SYLLABUS FOR THE BATCH FROM THE YEAR 2024 TO YEAR 2026

Programme Code: MCS

Programme Name: M.Sc. (Computer Science)

(Semester I-II)

Examinations: 2024-2026

P.G. Department of Computer Science & Applications

Khalsa College, Amritsar

Programme name: M.Sc. (Computer Science)
Programme code: MCS
Programme Duration :2 years

Programme Objectives

1.	To impart sound knowledge in Computer Science and to enable students to apply the acquired skills creatively in computer and related technologies in practical scenarios.
2.	To effectively utilize knowledge of computing and mathematical principles to develop sustainable solutions to the present and the prospective computing problems.
3.	To effectively initiate, create and to communicate innovation through social, legal, ethical, and cultural issues inherent in the discipline of computing concepts and solutions to bridge the gap between computing industry experts and business leaders.
4.	To exhibit computing expertise through corporate leadership and entrepreneurship;
5.	To address in the broad areas of multi-disciplinary in nature, and to keep pace with advances in computing technology.

Programme Specific Outcomes (PSOs):

PSO-1.	Students gain knowledge in the areas like Soft Computing, Web Services, Cloud Computing, Paradigm of Programming language, Design and Analysis of Algorithms, Database Technologies, Advanced Operating System, Image Processing, Software Project Management and core computing subjects.
PSO-2.	Students understand all dimensions of the concepts of software application and projects.
PSO-3.	Students become employable according to current demand of IT Industry.
PSO-4.	Work in a collaborative manner with others in a team, contributing to the management, planning and implementation of a computer system.

M.Sc. (Computer Science)
Semester I

S.N.	Course Code	Course Name	Distribution of The Marks				Lectures Per week			Credit Distribution			Total Credit L+T+P	Page No.
			Theory	Internal Assessment	Practical	Total	L	T	P	L	T	P	L+T+P	
Discipline Specific Course(DSC)														
1	MCS-411	Advanced Data Structure	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**4-5**
2	MCS-412	Advanced Software Engineering	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**6-8**
3	MCS-413	Network Design and Performance Analysis	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**9-10**
4	MCS-414	Discrete Structures	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**11-12**
5	MCS-415	R Programming	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**13-14**
Skill Enhancement Course(SEC)														
6	MCS-416P	Programming Laboratory-I(Based on Advanced Data Structures & R Programming)	**0**	**13**	**37**	**50**	**0**	**0**	**0**	**6**	**0**	**2**	**2**	**15**
							Total Credits =			**22**				

M.Sc. (Computer Science)
SEMESTER-I
MCS-411: Advanced Data Structures
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	T	P
3	1	0

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

1.	To provide the foundations of the practical implementation and usage of Algorithms and Data Structures.
2.	To ensure that the student evolves into a competent programmer capable of designing and analyzing implementations of algorithms and data structures for different kinds of problems.
3.	To expose the student to the algorithm analysis techniques, to the theory of reductions.

UNIT-I

Review of algorithm analysis, Binary search trees, balanced binary search trees (red-black trees), Btrees, AVL Trees, 2-3 trees, 2-3-4 trees.

Binary heaps, heap operations, specifications, implementation and applications. Advanced heap structures.

UNIT-II

Priority queue operations, and double-ended priority queues.

Dictionaries, binomial heaps, Fibonacci heaps. Data structures for disjoint sets, tables and table operations.

UNIT-III

Strings: Introduction, Operations, Memory representation, Pattern matching algorithms-Brute force, the Boyer –Moore algorithm, the Knuth-Morris-Pratt algorithm, Amortized analysis.

UNIT-IV

Graph algorithms: DFS, BFS, Shortest path algorithm, Spanning tree, Biconnected components.

External data structures - external storage, external files, external sorting searching indexing files, external hashing.

References:

1. Alfred V. Aho, Jeffrey D. Uuman, John E. Hopcroft, “Data Structures and Algorithms” Addision Wesley, 1983.
2. Dinesh P. Mehta, I. SartajSahni, “Handbook of Data Structures and Applications”, Chapman & Hall/CRC, 2004.
3. Sorenson and Trembley, “An Introduction to Data Structures with Applications, McGraw Hill,\2006 Edition.

Course Outcomes:

On Completing the course, the students will be able to:

CO-1.	Design and analyze programming problem statements.
CO-2.	Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem.
CO-3.	Understand the necessary mathematical abstraction to solve problems.
CO-4.	Come up with analysis of efficiency and proofs of correctness
CO-5.	Comprehend and select algorithm design approaches in a problem specific manner.

M.Sc. (Computer Science)
SEMESTER-I
MCS-412: Advanced Software Engineering
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	T	P
3	1	0

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections**

Course Objectives:

1.	Understand Knowledge about advanced software engineering.
2.	Understand System development life cycle.
3.	Learn Software process methodologies.
4.	Understand the principles of object-oriented software construction.
5.	To Know about the software-development process, including requirements analysis, design,programming, testing and maintenance.
6.	Able to model object-oriented software systems.
7.	Understand how to design and plans of software solutions to problems using an object-oriented strategy.

UNIT-I

Software Project Management and Requirements

Project Management: Management Activities, Project Planning, Project Scheduling, Risk Management; Software Requirements: Functional and Non-Functional Requirements, User Requirements, System Requirements, Requirements Document; Requirements Engineering Process: Feasibility Studies, Requirements Elicitation and Analysis, Requirements Validation, Requirements Management.

UNIT-II

System Models and Software Prototyping

System models: Context, Behavioural, Data, and Object models; Software Prototyping: Prototyping in the SoftwareProcess, Rapid Prototyping Techniques, User Interface Prototyping.

Software Design

Object Oriented Design: Objects and Object Classes, Object-Oriented Design Process, Design Evolution; Design with Reuse: Component-Based Development, Application Families, Design Patterns; User Interface Design: Principles, User Interaction, Information Presentation, User Support, Interface Evaluation.

UNIT-III

Software Testing

Software Testing:Defect Testing, Integration Testing, Interface Testing, Object-Oriented Testing.

Software Re-engineering

Introduction to Re-engineering, Software Reengineering and its importance, When to Reengineer, Goals of reengineering, Reengineering Techniques, Software reengineering process; Business process reengineering: Business processes, A BPR Model.

UNIT-IV

Reverse Engineering

Definition of Reverse Engineering, Need of reverse engineering, Advantages and Problems of reverse engineering, Reverse and Reengineering, Goals of Reverse Engineering, Reverse Engineering Techniques, Reverse engineering process, Software Re-use and Reengineering, Need, types and advantages of Reuse.

Software Agents

Definition of software Agent, Attributes of an Agent, Applications of Agents, Types and Classes of Agents, Characteristics of Agents, Multi-Agent systems.

References:

1.Software Engineering, Ian Sommerville, 6th Edition, Addison Wesley, 2000.
2.Software project management, Walker Royce, Pearson Education Inc. 7th year of publication.
3.Software Re-engineering, Robert S. Arnold IEEE Comp. Society.
4.Object Oriented Software Metrics, Lorenz and Kidd.
5.Object-Oriented Analysis and Design, Booch 3rd edition 2007.
6.Software Engineering, Roger S. Pressman 7th edition 2019.

Course Outcomes:
At the end of this course the student shall be able to:

CO-1.	Acquire the knowledge of software-engineering.
CO-2.	Knowledge of basic Software Engineering methods and practices.
CO-3.	Understand Software Engineering appropriate applications.

CO-4.	Understanding of different measurements of object oriented.
CO-5.	A general understanding of software process models such as the water fall and evolutionary models.

M.Sc. (Computer Science)
SEMESTER-I
MCS-413: Network Design & Performance Analysis
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	**T**	**P**
3	**1**	**0**

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

1.	Understand that global connectivity can be achieved through computer networks.
2.	Understand the function of networks and get exposure to different existing and upcoming communication technologies.
3.	Make them aware that knowledge about hardware and software requirements of networks is essential.
4.	Understanding the requirements, planning and choosing the technology for building a network.
5.	Providing the knowledge about network design, security, documentation and managing the network.

UNIT -I

Requirements, planning, & choosing technology: System requirements, traffic sizing characteristics time & delay consideration. Traffic engineering and capacity planning: Throughput calculation traffic characteristics &source models, traditional traffic engineering, queued data & packet switched traffic modelling, designing for peaks, delay or latency Network performance modelling- Creating traffic matrix, design tools, components of design tools, types of design projects.

UNIT -II

Technology Comparisons- Generic packet switching networks characteristics, private vs. public networking, Business aspects of packet, frame and cell switching services, High speed LAN protocols comparison, Application performance needs, Throughput, burstiness, response time and delay tolerance, selecting service provider, vendor, service levels etc.

UNIT -III

Access Network Design- N/W design layers, Access N/W design, access n/w capacity, Backbone n/w design, Backbone segments, backbone capacity, topologies, Tuning the network, securing the network, Design for network security.

UNIT -IV

Documentation and network management- Documentation, network management, SNMP, RMON. Network Optimization- Network optimization theory: Goals of network optimization, measurements for network optimization, optimization tools, optimization techniques.

References:

1. James D. McCabe, Network Analysis, Architecture and Design, 2nd Edition, Morgan Kaufman Series in Networking, 2007 Edition.
2. YoueuZheng, ShakilAkhtar, Network for Computer Scientists and Engineers, Indian University, Oxford University Press, 2007 Edition.
3. Forouzan, Data Communications and Networking, Tata McGraw Hill, 2007 Edition.

Course Outcomes:

At the end of this course the student shall be able to:

CO-1.	Familiar with the concept of Network hardware and software requirements.
CO-2.	Understand the different protocols working at different layers of OSI and TCP/IP models.
CO-3.	Learn the concepts of different networking devices like router, hub, and switch.
CO-4.	Understanding the concept of traffic engineering and capacity planning.
CO-5.	Learn the concepts of switching and network performance modeling.
CO-6.	Comparing the private and the public networking.
CO-7.	Understanding the network design and network management.

M.Sc. (Computer Science)
SEMESTER-I
MCS-414: Discrete Structures
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	**T**	**P**
3	**1**	**0**

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

1.	To construct correct direct and indirect proofs.
2.	Understand sets and perform different operations on sets.
3.	Identify functions and determine their properties
4.	Apply logical reasoning to solve a variety of Problems.
5.	To use Graph Theory to solve the Problems
6.	To formulate problems and solve recurrence relations.

UNIT -I

Graph Theory: Basic terminology, Path v/s Circuit, Types of graphs, Directed and Undirected Graphs, Eulerian Chains and Cycles, Hamiltonian Chains and Cycles, Graph Representation, Planar graphs, Graph- Coloring, Chromatic number, Connectivity and other graphical parameters, Trees, Spanning tree, Minimum Spanning tree(Kruskal's and Prim's Method)

UNIT -II

Sets and Functions: Sets, Subsets, Equivalence and Partial ordering, , Inclusion and Exclusion Principle, Relations, relation of Partial order partitions, Equivalence relations, Composition of relations, Binary relation, Identity and Inverse relation, Functions.

Propositional Logic: Statements and notations, Connectives, Truth Tables, Tautology, Contradiction, Rules of Inference.

UNIT –III

Combinatorial Mathematics: Basic Counting Principles, Permutations and Combinations, Pigeonhole Principle and its Applications, Recurrence relations, Generating Function, Applications of recurrence relations.

UNIT -IV

Rings and Boolean Algebra: Rings, Subrings, Morphism of rings, Ideals and Quotient rings. Euclidean domains, Integral domains and Fields, Boolean Algebra, Direct Product Morphisms, Application of Boolean algebra in Logic Circuits and Switching functions.

References:

1. Fundamentals of Algebraic Specification I, EATCS Monographs on (Theory. Comp. Sc.Vol. 6), HartmutEhrig, Bernd MahrSpringer Verlag, Berlin 1985.
2. Mathematical Structures for Computer Science,Judith L. Gersting,W. H. Freeman & Co.,2nd Edition, New York,1987.
3. Algorithmic Graph theory,Alan Gibbons, Cambridge University Press, 1985.
4. The art of Computer Programming, Knuth, Donald Ervin, Vol. I, Fundamental Algorithms. 2nd ed. Reading, Mass, Addison Wesley 1973.
5. Kolman B. Busby R. Discrete Mathematical Structures for Computer Science, Prentice HallEnglewood Cliffs. 1987.
6. Sahni, S. Concepts in Discrete Mathematics Fridley MN., Camelot Publ. Comp., 1981.
7. Schmidt G. Strohlein T. Relations Graphs Program, EATS Monograph on Theor. Comp. Sc. Vol. 29 Berlin Spinger 1993.
8. Wheeler W. Universal Algebra for Computer Scientist EATCS Monographs on Theor.Comp. Sc. Vol. 25 Spinger-Verlag, Berlin 1991.

Course Outcomes:

The students, after the completion of the course, are expected to:

CO-1.	Identify sets, different properties of sets, set operations and set identities
CO-2.	Explain the different methods for representing the relationship between sets.
CO-3.	Evaluate Boolean functions and simplify the expressions using properties of Boolean algebra.
CO-4.	Learn the basic concepts involving functions needed in discrete structures.
CO-5.	Define and interpret the concepts of divisibility, congruence etc.
CO-6.	Express a logic sentence in terms of predicates, quantifiers and logical connectives

M.Sc. (Computer Science)
SEMESTER-I
MCS-415: R – Programming
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	**T**	**P**
3	**1**	**0**

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

1.	The basics of statistical computing and data analysis.
2.	How to use R for analytical programming.
3.	How to implement data structure in R.
4.	R loop functions and debugging tools.
5.	Object-oriented programming concepts in R.
6.	Data visualization in R.
7.	How to perform error handling.
8.	Writing custom R functions.

UNIT-I

Introduction to R: R character set, R words, constants, operators, precedence and associativity of the operators, R working environment as a displayer, R as a calculator, R as a data manipulator, R objects and their data types.

UNIT-II

R programming environment: Programming in R using, Sequence, Selection iteration and Case logic structures. User-defined functions in R, Recursion, Basic data structures in R (vector, factor, list, data frame, matrix, array).

UNIT-III

R factors: Understanding factors, Modifying factors, Factors in Data frames. Data frames in R: Creating data frame, Operations on data frames, Accessing data frames, Creating data frames, from various sources

UNIT-IV

Data visualization in R: Plot() function and line plot, pie chart / 3D pie chart, Scatter plot, Box plot.

Stringr package: Important functions in stringr, Regular expressions.

Dplyr package: Load data into dataframe, Viewing the data, selecting columns, selecting rows, Reordering the rows, Pipe operator, Group operations.

References:

1. The art of Programming through R by Anil BikashChowdhury
2. The art of R programming by Norman Matloff, , No Starch Press, Sanfrancisco.
3. Statistical Programming in R by Srinivasa,Siddesh,Shetty and Sowmya, Oxford Higher Education

Course Outcomes:

At the end of this course the student shall be able to

1.	Explain critical R programming concepts.
2.	Demonstrate how to install and configure RStudio.
3.	Apply OOP concepts in R programming.
4.	Explain the use of data structure and loop functions.
5.	Analyse data and generate reports based on the data.
6.	Apply various concepts to write programs in R.

M.Sc. (Computer Science)
SEMESTER-I
MCS-416 P
Programming Laboratory – I
(Based on Advanced Data Structures and R Programming)
Skill Enhancement Course (SEC)

Time: 3 Hrs. **Total Marks: 50**

Credits		
L	**T**	**P**
0	**0**	**2**

Practical Marks: 37

Practical Internal Assessment Marks:13

Course Objectives:

1.	Understand and apply linear data structures-List, Stack and Queue.
2.	Understand the graph algorithms.
3.	Learn different algorithms analysis techniques.
4.	Apply data structures and algorithms in real time applications
5.	The basics of statistical computing and data analysis.
6.	How to use R for analytical programming.
7.	How to implement data structure in R.
8.	R loop functions and debugging tools.
9.	Object-oriented programming concepts in R.

Programs based on Advanced Data Structures using C/C++ and R Programming.
Course Outcomes (COs):

At the end of this course student will:

CO-1.	Formulate, design and analyse algorithms for problem statements.
CO-2.	Implement basic data structures and sorting algorithms.
CO-3.	Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem.
CO-4.	Design and develop efficient algorithms for problem.
CO-5.	Explain critical R programming concepts.
CO-6.	Demonstrate how to install and configure R Studio.

M.Sc. (Computer Science)
Semester II

SN	Course Code	Course Name	Distribution of The Marks				Lectures Per week			Credit Distribution			Total Credit L+T+P	Page No.
			Theory	Internal Assessment	Practical	Total	L	T	P	L	T	P		
Discipline Specific Course(DSC)														
1	MCS-421	Theory of Computation	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**17-18**
2	MCS-422	Image Processing	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**19-20**
3	MCS-423	Design and Analysis of Algorithms	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**21-22**
4	MCS-424	Cloud Computing	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**23-24**
5	MCS-425	Artificial Intelligence	**75**	**25**	**0**	**100**	**5**	**1**	**0**	**3**	**1**	**0**	**4**	**25-26**
Skill Enhancement Course(SEC)														
6	MCS-426P	Programming Laboratory-II	**0**	**13**	**37**	**50**	**0**	**0**	**6**	**0**	**0**	**2**	**2**	**27**
							Total Credits =			**22**				

M.Sc. (Computer Science)
SEMESTER-II
MCS-421: Theory of Computation
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	T	P
3	1	0

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

1.	To make students understand the basic mathematical model of computation
2.	To understand the relation between these formal languages, grammars, and machines.
3.	To understand the complexity or difficulty level of problems when solved using these machines.
4.	To compare the complexity of problems.
5.	Introduction to Recursively Enumerable Languages and Computable Functions

UNIT –I

Finite Automata Deterministic Finite Automata, non deterministic finite Automata, Transition System, Equivalence of NFA and DFA, Finite Automata with Null-moves. 2-Way Finite Automata, crossing sequences, Moore and Mealy Machine, Inter Conversion of Moore and Mealy Machine, Application of finite automata, Chomsky Hierarchy of Languages, Recursive and recursively-enumerable languages sets, Language and their relation, Languages and automata.

UNIT –II

Regular Expression and Languages: Regular expression, Equivalence of finite Automata and Regular expressions, Conversion between regular expressions and finite automata, Application of Regular Expressions.

Regular Languages and Regular sets, Pumping lemma for regular sets, Applications of pumping lemma. Closure properties of regular language.

UNIT –III

Context free Grammar and Languages: Context free Grammars, Derivation Trees, Leftmost and rightmost derivations, Ambiguity, Properties of Context free Languages- Normal forms for context free grammars (Chomsky Normal Form, Griebach Normal Form, The Kuroda Normal Form)

Pushdown Automata: Deterministic Push down Automata; Equivalence of Push Down Automata and Context free grammar. Linear Bounded Automata (LBA): Power of LBA, Closure Properties.

UNIT –IV

Turing Machine (TM): One Tape, multi tape, the notions of time and space complexity in terms of T.M. Construction of simple problems. Computational complexity.

Recursive And Recursively Enumerable Languages (REF)-: Properties of recursive and recursively enumerable languages, Universal Turing machine, The halting problem, Undecidable problem about the TMs . Context sensitive language and linear bounded Automata (LBA), Post's correspondence problem (PCP) ,undecidability of PCP

References:

1. J.E. Hopcroft, R. Motwani and J.D. Ullamn, "Introduction to Automata Theory, Languages and Computation", Pearson Education Asia, 2nd Edition.
2. John C. Martin, "Introduction to Languages and the Theory of Computation", Tata McGraw Hill Publication Company Limited, 3rd Edition.
3. K.L.P Mishra and N. Chandrasekaran," Theory of Computer Science",Prenctice-Hall of IndiaPvt.Ltd. 3rd Edition"
4. Daniel I.A. Cohen, "Introduction to Computer Theory", Wiley, Second edition.
5. B. M. Moret, "The Theory of Computation", Pearson Education Asia.
6. Formal Languages and automata theory by C K Nagpal.

Course Outcomes:

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

CO-1.	Learn about deterministic and non-deterministic finite state machines along with their designing, conversion from finite machines to regular grammar, conversion from regular grammar to finite automata, and their applications.
CO-2.	Comprehend the working and applications of pumping lemma.
CO-3.	Gain insight into the concept of Context free grammar and normal forms of context free grammar.
CO-4.	Design the pushdown automata.
CO-5.	Design the Turing Machines and will get knowledge about the notions of time and space complexity in terms of Turing Machine.
CO-6.	Apply the theoretical concepts to the practice of program design with regular expressions, parsing, and complexity analysis

M.Sc. (Computer Science)
SEMESTER-II
MCS-422: Image Processing
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	T	P
3	1	0

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

The objective of this course is :

1.	To learn the Fundamental concepts of a digital image processing system.
2.	To Learn the image compression procedures.
3.	To study Compression techniques and morphological concepts.
4.	To learn Colour models and various applications of image processing
5.	To expose students to current applications in the field of digital image processing.

UNIT –I

Introduction: Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, overview of practical applications

Digital Image Fundamentals: Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some basic Relationships between Pixels, role of computers, image data formats.

UNIT –II

Image Enhancement in the Spatial Domain: Some Basic Gray Level Transformation, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing spatial Filters, Sharpening spatial Filters.

Image Enhancement in the Frequency Domain: Introduction to the Fourier Transform and the Frequency Domain, Smoothing frequency-domain Filters, Sharpening Frequency-domain Filters, Homomorphic Filtering

UNIT -III

Image Restoration: Image degradation and restoration process, Noise Models, Noise Filters, degradation function, Inverse Filtering, Homomorphic Filtering

Image Compression: Coding redundancy, Interpixel redundancy, Psychovisual redundancy, Huffman Coding, Arithmetic coding, Lossy compression techniques, JPEG Compression.

UNIT -IV

Techniques of Colour Image Processing: Colour image signal representation, colour system transformations, extension of processing techniques to colour domain.

Applications of Image Processing: Picture data archival, machine vision, medical image processing.

References:

1. Pratt, W.K. Digital Image Processing, John Wiley, N.Y./.4th Edition (2 March 2007)
2. Jain, A.K., Fundamentals of Digital Image Processing, Englewood Cliffs, Prentice Hall, Pearson (23 September 1988).
3. Chris Soloman, Stuart Gibson, Fundamentals of Digital Image Processing: A PracticalApproach using MatLab, John Wiley and Sons, 2007.
4. Digital Image Processing by Gonzalez & Wood, Addison Wesley, 2000.
5. Solomon Chris , Toby Breckon Fundamentals of Digital Image Processing :A Practical Approach with Examples in Matlab. 1st edition (January 4, 2011)

Course Outcomes:

At the end of this course the student shall be able to:

CO-1	Study the fundamental concepts of image processing
CO-2	Study the practical applications of image processing
CO-3	Contrast image segmentation and representation
CO-4	Analyse images in the frequency domain using various transforms.
CO-5	Review the fundamental concepts of a digital image processing system.

M.Sc. (Computer Science)

SEMESTER-II

MCS-423

Design & Analysis of Algorithms

Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	**T**	**P**
3	**1**	**0**

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

1.	This course aims to introduce the classic algorithms in various domains, and techniques for designing efficient algorithms.
2.	Algorithm design and analysis provide the theoretical backbone of computer science and are a must in the daily work of the successful programmer.
3.	The goal of this course is to provide a solid background in the design and analysis of the major classes of algorithms. At the end of the course, students will be able to develop their own versions for a given computational task and to compare and contrast their performance.
4.	The goal is to provide students with a wide variety of computational problems, and to provide a thorough knowledge of the most common algorithms and data structures.

UNIT -I

Algorithm And Analysis: Concept of Algorithm, Algorithm Specification, Performance Analysis (Time and space complexities), Best, Average and Worse case performance of algorithms, Asymptotic Notations,

Divide and Conquer: General Method, Binary Search, Merge Sort, Quick Sort, Selection Sort and analysis of these Problems.

UNIT –II

Greedy Method: General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum Cost Spanning Trees (Prim's Algorithm, Kruskal's Algorithm) and Single-Source Shortest Path and its analysis.
String Processing: The Boyer –Moore algorithm, Robin Karp Algorithm, Knuth-Morris-Pratt algorithm.

UNIT –III

Dynamic Programming: General Single Method, Multistage Graphs, All Pairs ShortestPaths, Single-Source Shortest Paths, Optimal Binary Search Trees.
Backtracking: General Method, 8-Queens Problem, Graph Coloring and HamiltonianCycles.
Search and Traversal Technique: Techniques for Binary Trees, Techniques for Graphs.

UNIT –IV

Branch and Bound: Least cost search, LC branch and Bound, Bounding, FIFO Branch and Bound, 0/1 Knapsack and Travelling Salesman Problem.
Introduction to complexity theory: NP- Hard and NP- Complete Problem, Basic Concepts, Cook's Theorem, examples of NP- Hard problems, Approximation Algorithms.

References:
1. V. Aho, J.E. Hopcroft, J.D. Ullman, Design and Analysis of Algorithms, AddisonWesley, 1976.
2. Horowitz, S. Sahni, Fundamentals of Computer Algorithms, Galgotia Publishers,1984.
3. K. Mehlhorn, Data Structures and Algorithms, Vols. 1 and 2, Springer Verlag, 1984.
4. Purdom, Jr. and C. A. Brown, The Analysis of Algorithms, Holt RinechartandWinston, 1985.
5. D. E. Kunth, The Art of Computer Programming, Vols. I and 3, Addison Wesley,1975.
6. AnanyLevitin, Introduction to the Design & Analysis of Algorithms, Addison,Wesley, 2002.

Course Outcomes:

CO-1.	To analyse the problem and identify the computing requirements appropriate for its solution.
CO-2.	Write rigorous correctness proofs for algorithms.
CO-3.	To apply mathematical foundations, algorithmic principles, and computer science theory to the modelling and design of computer- based systems in a way that demonstrates comprehension of the trade- offs involved in design choices.
CO-4.	Synthesize efficient algorithms in common engineering design situations.

M.Sc. (Computer Science)
SEMESTER-II
MCS-424: Cloud Computing
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	T	P
3	1	0

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

Course Objectives:

1.	Highlight the specific privacy and information security risks that can exists using cloud computing services.
2.	Explain the various open challenges and issues of cloud computing.
3.	Understanding of the role and usage of virtualization technologies.
4.	Clarify what cloud computing is and what are the various advantages and limitations of using cloud computing.
5.	To understand the features and usage of cloud platforms by studying the existing systems.
6.	Introduce the advance concepts such as Big Data Analytics, Federated Cloud Computing.

UNIT -I

Introduction: Definition, Vision, Reference Model, Benefits, Limitations, Terminology and Types of Cloud.

Cloud Issues and Challenges: Cloud Computing issues and challenges like Elasticity, Resource Management and Scheduling, Cost Management, Big Data, Pre-reservation and Cloud bursting.

UNIT -II

Virtualization: Definition, Type of Virtualization- CPU Virtualization, Memory Virtualization, Network Virtualization, Server Virtualization, Client Virtualization, Application Virtualization, Benefits, Limitations, Virtualization and Cloud, Virtual Appliance.

UNIT -III

Cloud Computing Architecture: Service Models- IaaS, PaaS, SaaS, Deployment Models-Automation of Cloud Deployment, Self Service Features in a Cloud Deployment, Federated Cloud Deployment, Cloud Entities, Cloud Clients, Service Level Agreement (SLA) and Quality of Service (QoS) in Cloud Computing.

Programming Models in Cloud: Thread Programming, Task Programming-High Performance Computing, High Throughput Computing, Many Task Computingand Map–Reduce Programming.

UNIT -IV

Cloud Security: Infrastructure Security, Data Security, Identity and Access Management, Privacy Management, Security as a Service on Cloud.

Advance Topic in Cloud: Energy Efficiency in cloud, Market Oriented Cloud Computing, Big–Data Analytics, Federated Cloud Computing, Advantages and Challenges of Federated Cloud Computing.

References:

1. Barrie Sosinsky, Cloud Computing Bible, Wiley India Pvt. Ltd., ISBN–13: 978–8–12–652980–3, New Delhi, India, 2011.
2. Dr.Saurabh Kumar, Cloud Computing: Insights Into New–Era Infrastructure, Wiley India Pvt. Ltd, ISBN–13: 978–8–12–652883–7, New Delhi, India, 2011.
3. Fern Halper, Hurwitz, Robin Bloor, Marcia Kaufman, Cloud Computing for Dummies, Wiley India Pvt. Ltd, ISBN–13: 978–0–47–059742–2, New Delhi, India, 2011.
4. RajkumarBuyya, Christian Vecchiola and ThamaraiSelvi, Mastering Cloud Computing: Foundation and Application Programming, Tata McGraw Hill, ISBN–13: 978–1–25–902995–0, New Delhi, India, Feb 2013.
5. Tim Mather, SubraKumaraswamy, ShahedLatif, Cloud Security and Privacy, O'Reilly,ISBN–13: 978–8–18–404815–5.
6. Puttini R. and Mahmood Z., Cloud Computing: Concepts, Technology & Architecture, Service Tech press (2013) 1st ed.
7. Buyya K, R., Broberg J. and Goscinski M. A., Cloud Computing: Principles and paradigms, MIT Press (2011) 4th ed.

Course Outcomes:

At the end of this course the student shall be able to:

CO-1.	Analyze the performance, scalability, and availability of the underlying cloud technologies and software.
CO-2.	Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.
CO-3.	Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds.
CO-4.	Design different work flows according to requirements and apply map reduce programming model.
CO-5.	Address cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application.
CO-6.	Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures.

M.Sc. (Computer Science)
SEMESTER-II
MCS-425: Artificial Intelligence
Discipline Specific Course (DSC)

Time: 3 Hrs. **Total Marks: 100**

Credits		
L	T	P
3	1	0

Theory Marks: 75

Theory Internal Assessment Marks:25

Note for paper setter and students:

1. **Medium of Examination is English Language.**
2. **There will be five sections.**
3. **Section A is compulsory and will be of 15 marks consisting of 8 short answer type questions carrying 2.5 mark each covering the whole syllabus. The answer should not exceed 50 words. The students will have to attempt any 6 questions in this section.**
4. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 15 marks each from the respective unit. The students are required to attempt one question from each of these sections.**

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Course Objectives:

1.	Helping student understand the world of Artificial Intelligence and its applications through games, activities and multi-sensorial learning to become AI-Ready.
2.	Introducing the student to domains of AI in an age appropriate manner.
3.	Allowing the student to construct meaning of AI through interactive participation and engaging hands-on activities.
4.	Learn the methods of solving problems using Artificial Intelligence

UNIT-I

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and NeuralNetworks

Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process

UNIT-II

Single Layer Perceptrons: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment

UNIT-III

Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection

Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning

UNIT-IV

Self-Organization Maps (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification.

References:

1. Gallant S.L., Neural Networks Learning & Expert Systems, MIT Press, 1993.
2. Haykin S., Neural Networks: A Comprehensive Foundation, Pearson Education Inc.,Second Edition, 2003.
3.Freeman J.A., Skapura D.M., Neural Network Algorithms, Applications and Programming Techniques, Addison-Wesley Publications, 1992.
4. Jacek M. Zurada, Introduction to Artificial Neural Systems, JAICO Publishing House Ed. 2006.
5. Li Min Fu, Neural Networks in Computer Intelligence, TMH 2003.
6. B. Vegnanarayana, Artificial Neural Networks, Prentice Hall of India P Ltd 2005

Course Outcomes:

At the end of this course the student shall be able to

CO-1.	Explain the basic knowledge representation, problem solving, and learning methods of Artificial Intelligence.
CO-2.	Assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving particular engineering problems.
CO-3.	Develop intelligent systems by assembling solutions to concrete computational problems.
CO-4.	Understand the role of knowledge representation, problem solving, and learning in intelligent-system engineering
CO-5.	Develop an interest in the field sufficient to take more advanced subjects.

M.Sc. (Computer Science)
SEMESTER-II

MCS-426P
Programming Laboratory – II
Skill Enhancement Course (SEC)

Time: 3 Hrs. **Total Marks: 50**

Credits		
L	**T**	**P**
0	**0**	**2**

Practical Marks: 37

Practical Internal Assessment Marks:13

Course Objectives:

1.	To develop proficiency in problem solving and programming.
2.	To be able to carry out the Analysis of various Algorithms for mainly Time and Space Complexity.
3.	To develop a base for advanced study in Computer Science.

Implementations based on Design & Analysis of Algorithms or Artificial Intelligence or Cloud Computing or Image Processing

Course Outcomes:

At the end of this course student will:

CO-1.	Get a good understanding of applications of Data Structures
CO-2.	Understand problems by applying appropriate algorithms.
CO-3.	Apply techniques of stacks and queues to solve problems.
CO-4.	Analyse the efficiency of various algorithms.
CO-5.	Solve a program in many ways using different techniques.