**MATS UNIVERSITY**

**MASTER OF COMPUTER SCIENCE(MCS)**

**REGULATIONS**

**Introduction**

The course has been designed and updated by keeping the current demands and expectation of the industry in mind. The programme provides comprehensive training in various areas of computer science to equip the students for the industry as well as for further degree in computer science. The objective of the course is to mould students to acquire analytical, creative and problem-solving skills to meet the industry standards and be well prepared for research activities. The research horizons also open up after completion of this course. To make students to be proficient in the use of mathematical tools including discrete mathematics, calculus, elementary statistics, and probability to understand the basics of science, and specifically the scientific method to possess sufficient fundamental knowledge of computer science to be a life-long learner to understand the social and ethical issues which face computer scientists, and thus be able to contribute to society in a positive and productive manner. This production-oriented approach to training prepares students for a successful animation career in the entertainment industry.

**Program Objective**

* To prepare for advance educational in computer science
* To provide enough skill and applied knowledge of computing to produce effective designs and solutions for specific problems
* Student get computing paradigm to use software development tools and modern computing platforms.
* Demonstrate a sense of societal and ethical responsibility in all professional endeavors.

**Program Outcome**

    Student will get

* Knowledge of algorithms
* Knowledge of data structures
* Knowledge of computer organization and architecture
* Knowledge of contemporary and emerging issues in computer science
* An understanding of professional and ethical responsibility.
* An ability to design and conduct experiments, as well as analyze and interpret data.
1. **Scope and Content**
	1. The regulations documented here are applicable to the M.Sc.(CS) programme offered by the university.
	2. The applicability of the Regulations must be understood in the context of the given Scheme of study and the Syllabus of the programme.
	3. The Regulations given here are in addition to the rules and regulations notified at the time of the admission.
	4. The authorities of University may modify, add, delete, expand or substantiate any part of the Regulations and syllabi, at any time.
2. **Course Content**

The programme shall be for duration of six semesters, spread out in three years. Each semester of the programme shall consist of either all or some of the following components:

* 1. Core Subjects
	2. AECC (Ability Enhancement Compulsory Course)
	3. SEC (Skill Enhancement Course)
	4. DSE (Discipline Specific Electives) /Choice Based

**2.5** GE (Generic Electives)

* 1. Lab Course
	2. Project Work

**2.1 Core Subjects**

Core subjects comprises of subjects that form an integral part of the programme. These subjects provide a strong ground in basic disciplines of study.

* 1. **AECC (Ability Enhancement Compulsory Course)**

The students who have not done English up to class XII are to opt for Hindi Communication. They can opt Environment studies and other languages also.

* 1. **SEC (Skill Enhancement Course)**

This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students.

* 1. **DSE (Discipline Specific Electives) /Choice Based**

Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study)

* 1. **GE (Generic Electives)**

An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

* 1. **Lab Courses**

These subjects are totally practical-based subjects. The learning of these subjects will be performed in laboratories/practical sites with equipment/resources. These subjects shall support the practical implementation of the core/core-bracket subjects. The processes of evaluation of their subjects will depend on the nature of that individual subject.

* 1. **Project Work**

The project work shall be done for a duration as specified by the Coordinator, in the area, related to the main subject of study or the specialization. The project work shall give the student an insight to the situations existing in the field/marked/industries, etc.

1. **Eligibility for Admission and Mode of Selection**
	1. The minimum qualification required to be eligible for admission is a pass in the Graduation examination in Computer or a course recognized as equivalent thereto buy the University, desirably with the relevant or related subjects as one of the subjects of study.
	2. The method of selection for the course shall normally by means of a Personal interview. However, the admission might also by means of an entrance test.
2. **Attendance and Examination**

A student is eligible to appear for the term-end examinations, only if he/she has put in a minimum of 75% attendance in each subject individually.

1. **Assessment and Examination**
	1. **Credits**

Credit Points will be awarded for all the subjects. One credit is equivalent to ten classrooms contact hours.

Each core subjects will carry either 6 or 4 or 2 credits, each core bracket subject will carry 2 credits and practical courses will carry either 6 or 4or 2 credits depending on the number of hours of teaching and training.

* 1. **Pattern of Assessment**

Assessment of student’s performance will be based on two components i.e. Internal Assessment and Term-end Examination conducted at the end of each semester.

A six-credit subject will comprise of an Internal Assessment component of 30 marks and a Term-end Examination component of 70 marks.

A four-credit subject will comprise of an Internal Assessment component of 30 marks and a Term-end Examination component of 70 marks.

A two-credit subject will comprise of an Internal Assessment component of 15 marks and a Term-end Examination component of 35 marks.

* 1. **Purpose of Internal Assessment**

The Term-end Examination will be conducted as per the University regulations Sessional tests, assignment, mid-term examination, etc. will be conducted in each subject during the course of each semester, for the.

* 1. **Assessment for Core Bracket Subjects**

Depending on the participation and performance of students, the faculty of the Core Bracket subject will grad the student in term of a five-point scale as given below:

|  |  |  |
| --- | --- | --- |
| **Marks Secured** | **Grade Point** | **Letter Grade** |
| 80 and above | 10 | Outstanding(O) |
| 70 and above but below 80 | 9 | Excellent (A+) |
| 65 and above but below 70 | 8 | Very Good (A) |
| 60 and above but below 65 | 7 | Good (B+) |
| 55 and above but below 60 | 6 | Above Average (B) |
| 50 and above but below 55 | 5 | Average (C) |
| 45 and above but below 50 | 4 | Pass(P) |
| Below 45 | 0 | Fail (F) |
|  | 0 | Absent (AB) |

This assessment is purely based on internal assessment of the subject faculty/coordinator.

* 1. **Assessment of Project Work**

The project work will carry a total of 150 marks. Of this, 45% marks are for required to clear the examination.70% marks are for the external examination and 30% marks will be awarded for internal evaluation.

* 1. **Eligibility to Appear for the Term-End Exam**

Students, who have put in a minimum of 75% attendance in each subject, shall be eligible to appear for the Term-end examination.

1. **Eligibility for Pass**
	1. A student shall be declared to have passed in a subject, if he/she secures at least 45% marks in the term-end examination and an aggregate of 45% including internal assessment.
	2. When a student reappears for the failed subject(s), the internal assessment marks originally secured by him/her in the first appearance in the subject(s), if any, will be carried forward.
	3. A student shall be declared to have passed in Core Bracket subject, if he/she secures at least a pass grade.
	4. Promotion of the student to the next semester, is not automatic, but is dependent on certain other conditions.
2. **Classification of Successful Students**
	1. On successful completion of the programme, the students will be classified as below:

|  |  |
| --- | --- |
| Distinction | Those securing an aggregate mark of 75% and above in all the   subjects; |
| First Class | Those securing an aggregate mark of less than 75%, but above 60% in all the subjects; |
| Second Class | Those securing an aggregate mark of less than 60%, but above 50% in all the subjects; |
| Pass | Those securing an aggregate mark of more than 45% in all the subjects; |

* 1. **Ranks**

Only students who have passed each of the semester examination at the first appearance, shall be eligible for award of Ranks. The first three ranks shall be notified.

**Award of Qualification**

Students will be awarded the Bachelor Degree of M.Sc. (CS), upon fulfillment of the following criteria:

* 1. Must have passed all the subjects of thee six semesters with a minimum of 45% om each subject including Internal assessment and secured 45% in aggregate;
	2. Must have secured at least a pass grade in all the Core Bracket subjects.
	3. Must have secured a minimum of 45% marks in the project work (wherever applicable).

8.4Must have complied with all other assessment guidelines and criteria notified during the conduct of the programme.

1. **Maximum period for the complement of the Programme**

The maximum period for the completion of the programme shall be five years from the date of joining the programme.

1. **General Guidelines**
	1. **Academic Integrity and Ethics**
2. A student who has committed an act of academic dishonesty will be deemed to have failed to meet a basic requirement of satisfactory academic performance. Thus, academic dishonesty is not only a basic for disciplinary action but also is relevant to the evaluation of student’s level of performance and progress.
3. Where there has been violation of the basic ethos and principles of academic integrity and ethics, the Director/Board of Examiners/Course coordinator may use their discretion in terms of disciplinary action to be taken.
4. Academic dishonesty includes, but is not necessarily limited, to the following:
5. Cheating or knowingly assisting another student in committing an act of cheating;
6. Unauthorized possession of examination materials, destruction or hiding of relevant materials;
7. Act of plagiarism;
8. Unauthorized changing of marks or marking on examination records.
	1. **Attendance**
9. Student are required to attend and participate in all scheduled class sessions, guest lecturer, workshops, outbound learning programs and club/ forum activities of both academic and non-academic nature.
10. Students may be dropped from the programs due to excessive and non-intimated absences.
11. Students must notify the program coordinator in writing, the reasons for absence, if any, from class sessions, activities and assessment components.
12. On notification of absences (including anticipated absences), the Director/ Programmer coordinator would determine whether the absences could be rectified or whether it is possible to satisfactorily complete the subject with the number of identified absences.
	1. **General**
13. The students are expected to spend a considerable amount of time in research, reading and practice.
14. All students are expected to develop and maintain a positive profession attitude and approach throughout the Programme and in conduct of all other activities.
15. Attendance alone is not sufficient. Students are expected to participate, to help the class learn and understand the topics under consideration.
16. Food and drinks are not permitted in the classroom / conference hall.
17. All students are expected to dress as per stipulated dress code.

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| **M.Sc. (Computer Science)** |
| **SEMESTER -I** |
| **Subject****Code** | **Subject** | **Credit** | **L+T+P** | **Univ.** | **Int.****Marks** | **Total****Marks** |
| **1 Cr=****1 hr.** | **Exam****Marks** |
| **CORE COURSES** |
| MCS 101 | RDBMS | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 102 | Data Structure using C | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 103 | Operating System Architectures and Concepts | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 104 | Computer System Architecture | **4** | 3+1+0 | 70 | 30 | 100 |
|  |  |  |  |  |  |  |
| **DSE (DISCIPLINE SPECIFIC ELECTIVES) /CHOICE BASED** |
| MCS 105 | Elective I – Big Data Management/ Data Communication and Networking | **4** | 3+1+0 | 70 | 30 | 100 |
|  |  |  |  |  |  |  |
| **SEC (SKILL ENHANCMENT COURSE)** |
| MCS 106 | Internship | 2 | 1+1+0 | 35 | 15 | 50 |
| **LAB COURSES** |
| MCS 107 | RDBMS Lab | **2** | 0+0+2 | 35 | 15 | 50 |
| MCS 108 | Data Structure using C Lab | **2** | 0+0+2 | 35 | 15 | 50 |
|  |  | **26** |  | **455** | **195** | **650** |

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| **M.Sc. (Computer Science)** |
| **SEMESTER -II** |
| **Subject****Code** | **Subject** | **Credit** | **L+T+P** | **Univ.** | **Int.****Marks** | **Total****Marks** |
| **1 Cr=****1 hr.** | **Exam****Marks** |
| **CORE COURSES** |
| MCS 201 | Programming in C++ | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 202 | Web Technology with React | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 203 | Research Methodology | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 204 | Artificial Intelligence | **4** | 3+1+0 | 70 | 30 | 100 |
|  |  |  |  |  |  |  |
| **DSE (DISCIPLINE SPECIFIC ELECTIVES) /CHOICE BASED** |
| MCS 205 |  Elective II – Cloud Computing/ Advanced Networking | **4** | 3+1+0 | 70 | 30 | 100 |
|  |  |  |  |  |  |  |
| **SEC (SKILL ENHANCMENT COURSE)** |
| MCS 206 | Internship | 2 | 1+1+0 | 35 | 15 | 50 |
| **LAB COURSES** |
| MCS 207 | Programming in C++ Lab | **2** | 0+0+2 | 35 | 15 | 50 |
| MCS 208 | Web Technology with React Lab | **2** | 0+0+2 | 35 | 15 | 50 |
|  |  | **26** |  | **455** | **195** | **650** |

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| **M.Sc. (Computer Science)** |
| **SEMESTER -III** |
| **Subject****Code** | **Subject** | **Credit** | **L+T+P** | **Univ.** | **Int.** **Marks** | **Total** **Marks** |
| **1 Cr=****1 hr.** | **Exam** **Marks** |
| **CORE COURSES** |
| MCS 301 | Programming in Core Java | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 302 | Information Security | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 303 | Operation Research  | **4** | 3+1+0 | 70 | 30 | 100 |
|  |  |  |  |  |  |  |
| **DSE (DISCIPLINE SPECIFIC ELECTIVES) /CHOICE BASED** |
| MCS 306 | Elective III – Data Mining and Data Warehousing / Artificial Neural Network | **4** | 4+2+0 | 70 | 30 | 100 |
| MCS 305 | Research Paper Publication | **4** | 1+1+2 | 70 | 30 | 100 |
|  |  |  |  |  |  |  |
| **GE (GENERIC ELECTIVES)** |
| MCS 304 | Industrial/Company/Professional Training  | **4** | 0+2+2 | 70 | 30 | 100 |
| **LAB COURSES** |
|  |
| MCS 307 | Programming Core Java Lab | **2** | 0+0+2 | 35 | 15 | 50 |
|  |  | **26** |  | **455** | **195** | **650** |

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| **M.Sc. (Computer Science)** |
| **SEMESTER -IV** |
| **Subject****Code** | **Subject** | **Credit** | **L+T+P** | **Univ.** | **Int.****Marks** | **Total****Marks** |
| **1 Cr=****1 hr.** | **Exam****Marks** |
| **CORE COURSES** |
| MCS 401 | Programming in Advance Java | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 402 | Digital Image Processing | **4** | 3+1+0 | 70 | 30 | 100 |
| MCS 403 | Introduction to Blockchain | **4** | 3+1+0 | 70 | 30 | 100 |
| **SEC (Skill Enhancement Course)** |
| MCS 404 | Personality Development & Professional Communication Skill | **2** | 1+10 | 35 | 15 | 50 |
|  |  |  |  |  |  |  |
| **DSE (DISCIPLINE SPECIFIC ELECTIVES) /CHOICE BASED** |
| MCS 405 | Elective IV – Machine Learning/ Internet of Things | **4** | 4+2+0 | 70 | 30 | 100 |
|  |  |  |  |  |  |  |
| **GE (GENERIC ELECTIVES)** |
| MCS 406 | System Development project (System Design and Implementation | **6** | 3+1+0 | 105 | **45** | 150 |
| **LAB COURSES** |
|  |
| MCS 407 | Programming in Advance Java Lab | **2** | 0+0+2 | 35 | 15 | 50 |
|  |  | **26** |  | **455** | **195** | **650** |

**MCS 101**

**RDBMS**

**MODULE I :** Introduction to Database Advantages of DBMS, Type of Data Models, Classification of DBMS, Schema and instances, DBMS Architecture and Data Independence, Entity- Relationship Model, Attributes and Keys, Relationship Types, Types of Entity, Enhanced E–R Modeling, Specialization and Generalization, Construction & Conversion of E-R Diagram into Tables, Constraints of E-R Diagram, Merits & Demerits of E-R diagram.

**MODULE II :** Database Design Logical Database design: various Database Design Strategies, Functional Dependencies, Types and Characteristics of FD, inference Rule, closure set of attributes & applications (equivalences & canonical form), Normalization for Relational Databases: Definition, Types of Normalization: First Normal form, Second Normal form, Third Normal form, Boyce-codd normal form, problem related with normal forms & solutions. Multivalued & Join Dependencies, 4th & 5th Normalization, Numerical based on Normal forms, Merits & Demerits of Normalization.

**MODULE III :** Structured Query Language Components of SQL: DDL, DML, DCL, View, Index, Cursors and Triggers, Query Processing: Query processing stages, Query interpretation, Query execution plan, Table scans, Classification Queries, Aggregate function, Use of Group By, Having, Order by Clause, sub queries characteristic & classification, Use of Any, All, Exist & Not Exist operator, join operator, types of join, Structure of a query optimizer.

**MODULE IV :** Relational Algebra, Relational Calculus & Transaction Processing Classification of Relational Algebra operator (Native, Extended and Set Operators), Relational data model concepts, constraints, Relational Calculus: Tuple Relational Calculus & Domain Relational Calculus. Transaction Processing: Types of failures, ACID property, Six different isolation problems, schedules and recoverability, serialisability of schedules, Levels of transaction consistency, Deadlocks, Nested transaction, Transaction benchmarking.

**MODULE V :** Indexes, Concurrency Control & Crash Recovery File Organizations: Introduction, Secondary Storage Devices, Buffering of Blocks, Structure of Files: Types of Single Level ordered indexes, Multilevel indexes, Dynamics Multilevel indexes using B-trees and B+- Trees. Concurrency Control: Different type of concurrency control techniques & their comparative analysis, Locking techniques, Time-stamp ordering, Multi-version techniques, Optimistic techniques, Multiple granularity. Integrity, Security, Non-procedural and procedural integrity constraints, Integrity constraints specifications in SQL. Failure classification, Different type of Recovery techniques & their comparative analysis, deferred update, immediate update, Shadow paging, Check points, On-line backup during database updates.

**TEXT BOOKS:**

1. Database system concept, Korth & Sudarshan, MH.

2. Introduction to Database Systems, C.J.Date, Pearson Education.

**REFERENCE BOOKS:**

1. Principles of Database Systems”, 2nd Edn., Ullman, J.O, Galgotia Publications.

2. Fundamentals of Database Systems, Elmasri & Navathe, Pearson Education.

3. Database Design Fundamentals, Rishe, PHI.

**MCS 102**

**Data Structure using ‘C’**

**MODULE – I**

Arrays Basics, Practice : Arrays Basics, Structures, Practice : Structures, Pointers, Practice : Pointers, Reference in C++, Practice : Reference, Pointer to Structure, Practice : Pointer to Structure, Functions, Practice : Functions, Parameter Passing Methods, Practice : Parameter Passing Methods, Array as Parameter, Practice : Array as Parameter, Structure as Parameter, Practice : Structure as Parameter, Structures and Functions, Practice : Monolithic Program, Practice : Modular Program, Practice : Structure and Functions,

**MODULE - II**

Introduction, Stack vs Heap Memory, Physical Vs Logical data structure, ADT, Time and space Complexity with code, Recursion: How Recursion Works, Generalizing Recursion, How recursion uses in stack, Recursion Relation- Time complexity of recursion, static and global variable in recursion, tail recursion, head recursion, indirect recursion, nested recursion, Array Representation: Introduction to array, declaration of array, static vs dynamic array, how to increase array size, 2D array, Array representation by compiler, row major formula for 2D array, column major formula for 2D array, Array ADT, inserting in an array, deleting from array, Linear search, Linear search algorithm, Binary Search, Binary Search algorithm, analysis of binary search. Merging array, set operation on array, matrix introduction, diagonal matrix, symmetric matrix, tri-diagonal and tri-band matrix. Sparse matrix representation, addition of Sparse matrices, polynomial representation, polynomial evaluation, polynomial addition.

**MODULE – III**

LINKED LIST: Why we need Dynamic Data Structure Linked List, About Linked List, Learn Important Syntax used for Linked List, Display Linked List, Counting Nodes in a Linked List, Sum of All Elements in a Linked List, Maximum Element in a Linked List, Searching in a Linked List, Improve Searching in Linked List, Inserting in a Linked List, Creating a Linked List using Insert, Creating a Linked List by Inserting at Last, Deleting from Linked List, Check if a Linked List is Sorted, Reversing a Linked List, Doubly Linked List, Circular linked list.Introduction to Stack, Stack using Array, Implementation on Stack using Array, Stack using Linked List, Stack Operations using Linked List, Infix to Postfix Conversion, Associativity and Unary Operators, Evaluation of Postfix Expression, Queue ADT, Queue ADT, Queue using Two Pointers, Implementing Queue using Array, Circular Queue, Double Ended Queue DEQUEUE, Priority Queues.

**MODULE - IV**

Tree: Terminology, Number of Binary Trees using N Nodes, Height vs Nodes in Binary Tree, Internal Nodes vs External Nodes in Binary Tree, Strict Binary Tree, Height vs Node of Strict Binary Tree, n-ary Trees, Analysis of n-Ary Trees, Representation of Binary Tree, Full vs Complete Binary Tree, Strict vs Complete Binary Tree, Preorder Tree Traversal, Height and Count of Binary Tree. BST introduction, Searching in a Binary Search Tree, Inserting in a Binary Search Tree, Creating a Binary Search Tree, Deleting from Binary Search Tree, Generating BST from Preorder, Drawbacks of Binary Search Tree, Introduction to AVL Trees, Introduction to AVL Trees, General form of AVL Rotations, Generating AVL Tree, 2-3 Trees, 2-3-4 Trees, Red-Black Trees Introduction, Red-Black Tree creation.

**MODULE – V**

Introduction to Heap, Inserting in a Heap, Creating a Heap, Deleting from Heap and Heap Sort, Heapify - Faster Method for creating Heap, Criteria used for Analysing Sorts, Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Merging, iterative Merge Sort, Introduction to Hashing, Chaining, Linear Probing, Quadratic Probing, Double Hashing, Introduction to Graphs, Representation of Undirected Graph, Representation of Directed Graphs, Breadth First Search, Depth First Search, Spanning Trees, Prim's Minimum Cost Spanning Tree, Kruskal's Minimum Cost Spanning Tree, Disjoint Subsets, Kruskal's Program.

**MCS 103**

**Operating System Architecture and Concepts**

**Module-I**

Introduction to Operating Systems, Types of operating systems, Major components of OS, BIOS, IVT, BIOS versions, Dual booting, Various Operating system architectures, Design Principles, Operating Systems for tiny devices (like mobile, tablets, set-top boxes).

**Module-II**

Introduction to Unix, versions of Unix, Kernel architecture, Unix Shell and its types, File system, Structure of the inode, etc. Memory Management in Unix.Process States, Process State Transition, Process Control Block (PCB), Parent-child relationship, The different segments of a process, Internal and external commands.

**Module-III**

Introduction to Linux, versions of Linux, Kernel architecture, File system- ext2, ext3, ResierFS, Journaling capability, Linux Booting process. Memory Management in Linux. Linux Shell and its types, concept of X-Window, KDE, Gnome. Understanding shells, batch commands, kill, ps, who, sleep.

**Module-IV**

Microsoft Windows families, Windows NT family,  Windows File Systems, Booting Sequence, Windows 8 as Case Study: Architecture, aero and metro interfaces.Introduction to Apple’s Mac OS X, basics, The Mac OS X File Structure, Units of Measure ,  storage, and organization methods.

**Module-V**

RealTime Operating System: Principles, Semaphores and Queues, Hard RealTime Scheduling Considerations, Saving Memory and Power, An example RTOS like uCOS (Open Source).

**Text Books and References:**

* “Operating Systems Design & implementation”, Andrew S. Tanenbam, Albert S. Woodhull Pearson.
* Operating System Concepts (7thEd) by Silberschatz and Galvin, Wiley, 2000.
* Sumitabha Das, Unix : Concepts and Applications, Third Edition, 1998, Tata McGraw Hill.
* Refer Research Papers and Google Scholar.

**MCS 104**

**Computer System Architecture**

**MODULE I :** Data Representation and Digital Components: Number systems, integer and floating point representation, character codes (ASCII, EBCDIC), Error detection and correction codes, Boolean algebra, map simplification, logic gates; combinational circuits: half and full adders, multiplexers, decoders and encoders; sequential circuits: flip-flops, registers, counters; basic computer components and their function.

**MODULE II :** Principles Of Computer Design: Machine language instructions, Memory address structure, register organization, Instruction fields, instruction types, instruction set selection, Micro operations, Register transfer language, Instruction cycle and Interrupt cycle, Instruction formats and addressing modes.

**MODULE III :** CPU & Control Unit Stack, Instruction formats, Addressing Modes, Data Transfer, Data path and control path design, microprogrammed and hardwired control, RISC vs CISC, pipelining in CPU design, super scalar processors.

**MODULE IV :** Computer Arithmetic & I/O Techniques: Addition, Subtraction, Multiplication and Division Algorithms, I/O addressing, Synchronization, I/O interfacing, Programmed I/O, Interrupt mechanism, DMA, I/O processors.

**MODULE V :** Memory System & Multiprocessor: Basic cell of static and dynamic RAM, building large memories using chips, memory array organization', memory hierarchy, memory interleaving, associative memory, cache memory organization, and virtual memory organization, coherence, interconnection structure, inter-processor arbitration communication and synchronization

**TEXT BOOKS**

1. Computer System Architecture by Morris Mano (PHI 3rd edition)

2. Digital Computer Logic Design by Morris Mano (PHI)

**REFERENCES BOOKS**

1. Computer organization and architecture by Willian Stallings (PHI)

2. Computer Organization and Architecture by J.P.Hayes (TMH) 3. Computer Architecture by Chaudhary, IIT-Kharagpur.

**MCS 105**

**Elective I – Big Data Management**

**MODULE I - INTRODUCTION TO BIG DATA**

Introduction – distributed file system – Big Data and its importance, FiveVs, Drivers for Big data, Big data analytics, big data applications. Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce.

**MODULE II - INTRODUCTION TO HADOOP**

Big Data – Apache Hadoop & HadoopEcoSystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.

**MODULE III - HADOOP ARCHITECTURE**

Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, HadoopMapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH &Hadoop Configuration – HDFS Administering –Monitoring & Maintenance.

**MODULE IV - HADOOP ECOSYSTEM AND YARN**

Hadoop ecosystem components - Schedulers - Fair and Capacity, Hadoop 2.0 New FeaturesNameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.

**MODULE V - HIVE AND HIVEQL, HBASE**

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying, Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBaseconceptsAdvanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

**REFERENCES**

1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, ISBN: 9788126551071, 2015.

2. Chris Eaton, Dirk deroos et al. , “Understanding Big data ”, McGraw Hill, 2012.

3. Tom White, “Hadoop: The definitive Guide” , O Reilly 2012.

4. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packet Publishing 2013.

5. Tom Plunkett, Brian Macdonald et al, “Oracle Big Data Handbook”, Oracle Press, 2014.

6. http://www.bigdatauniversity.com/

7. JyLiebowitz, “Big Data and Business analytics”, CRC press, 2013.

**MCS 105**

**Elective I – Data Communication and Networking**

**MODULE I :** Analog and Digital signals, Wired and Wireless transmission channels, Modulation - Analog and Digital, Multiplexing- Analog and Digital, Signal encoding techniques, Wireless Transmission: Frequency for radio transmission, Signals, Antennas, Signal propagation techniques.

**MODULE II :** Circuit switching Networks and concepts – Asynchronous transfer mode – ATM Cells – routing in packet switching networks – effects of congestion-congestion control- traffic management.

    Network Connectivity Devices: Amplifier, Repeater, Hub, Switch, Bridge, Router, Gateway, Intrusion Detection/Protection Systems, Firewall, DNS (Domain Name Server).

**MODULE III :** Common Protocols and Interfaces in the LAN environment: Data link layers protocols, LLC and MAC sub layer protocols, Data Link Control Protocol – Flow and error control, HDLC, IEEE 802 Project and Layers, Ethernet, Token Ring, Token Bus and FDDI, Bridge protocols, Switching in the LAN environment.

**MODULE IV :** Common Protocols and Interfaces in the Upper Layers (TCP/IP): Background (Routing protocols), TCP/IP suite, Network layer (Internetwork layer), Transport layer, Application layer, Addressing and routing design, FTP (File Transfer Protocol), SMTP (Simple Mail Transfer Protocol), NTP (Network Time Protocol), Common WAN Protocol, ISDN, SONET.

**MODULE V :** Medium Access Techniques: SDMA, FDMA, TDMA, CDMA, Spread Spectrum Concepts – Frequency Hopping, Infrastructure Based and Infrastructure-less (Ad hoc) networks, Cellular systems, Mobile IP Concept, Wireless LAN, IEEE 802.11: System architecture, Protocol architecture, Physical layer, Medium access control layer, MAC management, Future development, Satellite Systems: History, Applications, Basics: GEO, LEO, MEO; Routing, Localization, Handover, Examples.

**Text Books and References:**

* William Stallings, “Data computer communication”, Prentice Hall India, 8th Edition.
* Andrew & Tanenbaum, “Computer Network ”.
* Jochen Schiller, Mobile communications, Addison wisely , Pearson Education.
* Wiiliam Stallings, Wireless Communications and Networks.

**MCS 106**

**Internship**

**MCS 107**

**RDBMS Lab**

**MCS 108**

**Data Structure using ‘C’ Lab**

**MCS 201**

**Programming in C++**

**MODULE I :** Overview of Object Oriented System, Concept of class, object, abstraction, inheritance, polymorphism and Encapsulation, OOP Paradigm and Advantages, Comparison between Functional Programming and OOP Approach, Overloading, Comparison between C++ and C.

**MODULE II :** Introduction to C++, Identifier and keywords, Constants, Basic program construction, input/output using cin/ cout; preprocessor Directives; Comments, integer, character, float data types manipulators, Arithmetic operators; Library functions. Variable declaration, statements, expressions, input and output, conditional expression loop statements, breaking control statements C++ Operators, type conversion, Defining a function, types of functions, Structure, Enumerated Data Types, simple functions, Passing arguments to and returning values from functions, Reference Arguments, Overloaded functions, Inline functions, Default Arguments, Variable and Storage classes, Returning by reference, Storage class specifier, recursion, Arrays, structures, pointers and structures, unions.

**MODULE III :** Classes, member functions, objects, Specifying & using class & object, Constructors, copy constructors, public, private & protected, constructors, destructors, objects as function Unary & Binary operators, Data conversion, Pitfalls of overloading & Conversion. Pointers and classes, nested classes, inline member functions, static class member, friend functions, Inheritance, derivation, Derived class and their constructs, Diamond Problem, overriding member functions, class hierarchies, Inheritance Visibility Specifiers.

**MODULE IV :**Dynamic memory allocation, pointer to objects, new-delete, Linked-Lists, Persistent objects; Polymorphism, compile time and runtime polymorphism, virtual functions, pure virtual functions, , Streams and files, Virtual, friend and static function; the this pointer; streams; string, character, object I/O; I/O with Multiple objects; File pointers; Disk I/O with member function; Error Handling.

**MODULE V :** Generic function – template function, function name overloading, container classes, member access control, container types, the array string, the ordered collection, the stack, the queue, iteration methods, linked list of objects, creating a container class, Exception handling and Namespaces.

**Text Books**

* K. R. Venugopal, “Mastering C++”, Tata Mgraw Hill.
* Robert Lafore, “Object Oriented Programming in Turbo C++”, Galgotia Publications.

**Reference Books**

* D. Ravichandran, “Programming with C++”, TMH, 1996.
* BjarneStrautrup, “The C++ Programming Language”, Addition- Wesley Publication Company,1995.
* BarkakatiNabajyoti , “Object Oriented Programming in C++”, Prentice Hall of India, 1996
* D. Parasons, “Object Oriented Programming with C++”, BPB Publication.
* Schildt Herbert, “C++: The Complete Reference”, 4th Ed., Tata McGraw Hill.

YeshwanthKanetkar, “Let us C++”, BPB Publications.

**MCS 202**

**Web Technology with React**

**MODULE I :**

**Web development fundamental :** Understand how websites work and how HTML, CSS and JavaScript contribute. Understand how the internet works. Start coding with HTML, CSS, and JavaScript. Learn and understand git, GitHub and version control. Use the Unix command line to become a power user and write bash commands. **HTML5 :** Learn the anatomy of HTML syntax to structure your websites. Understand the HTML boilerplate and HTML doctypes. How to structure text in HTML. How to structure HTML lists to create unordered and ordered lists. How to insert images using HTML How to create hyperlinks using anchor tags. Understand how to use HTML tables for content. How to use tables for layout. Learn HTML best practices. Understand about HTML forms and create a simple contact me form.

**MOCULE :**

**CSS 3 :** Understand what are cascading style sheets and how you can use it to style your website. How to use CSS selectors and properties. Learn about how to use inline, internal and external CSS. Understand CSS coding best practices. Learn about CSS sizing methods. Learn the anatomy of CSS syntax and structure. CSS specificity and implementing style hierarchy. Class vs. Ids and how to target each. CSS display and how to implement layout. How to use CSS static, relative and absolute positioning systems. Font styling using CSS and web safe fonts. Centering elements using CSS. Website design fundamentals and typography. How to use CSS float and clear. How combine CSS selectors and understand selector priority. **BOOTSTRAP 4 :** Learn the fundamentals of implementing responsive web design. How to use Balsamiq to mockup and wireframe websites. The fundamentals of UI design for websites. How to install the Bootstrap framework. Understanding the Bootstrap grid layout system. How to use bootstrap containers to layout your website easily. Learn to use other Bootstrap components such as buttons. Adding symbols using Font Awesome. Learn to use Bootstrap carousels. Add Bootstrap cards to your website. Using Bootstrap navigation bars.

**MODULE IV :**

**JAVASCRIPTES6 :** The Fundamentals of Code Starting code with alerts and prompts. Understand Variables and Data Types in JavaScript Variable naming in JS Working with strings and numbers Randomization and logical operators Loops, collections and Conditionals. Functions and invocation patterns Discussion of ECMA Scripts Intermediate JavaScript Learn to use JS Expressions, Operators, Statements and Declarations Object-Oriented Programming JS Objects and Prototypes `This`, Scope and Closures Objects and Prototypes Refactoring and Debugging.

**MODULE V :**

**DOCUMENTOBJECTMODEL(DOM) :** Learn the tree structure of HTML based websites. Traverse through the document using object notation. Separation of concerns and coding best practices. Manipulate and change the HTML elements using your understanding of the DOM. N O D E . J S : Explore the components of back-end development, working with an MVC framework Apply concepts like data types, objects, methods, objectoriented programming, and classes in the context of backend development.

**Module 5**

**DATABASEFUNDAMENTALS :** Data Relationships Designing a Data Model Relational Databases Alternative Databases Entity Relationship Modelling (ERM) and Object Relational Mapping (ORM) . Working with Database Schemas Create-Read-Update-Destroy (CRUD) Database Joins Querying SQL databases. **REACT.JS :** Learn front-end development with React. Understand when and how to use React Components. Learn to pass Props and work with them. Learn to write JSX and understand JSX syntax. Learn about the React DOM. Learn State Management in React. Learn about React Hooks. Learn about conditional rendering in React. Understand the difference between class and functional components. **DEPOYMENT :** Understand hosting and deployment.

**MCS 203**

**Research Technology**

**MODULE I:** Research Meaning, objective, Types of Research, research approach, significances of research, research process, criteria of good research, research problem, research design.

**MODULE II:** Sampling techniques: Sampling theory – types of sampling – Steps in sampling – Sampling and Non-sampling error – Sample size – Advantages and limitations of sampling. Collection of Data: Primary Data – Meaning – Data Collection methods – Secondary data.

**MODULE III:** Statistics in Research – Measure of Central tendency – Dispersion – Skewness and Kurtosis in research, Hypothesis – Fundamentals of Hypothesis testing – Standard Error.

**MODULE IV:** Para metric tests: Testing of significance – mean, Proportion, Variance and Correlation – testing for Significance of difference between means, proportions, Chi-square tests.

**MODULE V:** Research Report: Types of reports – contents – styles of reporting – Steps in drafting reports - Editing the final draft – Evaluating the final draft.

**Text/Reference Books:**

* Statistical Methods - S.P. Gupta.
* Research Methodology Methods and Techniques - C.R. Kothari.
* Statistics (Theory and Practice) - B.N. Gupta.

Research Methodology Methods and Statistical Techniques.

**MCS204**

**Artificial Intelligence**

**MODULE I:** Introduction and Overview: Meaning Of AI, The AI Problems, Task Domains, AI Technique, Criteria for Success, Problems, Problem Spaces & Search: Defining the Problem as a State Space Search.

**MODULE II:**     Production Systems – BFS, DFS, Heuristic Search, Common AI Problems, Heuristic Search Techniques: Generate & Test, Hill Climbing, Best First Search, Constraint Satisfaction, Means-End Analysis.

**MODULE III:**     Knowledge Representation: General Concepts of Knowledge, Approaches of Knowledge Representation, Predicate Logic to Represent Knowledge, Resolution, Unification algorithm, Knowledge Representation using Rules: Procedural Vs Declarative Knowledge, Logic Programming, Forward Vs Backward Reasoning, Matching & Control Knowledge.

**MODULE IV:**     Statistical Reasoning - Probability & Bayes Theorem, Certainty Factors and Rule Based Systems, Bayesian N/W, Fuzzy Logic and applications, Natural Language Processing – Introduction, Steps, Syntactic Processing, Semantic Analysis, Discourse & Pragmatic Processing, Spell Checking.

**MODULE V:**     Learning: Meaning, Rote Learning, learning by taking Advice, learning from examples, Explanation-Based learning, Expert Systems & Its Architecture, Speech Recognition, Overview of Prolog: Introduction, Converting English to Prolog Facts and Rules, Goals, Prolog Terminology.

**MCS205**

**Elective II – Cloud Computing**

**MODULE I -** Introduction of Cloud Computing: What is Cloud Computing?, How it works?, Types of Cloud, Goals & Challenges, Leveraging Cloud Computing, Cloud Economics and Total Cost of Ownership, Cloud Service Models Software as a Service (SaaS): Introduction, Challenges in SaaS Model, SaaS Integration Services, Advantages and Disadvantages. Infrastructure As a Services (IaaS): Introduction, Virtual Machines, VM Migration Services, Advantages and Disadvantages. Platform As a service (PaaS): Introduction, Integration of Private and Public Cloud, Advantages and Disadvantages.

**MODULE II -** Virtualization and Abstraction: What is Virtualization and how abstraction is provided in cloud? Advantages and Disadvantages, Types of Hypervisor, and Load balancing, Cloud Security Tools and technologies to secure the data in Private and Public Cloud Architecture. Security Concerns, Legal issues and Aspects, Multi-tenancy issues.

**MODULE III -** Introduction to Simulator, understanding CloudSim simulator, CloudSim Architecture(User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to GreenCloud.

**MODULE IV -** Introduction to AWS AWS history, AWS Infrastructure, AWS services, AWS ecosystem, Programming, management console and storage on AWS Basic Understanding APIs - AWS programming interfaces, Web services, AWS URL naming, Matching interfaces and services, Elastic block store - Simple storage service, Glacier - Content delivery platforms, AWS identity services, security and compliance Users, groups, and roles - Understanding credentials, Security policies, IAM abilities and limitations, AWS physical security - AWS compliance initiatives, Understanding public/private keys, Other AWS security capabilities.

**MODULE V -** AWS computing and marketplace Elastic cloud compute - Introduction to servers, Imaging computers, AWS networking and databases Virtual private clouds, Cloud models, Private DNS servers (Route 53), Relational database service – DynamoDB, ElastiCache, Redshift. Other AWS services and management services Analytics services, Application services, AWS billing and Dealing with disaster Managing costs, Utilization and tracking.

**Text:**

1. David Marshall, Wade A. Reynolds, Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center, Auerbach
2. Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online - Michael Miller - Que 2008

**References:**

1. Publications, 2006. Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011

Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill , New Delhi – 2010

**MCS 205**

**Elective II – Advanced Networking**

**MODULE I** : Introduction: Layered Network Architecture, Review of ISO-OSI Model, Introduction to TCP/IP Model.; Data Communication Techniques; Pulse Code Modulation (PCM), Differential Pulse Code Modulation (DPCM), Delta Modulation (DM).; Multiplexing Techniques; Frequency Division, Time Division, Statistical Time Division Multiplexing.; Physical Layer: Transmission Media: Wires, Cables, Radio Links, Satellite Link, Fiber Optic.; Error Detection and Correction: Single and Burst Error, parity Check Codes, Cyclic Redundancy Code & Hamming Code.

**MODULE II** : Data Link Layer Protocols: Stop and Wait Protocols: Noise free and Noisy channels, performance and efficiency, Sliding Window Protocols: Go Back and Selective Repeat ARQS, performance and efficiency, verification of protocol., HDLC and ATM: HDLC data link protocol, ISDN, Channel Structure, Asynchronous Transfer Mode (ATM), ATM Cells, Header and Cell Format. Layers in ATM Class 1,2,3,4 traffic.

**MODULE III** : Medium Access Control Sub layer: Concept of Random Access, Pure ALOHA throughput characteristics of ALOHA Throughputs for finite and infinite populations S-ALOHA., LAN: IEEE 802.3, 802.4 and 802.5 Protocols performance of Ethernet. Token Ring Protocol, FDDI Protocol, Distributed Queue Dual Bus (DQDB) Protocol.

**MODULE IV :** Network and Transport Layer Protocols: General Principles, Virtual circuits and datagram’s, Windows flow control, Packet Discarding, Traffic Shaping, Choke RSVP, Network Layer in ATM, Internetworking using Bridge, Routers and Gateways, Routing Algorithms: Optimality principle, shortest path routing-Dijkstra, Flooding and broadcasting, distance vector routing, link state routing, flow based routing, Multicasting routing flow and congestion control. Internet Architecture and Addressing. Transport Layer: Design issues, Quality of Services, Primitives Connection Management: Addressing, Connection Establishment and Releases. Flow control and Buffering, Crash recovery, Element of TCP/ IP protocol: User Data gram Protocol, (UDP/TCP) Layering.

**MODULE V** : Presentation And Application Layer Protocols: Presentation concepts SNMP Abstract Syntax notation. I (ASN-I), Cryptography: Substitutions and Transposition, Ciphers, Data Encryption Standard (DES), DES Chaining, Breaking DES, Public Key Cryptography, Authentication Protocols.

**Text Books :**

1. A. S. Tanenbaum “Computer Network: Second Ed. Prentice Hall, India (tan).

2. B. A. Frouzan, Data Communication, Tata Mc Graw Hill. Reference: 1. D. Berekas an R. Gallager, “Data Networks:, second Ed. Prentice Hall, India.

**MCS 206**

**Internship**

**MCS 207**

**Programming in C++ Lab**

**MCS 208**

**Web Technology with React Lab**

**MCS 301**

**Programming in Core Java**

**MODULE I:** Introduction to java programming An overview of Java: Object Oriented Programming, History of java, Features of Java, Java Virtual Machine, Java Environment: Java Development Kit, Java Standard Library, introduction to java.lang package, Data Types, Variables: Declaring a variable, Dynamic Initialization, The scope and life time of variable, Type conversion and Casting: Narrowing and Widening Conversions, Numeric Promotions, Type Conversion Contexts; Operators: Arithmetic Operators, Relational Operators, Logical Operators, Bit wise Operators, Conditional Operators, new operator, [ ] and instance of operator. Control Statements: Java’s Selection statement, Iteration Statement, Jump Statement, Array: Declaring Array variables, constructing an Array, Initializing an Array, Multidimensional Arrays, Anonymous Arrays.

**MODULE II:** Define the Class and interface -Introducing Classes: Class Fundamentals, Declaring Object, Assigning Object Reference Variables, Defining Methods, method overloading, Using objects as parameter, Constructor, Garbage collection and it’s algorithms, finalize () method, System.gc() and Runtime.gc(). Inheritance: Inheritance basic, method overloading, object reference, this and super keyword, Chaining constructor using this, use of super, Member accessibility modifier: public, protected, private and default accessibility of member.Package: Define package, CLASSPATH, importing package, Abstract class and abstract methods, Interface: Define an interface, Abstract class Vs Interface, implementing interface, extending interface, variable in interface, Overview of nested class: Top level nested class and interface, Non static inner class, Local class, Anonymous class. Method References, Types, Functional Interface, Static and default method in interface, private method in interface.

**MODULE III:** Exception handling and Multithreading -Exception Handling: Exception Hierarchy, Exception types, Exceptions vs Error Uncaught Exception, Using try and catch, multiple catch, nested try block, throw, and throws, finally. Multithreading: creating Thread, Using Thread Class and Implementing Runnable Interface, Difference between Thread class and Runnable Interface, Thread priority, synchronization, Thread Scheduler, Running & yielding, sleeping and waking up, waiting and notifying, suspend and resume, miscellaneous method in thread class, Lambda Expression, Stream API, Stream Filter, Collectors Class, String joiner class, Optional class, JavaScript Nashorn, Type Inference, Parameter Reflection, Type Annotation.

**MODULE- IV :**Input output, Networking and Fundamental class of java Object class, String class, StringBuffer class, Wrapper class, Math class, Collection: Collection interface, List interface, Set interface sorted interface, Array List class, Liked List class, Tree Set, Comparator, Vector, Stack. Input output classes and interface: File class, Reader class, Writer class, InputStream class, OutputStream class, Random AccessFile class, various ways for reading from and writing into a file, Object Serialization. Networking: Socket overview, Client/Server, Proxy Server, Network class and interface, TCP/IP client socket, TCP/IP Server socket, URL Connection, Datagrams, Datagram Packets.

**MODULE V:** GUI programming using SWING- Applet: Applet and Application program, Difference between an Applet and a standard program, Creating Applets, Applet Life Cycle, Applet and Thread, Supplying Applet parameter, Using Images and Sound in Applets, JAR files, Applet Security. Introducing the AWT and SWING: Overview of the java.awt, javax. swing package, Component and Containers: Component, Container, JPanel, JApplet, Window, JFrame, and JDialog classes. Working with Graphics, Working with Fonts, Working with Colors, GUI Control Components: Button, Canvas, Checkbox and Checkbox Group, Choice, JList, JLabel, Scrollbar, JTextField and JTextArea, JFrame, JMenuBar, JMenu and JMenuItem. Layout Management: Layout Management Policies, Flow Layout, Grid Layout, Border Layout, Card Layout, Grid Bag Layout, Customized Layout. Event Handling: Overview of Event Handling, Event Hierarchy, Event Delegation Model, Event Listeners, Event Adapter classes, Low Level Event Processing.

**MCS 302**

**Information Security**

**Course Objectives:**

Information Security is a comprehensive study of the principles and practices of computer system security including operating system security, network security, software security and web security. Topics include common attacking techniques such as virus, trojan, worms and memory exploits; the formalisms of information security such as the access control and information flow theory; the common security policies; the basic cryptography, RSA, cryptographic hash function, and password system; network intrusion detection; software security theory; web security; legal and ethical issues in computer security.

**Learning Outcomes:**

The learning outcome is students shall be able to understand what are the common threats faced today, what are the foundational theory behind information security, what are the basic principles and techniques when designing a secure system, how to think adversarial, how today's attacks and defenses work in practice, how to assess threats for their significance, and how to gauge the protections and limitations provided by today's technology.

**Syllabus:**

**MODULE I:**

    History of Information Systems and its Importance; Changing Nature of Information Systems, Need of Distributed Information Systems; Information System Threats and attacks, Classification of Threats and Assessing Damages.

**MODULE II:**

    Security in Mobile and Wireless Computing; Security Implication for organizations, Laptops Security; Basic Principles of Information Security, Confidentiality, Integrity Availability.

**MODULE III:**

E Commerce and Security Threats; E Governance and EDI; Concepts in Electronics payment systems, E Cash, Credit/Debit Cards.  Physical Security- Needs, Disaster and Controls; Biometric Access Control- Factors, Criteria for selection, Design Issues, Economic and Social Aspects and Legal Challenges

**MODULE IV:**

Model of Cryptographic Systems, Issues in Documents Security, System of Keys, Public Key Cryptography, Digital Signature, Finger Prints, Firewalls, Network Attacks, Need of Intrusion Monitoring and Detection, Intrusion Detection; Virtual Private Networks- Need, Use and Types of VPNs.

**MODULE V:**

Security metrics- Classification and their benefits Information Security & Law, IPR, Patent Law, Copyright Law, Legal Issues in Data mining Security, Cyber Crime Types & overview of Cyber Crimes. Recent software and platform supporting IS

**References :**

1.  Godbole,“ Information Systems Security”, Willey

2.  Merkov, Breithaupt,“ Information Security”, Pearson Education

3.  Yadav, “Foundations of Information Technology”, New Age, Delhi

4.  Schou, Shoemaker, “ Information Assurance for the Enterprise”, Tata McGraw Hill

5.  Sood,“Cyber Laws Simplified”, Mc Graw Hill

6.  Furnell, “Computer Insecurity”, Springer

**MCS 303**

**Operation Research**

**Course Objective**

In synchronization of latest trends and demands from the industry, the syllabus of this course is designed and revised accordingly. It aims at boosting the knowledge and polishing the skills of the students that are applicable in operational research. The main objective are

* To classify and formulate real-life problem for modeling, solving and applying for decision making.
* To study the formulation and various methods of solutions for linear programming, transportation, assignment problems, optimization techniques, etc.
* To solve problems using dynamic programming method.

**Course Outcome**

After the completion of this course, students will be able to describe the basic components and fundamental principles of operation research and its application to industrial problem. The main outcomes are

* Analyse problems in engineering, management, or business environment, focusing on important details.
* Understand and apply the concept of optimality criteria for various problems.
* Formulate of real problems in terms of input-output-parameters relationships and identify the solution procedure.

**Module 1**: Introduction to Operational research:Introduction and use of interdisciplinary Teams in Operation Research, Modeling in Operation Research, Features and scope of Operation Research. Linear programming- Formulation of linear programming problem, Feasible and basic feasible solutions of linear programming problem, Graphical Method, Simplex Method (including 2-Phase method).

**Module 2:** Duality theory: Duality Theory, Existence of Dual of a Linear Programming Problem, Primal Dual Relationships in Formulation and Their Solutions, Dual Simplex Method-Primal, dual computations, Integer programming problem -Introduction to Integer programming problem, Solution of Integer programming problem using Gomorian constraint.

**Module 3:** Transportation models: The Transportation Algorithm, Formulation of a Transportation problem, Basic feasible solution, North West Corner Method, Least Cost Method, Vogel’s Approximation Method, Optimum solution-MODI Method. The Assignment problem-Mathematical formulation, Balanced and unbalanced assignment problem, The Hungarian Method of Solution.

**Module 4:** Job sequencing: Introduction of Job sequencing, Processing n Jobs through 2 machine, Processing n Jobs through 3 machine, Processing 2 Jobs through m machine, Replacement problem-Replacement policy for items whose maintenance cost increases with time and money value is constant, money value changes with constant rate.

**Module 5:** Network Model: Introduction, Network diagram representation, time estimate and critical path with saddle point, Game theory**-** Formulation of Two-Person Zero-Sum Game, Solution of Simple Games, Mixed Strategy Games-Solving Using Graphical Method, Solving using LP; Reduction using Dominated Strategies-Saddle Point Condition.

**References**

1. Linear Programming : G. Hardley.
2. Operation Research: F. H. Gerald, J. Lieberman.
3. Operation Research: B. S. Goel, S. K. Mittal.
4. Principles of operation Research: H. M. Wagner.
5. Operation Research: S. D. Sharma.
6. Operation Research: R. K. Gupta.

**MCS 304**

**Elective III – Data Mining and Data Warehousing**

**MCS 304**

**Elective III – Artificial Neural Network**

**MCS 305**

**Research Paper Publication**

**MCS 306**

**Industrial/Company/Professional Training**

**MCS 307**

**Programming in Core Java Lab**

**MCS 401**

**Programming in Advance Java**

**MODULE I:** JDBC: Introduction, driver types, connectivity steps, Driver Manager, Connection, Statement, ResultSet, Prepared Statement, ResultsetMetaData, DatabaseMetaData, CallableStatement, Transaction Management, Batch Processing, Rowset Interface, RowSetFactory interface, RowSetProvide, JDBC 4.2, Driver Action, Driver Action Method, JDBC SQLType, JDBCTypes, JDBCType fields, JDBCType Methods.

**MODULE II:** Java EE, Specification of Java EE, Java Se vs Java EE, Understanding server side scripting and web application structure, introduction to servlet, web server and web container, web.xml, javax.servlet and javax.servlet.http package, life cycle of servlet, servlet request, servlet response, HTTP methods, creating a servlet application, ServletConfig and ServletContext, request, init and context parameters, Servlet Chaining,Request Dispatcher, Send Redirect, Forward, Include, Working with Attributes, Working with database, Session Tracking, Filters, Listeners, Servlet Miscellaneous.

**MODULE III:** JSP Technology, Introduction, Life cycle of JSP, JSP API, Scripting elements: scriptlet tag, expression tag, declaration tag. Implicit Objects: Request, Response, Config, Application, Session, PageContext, Page, Exception. Directive Elements: Page, Include, Taglib. JSP Exception, Action Elements: forward, include. Pagonation, Custom Tag, Attributes, Iteration, Custom URI, MVC, JAVA Mail API: mail introduction, sending and receiving mail, sending attachment, receiving attachment, forwarding and deleting email.

**MODULE IV:** Introduction of Struts, Features of Struts, Core Component: Intercptor, ValueStack, Action Context, Action Invocation, OGNL, Architecture, Action, Configuration of Struts, with multiple interceptor and namespace, Interceptor: Custom interceptor, Parameterized interceptor, prepare interceptor, ModelDriven Interceptor, exception interceptor, fileupload interceptor, Struts Validation: Custom, Bundles and AJAX Validation, Aware Interface: SevetActionContext, SessionAware, ServletContextAware, Zero Configuration: convention and annotation.

**MODULE V:** HB Introduction, HB Architecture, HB using XML, HB using annotation, HB Web Application, HB Generator class, HB Dialects, Inheritance Mapping: Table per hierarchy, TPH using annotation, Table Per Concrete, TPC using annotation, Table Per SubCLass, TPS using Annotation, Hibernate Mapping: Collection Mapping, Mapping List, Mapping Bag, Mapping Set, Mapping Map, One to Many, Many to Many, One to One, Many To One XML and Annotation, Tx Management, HQL, HCQL, Named Query, HB Caching.

**MCS 402**

**Digital Image Processing**

**Course Objectives:**

This course is an introduction to the fundamental concepts and techniques in basic digital image processing and their applications to solve real life problems. The topics covered include Digital Image Fundamentals, Image Transforms, Image Enhancement, Restoration and Compression, Morphological Image Processing, Nonlinear Image Processing, and Image Analysis. Application examples are also included.

**Learning Outcomes:**

Upon completion of this course, students will be familiar with basic image processing techniques for solving real problems. Student will also have sufficient expertise in both the theory of two- dimensional signal processing and its wide range of applications, for example, image restoration, image compression, and image analysis.

**Syllabus:**

**MODULE I: INTRODUCTION**

    Fundamental Steps in Image Processing: Element of visual perception, Digital Image Fundamentals: A simple image formation model, image sampling and quantization, basic relationships between pixels.

    Color Image Processing: Color fundamentals, color models, pseudo color image processing, basics of full–color image processing, color transforms, smoothing and sharpening, color segmentation.

**MODULE II:**

    Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing and sharpening spatial filters, combining the spatial enhancement methods

    Image restoration: A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function.

**MODULE III: MORPHOLOGICAL ALGORITHMS**

    Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms, Image Segmentation: Detection of discontinuous, edge linking and boundary detection, thresholding, region–based segmentation, region-oriented segmentation, representation schemes like chain codes, polygonal approximations, boundary segments, skeleton of a region,

**MODULE IV: IMAGE COMPRESSION**

    Introduction – Principle of compression – Types of compression – Fundamentals, image compression models, error-free compression, lossy predictive coding, image compression standards, Run length Encoding – Huffman Coding – Modified Huffman Coding JPEG – Other State-of-the-Art Image Compression – Image Compression Standard File Formats.

**MODULE V: PATTERN RECOGNITION**

    Introduction, System Component, Complexity of Pattern Recognition, Object Representation, Feature Detection, Recognition Strategies – Classification, Matching, Feature Indexing, Recognition based on decision–theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods – matching shape numbers, string matching Machine learning and Deep Learning in Digital image processing. Software and tool for Digital image processing

**REFERENCES BOOKS**

1. Rafael C. Gonzalez, Richard.E, “Digital Image Processing (3rd Edition”) Woods Prentice Hall, 2007.

2. Anji Reddy.M, Hari Shankar.Y, “Textbook of Digital Image Processing”, BS Publications, 2006.

3. Robert Shcowebgerdt , “Remote sensing models & methods for image processing”, III edition, 2004.

4. William K. Pratt, Digital Image Processing: PIKS Inside (3rd ed.), John Wiley & Sons, Inc., 2001

5. M.A. Joshi, Digital Image Processing: An Algorithmic Approach, Prentice-Hall of India, 2006

6. B. Chandra and D.D. Majumder, Digital Image Processing and Analysis, Prentice-Hall of India, 2007

**MCS 403**

**Introduction to Block Chain**

**Course Objectives**

To understand the history, types and applications of Blockchain 2. To acquire knowledge about cryptography and consensus algorithms. 3. Deploy projects using Web3j and design blockchain based applications.

**Course Outcome:**

Upon completion of this course, the students will be able to 1. Contentedly discuss and describe the history, types and applications of Blockchain 2. Gains familiarity with cryptography and Consensus algorithms. 3. Create and deploy projects using Web3j. 4. Implement an ICO on Ethereum 5. Design blockchain based application with Swarm and IPFS

**MODULE 1:**

Introduction to Cyber Security, Need for security, Concept of Cyber Space, Cyber Crimes and Cyber- attack. Fundamental security principles – threats, attacks and vulnerability. Key Security triad – Confidentiality, Integrity and Availability. Key components of cybersecurity network architecture. Introduction to basic Security Management and Policies - Authentication, Authorization, Access control, Identification and Accounting.

**MODULE 2:**

Cryptography – Private key Cryptography - Classical Encryption Techniques - Substitution Techniques - Transposition Techniques - Rotor Machines - Steganography - Data Encryption Standard - Advanced Encryption Standard - Multiple Encryption and Triple DES

**MODULE 3:**

Public-Key Cryptography - RSA algorithm - Diffie-Hellman Key Exchange - Elgamal Cryptographic System - Elliptic Curve Arithmetic - Elliptic Curve Cryptography. MD5 message digest algorithm - Secure hash algorithm (SHA) Digital Signatures: Digital Signatures - authentication protocols - digital signature standards (DSS) - proof of digital signature algorithm -

**MODULE 4:**

History, A basic crypto currency, Creation of coins, Payments and double spending, Bitcoin – Digital Signatures as Identities – eWallets – Personal Crypto security - Bitcoin Mining – Mining Hardware – Energy Consumption – Mining Pools – Mining Incentives and Strategies.

The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule – Supporting Protocols – Solidity Language. Operation of Bitcoin Blockchain, Blockchain Architecture – Block, Hash, Distributer P2P, Structure of Blockchain- Consensus mechanism: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Proof of Authority (PoA) and Proof of Elapsed Time (PoET)

**MODULE 5:**

Project presentation- Futures smart contract: Blockchain oracles- Web3j: Setting up the Web3J- Installing web3j- Wallet creation, Java client: The wrapper generator- Initializing web3j- Setting up Ethereum accounts- Deploying the contract.

Public versus private and permissioned versus permission less blockchains- Privacy and anonymity in Ethereum- Why are privacy and anonymity important? - The Ethereum Enterprise Alliance- Blockchainas-a-Service- Initial Coin Offering (ICO): Project setup for ICO implementation- Token contracts- Token sale contracts-Contract security and testing the code.

Books:

1. Andreas M. Antonopoulos , “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O’Reilly Media Inc, 2015
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, Princeton University Press, 2016.
3. William Stallings, Network Security Essentials (Applications and Standards), Pearson Education, India,2017
4. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.

**MCS 404**

**Personality Development & Professional Communication Skill**

**MCS 405**

**Elective IV – Machine Learning**

**MODULE I - INTRODUCTION OF MACHINE LEARNING TECHNIQUES**

Introduction of Machine Learning, Techniques, Application of Machine Learning, Data types in Machine Learning, Data Preprocessing, Techniques of Data Preprocessing, Continues and discrete data Dimensionality Reduction, Visualization.

**MODULE II – REGRESSION;** Introduction to Regression, Types of Regression model, Mathematics Foundations, Model Building using Least squares, Model Accuracy & Selection, Overfitting, Interpretability of regression models

**MODULE III – CLASSIFICATION;** Overview of the Classification Module, Nearest-neighbour Methods. Naïve Bayes Classifier, Logistic Regression, Decision Tree, Optimization Foundations for Support Vector Machines, Support Vector Machines, Support Vector Machines in overlapping class distributions & Kernels, Ensemble Methods

**MODULE IV - UNSUPERVISED LEARNING & ASSOCIATION RULE MINING**

Introduction to Unsupervised Learning, Clustering, K-Means Algorithm, K-Means – Variations, Detecting Outliers, Math Fundamentals for EM Algorithm, EM Algorithm, Clustering for Customer Segmentation, Hierarchical Clustering, Density Based Clustering, Clustering for Anomaly Detection, Assessing Quality of Clustering, Significance of Clustering - Interpreting/ summarizing Clusters by businesses, Association Rule Mining, A priori Algorithm. Time series Prediction and Markov Process, Hidden Markov Model

**MODULE V - NATURAL LANGUAGE PROCESSING;** Introduction, Types of NLP, Classical Vs Deep learning Models, Bag of words model, Tools and techniques for Machine Learning.

**REFERENCES BOOKS**

1. [AurelienGeron](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Aurelien+Geron&search-alias=stripbooks) ,“Hands–On Machine Learning with Scikit–Learn and TensorFlow”(3rd Edition”) Paperback, 2017.
2. Sebastian Raschka ,VahidMirjalili, “Python Machine Learning”,Third EditionPackt Publications, 2019.

Kevin P. Murph, “[Machine learning: a probabilistic perspective](https://books.google.co.in/books?hl=en&lr=&id=RC43AgAAQBAJ&oi=fnd&pg=PR7&dq=Machine+Learning:+A+Probabilistic+Perspective&ots=umfxgCRoZ5&sig=KBCtYVQ-q0UK0g_t5TUujFOIopY)”, [MIT Press](https://books.google.co.in/url?id=RC43AgAAQBAJ&pg=PR7&q=http://mitpress.mit.edu&linkid=1&usg=AFQjCNEessG_tKWG3kvkCusFxbkUYjwFBQ&source=gbs_pub_info_r), 2012.

**MCS 406**

**Elective IV – Internet of Things**

**MODULE I: INTRODUCTION OF IoT**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

**MODULE II: IoT ARCHITECTURE**

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

**MODULE III: IoT PROTOCOLS**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP – Security

**MODULE IV: HARDWARE AND SOFTWARE OF IoT DEVICES**

Introduction of hardware used in IoT like Aurdino, raspberry Pi - Programming language of IoT implementation - Use of open source simulator for IoT.

**MODULE V: CASE STUDY OF SPEECH TO TEXT PROCESSING**

Application of IoT in Real Life.

Case study on sensor-based water distribution network system using data analytics.

Case study on sensor based smart city system using data analytics.

**MCS 406**

**System Development Project (System Design and Implementation)**

**MCS 407**

**Programming in Advance Java Lab**