M.Sc. Mathematics with Computer Science

Syllabus

Department of Mathematics
Jamia Millia Islamia

COURSE STRUCTURE

Semester-wise course structure is described in the following tables:

First Semester

Paper No.	Title of the Paper	Total Marks
MTM101	Real Analysis	100
MTM102	Differential Equations and Applications	100
MTM103	Abstract Algebra	100
MTM104	Discrete Mathematical Structures	100
MTM105	Computing Fundamentals & Programming	100
MTM106	Computer Based Numerical Methods	100
Practicals Lab-I	Programming in C	75
Lab-II	Numerical Methods	75
	Total = 750	

Second Semester

Paper No.	Title of the Paper	Total Marks
MTM201	Topology	100
MTM202	Linear Algebra	100
MTM203	Differential Geometry	100
MTM204	Data Structure & Algorithms	100
MTM205	Computer Organization & Architecture	100
MTM206	Operating Systems	100
Practicals Lab-III	Data Structures	75
Lab-IV	UNIX / LINUX Shell Programming	75
	Total = 750	

Third Semester

Paper No.	Title of the Paper	Total Marks
MTM301	Complex Analysis	100
MTM302	Functional Analysis	100
MTM303	Database Management Systems	100
MTM304	Object Oriented Programming	100
MTM305	Elective - I (Computer Science)	100
MTM306	Elective - II (Mathematics)	100
Practicals Lab-V	Programming in Java	75
Lab-VI	Oracle	75
	Total =	**750**

Fourth Semester

Paper No.	Title of the Paper	Total Marks
MTM401	Project / Dissertation + Viva Voce	250
	Grand Total	**2500**

PROJECT: As a component of M. Sc. Maths. with Computer Science Program, students are required to carry a four to six months Project/ Dissertation in an Industry/ Organization/ Department in the 4th semester of their program.

ELECTIVES

Elective – I (Computer Science)	
Data Mining	Information Security
Artificial Intelligence	Computer Networks
Software Engineering	Computer Graphics
Advanced Algorithms	*Any Other Course Approved by the BOS*
Elective – II (Mathematics)	
Differentiable Manifolds	Theory of Rings
Wavelet Analysis	Cryptography
Computational Fluid Dynamics	Matrix Analysis
Mathematical Modeling & Simulation	*Any Other Course Approved by the BOS*

NOTE: Electives will be offered on the availability of subject expert

DETAILED SYLLABUS

Code	Name	Lecture
MTM101	**Real Analysis**	4

Unit 1. Countability of sets. Outer and inner Lebesgue measure, Lebesgue measurable sets, Properties of measurable sets, Borel sets and their measurability, Non-measurable sets, Cantor's ternary sets and their properties.

Unit 2. Measurable function, Characteristic function, Step function, Continuous function, Set of measure zero, Borel measurable function, The structure of measurable function.

Unit 3. Riemann integral and its deficiency, Lebesgue integral of bounded function, Comparision of Riemann and Lebesgue integerals, Properties of Lebesgue integral for bounded measurable function, The Lebesgue integeral for unbounded functions, Integral of non-negative measurable functions, General Lebesgue integeral, Improper integral.

Unit 4. Point wise convergence, Convergence almost everywhere, Uniform convergence almost everywhere, Convergence in measure, F. Reisz's theorem on convergence a.e., D.F. Egoroff's theorem, Lebesgue bounded convergence theorem, Lebesgue domainated convergence theorem, Fatou's lemma, Monotone convergence theorem.

L^p-space, Properties of L^p-space, Holder's inequality, Minkowski's inequality and Schwartz's inequality, Convergence in the mean, Riesz-Fischer theorem.

References

1. Royden, H.L.,
   Real Analysis (2nd ed.)
   The Macmillan Co., new York (1968)

2. Jain, P.K. & Gupta V.P.,
   Lebesgue measure and Integration
   Willey Eastern Ltd., New Age Int. Ltd., New Delhi, (1994)

3. Inder K. Rana,
   An Introduction to measure and integration, Narosa Publishing House, Delhi, (1997)

4. D.Somasundaran

   A Second Course in Mathematical Analysis

   Narosa Publishing House, N.Delhi, (2010)

Code	Name	Lecture
MTM102	**Differential Equations and Applications**	4

Unit 1. Existence & uniqueness theorem, General theory of Homogenous and nonhomogeneous equations with constant coefficients, Theory of equations with variable coefficients, Method of variation parameter and the formula for particular integral in terms of Wronskian.

Unit 2. Series Solution of second order linear differential equations near ordinary point, Singularity and the solution in the neighborhood of regular singular point, Euler equation and Frobenious method, Solution of Legendre, Bessel, Hypergeometric, Hermite and Lagurre differential equations.

Unit 3. Formulation of heat conduction equation and its solution by variable sepration method, Steadystate condition and the solution of heat conduction problem with non-zero end conditions, Formation of wave equation and the solution of wave equation.

Unit 4. Linear homogeneous boundary value problems, Eigen values and Eigen functions, Sturm Liouville boundary value problems, Non-homogeneous boundary value problems, Green's functions and the solution of boundary value problems in terms of Green's functions.

References

1. Earl A. Coddington,
   An Introduction to Ordinary Differential Equation.

2. Boyce and Diprime.,
   Elementary Differential Equations and Boundary Value Problems.

3. E. Weinberger,
   A first course in partial differential equations

Code	Name	Lecture
MTM103	**Abstract Algebra**	4

1. Group Theory

Unit-I: Groups, Subgroups, Normal Subgroups, Quotient Groups, Right Cosets, Homomorphism, Kernel of Homomorphism, Isomorphism, Fundamental theorem of Homomorphism.

Unit-II: Order of an element of a group, Lagrange's Theorem for finite groups, Normalization of an element, Centre of a group, Conjugate class, Class Equation and its applications, Sylow Theorem.

2. Ring Theory

Unit-III: Ring, Subring, Ideal, Integral domain and their Properties, Ring Homomorphism, Isomorphism, Quotient Ring, Euclidian Ring, Rings of Polynomial and their properties.

Unit-IV: Unique Factorization Domain, Unique Factorization Theorem, Primitive Polynomials, Gauss lemma, Eienstein Criteria for Irreducibility.

References

- I. N. Herstein, Topics in Algebra.
- Surjeet Singh & Q Zameeruddin, Modern Algebra.
- D.A.R. Wallace, Group, Rings and Fields.

Code	Name	Lecture
MTM104	**Discrete Mathematical Structures**	4

Unit 1. Relations and Functions, Equivalence Relations, Partial Order, Recurrence Relations, Solutions of Linear homogeneous Recurrence Relations, Introduction to Mathematical Logic, Propositional Calculus.

Unit 2. Lattices and Boolean algebra, Boolean Functions, Connonical Form (Disjunctive Normal Form) of a Boolean function, Karnaugh Maps.

Unit 3. Graphs and their representations, Walk, Path, Cycle, Circuit, Eulerian Graphs, Connected Graphs, Planar Graphs, Trees, Spanning trees, Binary Tree Traversals.

Unit 4. Linear codes, Hamming Code, Generator and parity check matrix, Hamming distance standard array and Syndrome decoding, introduction to cyclic codes.

References

1. Discrete Mathematics
   K.A. Ross, Charles R.W. Wright,
   Prentice Hall Inc.

2. Discrete Mathematical Structure for Computer Sciences
   Bernard Kolman / Robert C. Busby
   Prentice Hall of India.

3. Theory of Error Correcting Codes
   F.J. Mac. Williams / N.J.A.Sloane,
   North Holland Pub. Co.

4. Graph Theory with Applications to Engineering and Computer Science
   Narsingh Deo,
   Prentice Hall of India.

Code	Name	Lecture
MTM105	**Computing Fundamentals & Programming**	4

Computer Fundamentals: Introduction, Computer Architecture, Program, Software, Types of Software, Problem Solving, Top-down Design, Implementation of Algorithms, Flow Chart.

Basic Concepts of C: Introduction to C, Features, Character Set, C Token, Identifier & Keyword, Constants, Variables, Data Types in C , Integer, Floating Point, Character, String, Enumeration, ,Data Declaration & Definition, Operator & Expression Arithmetic, Relational, Logical, Increment & Decrement, Bit wise, Assignment, Conditional, Precedence & Associability of Operators. Managing Console I/O, Control Statements, Selection Statements, If, Nested if, if-else-if, The Alternative, The Conditional Expression, Switch, Nested Switch, Iteration Statements for loop, while loop, do-while loop ,Jump Statements.

Functions: Introduction, Need for User-Defined Function, A Multi-function Program, Definition of Function, Arguments & local variables, Returning and Calling Function by reference & Call by value, Passing Arrays & Strings to Function, Returning Multiple Values, Recursion, Recursive Functions, Storage Class & Scope.

Arrays, Strings & Pointers: Single Dimension Arrays, Accessing array elements, Initializing an array, Multidimensional Arrays Initializing the arrays, Memory Representation Accessing array elements, Passing Single Dimension array to Function, Array & Pointer, Array of Pointers, String Manipulation Functions, The Pointer operator, Pointer Expression, Declaration of Pointer, Initializing Pointer, De-referencing Pointer, Pointer to Pointer, Constant Pointer, Array of Pointers, Pointer to Function.

Structure, Union, Enumeration & File Handling: Structures, Declaration and Initializing Structure, Accessing Structure members, Structure, Assignments, Arrays of Structure, Passing Structure to function, Structure Pointer, Unions, File handling, Introduction, Defining & Opening a File, Closing a File, Input/Output Operations on Files, Command Line Arguments.

Reference:

- E Balagruswamy, Programming in ANSI C, TMH, Third Edition 2005
- R G Dromey, How to Solve by Computer, Pearson Education, Fifth Edition 2007.
- Deitel & Deitel, C: How to Program, Pearson Education, , Third Edition, 2003

Code	Name	Lecture
MTM106	Computer Based Numerical Methods	4

Unit-1 (6+6):

Solution of algebraic and transcendental equations by Newton-Raphson method for simple and multiple roots and its convergence. Solution of system of non-linear equations by Iteration and Newton-Raphson method. Lagrange's form of interpolating polynomial. Existence and uniqueness of interpolating polynomial, Piecewise interpolation, Hermite and Cubic spline interpolation.

Unit-2 (10)

Least square approximation : Weighted least square approximation. Method of least square for continuous functions, orthogonal polynomials, Gram-Schmidt orthogonalization process and approximation of functions using Chebyshev polynomials.

Unit-3 (6+6)

Numerical integration by Romberg method; Guassian quadrature formula and error estimation. Numerical solution of initial value problems: Runge Kutta method of order four for system of equations and for second and higher order differential equations. Boundary Value problems by Finite difference method and shooting method. Convergence of finite difference scheme.

Unit-4 (10)

Numerical solution of partial differential equations: Parabolic equations- finite difference approximation to partial diff. derivatives, explicit method and Crank-Nicolson method with stability analysis.

Elliptic equations- Standard five point formula, Jacobi's iteration method and Leibmann's method. Hyperbolic equations: Explicit finite difference method.

Reference:

1. S.D. Conte & Carl D. Boor, Elementary Numerical Analysis
2. Iyengar and Jain: Numerical methods for Scientific and Engineering Computations
3. G.D. Smith, Numerical Solution of Partial Differential Equations
4. M.K. Jain, Numerical Solution of Differential Equations
5. Naseem Ahmad, Fundamentals Numerical Analysis with error estimation
6. Gerald & Wheatlay: Applied Numerical Analysis

Code	Name	Lecture
MTM201	Topology	4

Unit – 1:

Metric Spaces, Open and Closed spheres and sets. Topological Spaces. Closed set, Closure, Dense subsets, Neighborhoods, Interior, Exterior and Boundary of a set, Accumulation points and Derived sets, Bases and Sub bases, Subspaces and Relative topology. The Product topology on two spaces. The Metric topology. Continuous functions and Homeomorphism.

Unit – 2:

First and Second countable spaces, Separable spaces, Second countability and Separability, Separation Axioms, T_i (i = 0,1,2) spaces and their characterizations and basic properties, Regular and Normal Spaces, Urysohn's lemma, Tietze extension theorem.

Unit – 3:

Open covering and Compact spaces, Continuous functions and Compact sets, Finite intersection property, Locally compact spaces, Countable compactness and Sequential compactness, Bolzano Weierstrass property, Lebesgue covering lemma, Total boundedness, Equivalence of compactness.

Unit – 4:

Separation of a space, Connected spaces, Connected sets in the real line, Totally disconnected spaces, Intermediate value theorem, Path connected, Components, Local connectedness, Locally path connected spaces, Continuous functions and connected sets.

Books Recommended

1. J.R. Munkres: Topology (Relevant portions only)
   Pearson Education, 2004.
2. Benjamin T. Sims:
   Fundamentals of Topology (Relevant portions only)
   Macmillan Publishing Co. Inc. N.Y.

Help Books

1. Colin Adams and Robert Franzosa:
   Introduction to Topology Pure and Applied

Pearson Prentice Hall, 2009.

2. G.F. Simmons:
   Introduction to Topology and Modern Analysis
   McGraw Hill Book Company, 1963
3. B.K.Tyagi:
   Metric Spaces
   Cambridge University Press India Pvt. Ltd., 2010

Code	Name	Lecture
MTM202	**Linear Algebra**	4

Unit-I

Vector Space, Subspaces and properties, Quotient Space, Basis and Dimension, Linear Transformation, Rank And Nullity of a Linear Transformation, Sylvester's Law of Nullity.

Unit-II

Algebra of Linear Transformations, Hom(u,v), Dual Space, Bidual, Matrix of Linear Transformations, Change of Basis Equivalent and Similar Matrices, Dimension of Hom(u,v), Isomorphism between link of all linear Transformation on a Vector space and ring of all n x n matrices over F.

Unit-III

Minimal Polynomials, Invertible linear Transformation, Eigen Values, Eigen Vectors, Result on Minimal Polynomial related to Eigen Values and Eigen Vectors.

Unit-IV

More on Minimal Polynomials, Cyclic Space, Companion matrix, Jordan Blocks, Inner Product Space, Unitary, Adjoint, Hermition Adjoint, Skew Hermition, Normal Linear Operators.

References

- I. N. Herstein, Topics in Algebra.
- P. R. Halmos, Linear Algebra with Problems.
- Hoffman & Kunze, Linear Algebra.
- Surjeet Singh & Q Zameeruddin, Modern Algebra.

Code	Name	Lecture
MTM203	**Differential Geometry**	4

Unit-I:

Co-ordinate transformation, Covariant, Contravariant and Mixed tensors, Tensors of higher rank, Symmetric and Skew-symmetric tensors, Tensor algebra, Contraction, Inner product, Riemannian metric tensor, Christoffel symbols, Covariant derivatives of tensors.

Unit-II:

Differentible curves in R3 and their parametric representations, Vector fields, Tangent vector, Principal normal, Binormal, Curvature and torsion, Serret-Frenet formula, Frame fields, Covariant differentiation, Connection forms, The structural equations.

Unit-III:

Surfaces, Differentiable functions on surfaces, Differential of a differentiable map, Differential forms, Normal vector fields, First fundamental form, Shape operator, Normal curvature, Principal curvatures, Gaussian curvature, Mean curvature, Second fundamental form.

Unit-IV:

Gauss equations, Weingarten equation, Codazzi-Mainardi equations, Totally umbilical surfaces, Minimal surfaces, Variations, First and second variations of arc length, Geodesic, Exponential map, Jacobi vector field, Index form of a geodesic.

References

1. Elementary Differential Geometry
   Barett O' Neill, Academic Press, 2006.

2. Differential Geometry of Curves and Surfaces
   Manfredo P. Do' Carmo, Prentice Hall Inc., New Jersey U.S.A. 1976.

3. Curves and Surfaces
   S. Montiel and A. Ros, American Mathematical Society, 2005.

4. Differential Geometry, A first course
   Somasundaram, Narosa Publication.

5 Tensor Calculus
   Zafar Ahsan, Anamaya Publications, New Delhi.

6. Tensor Calculus
   U. C. De, Narosa Publications, New Delhi.

Code	Name	Lecture
MTM204	**Data Structures & Algorithms**	4

Introduction to Data Structure: Definition of Data Structure, Types & Characteristics of Data Structures, Abstract Data Type (ADT), Algorithms: Algorithm Concepts, Definition of Algorithm, Objectives of Algorithms, Quality of an Algorithm, Space Complexity and Time Complexity of an Algorithm.

Arrays, Stacks and Queues: Characteristics & of an Array, Row and Column Major Implementations of 1 - D, 2-D, 3-D Arrays. Operations on Stack, Stack Implementation using Array and Linked List, Applications of Stack - Polish and Reverse Polish Notations, Recursion, Buddy Systems, Garbage Collection. Operations on Queues, Types of Queues: Linear Queue, Circular Queue, Priority Queue, Double Ended Queue, Queue Implementation.

Linked Lists: Concept of a Linked List, Linear Single and Double Lists, Circular Single and Double List, Operations on Linked Lists. Applications of Linked Lists.

Trees and Graphs: Concepts of a Tree, Definitions of n-ary, Binary Trees, Strictly Binary Tree, Complete Binary Tree, Almost Complete Binary Tree, Level of a Node, Height/Depth of a Tree. Operations on Tree, Tree Search Algorithms, Binary Search Tree, Tree Traversal Algorithms, AVL Trees - Balance of a Node, Weight Balanced Trees. Threaded Binary Tree, Trees Traversal, Huffman Algorithm, Definitions of Vertex Edge and Graph, Types of Graphs – Directed/Undirected, Connected/Disconnected, Cyclic/Acyclic, Representation of Graphs: Adjacency Matrix, Linked List. Graph Algorithm-Warshalls, BFS, DFS, Kuruskal, Prims.

Sorting and Searching: Bubble Sort, Sequential Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort, Heap Sort. Linear Search and Binary Search

References:

- Classic Data Structures by D. Samanta, PHI
- Data Structures by S. Lipshutz, Schaum outline series, Tata Mc-graw Hill
- Data Structures Using C & C++ by Tananbaum
- Introduction to Algorithms Cormen, Leiserson, Rivest.

Code	Name	Lecture
MTM205	**Computer Organization & Architecture**	4

Unit-I

Information Representation: Number Systems, Binary Arithmetic, Fixed-point and Floating-point representation of numbers, Codes, Complements, Error detecting and correcting codes, Character Representation – ASCII, EBCDIC.
Boolean Algebra: Basic Definitions, Axiomatic definition of Boolean Algebra, Basic theorems and Properties of Boolean Algebra, Boolean functions, Canonical and Standard Forms.

Unit -II

Digital Logic: Basic Gates – AND, OR, NOT, Universal Gates – NAND, NOR, Other Gates – XOR, XNOR etc. NAND, NOR implementations of digital circuits, Simplification Of Boolean Expressions: Formulation of simplification problem, Karnaugh Maps, Minimal, Combinational Logic Design Procedure, Adders, Subtractors, Code Conversion, Decimal Adder, Magnitude Comparator, Decoders, Encoder, Multiplexers, De-multiplexer

Unit-III

Sequential Logic: Flip-Flops, Clocked RS, D type, JK, T type, State table, state diagram and state equations. Flip-flop excitation tables. Design Procedure, Design of sequential circuit and Counters, Shift registers, Synchronous Counters. Primary Memory, Secondary memory, Cache memory, Memory Hierarchy

Unit-IV

Architecture: Basic architecture of computer, Bus structures, Von Neumann Concept. Zero address, one address, two address and three address machine, Addressing modes, Microprogramming, Micro engine ,Micro instruction , Pipelining, Array processing, vector processing, Synchronous and Asynchronous Data transfer, DMA data transfer.

References

1. M.Morris Mano, 'Computer Engineering Hardware Design', PHI.
2. V. Rajaraman, T. Radhakrishnan, An Introduction to Digital Computer Design, Prentice Hall of India Pvt. Ltd.
3. Nicholas Carter, Schaum's Outlines Computer Architecture, Tata MH.
4. Andrew S. Tanenbaum, Structured Computer Organization, Prentice Hall of India Pvt. Ltd.
5. William Stalling, "Computer Organization and Architecture" Pearson Education

6. J. P. Hayes “Computer Architecture and Organization" McGraw Hill Education India.
7. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, “Computer Organization”, 5th Edition, Mc Graw-Hill Education India
8. M.Morris Mano : Computer System Architecture, Prentice Hall of India.
9. M.Morris Mano, ‘Digital Logic and Computer Design’, PHI.
10. Donald e Givone, Digital principles and Design, TMH (Unit II and V)

Code	Name	Lecture
MTM206	**Operating Systems**	4

Introduction: Evolution of Operating System, Types and Functions of Operating Systems, Operating System Structure, Operating System Classification, Characteristics of Modern Operating Systems.

Processor Management: Process Overview, Process States and State Transition, Multiprogramming, Multi-Tasking, Levels of Schedulers and Scheduling Algorithms. Process Communication, Process Synchronization, Semaphores, Critical Section and Mutual Exclusion Problem, Classical Synchronization Problems, Characterization of a Deadlock, Deadlock Prevention, Deadlock Avoidance, Multithreading.

Memory Management: Classical Memory Management Techniques, Paging, Segmentation, Virtual Memory - Demand Paging, Page Replacement Policies, Allocation of Frames, Thrashing.

File Management and Mass-Storage Structure: File Concept, Access Methods, Directory Structure, File-System Mounting, File Sharing, Protection, File-system Structure, File-System Implementation, Directory Implementation, Allocation Methods. Free-Space Management, Efficiency and Performance, Recovery, Log-Structured File System NFS. Overview of Disk Scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK, Disk Management.

Case Studies: The Linux-System Design Principles, Kernel Modules, Process Management, Scheduling, Memory Management, File-System, Input and Output, Interprocess Communication, Security.

References

- Silberschatz, P.B.Galvin and G. Gagne, **Operating System Concepts** (6th ed.), John Wiley & Sons, Inc., 200.
- A.S. Tanenbaum, **Modern Operating Systems** (2nd ed.), Prentice-Hall of India, 2001.
- William Stallings, **Operating Systems: Internals and Design Principles** (5th ed.), Prentice-Hall of India, 2006.
- Gary Nutt, **Operating Systems: A Modern Approach** (3rd ed.), Addison Wesley, 2004
- D.M. Dhamdhere, **Operating Systems: A Concept Based Approach** (2nd ed.), Tata McGraw-Hill, 2007
- Deitel Deitel Choffnes, **Operating Systems** (3 rd ed.), Pearson Education 2007.

Code	Name	Lecture
MTM301	Complex Analysis	4

Unit-I

Representation of Complex Numbers, Analytic Function, Cauchy Riemann Equations, Power Series, Some Elementary Functions, Harmonic Functions.

Unit-II

Properties of Line Integrals, Zeros of an Analytic Function, Cauchy's Theorem, Morera's Theorem, Cauchy's Integral Formula, Cauchy's Inequality, Fundamental Theorem of Algebra, Poisson's Formula, Liouville's Theorem, Rouche's Theorem, The Argument Principle.

Unit-III

Zeros and Poles, Classification of Isolated Singularities, Taylor's and Laurent's Series, Winding Numbers and Residues, Cauchy Residue Theorem and Application in Evaluation of Improper Real Integrals and Evaluation of Sum.

Unit-IV

Conformal Mapping Properties, Schwarg Lemma, Riemann Mapping Theorem (Without Proof), Maximum Modulus Theorem, Analytical Continuation.

References

- Rudin, Real and Complex Analysis
- J. B. Conway, Complex Analysis.
- Alfors, Complex Analysis.
- E. C. Titchmarsh, Complex Analysis.
- B. Choudhary, Complex Analysis.
- Anant R. Shastri – Complex analysis
- Zill Dennis G. & Shanahan Patrick D. – A first course in Complex Analysis with Applications.
- Fundamentals of Complex Analysis with Applications to Engineering and Science, E-B Saff and A-D Snider.

Code	Name	Lecture
MTM302	**Functional Analysis**	4

Unit 1. Normed Spaces, Banach Spaces and Bounded Linear Operators:

Definition and examples, subspaces, some concrete examples of Banach spaces, bounded linear operators, spaces of bounded linear operators, equivalent norms, open mapping and closed graph theorems and their consequences, uniform boundedness principle.

Unit 2. Bounded Linear Functionals:

Examples and basic properties, Forms of dual spaces, Hahm-Banach theorem and its consequences, embedding and reflexivity, adjoint of bounded linear operators, weak convergence.

Unit 3. Inner Product and Hilbert Spaces:

Definitions and examples, orthogonality of vectors, orthogonal complements and projection theorem, orthonormal sets, complete orthonormal sets.

Unit 4. Functionals and Operators on Hilbert Spaces:

Bounded linear functionals, Riesz-Frechet theorem, Hilbert-adjoint operators, self-adjoint operators, normal operators and unitary operators.

Books Recommended:

1. Introductory Functional Analysis and Applications
   E. Kreyszig,
   John-Wiley & Sons.

2. Introduction to Functional Analysis with Applications
   A.H.Siddiqi, Khalil Ahmad and P. Manchanda,
   Anamaya Publishers, New Delhi and Anshan Ltd., U.K. (2006).

Code	Name	Lecture
MTM303	Database Management Systems	4

Unit 1. Databases, DBMS, Advantages of DBMS, Role of DBA, data integrity, data independence.

Unit 2. Architecture of Database Management System: External level, conceptual level and internal level, Schemas, Distributed databases.

Unit 3. Three approaches to DBMS, Characteristics of Hierarchical model, DBTG Network Model, Introduction to Relational model, Security and Reliability, Audit trail.

Unit 4. Normalization, First Normal Form, Second Normal Form, Third Normal Form, BCNF, Relational Algebra and Relational Calculus, Well formed formula, SQL Language.

References:-

1. An Introduction to Database System
   C.J. Date, Sixth Ed.,
   Addison-Wesley Publishing Co.

2. Principles of Database System
   Ullman, Jeffery D.,
   Galgotia Publications (P) Ltd.

Code	Name	Lecture
MTM304	**Object Oriented Programming**	4

Object Oriented Methodology & Java Language Basics: Paradigms of Programming Languages, Evolution of OO Methodology, Basic Concepts of OO Approach, Comparison of Object Oriented and Procedure Oriented Approach, Benefits and Applications of OO Programming, Introduction to Common OO Languages, Introduction to Java, Basic Features of Java, Java Virtual Machine Concepts, Data type, Variables and Arrays, Operators, Control Statements.

Object Oriented Concepts: Classes and Objects, Constructors, Method Overloading, Argument Passing, Recursion, Access Control, Understanding Static. Inheritance and Polymorphism – Inheritance Basics, Access Control, Use of Super, Multilevel Inheritance, Method Overriding, Dynamic Method Dispatching, Preventing Inheritance and Overriding.

Packages, Interface and Exception Handling: Java API Package, Using System Packages, Naming Conventions, Creating Packages, Accessing a Package, Using a Package, Adding a Class to a Package. Interface – Defining an Interface, Implementing Interface, Applying Interface, Accession of Interface Variable, Interface and Abstract Class. Exception Handling - Exception Types, Handling of Exception using try-catch, Catching Multiple Exceptions, Nested try Statements, Use of throw, throws and finally Clause, Java Built-in Exception, Creating Exception Subclasses.

Multithreading, I/O and String Handling: Thread Models, Main Thread, Creating Threads, Thread Priorities, Life Cycle of Thread, Synchronization in Java, Thread Exceptions, Inter-Thread Communications. I/O Basics, Byte Stream and Character Stream Classes, Reading from and Writing to Console, Reading and Writing Files, Transient and Volatile Modifiers, Stream Tokenizer, Serialization. String – Fundamental of Characters and Strings, String Class, String Operations, String Buffer Class and Methods.

Applet Programming and Advance java Concepts: Applet Basics, Applet Architecture, Applet Initialization and Termination, Writing Applets, HTML Applet Tags, Passing Parameters to Applets, AudioClip Interface, and AppletStub interface. Java Database Connectivity – Different Types of Drivers, Establishing a Connection, Transactions with Database. Overview of Event Handling, AWT Controls, Layout Managers, Menus and Swing.

References

1. Cay Horstmann, **Computing Concepts with Java Essentials** (5th ed.), John Wiley & Sons, 2006

2. Bruce Eckel, **Thinking in Java**, Pearson Education, 2006.
3. H. Schildt, **Java 2: The Complete Reference** (5th ed.), Tata McGraw Hill, 2002
4. Richard Johnson, **An Introduction to Java Programming and Object-Oriented Application Development,** Thomson Learning, 2006
5. Cay S. Horstmann & Gary Cornell, **Core Java Volume I** (7th ed.), Sun Microsystems Press Java Series, 2006
6. Deitel & Deitel, **Java-How to Program** (7th ed.), Prentice Hall, 2006
7. Daniel Liang, **Introduction to Java Programming** (5th ed.), Prentice Hall, 2005
8. J.A. Slack, **Programming and Problem Solving with Java**, Thomson Learning, 1999

ELECTIVE – I (Computer Science)		
Code	**Name**	**Lecture**
MTM305	**Computer Networks**	4

Introduction: Hardware Architecture - Topologies, Media, Devices, Transmission Techniques Twisted Pair, Coaxial Cable, Fiber optics, Wireless Transmission Switching, Circuit Switching, Message Switching, Packet Switching. Common Network Architecture - Connection Oriented N/Ws, Connectionless N/Ws, Example of N/Ws-P2P, X.25, ATM, Ethernet, Wireless LANs - 802.11, 802.11x, Gigabit.

Computer Networks: The OSI Reference Model - Protocol Layering, TCP/IP Model, OSI vs. TCP/IP. LAN - Components & Technology, Access Techniques, Transmission Protocol & Media. Broad Band Networks - Integrated Service Digital Networks (ISDN), Broad Band ISDN, ATM, ATM Traffic Mgmt, Introduction to Very Small Aperture Terminal (VSAT).

IP Addressing, Routing and DNS: IP Addresses – Network Part and Host Part, Network Masks, Network Addresses and Broadcast Addresses, Address Classes, Loop Back Address, IP Routing Concepts, Routing Tables, Stream & Packets, TCP – a Reliable Pipe, TCP Connection – Multiple Conversations, Port Numbers, Multiple Connection from Many Hosts and One Host, IPV6. DNS - Domain Names, Authoritative Hosts, Delegating Authority, Resource Records, SOA records, DNS protocol, DHCP & Scope Resolution.

Network Applications and Security: Hyper Text Transfer Protocol (HTTP), HTTP Communications - HTTP request, Request Headers, Responses, Status Code, Error Status Code Email- Sending & Receiving Emails, Email Addressing, Message Structure MIME–Multipurpose Internet Mail Extensions, SMTP–Simple Mail Transfer Protocol with Examples. Mail Exchangers – Delivering a Message, Mail Boxes, POP, IMAP, FTP, Telnet – Remote Communication Protocol, Proxy Server, Proxy Web Servers.

Security - Threats, Packet-Filtering Firewalls, Fire Wall Policies and Rules, Common Problem with Packet Filtering, SSL – Secure Socket Layer, IPSec (Internet Protocol Security), Virtual Private Networks, Symmetric Key Signatures, Public key Signatures.

Reference:

- B. A. Forouzan, “Data Communication and Networking”, TMH, 4th Ed., 2006.
- A S. Tananbaum, “Computer Networks”, 4th Ed., Pearson, 2003
- W. Stallings, “Data and Computer Communications”, 7th Ed., Pearson, 2002.
- Black U, “Computer Networks-Protocols, Standards and Interfaces”, PHI 1996
- Comer E. Doughlas, “Computer Networks and Internets”, 2nd Ed., Pearson, 2000
- Comer E. Doughlas, “Internetworking with TCP/IP, Vol. 1, PHI, 2000.

ELECTIVE – I (Computer Science)

Code	Name	Lecture
MTM305	**Data Mining**	4

Data Warehouse and OLAP Technology: Introduction to Data Warehouse; Features of Data Warehouse; Operational Database Systems vs. Data Warehouses; Difference Between OLTP and OLAP; Multidimensional Data Models: Data cubes, Star Schema, Snowflake Schema; Concept Hierarchies; OLAP Operations: Roll-up, Drill-down, Slice, Dice, and Pivot; Three-Tier Data Warehouse Architecture; Types of OLAP Servers: ROLAP, MOLAP, and HOLAP.

Introduction to Data Mining: KDD (Knowledge Discover from Databases) Process and Data Mining; KDD Steps; Types of Data for Data Mining, Data Mining Functionalities, Classification of Data Mining Systems; Data Mining Task Primitives; Major Issues in Data Mining.

Data Preprocessing: Introduction to Data Preprocessing; Descriptive Data Summarization: Measuring and Central Tendency and Dispersion of Data; Visualization of Descriptive Data Summaries; Data Cleaning: Handling Missing Values, Filtering Noisy Data – Binning Method; Data Integration; Data Transformation: Smoothing, Aggregation, Generalization, Normalization and Feature Selection; Data Reduction; Data Discretization and Concept Hierarchy Generation.

Association Rule Mining: Market basket Analysis; Frequent Itemsets, Closed Itemsets, and Association Rules; Support and Confidence; Apriori Algorithm for Mining Frequent Itemsets Using Candidate Generation; Generating Association Rules from Frequent Itemsets; Improving the Efficiency of Apriori Algorithm; FP-Growth Algorithm for Mining Frequent Itemsets without Candidate Generation; Mining Closed Frequent Itemsets; Correlation Analysis.

Classification Rule Mining: Introduction to Classification and Prediction; Classification by Decision Induction; Attribute Selection Measures: Information Gain, Gain Ratio, and Gini Index; Tree Pruning; Bayesian Classification: Bayes' Theorem, Naïve Bayesian Classification, Bayesian Belief Networks; Classifier Accuracy Measures: Sensitivity, Specificity, Precision, and Accuracy; Predictor Error Measures; Accuracy Evaluation Methods: Holdout, Random Subsampling, Cross-validation, and Bootstrap; Accuracy Enhancement Methods: Bagging and Boosting.

Cluster Analysis: Introduction to Cluster and Clustering; Features Required for Clustering Algorithms; Data Types and Dissimilarity Measures in Cluster Analysis; Categorization of Clustering Methods; Partitioning-Based Clustering: k-means Algorithms, k-medoids algorithms (PAM, CLARA, CLARANS); Hierarchical Clustering: Agglomerative and Divisive Methods (AGNES, DIANA, BIRCH; Density-Based Clustering: DBSCAN.

References:

- J. Han & M. Kamber: Data Mining Concepts and Techniques, 2nd Ed., Morgan Kaufman
- Witten & E. Frank: Data Mining – Practical Machine Learning Tools and Techniques, 2nd Ed., Morgan Kaufman
- Michael Berry & Gordon Linoff: Data Mining Techniques , Revised Ed.

ELECTIVE – I (Computer Science)

Code	Name	Lecture
MTM305	**Software Engineering**	4

Introduction: Definition, Program Vs Software, Overview of S/W Engineering Process, Software life cycle Models: Build and Fix, Waterfall, Prototype, Iterative Enhancement Model, Evolutionary, Spiral Model, RAD Model.

Software Requirement Analysis and Specifications: Problem Analysis, Functional & Non-Functional Requirements, User & System Requirements, Requirements Engineering Process, Requirements Elicitation & Analysis Techniques, Requirements Validation, Requirements Management, Metrics for Analysis Model, Data Flow Diagrams, Data Dictionaries, Decision Table, Decision Tree, Software Requirement and Specifications.

Software Project Planning: Objectives, Project Size Estimation, Cost Estimation, Decomposition Techniques, Empirical Estimation Model, COCOMO Estimation Model, Project Scheduling & Tracking, Risk Management: S/W Risks, Risk Identification, Risk Refinement, Risk Monitoring & Management.

Software Design: Introduction, Principles, Abstraction, Refinement, Modularity, Information Hiding, Module Level Concepts: Cohesion, Coupling, Functional Independence, Design Models, Metrics for Design Model, Data Design, Object Oriented Design, User Interface Design, Component Design, Detailed Design Document.

Software Testing and Quality Assurance: Introduction, Error, Faults, Failure and Reliability, Testing Levels: Unit, Integration, Validation and System Testing, Functional and Structural Testing, Test Case Design, Quality Assurance and Standards.

References

- Prof. K.K. Aggarwal & Yogesh Singh: SOFTWARE ENGG:
- Pankaj Jalote, " An Integrated Approach to Software Engg" Narosa Publishing House, New Delhi.
- Pressman"Priciples of Software Engg" TMC, 5th Ed. 2005

ELECTIVE – I (Computer Science)

Code	Name	Lecture
MTM305	**Artificial Intelligence**	4

Introduction: AI Problems, Foundation of AI and History of AI Intelligent Agents: Agents and Environments, The Concept of Rationality, The Nature of Environments, Structure of Agents, Problem Solving Agents and Problem Formulation.

Searching: Searching For Solutions, Uniformed Search Strategies – Breadth First Search, Depth First Search, Depth Limited Search, Iterative-Deepening Depth First Search Bi-Direction Search - Comparison. Search with Partial Information (Heuristic Search) Greedy Best First Search, A* Search, Memory Bounded Heuristic Search, Heuristic Functions. Local Search Algorithms: Hill Climbing, Simulated, Annealing Search, Local Beam Search, Genetical Algorithms. Constrain Satisfaction Problems: Backtracking Search for CSPS Local Search for Constraint Satisfaction Problems.

Knowledge Representation & Reasons Logical Agents: Knowledge – Based Agents, the Wumpus World, Logic, Propositional Logic, Resolution Patterns in Propos Ional Logic, Resolution, Forward & Backward. Chaining. First Order Logic. Inference in First Order Logic, Propositional Vs. First Order Inference, Unification & Lifts Forward Chaining, Backward Chaining, Resolution.

Planning: Classical Planning Problem, Language of Planning Problems, Expressiveness and Extension, Planning With State – Space Search, Forward States Spare Search, Backward States Space Search, Heuristics for Stats Space Search. Planning Search, Planning With State Space Search, Partial Order Planning Graphs.

Learning: Forms of Learning, Induction Learning, Learning Decision Tree, Statistical Learning Methods, Learning With Complex Data, Learning With Hidden Variables – The EM Algorithm, Instance Based Learning, Neural Networks.

References

- Introduction to Artificial Intelligence – Rajendra Akerkar, PHI.
- Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/Pearson Education.
- Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition,
- Artificial Intelligence , 2nd Edition, E.Rich and K.Knight (TMH).
- Artificial Intelligence and Expert Systems – Patterson PHI
- Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson
- PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.

ELECTIVE – I (Computer Science)

Code	Name	Lecture
MTM305	**Computer Graphics**	4

Overview of Graphics Systems: Overview of Computer Graphics; Video Display Devices; Raster Scan Display; Random Scan Display; Cathode Rays Tube (CRT) Display Device; Direct View Storage Tube (DVST) Display Device; Flat Panel display: Plasma Panel Display, Thin Film Electroluminescent Display, Light Emitted Diode (LED) Display Device, Liquid Crystal Display Device; Color CRT Display Devices: Beam-Penetration Method, Shadow-Mask Method.

Line, Curves and Surfaces: Line Drawing Algorithm, DDA Algorithm, Bresenham's Line Drawing Algorithm, Bresenham's Circle Drawing Algorithm, Mid-Point Circle and Ellipse Drawing Algorithm, Bezier Curves, 4 point and 5 point Bezier Curves using Bernstein Polynomials, B-Spline Curves, Computing control points given end slopes for a specified curve segment, Scan-Line Polygon Fill Algorithms, Boundary Fill and Flood-Fill Algorithms.

Two Dimensional Geometric Transformation, Viewing and Clipping: Basic Transformations: Translation, Rotation, Scaling; Other Transformations: Reflection and Shearing Operations; Transformation between Cartesian Coordinate Systems; Viewing: The viewing Pipeline, Viewing Coordinate Reference Frame, Window to Viewport Coordinate Transformation; Clipping: Point clipping; Line Clipping; Cohen-Sutherland Line Clipping Algorithm, Liang-Barsky Line Clipping Algorithm, Liang-Barsky Line Clipping Algorithm to Clip a Line Against Non-Rectangular Convex Polygon, Polygon Clipping: Sutheland-Hodgeman Polygon Clipping, Weiler-Atherton Polygon Clipping; Text clipping.

Three Dimensional Geometric Transformations and Clipping: Basic Transformations: Translation, Rotation, Rotation with Rotation Axis Parallel to one of the Principal Axis, General Rotation, Scaling; Other Transformations: Reflections, Shears; Three Dimensional Line Clipping: Mid-Point Subdivision Line Clipping Algorithm, Liang-Barsky Line Clipping Algorithms..

Projection, Fractal Generation, Shading and Surface Rendering: Projection: Types of Projections, Perspective Projection Transformation with Center at Origin, Perspective Projection Transformations with center at C0(a, b, c), Orthographic Projection Transformation with Projection Plane as one of the Standard Plane, Orthographic Projection Transformation with Projection Plane Passes Through R0(x0, y0, z0) and Normal Vector is N=n1i+n2j+n3k, Isometric Projection Transformation; Fractal Geometric: Fractal Generation Procedure, Classification of Fractal, Fractal Dimension, Fractal Construction Methods; Shading: Shading Algorithms, Shading Model,

Illumination Model; Hidden Surface Detection: Z-Buffer Method, A-Buffer Method, Scan Line Method.

References

- D. Hearn and P. Baker, “Computer Graphics”, Prentice Hall 2nd Edition, 19999.
- R. Plastock and Z.Xiang, “ Computer Graphics”, 2nd Edition Schaum’s Series, McGraw Hill, 2001.
- Foley et. al., “Computer Graphics Principles & practice”, Addison Wesley, 1999.
- David F. Rogers, “Procedural Elements for Computer Graphics”, McGraw Hill Book Company, 1985.
- W. Newman and R. Sproul, “Principles of Interactive Computer Graphics, McGraw-Hill, 1973.
- Rogars and Adams “Mathematical elements of computer graphics” Mc Graw Hill
- Edward Angele, Interactive Computer Graphics, A top-down approach with OpenGL , Addisen Wesley.
- Woo, Open GL Programming, Pearson Education