorithms as referred above would include various operations on Queues, Stacks, Linked Lists, Trees, Graphs, Sorting, Searching, Hash tables
- Ability to compare algorithms with respect to time and space complexity

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**Course Name: Operating Systems****Course Code: MCA 212****Objectives:**

At the end of the course, student will be able to:

- Understand the functionalities and internals of operating systems
- Optimize their programs to execute on any operating system
- Able to implement tasks using Linux shell scripting

**Prerequisites:**

Fundamentals of Computers

**Contents:****1. Overview of Operating Systems**

Role of Operating Systems(OS), Operations of OS, Resource Management, Security and Protection, Virtualization, Distributed Systems, Kernel Data Structures, Computing Environments, Free and Open-Source OS, OS Services, User and OS Interface, System Calls, System Services, OS Specific applications, OS Design and Implementation, OS Structure, Building and Booting an OS

**2. Process Management**

Process Concept, Process Scheduling, Operations on Process, Interprocess Communication, IPC in Shared-Memory Systems and Message-Passing Systems, Examples of IPC Systems, Communication in Client-Server Systems, Threads & Concurrency, Multicore Programming, Multithreading Models, Thread Libraries, Implicit Threading, Threading Issues, Concepts of CPU Scheduling, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiprocessor Scheduling, Real-Time Scheduling, Algorithm Evaluation

**3. Process Synchronization**

Overview of Synchronization Tools, The Critical-Section Problem, Peterson's Solution, Hardware Support for Synchronization, Mutex Locks, Semaphores, Monitors, Liveness, Evaluation, Classical Problems of Synchronization, POSIX and Java Synchronization, Overview of Deadlocks, Deadlock in Multithreaded Applications, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock

**4. Memory Management**

Background, Contiguous Memory Allocation, Paging, Structure of the Page Table, Swapping, Virtual Memory Overview, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory Compression, Allocating Kernel Memory, Considerations for Virtual Memory Management

**5. Storage Management**

Overview of Mass Storage Structure, HDD Scheduling, NVM Scheduling, Error Detection and Correction, Storage Device Management, Swap-Space Management, Storage Attachment, RAID Structure, Overview of I/O Systems, Application I/O Interface, Streams, Performance of I/O

**6. File System**

Overview of File-System Interface, File-System Structure, File-System Operations, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery, File Systems, File-System Mounting, Partitions and Mounting, File Sharing, Virtual File Systems, Remote File Systems, NFS

**7. Protection in OS**

Goals of Protection, Principles of Protection, Protection Rings, Domain of Protection, Access Matrix, Implementation of Access Matrix, Revocation of Access Rights, Role-Based Access Control, Mandatory Access Control, Capability-Based Systems

**8. Linux Shell Scripting**

Basic commands of Linux, Process related commands of Linux, Linux APIs for process management and IPC, File related commands of Linux, Linux Shell Scripting to automate tasks

**Main Reference Books:**

1. Operating System Concepts, Silberschatz, A., Peter B. Galvin and Greg Gagne, 10th Ed, Wiley International Edition
2. Introduction to Unix and Shell Programming, Venkateshmurthy, Pearson Education (India)
3. Operating Systems, Stallings W, 7th edition, Pearson Education
4. The Design of Unix Operating System, Bach M J, Prentice Hall India
5. Understanding Operating Systems, Flynn I. M, Cengage India Publication
6. Modern Operating Systems, Tanenbaum A.S., 4th Edition, Pearson Education India
7. Beginning Shell Scripting, Eric Foster, John Welch, Micah Anderson, Wrox Publication
8. Operating Systems, Sibsankar Haldar, Alex Aravind, 1st Ed, Pearson Education

**Accomplishments of the student after completing the Course:**

- Working knowledge of Linux System and shell scripting
- Ability to harness the facilities provided by Operating System in application development
- Ability to optimize the programs for specific Operating System

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**Course Name: System Software**

**Course Code: MCA 213**

**Objectives:**

At the end of the course, student will be able to

- Understand the relationship between system software and machine architecture
- Know the design and implementation of assemblers, macro processor, linker and compiler
- Have an understanding of loader, system software tools
- Understand and know the working of device drivers

**Prerequisites:**

Basic knowledge of computer architecture and C programming

**Contents:**

**1. Introduction to System Software and software tools**

*Language Processors:* Introduction, Language Processing Activities, Fundamentals of Language Processing & Language Specification, Language Processor Development Tools, Data Structures for Language Processing: Search Data structures, Allocation Data Structures, *Software Tools:* Software Tools for Program Development, Editors, Debug Monitors, Programming Environments, and User Interfaces

**2. Assemblers**

*Assemblers:* Elements of Assembly Language Programming, A Simple Assembly Scheme, Pass Structure of Assemblers, Design of a Two Pass Assembler, A single pass Assembler for IBM PC

**3. Macro Processors**

Macros and Macro Processors: Macro Definition and Call, Macro Expansion, Nested Macro Calls, Advanced Macro Facilities, Design of a Macro Preprocessor

**4. Compilers and Interpreters**

Scanning and Parsing: Introduction to NFA and DFA, Approaches of parsing, Different types of parsing techniques namely, Recursive decent parser, LL (1) parser, Operator precedence parser. (First and follow technique for generating a parse table is to be taught),



Phases of the Compiler, Aspects of compilation, Memory allocation. Compilation of expressions and control structures. Code optimization. Interpreters: Use and overview of interpreters, pure and impure interpreters

#### **5. Linkers and Loaders**

Introduction to linkers, Relocation and Linking Concepts, Design of a Linker, Self-Relocating Programs, A Linker for MS-DOS, Linking for Overlays, Introduction to Loaders

### **Main Reference Books:**

1. Systems Programming and Operating Systems, D. M. Dhamdhare, 1999, Tata McGraw-Hill
2. Writing UNIX device drivers, George Pajari, Pearson Education Asia
3. System Software – An Introduction to Systems Programming, Leland L. Beck, Pearson Education Asia
4. System Software, Santanu Chattopadhyay, Prentice-Hall India.
5. Compilers: Principles, Techniques, and Tools, Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, Pearson Education Asia
6. Compiler Construction: Principles and Practice, Kenneth C. Loudon, (Thomson/Cengage)

### **Accomplishments of the student after completing the Course:**

- Good understanding of basic design and implementation of various system software
- Ability to design and implement better and more efficient programs/applications as a result of the knowledge gained

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**Course Name: Java Programming****Course Code: MCA 214****Objectives:**

At the end of the course, student will be able to

- Understand the concepts of Object Oriented Programming Language and easily use Java
- Get good understandings of developing multi-threaded applications using the Java Programming Language
- Harness the features of Java using APIs of Collection Framework, Lambda expressions and streams for effective programming

**Prerequisites:**

Basic knowledge of C programming language

**Contents:****1. Introduction**

Introduction to Java and OOP, Features of the Java Language, Java Environment, Object Oriented Programming in Java, Java Program Structure, Java and Unicode, Writing first Java Application, command-line arguments, Use of System.out, System.console().printf and System.console().readLine() methods

**2. Data Type, Variables and Constants, Loops and Logic:**

Data and Variables, Primitive Types, Reference Types, Difference from C++ in usage of Reference types, Arithmetic Calculations, Mixed Arithmetic expressions, Mathematical functions and constants, Bitwise operators, Enumerated data type, Boolean Variables Operator precedence, Program comments, Loops and Logic Making decisions, Logical operators, The Conditional Operator, the new operators and statements, The switch Statement, Variable scope, Loops, Assertions

**3. Defining Classes**

Significance of class, Defining classes, Various members which go in a class definition – instance variable, class variable, methods, static methods, constructors, initializer block and class initializer block, method and constructor overloading, Using Objects, Use of this keyword, Nested classes, The finalize() method

**4. Extending classes and Inheritance**

Overview of Inheritance, Use of keywords extends and super, “is-a” relationship for inheritance, Packages and access specifiers, package keyword, import and import static keywords, private, public and protected keywords, Abstract classes, Abstract methods, Multiple Inheritance using Interfaces, Static and Default methods in Interfaces, Functional Interfaces and Syntax of Lambda Expression

**5. Generics in Java and Commonly used Classes**

Generic classes, Interfaces and Methods, Concept of type parameter, Bounded type parameter, using unbounded and bounded wild-cards, Commonly used classes like String, StringBuilder, Math, Wrapper classes, BigInteger, BigDecimal

**6. Comparators and Lambda Expressions**

Comparison using Comparable and Comparator interfaces, Using methods and constructor reference for lambda expressions with single method invocation, Arrays class from java.util package, sorting arrays, Using Comparators, Functional interfaces from java.util.function package, Revisiting Comparator and using new static and default methods for creating Comparator

**7. Exceptions**

Understanding Exceptions, Types of Exceptions, throw and throws keywords, checked and unchecked exceptions, handling exceptions using try-catch and finally blocks, multi-catch blocks, Creating custom exceptions

**8. Collection Framework, java.time package, java.util package**

The Collection Framework from java.util package, Collection, Iterable, List, Set, Map, Queue, Dequeue, utility methods from Collections class, java.time package, classes, LocalDate, LocalTime, LocalDateTime, OffsetDate, ZonedDateTime, Duration, Period, Clock and Instant classes, The IntSummaryStatistics, LongSummaryStatistics, DoubleSummaryStatistics from java.util package, understanding the Optional class

**9. Stream API from java.util.stream package**

Stream, IntStream, LongStream, DoubleStream, Understanding the intermediate and terminal operations on streams, reduce and collect methods, understanding the Collector, creating useful Collector using methods from the Collectors class

**10. The java.io package**

The File class, IO Stream classes for reading and writing to files, RandomAccessFile class

**11. Threads**

Understanding Threads, the Thread class, creating thread of executing using Runnable and using sub-class of Thread, various properties of Thread, using synchronized keyword, using wait and notify

**Main Reference Books:**

1. The class of Java, Jain Pravin, Pearson India
2. Beginning Java, Horton I., 7<sup>th</sup> ed., Wrox India
3. Core Java, Volume 1 – Fundamentals, Cay S Horstmann, Gary Cornell, Pearson Education
4. The Java Programming Language, Ken Arnold, James Gosling, David Holmes, Addison-Wesley Pearson Education.
5. Functional Programming in Java, Subramian, VPragmatic Bookshelf
6. Java 8 in action, Urma R., Fusco M., Mycroft A., Manning Publications

**Accomplishments of the student after completing the Course:**

- Ability to create appropriate classes using the Java Programming Language to solve a problem using Object Oriented Approach and use concepts of Functional programming
- Ability to develop to multi-threaded applications using the Java Programming Language
- Ability to use data structures effectively to design applications in Java Programming Language

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**Course Name: Computer Oriented Statistical Methods****Course Code: MCA 215****Objectives:**

At the end of the course, student will be able to

- Develop proficiency in applying statistical techniques that helps in decision making while solving real-world problems
- Introduce the use of computers to analyze the data
- Understand statistical reasoning concepts and develop statistical reasoning skills also computational skill

**Prerequisites:**

None

**Contents:****1. Descriptive Statistics**

Introduction to statistics, Data, Scales of measurements, Sample vs. population, Introduction to frequency distribution including types of classes, types of class limits etc. (Only uni-variate), *Measures of central tendency*: Mean, median, mode, weighted mean, basic mathematical properties and applications of these measures, *Measures of dispersion*: absolute and relative measures of range, quartile deviation, standard deviation, basic mathematical properties and applications of the measures, *Measures based on shape of distribution* : Skewness and Kurtosis (basic concepts only, introduction using curve, possible values of these measures, relationship (distance) between mean, median, mode, *Measures of association between two variables* (Correlation: for paired observations only): Covariance, Types of correlation: (+ve, -ve, 0), (Linear, non-linear), Karl Pearson's correlation coefficient, its mathematical properties, Spearman's correlation coefficient, applications, *Regression*: concept of regression, difference between correlation and regression, linear regression equations, properties of regression coefficients, use in forecasting/estimation

**2. Probability and Probability distributions***(a) Probability:*

Basic probability concepts (Experiment, sample space, events, exclusive events, exhaustive events, independent events, dependent events), methods for assigning probability (Classical method, relative frequency method, subjective method), events

and their probability, addition rule (not to be proved or derived), conditional probability, multiplication rule (not to be proved or derived), Bayes' theorem (statement only, not to be proved or derived)

*(b) Probability distribution:*

Random variable, Discrete and continuous random variable, expected value and variance of random variable, Probability distribution, Binomial distribution, Poisson distribution, Uniform distribution, Normal distribution, Normal approximation of Binomial, exponential distribution, relationship between Poisson and Exponential distribution

*Note:* Discuss pmf/pdf, properties and applications of all distribution

**3. Statistical Inference**

Sampling methods, sampling distribution, central limit theorem (statement only), point and interval estimation, sampling distribution of sample mean, sampling distribution of sample proportion, Hypothesis tests: Null & alternative hypothesis, Type I & II errors, one and two tailed test, rejection rule using p-value and critical value approach, test of hypothesis about population mean ( $\sigma$  known,  $\sigma$  unknown and small sample), test of hypothesis about population proportion, Sampling distribution and test of hypothesis about difference between two population means (known and unknown  $\sigma_1$  and  $\sigma_2$ ), sampling distribution and test of hypothesis about difference between two population proportions, analysis of variance (1-way, two-way), introduction of randomized block design

**4. Non – Parametric Methods**

Sign Test, Wilcoxon Signed-Rank Test, Mann-Whitney-Wilcoxon Test, Kruskal- Wallis Test, Chi-square test for goodness of fit and independence

**5. Time series analysis**

Components of a Time Series, measurement of secular trend (moving average method, least square method), measurement of seasonal trend (ratio-to-moving average method, ratio-to-trend method)

**Note:** Formulae may be provided for parametric and non – parametric tests.

**Main Reference Books:**

1. Statistics for business and economics, Anderson, Sweeney, Williams, 9th edition, Thomson Publication
2. Business Statistics, Bharat Jhunjhunwala, first edition, S Chand, 2008
3. Statistics for management, Richard Levin, David Rubin, 7th edition, PHI

4. Statistical methods, S P Gupta, 30<sup>th</sup> edition, S Chand
5. Statistics-Concepts and Applications, Nabendu Pal, Sahadeb Sarkar, 2<sup>nd</sup> edition, PHI

**Accomplishments of the student after completing the Course:**

- Ability to apply statistical techniques in decision making in solving real-world problems
- Ability to use computers to analyze the data

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