DEPARTMENT OF MATHEMATICS

OSMANIA UNIVERSITY

M.Sc. Mathematics Syllabus

Semester – I & II

(Choice Based Credit System)
(w.e.f. the academic year 2023-2024)

M.Sc. Mathematics Course Structure

(Choice Based Credit System)
(w.e.f. the academic year 2023-2024)

SEMESTER – I

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	M 101	**Abstract Algebra**	4	1	5	30	70	100
Core	M 102	**Mathematical Analysis**	4	1	5	30	70	100
Core	M 103	**Ordinary Differential Equations**	4	1	5	30	70	100
Core	M 104	**Linear Algebra**	4	1	5	30	70	100
			16	4	20			400

SEMESTER – II

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	M 201	**Galois Theory**	4	1	5	30	70	100
Core	M 202	**Lebesgue measure and Integration**	4	1	5	30	70	100
Core	M 203	**Complex Analysis**	4	1	5	30	70	100
Core	M 204	**Topology**	4	1	5	30	70	100
			16	4	20			400

T – Tutorial class: Each batch consists of 20 students and will be allotted to a teacher (Demonstrating the theory through a numerical example and practicing through mathematical software)
THPW = Teaching Hours Per Week.
IA = Internal Assessment (IA Test 20 Marks + Assignment 10 Marks).
ESE = End-Semester Examination.
End-Semester Examination Duration - 3 Hrs.

M. Sc. Mathematics

M/AM/MCS 101 **Semester-I**

Paper-I: Abstract Algebra

Unit- I
Automorphisms - Conjugacy and G - sets - Normal series - Solvable groups - Nilpotent groups.
(Page No. 104 to 128)

Unit- II
Structure theorems of groups: Direct products - Finitely generated abelian groups - Invariants of a finite abelian group - Sylow theorems - Groups of orders p^2, pq.
(Page No. 138 to 155)

Unit- III
Ideals and homomorphisms - Sum and direct sum of ideals, Maximal and Prime ideals - Nilpotent and nil ideals - Zorn's lemma.
(Page No. 179 to 211).

Unit- IV
Unique factorization domains - Principal ideal domains - Euclidean domains - Polynomial rings over UFD - Rings of Fractions.
(Page No. 212 to 228)

Text Book:

- **Basic Abstract Algebra** by P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul. Second Edition

References:

1. **Topics in Algebra** by I.N. Herstein.
2. **Elements of Modern Algebra** by Gibert and Gilbert.
3. **Abstract Algebra** by Jeffrey Bergen.
4. **Basic Abstract Algebra** by Robert B Ash.

M. Sc. Mathematics

M/AM/MCS 102 **Semester-I**

Paper - II: Mathematical Analysis

Unit- I
Metric spaces - Compact sets - Perfect sets - Connected sets.
(Page No. 30-46)

Unit- II
Limits of functions - Continuous functions - Continuity and compactness, Continuity and connectedness - Discontinuities - Monotonic functions, Differentiation.
(Page No. 83-102)

Unit- III
Riemann - Steiltjes integral - Definition and Existence of the Integral - Properties of the integral – Integration and differentiation, Integration of vector valued functions - Rectifiable curves.
(Page No. 120-133 & 135-142)

Unit- IV
Sequences and Series of Functions: Uniform convergence - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation – The Stone-Weierstrass theorem.
(Page No. 143-154, 159-161, 165-171 & 220-222)

Text Book:

- **Principles of Mathematical Analysis** (3rd Edition) By Walter Rudin, *McGraw-Hill International Edition.*

References:

1. **The Real Numbers** by John Stillwel.
2. **Real Analysis** by Barry Simon.
3. **Mathematical Analysis** Vol - I by D J H Garling.
4. **Measure and Integral** by Richard L.Wheeden and Antoni Zygmund.

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M/AM 103 **Semester-I**

Paper - III: Ordinary Differential Equations

Unit- I

Existence and Uniqueness of Solutions: Preliminaries – Successive approximations – Picard's theorem – Some examples – Continuation and dependence on initial conditions – Existence of solutions in the large – Existence and uniqueness of solutions of systems.

Unit- II

Linear Differential Equations of Higher Order: Introduction – Higher order linear differential equations – A Mathematical model – Linear dependence and Wronskian – Homogeneous linear equations with constant coefficients – Equations with variable coefficients – Method of variation of parameters – Some standard methods –Laplace transforms.

Unit- III

Solutions in Power Series : Introduction – Second order linear equations with ordinary points – Legendre equation and Legendre Polynomials – Second order equations with regular singular points – Bessel functions.

Unit- IV

Oscillations of Second Order Equations: Introduction – Sturm's comparision theorem – Sturm's separation theorem-Elementary linear oscillations – Comparision theorem of Hille – Wintner – Oscillations of $x'' + a(t)x = 0$, Boundary value problems: Sturm – Liouville problem.

Text Book:

- **Ordinary Differential Equations** by S.G. Deo, V. Raghavendra , Rasmita Kar and V. Lakshmikantham , Third Edition, *McGraw-Hill Education(India)Private Limited, New Delhi.*

References:

1. **Differential Equations with Applications with Historical Notes** by George F.Simmons, *Second Edition.*
2. **Ordinary Differential Equations** by Earl A Coddington.

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M 104 **Semester-I**

Paper-IV: Linear Algebra

Unit- I

Elementary Canonical forms - Introduction,Characteristic Values,Annihilating Polynomials, Invariant Sub-spaces, Simultaneous Triangulation and Simultaneous Diagonalization (Ch6, Sec6.1 - 6.5).

Unit- II

Direct sum Decomposition, Invariant Direct sums, The Primary Decomposition Theorem (Ch6, Sec 6.6 - 6.8). The Rational and Jordan Forms: Cyclic Subspaces and Annihilators (Ch7, Sec 7.1)

Unit- III

Cyclic Decompositions and the Rational Form, The Jordan Form, Computation of Invariant Factors, Semi Simple Operators (Ch7, Sec 7.2 - 7.5)

Unit- IV

Bilinear Forms: Bilinear Forms, Symmetric Bilinear Forms, Skew-Symmetric Bilinear Forms,Groups Preserving Bilinear Forms (Ch10, Sec 10.1 - 10.4)

Text Book:

- **Linear Algebra** by Kenneth Hoffman and Ray Kunze,(2e), PHI.

References:

1. **Advanced Linear Algebra** by Steven Roman(3e).
2. **Linear Algebra** by David C Lay.
3. **Linear Algebra** by Kuldeep Singh.

M. Sc. Mathematics

M/AM 201 **Semester-II**

Paper - I: Galois Theory

Unit- I

Algebraic extensions of fields: Irreducible polynomials and Eisenstein criterion - Adjunction of roots - Algebraic extensions - Algebraically closed fields.
(Page No. 281- 299).

Unit- II

Normal and separable extensions: Splitting fields - Normal extensions - Multiple roots - Finite fields - Separable extensions.
(Page No. 300 - 321).

Unit- III

Galois theory: Automorphism groups and fixed fields - Fundamental theorem of Galois theory - Fundamental theorem of Algebra.
(Page No. 322 - 339).

Unit- IV

Applications of Galois theory to classical problems: Roots of unity and cyclotomic polynomials - Cyclic extensions - Polynomials solvable by radicals – Symmetric functions-Ruler and Compass constructions.
(Page No. 340 - 364).

Text Book:

- **Basic Abstract Algebra** by P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul. *Second Edition*

References:

1. **Topics in Algebra** by I.N. Herstein.
2. **Elements of Modern Algebra** by Gibert and Gilbert.
3. **Abstract Algebra** by Jeffrey Bergen.
4. **Basic Abstract Algebra** by Robert B Ash.

M 202 **Semester-II**

Paper - II: Lebesgue Measure and Integration

Unit- I

Algebra of sets - Borel sets - Outer measure - Measurable sets and Lebesgue measure - A non - measurable set - Measurable functions – Littlewood's three principles.

Unit- II

The Riemann integral - The Lebesgue integral of a bounded function over a set of finite measure - The integral of a non - negative function - The general Lebesgue integral.

Unit- III

Convergence in measure - Differentiation of monotone functions - Functions of bounded variation.

Unit- IV

Differentiation of an integral - Absolute continuity - The L_p - spaces - The Minkowski and Holder inequalities - Convergence and completeness.

Text Book:

- **Real Analysis** (3rd Edition)(Chapters 3, 4, 5) by H. L. Royden, *Prentice-Hall India.*

References:

1. **Lebesgue measure and Integration** by G.de Barra.
2. **Measure and Integral** by Richard L.Wheeden, Anotoni Zygmund.

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MM/AM/MCS 203 **Semester-II**

Paper III: Complex Analysis

Unit- I

Regions in the Complex Plane - Functions of a Complex Variable - Limits - Continuity - Derivatives - Cauchy – Riemann Equations - Sufficient Conditions for Differentiability - Analytic Functions - Harmonic Functions - Reflection Principle - The Exponential Function - The Logarithmic Function - Complex Exponents- Trigonometric functions- Hyperbolic functions .

Unit- II

Derivatives of Functions $w(t)$ - Definite Integrals of Functions $w(t)$ - Contours - Contour Integrals - Some Examples - Upper Bounds for Moduli of Contour Integrals – Anti derivatives - Cauchy – Goursat Theorem - Simply Connected Domains - Multiply Connected Domains - Cauchy Integral Formula - An Extension of the Cauchy Integral Formula - Liouville's Theorem and the Fundamental Theorem of Algebra - Maximum Modulus Principle.

Unit- III

Convergence of Sequences - Convergence of Series - Taylor Series - Laurent Series - Absolute and Uniform Convergence of Power Series - Isolated Singular Points - Residues - Cauchy's Residue Theorem - Residue at Infinity - The Three Types of Isolated Singular Points - Residues at Poles - Examples - Zeros of Analytic Functions - Zeros and Poles - Behavior of Functions Near Isolated Singular Points.

Unit- IV

Evaluation of Improper Integrals - Improper Integrals from Fourier Analysis - Jordan's Lemma - Definite Integrals Involving Sines and Cosines - Argument Principle - Rouche's Theorem - Linear Transformations - The Transformation $w = 1/z$ - Mappings by $1/z$ - Linear Fractional Transformations - An Implicit Form.

Text Book:

- **Complex Variables with Applications** by James Ward Brown and Ruel V Charcill. *McGraw- Hill International Edition.*

References:

1. **Complex Analysis** by Dennis G. Gill.
2. **Complex Analysis** by Steven G. Krantz.
3. **Complex Variables with Applications** by S. Ponnusamy, Herb Silverman.
4. **Complex Analysis** by Joseph Bak, Donald J. Newman.

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MM 204 **Semester-II**

Paper - IV: Topology

Unit- I

Topological Spaces: The Definition and examples - Elementary concepts - Open bases and open subbases- Weak topologies.
(Page No. 91-106)

Unit- II

Compactness: Compact spaces - Products of spaces - Tychonoff's theorem and locally compact spaces - Compactness for metric spaces - Ascoli's theorem.
(Page No. 110-128)

Unit- III

Separation: T_1 - spaces and Hausdorff spaces - Completely regular spaces and normal spaces - Urysohn's lemma and the Tietze extension theorem - The Urysohn imbedding theorem.
(Page No. 129-141)

Unit- IV

Connectedness: Connected spaces - The components of a spaces - Totally disconnected spaces - Locally connected spaces.
(Page No. 142-152)

Text Book:

- **Introduction to Topology and Modern Analysis** By G.F. Simmon's. *Tata Mc Graw Hill Edition.*

References:

1. **Introductory Topology** by Mohammed H. Mortad.
2. **Explorations in Topology** by David Gay.
3. **Encyclopedia of General Topology** by Hart, Nagata, Vanghan.
4. **Elementary Topology** by Michael C. Gemignani.

DEPARTMENT OF MATHEMATICS

OSMANIA UNIVERSITY

M.Sc. Mathematics Syllabus

Semester – III & IV

(Choice Based Credit System)
(w.e.f. the academic year 2024-2025)

M.Sc. Mathematics Course Structure

(Choice Based Credit System)
(w.e.f. the academic year 2024-2025)

SEMESTER – III

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	M 301	**Functional Analysis**	4	1	5	30	70	100
Core	M 302	**Elementary Number Theory**	4	1	5	30	70	100
Elective	M 303(A)	**Mathematical Statistics**	4	1	5	30	70	100
	M 303(B)	**Discrete Mathematics**						
	M 303(C)	**Mechanics**						
Elective	M 304(A)	**Operations Research**	4	1	5	30	70	100
	M 304(B)	**Graph Theory**						
	M 304(C)	**Finite Difference Methods**						
			16	4	20			400

SEMESTER – IV

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	M 401	**Integral Equations and Calculus of Variations**	4	1	5	30	70	100
Core	M 402	**Partial Differential Equations**	4	1	5	30	70	100
Elective	M 403(A)	**Elementary Operator Theory**	4	1	5	30	70	100
	M 403(B)	**Analytical Number Theory**						
	M 403(C)	**Numerical Analysis**						
	M 403(D)	**Cryptography**						
Project	M 404	**Project**	5		5			100
			17	3	20			400

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THPW = Teaching Hours Per Week.
IA = Internal Assessment (IA Test 20 Marks + Assignment 10 Marks).
ESE = End-Semester Examination.
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M. Sc. Mathematics

M 301 **Semester-III**

Paper-I: Functional Analysis

Unit- I

Normed Spaces - Banach Spaces - Further properties of normed spaces - Finite dimensional normed spaces and sub spaces - compactness and finite dimension - linear operators - Bounded and continuous linear operators. [2.2, 2.3, 2.4, 2.5, 2.6 *and* 2.7].

Unit- II

Linear functional – normed spaces of operators – Dual space – Inner product space-Hilbert Space – Further Properties of Inner product Spaces – Orthogonal complements and direct sums – Orthogonal sets and sequences. [2.8, 2.10, 3.1, 3.2, 3.3 *and* 3.4]

Unit- III

Series related to Orthonormal Sequences and sets – Total Orthonormal sets and sequences – Representation of Functions on Hilbert spaces – Hilbert – Adjoint Operator-Self-Adjoint,unitary and normal operators. [3.5, 3.6, 3.8, 3.9 *and* 3.10]

Unit- IV

Hahn-Banach Theorem - Hahn-Banach Theorem for Complex Vector Spaces and Normed Spaces –Adjoint Operator- Reflexive Spaces- Category Theorem - Uniform Boundedness Theorem - Open Mapping Theorem - Closed Linear Operators – Closed Graph Theorem.
[4.2, 4.3, 4.5, 4.6, 4.7, 4.12 *and* 4.13]

Text Book:

- **Introductory Functional Analysis with Applications** by Erwin Kreyszig, John Wiley and sons, NewYork.

References:

1. **Functional Analysis** by B.V.Limaye 2nd Edition..
2. **Introduction to Topology and Modern Analysis** by G.F.Sinmmons. Mc.Graw-Hill International Edition.

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M 302 **Semester-III**

Paper - II: Elementary Number Theory

Unit- I

The Fundamental Theorem of Arithmetic: Divisibility- GCD- Prime numbers, Fundamental theorem of arithmetic- the series of reciprocal of the primes- The Euclidean algorithm.
(Page No. 13 - 23)

Unit- II

Arithmetical Functions and Dirichlet Multiplication: The functions $\phi(n)$, $\mu(n)$ and a relation connecting them- Product formula for $\phi(n)$ - Dirichlet product- Dirichlet inverse and Mobius inversion formula -The Mangoldt function $\wedge(n)$- Multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function- Liouville's function $\lambda(n)$- The divisor functions $\sigma_\alpha(n)$.
(Page No. 24-39 & 46-51)

Unit- III

Congruences: Properties of congruences- Residue classes and complete residue system- Linear congruences-Reduced residue systems and Euler-Fermat theorem- Polynomial congruence modulo p - Lagrange's theorem- Application of Lagrange's theorem- Chinese remainder theorem and its applications.
(Page No. 106-120 & 126-128)

Unit- IV

Quadratic Residues and The Quadratic Reciprocity Law: Quadratic residues- Legendre's symbol and its properties- Evaluation of $(-1|p)$ and $(2|p)$ - Gauss' lemma- The quadratic reciprocity law and its applications-The Jacobi symbol.
(Page No. 178-190 & 201-203)

Text Book:

- **Introduction to Analytic Number Theory** by Tom M. Apostol. *Narosa publishing house*

References:

1. **Number Theory** by Joseph H. Silverman.
2. **Theory of Numbers** by K.Ramchandra.
3. **Elementary Number Theory** by James K Strayer.
4. **Elementary Number Theory** by James Tattusall.

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M/AM 303(A) **Semester-III**

Paper-III(A): Mathematical Statistics

Unit- I

Probability: Sample space and events of an experiment, Properties of Probability experiments, Equally likely out comes, Conditional probability and independence, Bayes' Theorem. **Discrete Random Variables**: Random variables, Expected value, Properties of expected values, variance of random variables, Properties of variances, Binomial random variables and its Expected value and variance, Hyper-geometric random variables, Poisson random variables.[ch4, 5]

Unit- II

Normal Random Variables: Continuous random variables, Normal random variables, Probabilities associated with a standard Normal random variable, Finding Normal probabilities. Problems on related. **Distributions of Sampling Statistics**: Sample Mean, Central Limit Theorem, Distribution of the sample mean, Sample size needed, Sampling proportions from a finite population; Probabilities associated with sample proportions. **Estimation** : Point estimator of a population mean, population proportion, Estimating a population variance,.(Ch.6, 7, 8)

Unit- III

Testing Statistical Hypotheses: Hypothesis tests and Significance levels, Tests concerning the mean of a Normal population: Case of known variance, One-sided tests; the t-test for the mean of a Normal population: Case of unknown variance, Hypothesis Tests Concerning Population Proportions. Two-Sided Tests of p. **Hypothesis Tests Concerning Two Populations**:Testing equality of means of two Normal populations: Case of known and unknown variances and large Sample sizes, Testing equality of means: Small - sample tests when the unknown population variances are equal, Paired-sample t-test, Testing equality of population proportions. Problems on related.(Ch.9, 10)

Unit- IV

Chi-Squared Goodness of Fit Tests: Chi-Squared Goodness of fit Tests, Testing for independence in Populations classified according to two characteristics, Testing for independence in contingency tables with fixed marginal totals. Analysis of Variance: Introduction,One-factor and two factor Analysis of Variances, Parameter estimation, Degrees of freedom, Testing hypotheses.(ch11, 12)

Text Book:

- **Introductory Statistics** by Sheldon M.Ross(2010), Academic Press, Elsevier, 3rd Edition.(chapters 4 to 12).

References:

1. **Introduction to Probability Models** by Sheldon M.Ross(2010), Academic Press, Elsevier, 10th Edition. (chapters 4 to 13).

M/AM 303(B) **Semester-III**

Paper-III(B) : Discrete Mathematics

Unit- I

Propositional logic, Propositional Equivalences, Predicates and Quantifiers, Rules of Inference– Valid Arguments in Propositional Logic.Rules of Inference for Quantified Statements.Introduction to Proofs – Direct Proofs, Proofs by Contraposition, Proofs by Contradiction.NormalForms–Disjunctive Normal Form, Conjunctive Normal Forms, Principal Disjunctive Normal Form, Principal Conjunctive Normal Form. Boolean Algebra – Boolean Functions and Boolean Expressions, Identities of Boolean Algebra, Representing Boolean Functions. Logic Gates, Minimization of Circuits–K-maps. (1.1 *to* 1.3, 1.5 *to* 1.7, 10.1 *to* 10.4 *of* [1])

Unit- II

Elementary Combinatorics – Basics of Counting, Two Basic Counting Principles, Indirect ounting.Combinations and Permutations – Enumeration of Combinations and Permutations, Enumerating Combinations and Permutations with Repetitions, Enumerating Permutations with Constrained Repetitions. Binomial Coefficients – Pascal's Identity, Pascal's Triangle. Multinominal Theorem, The Principle of Inclusion–Exclusion and its Applications. (2.1 *to* 2.8 *of* [2])

Unit- III

Recurrence Relations – Generating Functions of Sequences, Generating Function Models, Calculating Coefficients of Generating Functions. Solutions of Recurrence Relations, the Fibonacci Relation. Solving Recurrence Relations by Substitution and by Generating Functions, Method of Characteristic Roots. Solution of Inhomogeneous Linear Recurrence Relations, the Method of Undetermined Coefficients: Solving Nonlinear Recurrence Relations. (3.1 *to* 3.6 *of* [2])

Unit- IV

Graphs – Graphs and Graph Models, Graph Terminology and Special Types of Graphs, The Hand shaking Theorem, Representing Graphs and Graph Isomorphism. Connectivity, Euler and Hamiltonian Paths and Circuits,Shortest Path Problems, Dijkstra's Algorithm,Planar Graphs,Euler formula. Trees – Introduction to Trees, Tree Traversal. Spanning Trees, DFS, BFS Algorithms, Minimum Spanning Trees. Prim's and Kruskal's Algorithms. (8.1 *to* 8.7, 9.1, 9.3, 9.5 *of* [1])

Text Book:

- **Discrete Mathematics and its Applications** by Kenneth HRosen, Seventh Edition, Mc GrawHill Education (India)Private Ltd, New Delhi.
- **Discrete Mathematics for Computer Scientists** & **Mathematicians** by JoeL.Mott, Abraham Kandel and Theodore P. Baker, Second Edition, Prentice Hall of India, Private Ltd, NewDelhi.

References:

1. **Elements of Discrete Mathematics** by C L Liu and D P Mohapatra, Third Edition, The McGraw-Hill Companies.
2. **Discrete and Combinatorial Mathematics** by Ralph P. Grimaldi and B. V. Ramana, 5th Edition,PEARSON education.

M. Sc. Mathematics

M 303(C) **Semester-III**

Paper-III(C): Mechanics

Unit- I

Dynamics of systems of Particles: Introduction - Centre of Mass and Linear Momentum of a system - Angular momentum and Kinetic Energy of a system, Centre of mass of Rigid body, symmetry considerations(Solid hemisphere,Hemispherical shell,Semicircle, Semicircular lamina), Rotation of a Rigid body about a fixed axis, Moment of Inertia, calculation of moment of Inertia, Perpendicular axis theorem for plane lamina,Parallel axis theorem for any rigid body, Radius of Gyration. (7.1, 7.2, 8.1, 8.2, 8.3 of [1])

Unit- II

Physical pendulum - Angular momentum Laminar Motion of a Rigid body in Laminar motion. Body rolling down an inclined plane. Motion of Rigid bodies in three dimension – Rotation of rigid body about an arbitrary axis,moments and products of inertia. (8.4, 8.5, 8.6, 9.1 of [1])

Unit- III

Angular momentum vector, Rotational kinetic energy of a rigid body, principles axes of a rigid body, Determination of the other two principal axes when one is known, Determining principal axes by diagonalizing the moment of inertia matrix, Dynamics of a particle in a rotating coordinate system. Euler's equation of motion of a Rigid body , Free rotation of a rigid body, Free rotation of a rigid body. (9.2, 5.2, 9.3, 9.4 of [1])

Unit- IV

Hamilton's variational principle-An example,Generalized Coordinates, Lagrange's Equations of motion for conservative systems, applications of Lagrange's equations, Generalized momenta,Ignorable coordinates, D'Alembert Principle-Generalised forces, Hamilton function - Hamilton's Equations. (10.1, 10.2, 10.4, 10.5, 10.6, 10.8, 10.9 of [1])

Text Book:

- **Analytical Mechanics** by G.R.Fowles G.L Cassiday, Cengage Learning , 7th edition.

References:

1. **Classical Mechanics** by Herbert Goldstein, Charles P.Poole and JhonSafko, Pearson pub.
2. **Principles Of Mechanics** by Synge J. L. and B.A. Griffith, McGraw Hill, 3rd edition.

M. Sc. Mathematics

M/AM/MCS 304(A) **Semester-III**

Paper-IV(A): Operations Research

Unit- I

Formulation of Linear Programming problems, Graphical solution of Linear Programming problem,Convex set,General formulation of Linear Programming problems, Standard and Matrix forms of Linear Programming problems,Simplex Method, Two-phase method, Big-M method, Method to resolve degeneracy in Linear Programming problem, Alternative optimal solutions.

Unit- II

Solution of simultaneous equations by Simplex Method, Inverse of a Matrix by Simplex Method,Revised Simplex Method,Concept of Duality in Linear Programming, Comparison of solutions of the Dual and its primal

Unit- III

Mathematical formulation of Transportation problem, Tabular representation, Methods to find initial basic feasible solution, North West corner rule, Lowest cost entry method, Vogel's approximation method, Optimality test, Method of finding optimal solution, Degeneracy in transportation problem, Method to resolve degeneracy, Unbalanced transportation problem. Mathematical formulation of Assignment problem, Reduction theorem, Hungarian Assignment Method, Travelling salesman problem, Formulation of Travelling Salesman problem as an Assignment problem, Solution procedure

Unit- IV

Concept of Dynamic programming, Bellman's principle of optimality, characteristics of Dynamic programming problem,Backward and Forward recursive approach,Minimum path problem,Single Additive constraint and Multiplicatively separable return, Single Additive constraint and Additively separable return, Single Multiplicatively constraint and Additively separable return.

Text Book:

- **Operations Research** by S.D.Sharma, 18th Revised Edition 2017, KedarNath Ram Nath Publications.

References:

1. **Operations Research – An Introduction** by Hamdy A. Taha, 10th Edition.
2. **Linear Programming** by G.Hadley.

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M 304(B) **Semester-III**

Paper-IV(B): Graph Theory

Unit- I

Basics of Graph Theory: Graphs, isomorphism, subgraphs, matrix representations, degree, operations on graphs, degree sequences.

Connected graphs and shortest paths: Walks, trails, paths, connected graphs, distance, cut-vertices, cut edges, blocks,connectivity, weighted graphs, shortest path algorithms.

Unit- II

Trees: Characterizations, number of trees, minimums panning trees.

Special classes of graphs: Bipartite graphs, line graphs, chordal graphs.

Eulerian graphs: Characterization, Fleury's algorithm, chinese - postman - problem.

Hamilton graphs: Necessary conditions and sufficient conditions

Unit- III

Independent sets, coverings, matchings: Basic equations, matchings in bipartite graphs, perfect matchings, greedy and approximation algorithms.

Vertex colorings: Chromatic number and cliques, greedy coloring algorithm, coloring of chordal graphs, Brook's theorem.

Edge colorings: Gupta - Vizing theorem, Class-1 graphs and class-2 graphs, equitable edge - coloring.

Unit- IV

Planar graphs: Basic concepts, Eulers formula, polyhedrons and planar graphs, characterizations, planarity testing, 5-color-theorem.

Directed graphs: Out-degree, in- degree, connectivity, orientation, Euleri and irected graphs, Hamiltondi - rected graphs, tournaments.

Text Book:

- **Graph Theory with Applications** by J.A.Bondy and U.S.R.Murty. (Freely downloadable from Bondy's web site; Google - Bondy).
- **Introduction to Graph Theory** by D.B. West, Prentice-Hall of India/Pearson, 2009 (latest impression).

References:

1. **Graph Theory** by J.A.Bondy and U.S.R.Murty, Springer, 2008.
2. **Graph Theory** by R.Diestel, Springer(low price edition), 2000.

M. Sc. Mathematics

M 304(C) **Semester-III**

Paper-IV(C): Finite Difference Methods

Unit- I

Partial Differential Equations: Introduction - Classification of Second order Partial Differential Equations PDE's - Difference Methods - Routh Hurwitz criterion - Domain of Dependence of Hyperbolic Equations. (1.1 to 1.4)

Unit- II

Difference Methods for Parabolic Partial Differential Equations : Introduction – One Space Dimension - Two Space Dimensions - Spherical and Cylindrical Coordinate System. (2.1 to 2.3, 2.5, 2.6).

Unit- III

Difference Methods for Hyperbolic Partial Differential Equations: Introduction - One Space Dimensions - Two Space Dimensions - System of First order equations.(3.1 to 3.5).

Unit- IV

Numerical Methods for Elliptic Partial Differential Equations: Introduction - Difference Methods for linear boundary value problems - General second order linear equation - Equation in polar coordinates.(4.1 to 4.5).

Text Book:

- **Computational Methods for Partial Differential Equations** by M.K.Jain, S.R.K.Iyengar, R.K.Jain, Wiley Eastern Limited, New Age International(P) Limited, New Delhi.

M. Sc. Mathematics

M/AM/MCS 401 **Semester-IV**

Paper-I: Integral Equations and Calculus of Variations

Unit- I

Volterra Integral Equations: Basic concepts - Relationship between Linear differential equations and Volterra Integral equations - Resolvent Kernel of Volterra Integral equation. Differentiation of some resolvent kernels - Solution of Integral equation by Resolvent Kernel - The method of successive approximations - Convolution type equations - Solution of Integro-differential equations with the aid of the Laplace Transformation – Volterra integral equation of the first kind-Euler integrals-Abel's problem-Abel's integral equation and its generalizations.

Unit- II

Fredholm Integral Equations : Fredholm integral equations of the second kind – Fundamentals – The Method of Fredholm Determinants - Iterated Kernels constructing the Resolvent Kernel with the aid of Iterated Kernels - Integral equations with Degenerated Kernels. Hammerstein type equation – Characteristic numbers and Eigen function and its properties.

Green's function :Construction of Green's function for ordinary differential equations-Special case of Green's function –Using Green's function in the solution of boundary value problem.

CALCULS OF VARIATIONS:

Unit- III

Introduction – The Method of Variations in Problems with fixed Boundaries: Definitions of Functionals –Variation and Its properties - Euler's'equation- Fundamental Lemma of Calculus of Variation – The problem of minimum surface of revolution - Minimum Energy Problem Brachistochrone Problem - Variational problems involving Several functions - Functional dependent on higher order derivatives - Euler Poisson equation.

Unit- IV

Functional dependent on the functions of several independent variables - Euler's equations in two dependent variables – Variational problems in parametric form-Applications of Calculus of Variation-Hamilton's principle - Lagrange's Equation,Hamilton's equations.

Text Book:

- **Problems and Exercises in Integral Equations** by M.KRASNOV, A.KISELEV, G.MAKARENKO, (1971).
- **Integral Equations** by S.Swarup, (2008).
- **Differential Equations and The Calculus of Variations** by L.ELSGOLTS, MIR Publishers, MOSCOW.
- **Analytical Mechanics** by Grant R. Fowles and George L. Cassiday, 7Th Edition.

M. Sc. Mathematics

M 402 **Semester-IV**

Paper-II: Partial Differential Equations

Unit- I

First order Nonlinear Equations, Cauchy's method of Characteristics, compatible systems of first order equations, Charpit's method, Special types of first order equations.

Unit- II

Higher order Linear Partial Differential Equations with constant coefficients, Homogeneous Partial Differential Equations with constant coefficients, Classification of second order Partial Differential Equations, Canonical forms, Canonical form for hyperbolic, parabolic and elliptic equations.

Unit- III

Fourier Transforms : Fourier Integral Representations, Fourier Transforms Pairs, Fourier Transform of Elementary Functions, Properties of Fourier Transform, Convolution theorem, Parseval's Relation,Transform of Dirac Delta Function, Finite Fourier Transforms.

Unit- IV

Solution of diffusion, wave and Laplace equations by using Fourier transforms and Separation of Variables Methods, D'Alembert's solution of wave equation, Dirichlet problem and Neumann problem.

Text Book:

- **Introdction to Partial Differential Equations** by K. Shankar Rao, PHI, Third Edition.

References:

1. **Elements of Partial Differential Equations** by Ian Sneddon, Mc.Graw-Hill International Edition.
2. **Partial Differential Equations** by Lawrence C. Evans, American Mathematical Society.

M. Sc. Mathematics

M 403(A) **Semester-IV**

Paper-III(A): Elementary Operator Theory

Unit- I

Spectral theory in finite dimensional normed spaces - Basic concepts of spectrum - Spectral properties of bounded linear operators –Further properties of resolvent and spectrum. (Sections7.1, 7.2, 7.3 and 7.4 of [1]).

Unit- II

Compact linear operators on normed spaces - Further properties of compact linear operators - Spectral properties of compact linear operators on normed spaces-Operator equations involving compact linear operators. (Sections 8.1, 8.2, 8.3 and 8.5 of [1]).

Unit- III

Spectral properties of bounded self adjoint linear operators - Further spectral properties of bounded linear operators – Positive operators –Square root of a positive operator. (Sections 9.1, 9.2, 9.3 and 9.4 of [1])

Unit- IV

Projection operators - Properties of projection operators - Spectral family - Spectral family of a bounded self adjoint linear operator. (Sections 9.5, 9.6, 9.7 and 9.8 of [1])

Text Book:

- **Introductory Functional Analysis** by E.Kreyszig, John Wiley and Sons, New York, 1978.

References:

1. **Elements of Functional Analysis** by Brown and Page, D.V.N. Comp.
2. **Functional Analysis** by B.V. Limaye, Wiley Eastern Limited,(2nd Edition).
3. **A Hilbert Space Problem Book** by P.R.Halmos, D.VanNostrand Company,Inc.1967.

M. Sc. Mathematics

M 403(B) **Semester-IV**

Paper-III(B): Analytical Number Theory

Unit- I

Averages of arithmetical function : The big oh notation- Asymptotic equality of functions- Euler summation formula- Some asymptotic formulas- The average order of $d(n)$- The average order of the divisor functions $\sigma(n)$ – The average order of $\phi(n)$ - An application to the distribution of lattice points visibletr on a the origin-The average order of $\mu(n)$ and $\Lambda(n)$ - The partial sums of dirichlet product- Applications to $\mu(n)$ and $\Lambda(n)$ - Another identity for the partial sums of a dirichlet product.(Sections 3.1 to 3.12).

Unit- II

Some elementary theorems on the distribution of prime numbers- Introduction chebyshev's functions - $\chi(x)$ and $\theta(x)$ - Relation connecting $\theta(n)$ and $\pi(n)$ - Some equivalent forms of the prime number theorem - Inequalities for $\pi(n)$ and p_n. (Sections 4.1 to 4.5)

Unit- III

Shapiro's Tauberian theorem – Applications of shapiro's theorem Anasymptotic formula for the partial sums $1/p$ - The partial sums of the mobins function - Selberg Asymptotic formula.(Sections 4.6 to 4.11 except 4.10)

Unit- IV

Finite Abelian groups and their character: Construction of sub groups - Characters of finite abelian group-The character group- The orthogonality relations for characters Dirichlet characters- Sums involving dirichelt characters the non vanishing of $L(1, \chi)$ for real non principal χ. (Sections 6.4 to 6.10)

Text Book:

- **An Introduction to Analytic Number Theory** by Tom M.Apostol - Springer.

M.Sc. Mathematics

M 403(C) **Semester-IV**

Paper-III(C): Numerical Analysis

Unit- I

Transcendental and Polynomial Equations: Introduction, Bisection Method - Iteration Methods Based on First Degree Equation: Secant Method, RegulaFalsi Method, Newton-Raphson Method - Iteration Methods Based on Second Degree Equation: Muller's Method, Chebyshev Method, Multipoint Iteration Methods, Rate of convergence - Iteration Methods.

Unit- II

System of Linear Algebraic Equations: Introduction - Direct Methods: Gauss Elimination Method, Gauss Jordan Elimination Method, Triangularization Method, Cholesky Method, Partition Method - Iteration Methods: Jacobi Iteration Method, Gauss Seidel Iteration Method, SOR Method, Convergence Analysis for iterative Methods.

Unit- III

Interpolation and Approximation: Interpolation: Introduction - Lagrange and Newton Interpolations, Finite Difference Operators - Interpolating Polynomials using Finite Differences - Hermite Interpolations, Piecewise and Spline Interpolations. Approximation: Least Squares Approximation.
Differentiation : Methods based on interpolation, Methods based on finite differences.

Unit- IV

Numerical Integration: Methods Based on Interpolation: Newton- Cotes Methods - Methods Based on Undetermined Coefficients: Guass- Legendre Integration Methods - Composite Integration Methods.
Numerical Solution of ODEs: Introduction - Numerical Methods: Euler Methods-Mid point Method Single Step Methods: Taylor series method, Runge-Kutta Method (2nd and 4th orders). Multistep Methods: Adams Bashforth Method - Adams Moulton Method, Milne-Simpson Method - Predictor Corrector Methods.

Text Book:

- **Numerical Methods for Scientific and Engineering computation** by M.K. Jain, S.R.K. Iyengar, R.K. Jain, 7th Edition, *New Age International Publishers,2019.*

M. Sc. Mathematics

M 403(D) **Semester-IV**

Paper-III(D): Cryptography

Unit- I

Simple substitution ciphers; Divisibility and greatest common divisors Modular arithmetic; Prime numbers, unique factorisation, and finite fields; Powers and primitive roots in finite fields; Cryptography before the computer age; Symmetric and asymmetric ciphers.

Unit- II

The birth of public key cryptography, The discrete logarithm problem Diffie – Hell mankey exchange, The ElGamal public key crypto system, An overview of the theory of groups, How hard is the discrete logarithm problem?, A collision algorithm for the DLP.

Unit- III

The Chinese remainder theorem, The Pohlig-Hellman algorithm, Rings, quotients, polynomials, and finite fields, Euler's formula and roots modulo pq, Primality testing.

Unit- IV

Elliptic curves, Elliptic curves over finite fields, The elliptic curve discrete logarithm problem, Elliptic curve cryptography.

Text Book:

- **Mathematical Cryptography** by Jeffrey Hoffstein, JillPipher, JosephH.Silverman.

References:

1. **Fundamental Principles and Applications** by Everyday Cryptography, Keith Martin.
2. **Cryptography: An Introduction** by N.P.Smart.

M. Sc. Mathematics

M 404 **Semester-IV**

PROJECT

DEPARTMENT OF MATHEMATICS
OSMANIA UNIVERSITY

M.Sc. Applied Mathematics Syllabus

Semester – I & II

(Choice Based Credit System)
(w.e.f. the academic year 2023-2024)

M.Sc. Applied Mathematics Course Structure

(Choice Based Credit System)
(w.e.f. the academic year 2023-2024)

SEMESTER – I

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	M 101	**Abstract Algebra**	4	1	5	30	70	100
Core	M 102	**Mathematical Analysis**	4	1	5	30	70	100
Core	M 103	**Ordinary Differential Equations**	4	1	5	30	70	100
Core	M 104	**Numerical Analysis**	4	1	5	30	70	100
			16	4	20			400

SEMESTER – II

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	M 201	**Galois Theory**	4	1	5	30	70	100
Core	M 202	**Partial Differential Equations**	4	1	5	30	70	100
Core	M 203	**Complex Analysis**	4	1	5	30	70	100
Core	M 204	**Fluid Mechanics**	4	1	5	30	70	100
			16	4	20			400

T – Tutorial class: Each batch consists of 20 students and will be allotted to a teacher (Demonstrating the theory through a numerical example and practicing through mathematical software)
THPW = Teaching Hours Per Week.
IA = Internal Assessment (IA Test 20 Marks + Assignment 10 Marks).
ESE = End-Semester Examination.
End-Semester Examination Duration - 3 Hrs.

M. Sc. Applied Mathematics

M/AM/MCS 101 **Semester-I**

Paper-I: Abstract Algebra

Unit- I
Automorphisms - Conjugacy and G - sets - Normal series - Solvable groups - Nilpotent groups.
(Page No. 104 to 128)

Unit- II
Structure theorems of groups: Direct products - Finitely generated abelian groups - Invariants of a finite abelian group - Sylow theorems - Groups of orders p^2, pq.
(Page No. 138 to 155)

Unit- III
Ideals and homomorphisms - Sum and direct sum of ideals, Maximal and Prime ideals - Nilpotent and nil ideals - Zorn's lemma.
(Page No. 179 to 211).

Unit- IV
Unique factorization domains - Principal ideal domains - Euclidean domains - Polynomial rings over UFD - Rings of Fractions.
(Page No. 212 to 228)

Text Book:

- **Basic Abstract Algebra** by P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul. Second Edition

References:

1. **Topics in Algebra** by I.N. Herstein.
2. **Elements of Modern Algebra** by Gibert and Gilbert.
3. **Abstract Algebra** by Jeffrey Bergen.
4. **Basic Abstract Algebra** by Robert B Ash.

M.Sc. Applied Mathematics

M/AM/MCS 102 **Semester-I**

Paper - II: Mathematical Analysis

Unit- I
Metric spaces - Compact sets - Perfect sets - Connected sets.
(Page No. 30-46)

Unit- II
Limits of functions - Continuous functions - Continuity and compactness, Continuity and connectedness - Discontinuities - Monotonic functions, Differentiation.
(Page No. 83-102)

Unit- III
Riemann - Steiltjes integral - Definition and Existence of the Integral - Properties of the integral – Integration and differentiation, Integration of vector valued functions - Rectifiable curves.
(Page No. 120-133 & 135-142)

Unit- IV
Sequences and Series of Functions: Uniform convergence - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation – The Stone-Weierstrass theorem.
(Page No. 143-154, 159-161, 165-171 & 220-222)

Text Book:

- **Principles of Mathematical Analysis** (3rd Edition) By Walter Rudin, *McGraw-Hill International Edition.*

References:

1. **The Real Numbers** by John Stillwel.
2. **Real Analysis** by Barry Simon.
3. **Mathematical Analysis** Vol - I by D J H Garling.
4. **Measure and Integral** by Richard L.Wheeden and Antoni Zygmund.

M.Sc. Applied Mathematics

M/AM 103 **Semester-I**

Paper - III: Ordinary Differential Equations

Unit- I

Existence and Uniqueness of Solutions: Preliminaries – Successive approximations – Picard's theorem – Some examples – Continuation and dependence on initial conditions – Existence of solutions in the large – Existence and uniqueness of solutions of systems.

Unit- II

Linear Differential Equations of Higher Order: Introduction – Higher order linear differential equations – A Mathematical model – Linear dependence and Wronskian – Homogeneous linear equations with constant coefficients – Equations with variable coefficients – Method of variation of parameters – Some standard methods –Laplace transforms.

Unit- III

Solutions in Power Series : Introduction – Second order linear equations with ordinary points – Legendre equation and Legendre Polynomials – Second order equations with regular singular points – Bessel functions.

Unit- IV

Oscillations of Second Order Equations: Introduction – Sturm's comparision theorem – Sturm's separation theorem-Elementary linear oscillations – Comparision theorem of Hille – Wintner – Oscillations of $x'' + a(t)x = 0$, Boundary value problems: Sturm – Liouville problem.

Text Book:

- **Ordinary Differential Equations** by S.G. Deo, V. Raghavendra , Rasmita Kar and V. Lakshmikantham , Third Edition, *McGraw-Hill Education(India)Private Limited, New Delhi.*

References:

1. **Differential Equations with Applications with Historical Notes** by George F.Simmons, *Second Edition.*
2. **Ordinary Differential Equations** by Earl A Coddington.

M.Sc. Applied Mathematics

AM 104 **Semester-I**

Paper-IV: Numerical Analysis

Unit- I

Transcendental and Polynomial Equations: Introduction, Bisection Method - Iteration Methods Based on First Degree Equation: Secant Method, RegulaFalsi Method, Newton-Raphson Method - Iteration Methods Based on Second Degree Equation: Muller's Method, Chebyshev Method, Multipoint Iteration Methods, Rate of convergence - Iteration Methods.

Unit- II

System of Linear Algebraic Equations: Introduction - Direct Methods: Gauss Elimination Method, Gauss Jordan Elimination Method, Triangularization Method, Cholesky Method, Partition Method - Iteration Methods: Jacobi Iteration Method, Gauss Seidel Iteration Method, SOR Method, Convergence Analysis for iterative Methods.

Unit- III

Interpolation and Approximation: Interpolation: Introduction - Lagrange and Newton Interpolations, Finite Difference Operators - Interpolating Polynomials using Finite Differences - Hermite Interpolations, Piecewise and Spline Interpolations. Approximation: Least Squares Approximation.
Differentiation : Methods based on interpolation, Methods based on finite differences.

Unit- IV

Numerical Integration: Methods Based on Interpolation: Newton- Cotes Methods - Methods Based on Undetermined Coefficients: Guass- Legendre Integration Methods - Composite Integration Methods.
Numerical Solution of ODEs: Introduction - Numerical Methods: Euler Methods-Mid point Method Single Step Methods: Taylor series method, Runge-Kutta Method (2nd and 4th orders). Multistep Methods: Adams Bashforth Method - Adams Moulton Method, Milne-Simpson Method - Predictor Corrector Methods.

Text Book:

- **Numerical Methods for Scientific and Engineering computation** by M.K. Jain, S.R.K. Iyengar, R.K. Jain, 7th Edition, *New Age International Publishers,2019.*

M.Sc. Applied Mathematics

M/AM 201 **Semester-II**

Paper - I: Galois Theory

Unit- I

Algebraic extensions of fields: Irreducible polynomials and Eisenstein criterion - Adjunction of roots - Algebraic extensions - Algebraically closed fields.
(Page No. 281- 299).

Unit- II

Normal and separable extensions: Splitting fields - Normal extensions - Multiple roots - Finite fields - Separable extensions.
(Page No. 300 - 321).

Unit- III

Galois theory: Automorphism groups and fixed fields - Fundamental theorem of Galois theory - Fundamental theorem of Algebra.
(Page No. 322 - 339).

Unit- IV

Applications of Galois theory to classical problems: Roots of unity and cyclotomic polynomials - Cyclic extensions - Polynomials solvable by radicals – Symmetric functions-Ruler and Compass constructions.
(Page No. 340 - 364).

Text Book:

- **Basic Abstract Algebra** by P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul. *Second Edition*

References:

1. **Topics in Algebra** by I.N. Herstein.
2. **Elements of Modern Algebra** by Gibert and Gilbert.
3. **Abstract Algebra** by Jeffrey Bergen.
4. **Basic Abstract Algebra** by Robert B Ash.

M.Sc. Applied Mathematics

AM 202 **Semester-II**

Paper-II :Partial Differential Equations

Unit- I

First order Nonlinear Equations, Cauchy's method of Characteristics, compatible systems of first order equations, Charpit's method, Special types of first order equations.

Unit- II

Higher order Linear Partial Differential Equations with constant coefficients, Homogeneous Partial Differential Equations with constant coefficients, Classification of second order Partial Differential Equations, Canonical forms, Canonical form for hyperbolic, parabolic and elliptic equations.

Unit- III

Fourier Transforms : Fourier Integral Representations, Fourier Transforms Pairs, Fourier Transform of Elementary Functions, Properties of Fourier Transform, Convolution theorem, Parseval's Relation,Transform of Dirac Delta Function, Finite Fourier Transforms.

Unit- IV

Solution of diffusion, wave and Laplace equations by using Fourier transforms and Separation of Variables Methods, D'Alembert's solution of wave equation, Dirichlet problem and Neumann problem.

Text Book:

- **Introdction to Partial Differential Equations** by K. Shankar Rao, PHI, Third Edition.

References:

1. **Elements of Partial Differential Equations** by Ian Sneddon, Mc.Graw-Hill International Edition.
2. **Partial Differential Equations** by Lawrence C. Evans, American Mathematical Society.

M.Sc. Applied Mathematics

MM/AM/MCS 203 **Semester-II**

Paper III: Complex Analysis

Unit- I

Regions in the Complex Plane - Functions of a Complex Variable - Limits - Continuity - Derivatives - Cauchy – Riemann Equations - Sufficient Conditions for Differentiability - Analytic Functions - Harmonic Functions - Reflection Principle - The Exponential Function - The Logarithmic Function - Complex Exponents- Trigonometric functions- Hyperbolic functions .

Unit- II

Derivatives of Functions $w(t)$ - Definite Integrals of Functions $w(t)$ - Contours - Contour Integrals - Some Examples - Upper Bounds for Moduli of Contour Integrals – Anti derivatives - Cauchy – Goursat Theorem - Simply Connected Domains - Multiply Connected Domains - Cauchy Integral Formula - An Extension of the Cauchy Integral Formula - Liouville's Theorem and the Fundamental Theorem of Algebra - Maximum Modulus Principle.

Unit- III

Convergence of Sequences - Convergence of Series - Taylor Series - Laurent Series - Absolute and Uniform Convergence of Power Series - Isolated Singular Points - Residues - Cauchy's Residue Theorem - Residue at Infinity - The Three Types of Isolated Singular Points - Residues at Poles - Examples - Zeros of Analytic Functions - Zeros and Poles - Behavior of Functions Near Isolated Singular Points.

Unit- IV

Evaluation of Improper Integrals - Improper Integrals from Fourier Analysis - Jordan's Lemma - Definite Integrals Involving Sines and Cosines - Argument Principle - Rouche's Theorem - Linear Transformations - The Transformation $w = 1/z$ - Mappings by $1/z$ - Linear Fractional Transformations - An Implicit Form.

Text Book:

- **Complex Variables with Applications** by James Ward Brown and Ruel V Charcill. *McGraw- Hill International Edition.*

References:

1. **Complex Analysis** by Dennis G. Gill.
2. **Complex Analysis** by Steven G. Krantz.
3. **Complex Variables with Applications** by S. Ponnusamy, Herb Silverman.
4. **Complex Analysis** by Joseph Bak, Donald J. Newman.

M.Sc. Applied Mathematics

AM 204 **Semester-II**

Paper IV: Fluid Mechanics

Unit- I

General Orthogonal Curvilinear Coordinates, Arc Length in orthogonal coordinates, Gradient in orthogonal coordinates , Divergence in orthogonal coordinates, Laplacian in orthogonal coordinates, Curl of a Vector Function in in orthogonal coordinates, Real fluids and ideal fluids, Velocity of a fluid at a point, Stream lines, path lines,The velocity potential, The vorticity vector, Local and particle rates of change

Unit- II

The Equation of Continuity, Worked Examples, Acceleration of fluid, Conditions at a rigid boundary, General analysis of fluid motion, Pressure at a Point in a Fluid at Rest, Pressure at a Point in a Moving Fluid, Condition at a Boundary of Two Inviscid Immiscible Fluids, Euler's Equation of Motion, Bernoulli's Equation, Discussion of the Case Steady Motion under Conservative Body Forces.

Unit- III

Some flows involving Axial Symmetry, Examples (Stationary sphere in uniform stream, Sphere moving with constant velocity in liquid which is otherwise at rest) , Some further aspects of vertex motion(Kelvin theorems), Sources, Sinks, and Doublets, Images in a Rigid Infinite Plane, Axi-Symmetric Flows, Stokes Stream function.

Unit- IV

Meaning of two dimensional flow, Use of Cylindrical Polar Coordinates,Example (Uniform flow past a fixed infinite circular cylinder), The stream function, The complex potential for two dimensional Irrotational incompressible flow, Complex velocity potentials for standard two dimensional flows, Some worked examples, Two dimensional image systems, Milne Thomson Circle Theorem , Applications of circle theorem, The Theorem of Blasius.

Text Book:

1. **Textbook of Fluid Dynamics**, by FRANK CHORLTON, CBS-Publishers, NewDelhi,India.

Reference Books:

1. **Foundation on Fluid Mechanics**, by S.W.YUAN, Prentice-Hall India Ltd. NewDelhi.
2. **Fluid Dynamics**, by M.D.RAISINGHANIA, S.Chand & Company, NewDelhi.

DEPARTMENT OF MATHEMATICS

OSMANIA UNIVERSITY

M.Sc. Applied Mathematics Syllabus

Semester – III & IV

(Choice Based Credit System)
(w.e.f. the academic year 2024-2025)

M.Sc. Applied Mathematics Course Structure

(Choice Based Credit System)
(w.e.f. the academic year 2024-2025)

SEMESTER – III

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	AM 301	**Viscous Flows**	4	1	5	30	70	100
Core	AM 302	**Linear Algebra**	4	1	5	30	70	100
Elective	AM 303(A)	**Mathematical Statistics**	4	1	5	30	70	100
	AM 303(B)	**Discrete Mathematics**						
	AM 303(C)	**Compressible Flows**						
Elective	AM 304(A)	**Operations Research**	4	1	5	30	70	100
	AM 304(B)	**Topology**						
	AM 304(C)	**Bio-Fluid Mechanics**						
			16	4	20			400

SEMESTER – IV

Subjects	Code	Paper Title	THPW	T	Credits	IA	ESE	Total
Core	AM 401	**Integral Equations and Calculus of Variations**	4	1	5	30	70	100
Core	AM 402	**Finite Difference Methods**	4	1	5	30	70	100
Elective	AM 403(A)	**Mechanics**	4	1	5	30	70	100
	AM 403(B)	**Functional Analysis**						
	AM 403(C)	**Finite Element Methods**						
	AM 403(D)	**Cryptography**						
Project	AM 404	**Project**	5		5			100
			17	3	20			400

T – Tutorial class: Each batch consists of 20 students and will be allotted to a teacher (Demonstrating the theory through a numerical example and practicing through mathematical software)
THPW = Teaching Hours Per Week.
IA = Internal Assessment (IA Test 20 Marks + Assignment 10 Marks).
ESE = End-Semester Examination.
End-Semester Examination Duration - 3 Hrs.

M. Sc. Applied Mathematics

AM 301 **Semester-III**

Paper-I: Viscous Flows

Unit- I

Viscosity - Body forces, Surface forces - Stress components in a Real fluid – Relations between Cartesian components of Stress – Translational Motion of fluid element – The rate of Strain Quadric and Principal Stresses – Properties of the rate of Strain Quadric – Stress analysis in fluid motion – Relations between Stress and rate of Strain – The coefficient of Viscosity and Laminar flow – The Navier - Stokes equations of Motion of a viscous fluid.

Unit- II

Dynamic Similarity and Inspection and Dimensionless Analysis – Dimensions and Unit systems - Dimensional homogeneity - Dimensional Matrix – Similitude: - Dynamical Similarity - Inspection Analysis of visocus fluid flow - Reynold's principle of similarity - Significance of Reynold's number - Non-dimensional parameters: Signification of common Non-dimensional parameters – Non - dimensionalization of the Governing Equations - Dimensionless Coefficients: Local skin-friction coefficient - Lift and drag coefficient - Nusselt number - Shrewood number. **Dimensional Analysis**: Techniques of Dimensional Analysis - Rayleigh's technique - Buckingham π- theorem - Applications of π-theorem.

Unit- III

Exact solution of the Navier-Stokes equations: Steady motion between two parallel plates – Plane Couette flow – Fully developed Plane Poiseuille flow –Plane Poiseuille flow with slip – Plane Couette-Poiseuille flow - Poiseuille flow between inclined plates - Couette flows between two parallel plates – Flow through a circular pipe (The Hagen Poiseuille flow) - Uniqueness Theorem - Steady motion in Tubes of uniform cross section of Elliptical and Equilateral triangle – Unsteady flow over a flat plate.

Unit- IV

Boundary Layer Theory – Boundary layer approximation – Separation of Boundary layer Thickness - Different measures of boundary layer thickness - Displacement thickness – Momentum thickness-Energy thickness. Boundary Layer equations in two dimensions- Boundary layer on a flat plate (Blasius Solution) – Falkner-Skan Solution of the Laminar Boundary layer Equations - Approximate solutions of Boundary Layer Equations - Von Karman's Integral relation - Von Karman Integral relation by momentum law.

Text Book:

1. FRANK CHORLTON, **Textbook of Fluid Dynamics** , CBS-Publishers, New Delhi, India.
2. J.L.BANSAL, **Viscous Fluid Dynamics**, Oxford & IBH Publishers Co.Ltd.,New Delhi
3. TASOS C. PAPANASTASIOU, GEORGIOS C. GEORGIOU, ANDREAS N. ALEXANDROU; **Viscous Fluid Flow**, CRC Pub., New Delhi.
4. M.D.RAISINGHANIA, **Fluid Dynamics**, S.Chand & Company, NewDelhi.

M. Sc. Applied Mathematics

AM 302 **Semester-III**

Paper-II: Linear Algebra

Unit- I

Elementary Canonical forms - Introduction,Characteristic Values,Annihilating Polynomials, Invariant Sub-spaces, Simultaneous Triangulation and Simultaneous Diagonalization (Ch6, Sec6.1 - 6.5).

Unit- II

Direct sum Decomposition, Invariant Direct sums, The Primary Decomposition Theorem (Ch6, Sec 6.6 - 6.8). The Rational and Jordan Forms: Cyclic Subspaces and Annihilators (Ch7, Sec 7.1)

Unit- III

Cyclic Decompositions and the Rational Form, The Jordan Form, Computation of Invariant Factors, Semi Simple Operators (Ch7, Sec 7.2 - 7.5)

Unit- IV

Bilinear Forms: Bilinear Forms, Symmetric Bilinear Forms, Skew-Symmetric Bilinear Forms,Groups Preserving Bilinear Forms (Ch10, Sec 10.1 - 10.4)

Text Book:

- **Linear Algebra** by Kenneth Hoffman and Ray Kunze,(2e), PHI.

References:

1. **Advanced Linear Algebra** by Steven Roman(3e).
2. **Linear Algebra** by David C Lay.
3. **Linear Algebra** by Kuldeep Singh.

M. Sc. Applied Mathematics

M/AM 303(A) **Semester-III**

Paper-III(A): Mathematical Statistics

Unit- I

Probability: Sample space and events of an experiment, Properties of Probability experiments, Equally likely out comes, Conditional probability and independence, Bayes' Theorem. **Discrete Random Variables**: Random variables, Expected value, Properties of expected values, variance of random variables, Properties of variances, Binomial random variables and its Expected value and variance, Hyper-geometric random variables, Poisson random variables.[ch4, 5]

Unit- II

Normal Random Variables: Continuous random variables, Normal random variables, Probabilities associated with a standard Normal random variable, Finding Normal probabilities. Problems on related. **Distributions of Sampling Statistics**: Sample Mean, Central Limit Theorem, Distribution of the sample mean, Sample size needed, Sampling proportions from a finite population; Probabilities associated with sample proportions. **Estimation** : Point estimator of a population mean, population proportion, Estimating a population variance,.(Ch.6, 7, 8)

Unit- III

Testing Statistical Hypotheses: Hypothesis tests and Significance levels, Tests concerning the mean of a Normal population: Case of known variance, One-sided tests; the t-test for the mean of a Normal population: Case of unknown variance, Hypothesis Tests Concerning Population Proportions. Two-Sided Tests of p. **Hypothesis Tests Concerning Two Populations**:Testing equality of means of two Normal populations: Case of known and unknown variances and large Sample sizes, Testing equality of means: Small - sample tests when the unknown population variances are equal, Paired-sample t-test, Testing equality of population proportions. Problems on related.(Ch.9, 10)

Unit- IV

Chi-Squared Goodness of Fit Tests: Chi-Squared Goodness of fit Tests, Testing for independence in Populations classified according to two characteristics, Testing for independence in contingency tables with fixed marginal totals. Analysis of Variance: Introduction,One-factor and two factor Analysis of Variances, Parameter estimation, Degrees of freedom, Testing hypotheses.(ch11, 12)

Text Book:

- **Introductory Statistics** by Sheldon M.Ross(2010), Academic Press, Elsevier, 3rd Edition.(chapters 4 to 12).

References:

1. **Introduction to Probability Models** by Sheldon M.Ross(2010), Academic Press, Elsevier, 10th Edition. (chapters 4 to 13).

M. Sc. Applied Mathematics

M/AM/MCS 303(B) **Semester-III**

Paper-III(B) : Discrete Mathematics

Unit- I

Propositional logic, Propositional Equivalences, Predicates and Quantifiers, Rules of Inference– Valid Arguments in Propositional Logic.Rules of Inference for Quantified Statements.Introduction to Proofs – Direct Proofs, Proofs by Contraposition, Proofs by Contradiction.NormalForms–Disjunctive Normal Form, Conjunctive Normal Forms, Principal Disjunctive Normal Form, Principal Conjunctive Normal Form. Boolean Algebra – Boolean Functions and Boolean Expressions, Identities of Boolean Algebra, Representing Boolean Functions. Logic Gates, Minimization of Circuits–K-maps. (1.1 *to* 1.3, 1.5 *to* 1.7, 10.1 *to* 10.4 *of* [1])

Unit- II

Elementary Combinatorics – Basics of Counting, Two Basic Counting Principles, IndirectCounting.Combinations and Permutations – Enumeration of Combinations and Permutations, Enumerating Combinations and Permutations with Repetitions, Enumerating Permutations with Constrained Repetitions. Binomial Coefficients – Pascal's Identity, Pascal's Triangle. Multinominal Theorem, The Principle of Inclusion–Exclusion and its Applications. (2.1 *to* 2.8 *of* [2])

Unit- III

Recurrence Relations – Generating Functions of Sequences, Generating Function Models, Calculating Coefficients of Generating Functions. Solutions of Recurrence Relations, the Fibonacci Relation. Solving Recurrence Relations by Substitution and by Generating Functions, Method of Characteristic Roots. Solution of Inhomogeneous Linear Recurrence Relations, the Method of Undetermined Coefficients: Solving Nonlinear Recurrence Relations. (3.1 *to* 3.6 *of* [2])

Unit- IV

Graphs – Graphs and Graph Models, Graph Terminology and Special Types of Graphs, The Hand shaking Theorem, Representing Graphs and Graph Isomorphism. Connectivity, Euler and Hamiltonian Paths and Circuits,Shortest Path Problems,Dijkstra's Algorithm,Planar Graphs,Euler formula. Trees – Introduction to Trees, Tree Traversal. Spanning Trees, DFS, BFS Algorithms, Minimum Spanning Trees. Prim's and Kruskal's Algorithms. (8.1 *to* 8.7, 9.1, 9.3, 9.5 *of* [1])

Text Book:

- **Discrete Mathematics and its Applications** by Kenneth HRosen, Seventh Edition, Mc GrawHill Education (India)Private Ltd, New Delhi.
- **Discrete Mathematics for Computer Scientists** & **Mathematicians** by JoeL.Mott, Abraham Kandel and Theodore P. Baker, Second Edition, Prentice Hall of India, Private Ltd, NewDelhi.

References:

1. **Elements of Discrete Mathematics** by C L Liu and D P Mohapatra, Third Edition, The McGraw-Hill Companies.
2. **Discrete and Combinatorial Mathematics** by Ralph P. Grimaldi and B. V. Ramana, 5th Edition,PEARSON education.

M. Sc. Applied Mathematics

AM 303(C) **Semester-III**

Paper - III(C): Compressible Flows

Unit- I

Thermodynamics and Physical properties of Gases: Introduction to equation of state – Perfect gas – First law of Thermodynamic – Internal Energy and Enthalpy, Specific Heats – Entropy and Second law of Thermodynamics and perfect gas mixture – Dissociation and Ionization – Real gases – Physical properties of gases.

Unit- II

Fundamental Equations of the Aerodynamics of a Compressible Inviscid and non-heat conducting fluid: Equation of State – Equation of Continuity – Equation of motion – Equation of energy – Maxwell's Thermodynamics Relations – Isothermal, Adiabatic and Isentropic processes – Kelvin's Theorem – Irrotational Motion – Vortex Motion – Helmholtz's Theorem.

Unit- III

One dimensional flow of an inviscid compressible Fluid: Energy Equation – Velocity of sound and Mach number – Subsonic, Sonic and Supersonic Flows – Pressure Coefficient - Steady flow in a Nozzle – Non-steady one dimensional flow – Sound wave with finite amplitude – Formation of a Shock – The elements of wave motion - wave equations in two and three dimensions.

Unit- IV

Flow of Viscous Compressible Fluids: One dimensional flow of a Compressible Viscous fluid – Plane Couette flow of a Compressible viscous fluid. Boundary Layer Theory of Viscous Compressible Fluid: Introduction – Mathematical structure for Boundary Layer Theory – Two dimensional Boundary Layer Theory for a Compressible fluid – Laminar Boundary Layer equations in Compressible flow.

Text Book:

- **Introduction to Theory of Compressible Flow** by S.I,Pai, Van Nostrand Reinhold Company.
- **Text Book of Fluid Dynamics** F.Chorlton, CBS Publications and Distributors, New Delhi.

M. Sc. Applied Mathematics

M/AM/MCS 304(A) **Semester-III**

Paper-IV(A): Operations Research

Unit- I

Formulation of Linear Programming problems, Graphical solution of Linear Programming problem,Convex set,General formulation of Linear Programming problems, Standard and Matrix forms of Linear Programming problems,Simplex Method, Two-phase method, Big-M method, Method to resolve degeneracy in Linear Programming problem, Alternative optimal solutions.

Unit- II

Solution of simultaneous equations by Simplex Method, Inverse of a Matrix by Simplex Method,Revised Simplex Method,Concept of Duality in Linear Programming, Comparison of solutions of the Dual and its primal

Unit- III

Mathematical formulation of Transportation problem, Tabular representation, Methods to find initial basic feasible solution, North West corner rule, Lowest cost entry method, Vogel's approximation method, Optimality test, Method of finding optimal solution, Degeneracy in transportation problem, Method to resolve degeneracy, Unbalanced transportation problem. Mathematical formulation of Assignment problem, Reduction theorem, Hungarian Assignment Method, Travelling salesman problem, Formulation of Travelling Salesman problem as an Assignment problem, Solution procedure

Unit- IV

Concept of Dynamic programming, Bellman's principle of optimality, characteristics of Dynamic programming problem,Backward and Forward recursive approach,Minimum path problem,Single Additive constraint and Multiplicatively separable return, Single Additive constraint and Additively separable return, Single Multiplicatively constraint and Additively separable return.

Text Book:

- **Operations Research** by S.D.Sharma, 18th Revised Edition 2017, KedarNath Ram Nath Publications.

References:

1. **Operations Research – An Introduction** by Hamdy A. Taha, 10th Edition.
2. **Linear Programming** by G.Hadley.

M. Sc. Applied Mathematics

AM 304(B) **Semester-III**

Paper - IV(B): Topology

Unit- I

Topological Spaces: The Definition and examples - Elementary concepts - Open bases and open subbases- Weak topologies.
(Page No. 91-106)

Unit- II

Compactness: Compact spaces - Products of spaces - Tychonoff's theorem and locally compact spaces - Compactness for metric spaces - Ascoli's theorem.
(Page No. 110-128)

Unit- III

Separation: T_1 - spaces and Hausdorff spaces - Completely regular spaces and normal spaces - Urysohn's lemma and the Tietze extension theorem - The Urysohn imbedding theorem.
(Page No. 129-141)

Unit- IV

Connectedness: Connected spaces - The components of a spaces - Totally disconnected spaces - Locally connected spaces.
(Page No. 142-152)

Text Book:

- **Introduction to Topology and Modern Analysis** By G.F. Simmon's. *Tata Mc Graw Hill Edition.*

References:

1. **Introductory Topology** by Mohammed H. Mortad.
2. **Explorations in Topology** by David Gay.
3. **Encyclopedia of General Topology** by Hart, Nagata, Vanghan.
4. **Elementary Topology** by Michael C. Gemignani.

M. Sc. Applied Mathematics

AM 304(C) **Semester-III**

Paper-IV(C): Bio-Fluid mechanics

Unit- I

Introduction - Continuum Approach - **Blood Flow in Heart, Lung, Arteries and Veins**: Introduction - The geometry of the circulation system - Field equations and Boundary conditions - Coupling of Left Ventricle to Aorta and Right Ventricle to Pulmonary Artery - Pulsatile Flow in Arteries - Progressive waves superposed on a Steady flow - Reflection and Transmission of Waves at Junctions - Velocity profile of a steady flow in a Tube - Steady Laminar Flow in Elastic Tube. Velocity Profile of Pulsatile flow. (1.1, 1.7, 5.1, 5.2, 5.4, 5.6 – 5.12 of [1]).

Unit- II

The Reynolds Number, Stokes Number, and Womersley Number - Equations of Balance of Energy and Work - Systemic Blood Pressure - Flow in a Collapsible Tubes - **Micro and Macro Circulation**: Introduction - Major Feature of Microcirculation - The Rheological Properties of Blood - Pulmonary Blood Flow - Waterfall Phenomenon in Zone 2 - (5.13-5.17, 6.1, 6.3, 6.4, 6.7-6.8 of [1]).

Unit- III

Respiratory Gas Flow: Introduction - Gas flow in the airway - Interaction between Convection and Diffusion - Exchange between Alveolar Gas and Erythrocytes (7.1 to 7.4 of]1]).

Unit- IV

Basic Transport Equations According to Thermodynamics - Molecular Diffusion - Mechanisms in Membranes and Multiphasic Structure: Introduction - The laws of Thermodynamics - The Gibbs and Gibbs-Duhem Equations - Chemical Potential - Entropy in a system with Heat and Mass transfer - Diffusion, filtration, and Fluid movement in Interstitial Space from the point of view of Thermodynamics - Diffusion from the Molecular Point of view (8.1 - 8.7).

Text Book:

- **Biomechanics** by Y.C.Fung, Springer- Verlag, New York Inc., 1990.

M. Sc. Applied Mathematics

M/AM/MCS 401 **Semester-IV**

Paper-I: Integral Equations and Calculus of Variations

Unit- I

Volterra Integral Equations: Basic concepts - Relationship between Linear differential equations and Volterra Integral equations - Resolvent Kernel of Volterra Integral equation. Differentiation of some resolvent kernels - Solution of Integral equation by Resolvent Kernel - The method of successive approximations - Convolution type equations - Solution of Integro-differential equations with the aid of the Laplace Transformation – Volterra integral equation of the first kind-Euler integrals-Abel's problem-Abel's integral equation and its generalizations.

Unit- II

Fredholm Integral Equations : Fredholm integral equations of the second kind – Fundamentals – The Method of Fredholm Determinants - Iterated Kernels constructing the Resolvent Kernel with the aid of Iterated Kernels - Integral equations with Degenerated Kernels. Hammerstein type equation – Characteristic numbers and Eigen function and its properties.

Green's function :Construction of Green's function for ordinary differential equations-Special case of Green's function –Using Green's function in the solution of boundary value problem.

CALCULS OF VARIATIONS:

Unit- III

Introduction – The Method of Variations in Problems with fixed Boundaries: Definitions of Functionals –Variation and Its properties - Euler's'equation- Fundamental Lemma of Calculus of Variation – The problem of minimum surface of revolution - Minimum Energy Problem Brachistochrone Problem - Variational problems involving Several functions - Functional dependent on higher order derivatives - Euler Poisson equation.

Unit- IV

Functional dependent on the functions of several independent variables - Euler's equations in two dependent variables – Variational problems in parametric form-Applications of Calculus of Variation-Hamilton's principle - Lagrange's Equation,Hamilton's equations.

Text Book:

- **Problems and Exercises in Integral Equations** by M.KRASNOV, A.KISELEV, G.MAKARENKO, (1971).
- **Integral Equations** by S.Swarup, (2008).
- **Differential Equations and The Calculus of Variations** by L.ELSGOLTS, MIR Publishers, MOSCOW.
- **Analytical Mechanics** by Grant R. Fowles and George L. Cassiday, 7Th Edition.

M. Sc. Applied Mathematics

AM 402 **Semester-IV**

Paper-II: Finite Difference Methods

Unit- I

Partial Differential Equations: Introduction - Classification of Second order Partial Differential Equations - Difference Methods- Routh Hurwitz criterion - Domain of Dependence of Hyperbolic Equations – Errors in Difference methods and Rate of convergence of Numerical solution. (1.1 to 1.5)

Unit- II

Difference Methods for Parabolic Partial Differential Equations : Introduction – One Space Dimension –One dimensional Convection-Diffusion Parabolic Equation - Two Space Dimensions –Alternative Direct Implicit (ADI) methods - Cylindrical and Spherical Coordinate Systems – Keller Box Method – One dimensional Quasi linear Parabolic equations (second order method) (2.1 to 2.4, 2.6, 2.7).

Unit- III

Difference Methods for Hyperbolic Partial Differential Equations: Introduction - One Space Dimension - Two Space Dimensions - Alternative Direct Implicit (ADI) methods – First order Equations - System of First order equations. (3.1 to 3.5).

Unit- IV

Numerical Methods for Elliptic Partial Differential Equations: Introduction - Difference Methods for linear boundary value problems - General second order linear equation - Equation in polar coordinates – Quasi linear Elliptic Equations (Second order method) – Convection Diffusion Equation (4.1 to 4.6).

Text Book:

- **Computational Methods for Partial Differential Equations** by M.K.Jain, S.R.K.Iyengar, R.K.Jain, Wiley Eastern Limited, New Age International(P) Limited, New Delhi, 2nd Edition.

M. Sc. Applied Mathematics

AM 403(A) **Semester-IV**

Paper-III(A): Mechanics

Unit- I

Dynamics of systems of Particles: Introduction - Centre of Mass and Linear Momentum of a system - Angular momentum and Kinetic Energy of a system, Centre of mass of Rigid body, symmetry considerations(Solid hemisphere,Hemispherical shell,Semicircle, Semicircular lamina), Rotation of a Rigid body about a fixed axis, Moment of Inertia, calculation of moment of Inertia, Perpendicular axis theorem for plane lamina,Parallel axis theorem for any rigid body, Radius of Gyration. (7.1, 7.2, 8.1, 8.2, 8.3 of [1])

Unit- II

Physical pendulum - Angular momentum Laminar Motion of a Rigid body in Laminar motion. Body rolling down an inclined plane. Motion of Rigid bodies in three dimension – Rotation of rigid body about an arbitrary axis,moments and products of inertia. (8.4, 8.5, 8.6, 9.1 of [1])

Unit- III

Angular momentum vector, Rotational kinetic energy of a rigid body, principles axes of a rigid body, Determination of the other two principal axes when one is known, Determining principal axes by diagonalizing the moment of inertia matrix, Dynamics of a particle in a rotating coordinate system. Euler's equation of motion of a Rigid body , Free rotation of a rigid body, Free rotation of a rigid body. (9.2, 5.2, 9.3, 9.4 of [1])

Unit- IV

Hamilton's variational principle-An example,Generalized Coordinates, Lagrange's Equations of motion for conservative systems, applications of Lagrange's equations, Generalized momenta,Ignorable coordinates, D'Alembert Principle-Generalised forces, Hamilton function - Hamilton's Equations. (10.1, 10.2, 10.4, 10.5, 10.6, 10.8, 10.9 of [1])

Text Book:

- **Analytical Mechanics** by G.R.Fowles G.L Cassiday, Cengage Learning , 7th edition.

References:

1. **Classical Mechanics** by Herbert Goldstein, Charles P.Poole and JhonSafko, Pearson pub.
2. **Principles Of Mechanics** by Synge J. L. and B.A. Griffith, McGraw Hill, 3rd edition.

M. Sc. Applied Mathematics

AM 403(B) **Semester-IV**

Paper-III(B): Functional Analysis

Unit- I

Normed Spaces - Banach Spaces - Further properties of normed spaces - Finite dimensional normed spaces and sub spaces - compactness and finite dimension - linear operators - Bounded and continuous linear operators. [2.2, 2.3, 2.4, 2.5, 2.6 *and* 2.7].

Unit- II

Linear functional – normed spaces of operators – Dual space – Inner product space-Hilbert Space – Further Properties of Inner product Spaces – Orthogonal complements and direct sums – Orthogonal sets and sequences. [2.8, 2.10, 3.1, 3.2, 3.3 *and* 3.4]

Unit- III

Series related to Orthonormal Sequences and sets – Total Orthonormal sets and sequences – Representation of Functions on Hilbert spaces – Hilbert – Adjoint Operator-Self-Adjoint,unitary and normal operators. [3.5, 3.6, 3.8, 3.9 *and* 3.10]

Unit- IV

Hahn-Banach Theorem - Hahn-Banach Theorem for Complex Vector Spaces and Normed Spaces –Adjoint Operator- Reflexive Spaces- Category Theorem - Uniform Boundedness Theorem - Open Mapping Theorem - Closed Linear Operators – Closed Graph Theorem.
[4.2, 4.3, 4.5, 4.6, 4.7, 4.12 *and* 4.13]

Text Book:

- **Introductory Functional Analysis with Applications** by Erwin Kreyszig, John Wiley and sons, NewYork.

References:

1. **Functional Analysis** by B.V.Limaye 2nd Edition..
2. **Introduction to Topology and Modern Analysis** by G.F.Sinmmons. Mc.Graw-Hill International Edition.

M. Sc. Applied Mathematics

AM 403(C) **Semester-IV**

Paper-III(C):Finite Element Methods

Unit- I

Introduction - **Weighted Residual Methods**: - Least Square Method - Partition Method - Galerkin Method- Moment Method - Collocation Method – problems. **Variational Methods**: Ritz Method - Examples.

Unit- II

Finite Elements: Line segment Element - Triangular Element - Rectangular Elements with examples -Numerical Integration over Finite Elements.

Unit- III

Finite Element Methods: Ritz Finite Element Method - Least Square Finite Element Method –Galerkin Finite Element Method - Boundary Value Problems in Ordinary Differential Equations - Assembly of Element Equations - Boundary Value Problem in Partial Differential Equations(with Linear triangular element) - Mixed boundary conditions - Boundary points - Examples.

Unit- IV

Finite Element Error Analysis: Approximation Errors - Various Measures of Error - Convergence ofsolution - Accuracy of the solution - Examples. Eigenvalue Problems: Introduction - Eigenvalue problems- Formulation of a Eigenvalue problems – Applications (5.1 to 5.4, 6.1) of [2]

Text Book:

- **Numerical Solution of Differential Equations** by M.K.Jain, New Age Int.(P).Ltd., New Delhi.(for Units I, II and III)
- **Finite Element Method** by J.N.Reddy, McGraw-Hill International Edition, Engineering Mechanics Series.(for Unit IV).

M. Sc. Applied Mathematics

AM 403(D) **Semester-IV**

Paper-III(D): Cryptography

Unit- I

Simple substitution ciphers; Divisibility and greatest common divisors Modular arithmetic; Prime numbers, unique factorisation, and finite fields; Powers and primitive roots in finite fields; Cryptography before the computer age; Symmetric and asymmetric ciphers.

Unit- II

The birth of public key cryptography, The discrete logarithm problem Diffie – Hell mankey exchange, The ElGamal public key crypto system, An overview of the theory of groups, How hard is the discrete logarithm problem?, A collision algorithm for the DLP.

Unit- III

The Chinese remainder theorem, The Pohlig-Hellman algorithm, Rings, quotients, polynomials, and finite fields, Euler's formula and roots modulo pq, Primality testing.

Unit- IV

Elliptic curves, Elliptic curves over finite fields, The elliptic curve discrete logarithm problem, Elliptic curve cryptography.

Text Book:

- **Mathematical Cryptography** by Jeffrey Hoffstein, JillPipher, JosephH.Silverman.

References:

1. **Fundamental Principles and Applications** by Everyday Cryptography, Keith Martin.
2. **Cryptography: An Introduction** by N.P.Smart.

M. Sc. Applied Mathematics

AM 404 **Semester-IV**

PROJECT

DEPARTMENT OF MATHEMATICS

OSMANIA UNIVERSITY

M.Sc. Mathematics with Computer Science Syllabus

Semester – I & II

(Choice Based Credit System)
(w.e.f. the academic year 2023-2024)

M.Sc. Mathematics with Computer Science Course Structure

(Choice Based Credit System)
(w.e.f. the academic year 2023-2024)

SEMESTER – I

Subjects	Code	Paper Title	THPW	T	P	Credits	IA	ESE	Total
Core1	MCS 101	**Abstract Algebra**	4	1	0	5	30	70	100
Core2	MCS 102	**Mathematical Analysis**	4	1	0	5	30	70	100
Core3	MCS 103	**Operating Systems**	4	0	0	4	30	70	100
Core4	MCS 104	**Programming in Java**	4	0	0	4	30	70	100
Lab1	MCS 103 L	**Operating Systems Lab**			2	1		25	25
Lab2	MCS 104 L	**Java Lab**		2		1		25	25
			16	2	4	20			450

SEMESTER – II

Subjects	Code	Paper Title	THPW	T	P	Credits	IA	ESE	Total
Core1	MCS 201	**Linear Algebra**	4	1	0	5	30	70	100
Core2	MCS 202	**Computer Networks**	4	0	0	4	30	70	100
Core3	MCS 203	**Complex Analysis**	4	1	0	5	30	70	100
Core4	MCS 204	**Programming in Python**	4	0	0	4	30	70	100
Lab1	MCS 202 L	**Computer Networks Lab**			2	1		25	25
Lab2	MCS 204 L	**Python Lab**			2	1		25	25
			16	2	4	20			450

T – Tutorial class: Each batch consists of 20 students and will be allotted to a teacher (Demonstrating the theory through a numerical example and practicing through mathematical software)
P - Practical
THPW = Teaching Hours Per Week.
IA = Internal Assessment (IA Test 20 Marks + Assignment 10 Marks).
ESE = End-Semester Examination.
End-Semester Examination Duration - 3 Hrs.

M. Sc. Mathematics with Computer Science

M/AM/MCS 101 **Semester-I**

Paper-I: Abstract Algebra

Unit- I
Automorphisms - Conjugacy and G - sets - Normal series - Solvable groups - Nilpotent groups.
(Page No. 104 to 128)

Unit- II
Structure theorems of groups: Direct products - Finitely generated abelian groups - Invariants of a finite abelian group - Sylow theorems - Groups of orders p^2, pq.
(Page No. 138 to 155)

Unit- III
Ideals and homomorphisms - Sum and direct sum of ideals, Maximal and Prime ideals - Nilpotent and nil ideals - Zorn's lemma.
(Page No. 179 to 211).

Unit- IV
Unique factorization domains - Principal ideal domains - Euclidean domains - Polynomial rings over UFD - Rings of Fractions.
(Page No. 212 to 228)

Text Book:

- **Basic Abstract Algebra** by P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul. Second Edition

References:

1. **Topics in Algebra** by I.N. Herstein.
2. **Elements of Modern Algebra** by Gibert and Gilbert.
3. **Abstract Algebra** by Jeffrey Bergen.
4. **Basic Abstract Algebra** by Robert B Ash.

M. Sc. Mathematics with Computer Science

M/AM/MCS 102 **Semester-I**

Paper - II: Mathematical Analysis

Unit- I
Metric spaces - Compact sets - Perfect sets - Connected sets.
(Page No. 30-46)

Unit- II
Limits of functions - Continuous functions - Continuity and compactness, Continuity and connectedness - Discontinuities - Monotonic functions, Differentiation.
(Page No. 83-102)

Unit- III
Riemann - Steiltjes integral - Definition and Existence of the Integral - Properties of the integral – Integration and differentiation, Integration of vector valued functions - Rectifiable curves.
(Page No. 120-133 & 135-142)

Unit- IV
Sequences and Series of Functions: Uniform convergence - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation – The Stone-Weierstrass theorem.
(Page No. 143-154, 159-161, 165-171 & 220-222)

Text Book:

- **Principles of Mathematical Analysis** (3rd Edition) By Walter Rudin, *McGraw-Hill International Edition.*

References:

1. **The Real Numbers** by John Stillwel.
2. **Real Analysis** by Barry Simon.
3. **Mathematical Analysis** Vol - I by D J H Garling.
4. **Measure and Integral** by Richard L.Wheeden and Antoni Zygmund.

M. Sc. Mathematics with Computer Science

MCS 103 **Semester-I**

Paper-III: Operating Systems

Unit- I

Introduction: Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection- Security, Kernel Data Structures, Computing Environments, Open-Source Operating Systems.

Operating-System Structures: Operating-System Services, User Interface for Operating-System(CLI and GUI), System Calls,Types of System Calls(fork, exec, wait, kill, exit).

Process Management: Process Concept, Process Scheduling, Operations on Processes (Process creation-fork system call, process termination),Inter ProcessCommunication,Types of IPC(Shared memory, message passing, signals, socket, pipes)Zombie and orphan processes.

Threads: Overview, Multithreading Models, Threading Issues.

Process Synchronization: Concept, Critical-Section Problem, Peterson's Solution, Synchronization, Classic Problems of Synchronization, Semaphores, Monitors.

Unit- II

CPU Scheduling: Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Real-Time CPU Scheduling, Algorithm Evaluation.

Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

Unit- III

Memory Management: Main Memory, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table. Virtual Memory: Demand Paging, Page Replacement, Allocation of Frames, Thrashing. **Mass-Storage Structure**: Overview, Disk Structure, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure.

Unit- IV

File Systems: File Concept, Access Methods, Directory and Disk Structure, File -System Mounting, Protection. File-System Structure and Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Recovery, Network File System. **Advanced Operating System**-Basics of Network Operating System, Server Operating System and Real Time Operating System, Mobile OS – iOS and Android – Architecture,Versions and SDK Framework

Text Book:

- **Operating System Concepts** by Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, (10e).

References:

1. **Operating systems in depth** by Thomas W. Doeppner.
2. **Modern Operating Systems** by Andrew S. Tanenbaum.
3. **Operating Systems – Internals and Design Principles** by William Stallings.
4. **Operating Systems-A Concept Based Approach** by Dhananjay M. Dhandhere.
5. **Modern Operating Systems** by Andrew S. Tanenbaum (PHI).

Paper-IV: Programming in Java

Unit- I Java Programming- **Fundamentals**: History of Java, comments, Data types, Variables, Constants, Scope and Lifetime of variables, Operators, Type conversion and casting, Enumerated types. **Control flow**: block scope, conditional statements, loops, break and continue statements, arrays,simple java stand aloneprograms,class,object and its methods, constructors and its types , methods, static fields and methods, access control, this reference, overloading methods and constructors, recursion, garbage collection, exploring string class. **Inheritance** – Inheritance types, super keyword, preventing inheritance: final classes and methods. **Polymorphism** – method overloading and overriding, abstract classes and methods. **Interfaces**- Interfaces Vs Abstract classes, defining an interface, implement interfaces, accessing implementations through interface references, extending interface. **Packages**- Defining, creating and accessing a package, importing packages.

Unit- II Exception handling- Define Exception, advantages of exception handling, the classification of exceptions- exception hierarchy, checked exceptions and unchecked exceptions, usage of try, catch, throw, throws and finally, creating own exception sub classes. **Multithreading** –Define Thread, multithreading, thread life cycle, creating threads, interrupting threads, thread priorities, synchronizing threads, inter-thread communication, producer consumer problem. **Files**- Streams-Byte streams, Character streams, Text input/output, Binary input/output, random access file operations, File management using File class.

Unit- III AWT: Introduction, AWT Class Hierarchy, Creating Container, Adding Components, Layout, Using Panel, Text Field, Text Area, List, Checkbox, Check Box Group, Choice, Event Handling, Dialog Boxes, ScrollBar, Menu. **Swing**: Containment Hierarchy, Adding Components, JTextField, JPasswordField, JTable, JComboBox, JProgressBar, JList, JTree, JColorChooser, Dialogs. **Remote Method Invocation (RMI)**: Introduction, Remote Method Invocation, Java RMI Interfaces and Classes, an Application, Compiling the Program, Generating Stub Classes, Running the Program, Callback with an Application.

Unit- IV Servlet: Server -Side Java, Servlet Alternatives, Servlet Strengths, Servlet Architecture, Servlet Life Cycle, GenericServlet, HttpServlet, Servlet Example, Passing Parameters to Servlets, Retrieving Parameters, Cookies, Filters. **Java Database Connectivity (JDBC)**: Introduction, JDBC Drivers, JDBC Architecture, JDBC Classes and Interfaces, Loading a Driver, Making a Connection, Execute SQL Statement, SQL Statements, Retrieving Result, Getting Database Information, Scrollable and Updatable Resultset, Result Set Metadata. **Hibernate**: Introduction, Writing POJO Class, Creating a Table, Writing a Hibernate Application, Compiling and Running Application, Book Application Using Annotation, Object Life Cycle, HQL, Using Native SQL Query, Named Queries, Generating DDL, Generator Class, Hibernate Tools.

Text Book:

- **Java Complete Reference** by Herbertt Schildt.
- **Advanced Java programming** by Uttam K. Roy.

References:

1. **Core Java Vol. II – Advanced Features** by Cay S. Horstmans, Gray Coronell.
2. **Java EE 7 for Beginners** by Sharanam Shah, Vaishali Shah.

M. Sc. Mathematics with Computer Science

MCS 103 L **Semester-I**

Operating Systems Lab

1. Write shell programs using 'case', 'then' and 'if' & 'else' statements.
2. Write shell programs using while, do-while and for loop statements.
3. Write a program to create a child process using fork(), exec() system calls and use other system calls.
4. Write a program to convert upper case to lower case letters of a given ASCII file.
5. Write a Shell program to check the given number is even or odd.
6. Write a shell program by using a switch case to construct a calculator(add,sub,mul,div).
7. Write a program to simulate UNIX commands like ls, grep, cp.
8. Write a program to demonstrate FCFS and SJF process schedules on the given data.
9. Write a program to demonstrate CPU Priority and Round Robin Scheduling on the given burst time and arrival times.
10. Write a program to simulate Inter Process Communication using pipes.
11. Write a program to implementing Producer and Consumer problem using Semaphores.
12. Write a program to simulate Bankers Algorithm for Dead Lock Avoidance
13. Write a program to simulate Bankers Algorithm Dead Lock Prevention.
14. Write a program to simulate Paging Techniques of memory management.
15. Write a program to simulate FIFO, LRU, LFU Page replacement algorithms.
16. Write a program to simulate Sequential, Indexed, and Linked file allocation strategies.

Note:

- Recommended to use Open Source Software like Fedora, Ubuntu, Cent OS etc...
- Recommended to write programs using C/C++ on Linux systems.

M. Sc. Mathematics with Computer Science

MCS 104 L **Semester-I**

Java Lab

1. a. Write a program to check whether a number is Armstrong or not
   b. Write Program to demonstrate Class and Constructors in Java
2. a. Write a Program to perform Method Overloading.
   b. Write a program to show the concept of Inheritance.
3. a. Write a program to show various string operations.
   b. Write a Program to demonstrate the interface in java
4. Write a program to show the concept of packages
5. Write a Java Program for creating threads using thread class
6. Write a Java Program illustrating thread priority and yield method
7. Write a program to show the concept of Applets.
8. Write a Program to demonstrate Exception Handling
9. Create GUI to present a set of choices for a user to select stationary products and display the price of Product after selection from the list.
10. Create GUI to demonstrate typical Editable Table which describing Employee for a software company.
11. Create GUI to demonstrate swing components using student registration form.
12. Create a Remote Object for simple arithmetic operators. Use AWT/SWING to create user interface.
13. Write an RMI application using call back mechanism
14. Develop Servlet Question-Answer Application using Http Servlet Request and Http Servlet Request interfaces.
15. Develop Servlet application to accept HTNO of a student from client and display the memorandum of marks from the server
16. Develop a Hibernate application to Store Feedback of Web site Visitors in MySQL Database.

M. Sc. Mathematics with Computer Science

MCS 201 **Semester-II**

Paper-I: Linear Algebra

Unit- I

Elementary Canonical forms - Introduction,Characteristic Values,Annihilating Polynomials, Invariant Sub-spaces, Simultaneous Triangulation and Simultaneous Diagonalization (Ch6, Sec6.1 - 6.5).

Unit- II

Direct sum Decomposition, Invariant Direct sums, The Primary Decomposition Theorem (Ch6, Sec 6.6 - 6.8). The Rational and Jordan Forms: Cyclic Subspaces and Annihilators (Ch7, Sec 7.1)

Unit- III

Cyclic Decompositions and the Rational Form, The Jordan Form, Computation of Invariant Factors, Semi Simple Operators (Ch7, Sec 7.2 - 7.5)

Unit- IV

Bilinear Forms: Bilinear Forms, Symmetric Bilinear Forms, Skew-Symmetric Bilinear Forms,Groups Preserving Bilinear Forms (Ch10, Sec 10.1 - 10.4)

Text Book:

- **Linear Algebra** by Kenneth Hoffman and Ray Kunze,(2e), PHI.

References:

1. **Advanced Linear Algebra** by Steven Roman(3e).
2. **Linear Algebra** by David C Lay.
3. **Linear Algebra** by Kuldeep Singh.

M. Sc. Mathematics with Computer Science

MCS 202 **Semester-II**

Paper II: Computer Networks

Unit- I

Computer Networks Fundamentals: Overview, Network Hardware, Network Software, Reference models– OSI Model, TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference Model, Example Networks, Network Standardization.
Physical Layer: Guided Transmission Media, Wireless Transmission, Multiplexing, Switching.
Data Link Layer: Design Issues, Error Detection and Correction, Data Link Layer Protocols, Sliding Window Protocol.

Unit- II

Multiple Access Sublayer: ALOHA, CSMA, Collision Free Protocols, Ethernet, Wireless LAN-802.11, Data Link Layer Switching –Repeaters, Hubs, Bridges, Switches, Routers, Gateways.
Network Layer: Design Issues, Routing Algorithms – Shortest path, Flooding, Distance Vector Routing, Link state Routing, Hierarchical, Broadcast Routing, Multicast Routing; Congestion Control Algorithms.

Unit- III

Internet working: Tunneling, Internet work Routing, Fragmentation, IPv4 Vs IPv6Protocol, IP Addresses, CIDR, Internet Control Protocols–IMCP, ARP, RARP, DHCP.
Transport Layer: Services provided to the upper layers, Transport Protocols, Overview of Congestion Control.

Unit- IV

The Internet Transport Protocols: Introduction to UDP & RPC, Real Time Transport Protocols, The Internet Transport Protocols–TCP, TCP Service Model, TCP protocol, TCP Segment Header, TCP Connection Establishment, TCP Connection Release, Modeling TCP Connection Management, TCP Sliding Window, TCP Time Management, TCP Congestion Control.
Application Layer: DNS, TELNET, E-Mail, FTP, HTTP, SSH, Overview of WWW.

Text Book:

- **Computer Networks** Andrew S. Tanenbaum, David J Wetherall. (5e)

References:

1. **Data and Computer Communications** by William Stallings.
2. **Data Communication and Networking** by Behrouz A. Forouzan.
3. **Computer Networks A Top-Down Approach** by Behrouz A Forouzan, FirouzMosharraf.

M. Sc. Mathematics with Computer Science

MM/AM/MCS 203 **Semester-II**

Paper III: Complex Analysis

Unit- I

Regions in the Complex Plane - Functions of a Complex Variable - Limits - Continuity - Derivatives - Cauchy – Riemann Equations - Sufficient Conditions for Differentiability - Analytic Functions - Harmonic Functions - Reflection Principle - The Exponential Function - The Logarithmic Function - Complex Exponents- Trigonometric functions- Hyperbolic functions .

Unit- II

Derivatives of Functions $w(t)$ - Definite Integrals of Functions $w(t)$ - Contours - Contour Integrals - Some Examples - Upper Bounds for Moduli of Contour Integrals – Anti derivatives - Cauchy – Goursat Theorem - Simply Connected Domains - Multiply Connected Domains - Cauchy Integral Formula - An Extension of the Cauchy Integral Formula - Liouville's Theorem and the Fundamental Theorem of Algebra - Maximum Modulus Principle.

Unit- III

Convergence of Sequences - Convergence of Series - Taylor Series - Laurent Series - Absolute and Uniform Convergence of Power Series - Isolated Singular Points - Residues - Cauchy's Residue Theorem - Residue at Infinity - The Three Types of Isolated Singular Points - Residues at Poles - Examples - Zeros of Analytic Functions - Zeros and Poles - Behavior of Functions Near Isolated Singular Points.

Unit- IV

Evaluation of Improper Integrals - Improper Integrals from Fourier Analysis - Jordan's Lemma - Definite Integrals Involving Sines and Cosines - Argument Principle - Rouche's Theorem - Linear Transformations - The Transformation $w = 1/z$ - Mappings by $1/z$ - Linear Fractional Transformations - An Implicit Form.

Text Book:

- **Complex Variables with Applications** by James Ward Brown and Ruel V Charcill. *McGraw- Hill International Edition.*

References:

1. **Complex Analysis** by Dennis G. Gill.
2. **Complex Analysis** by Steven G. Krantz.
3. **Complex Variables with Applications** by S. Ponnusamy, Herb Silverman.
4. **Complex Analysis** by Joseph Bak, Donald J. Newman.

MCS 204 **Semester-II**

Paper-IV: Programming in Python

Unit- I Introduction to Python Programming: How a Program Works, Using Python, Why Python, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations (Operators. Type conversions, Expressions), More about Data Output, Indentation.**Decision Structures and Boolean Logic**: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. **Repetition Structures**: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops.
Unit- II Functions: Introduction, Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value -Returning Functions-Generating Random Numbers, Writing Our Own Value-Returning Functions. **Modules-Importing module, creating and exploring modules**: math module, Numpy module, time module,random module, OS,calendar,sys.,Storing Functions in Modules.
Unit- III Lists and Tuples: Sequences, Introduction to Lists, List slicing, Finding Items in Lists with the in Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists, Two-Dimensional Lists, Tuples. **Strings**: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings. **Dictionaries and Sets**: Dictionaries, Sets, Serializing Objects. **Recursion**: Introduction, Problem Solving with Recursion, Examples of Recursive Algorithms. **File and Exceptions**: Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions.
Unit- IV OOPs Concept: Introduction to OOP, Classes and objects, Inheritance Method overloading and method overriding,Abstract method and Abstract class, Interfaces in python,Abstract class VS Interfaces,constructor,instance methods ,class methods, static methods. **GUI Programming**: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Text Book:

- **Starting Out With Python** by Tony Gaddis. (4e)

References:

1. **Fundamentals of Python** by Kenneth A. Lambert.
2. **Foundations for Analytics with Python** by Clinton W. Brownley.
3. **Beginning Python using Python 2.6 and Python 3** by James Payne.
4. **Introduction to Computer Science using Python** by Charles Dierach.
5. **Practical Programming: An Introduction to Computer Science using Python 3** by Paul Gries.

M. Sc. Mathematics with Computer Science

MCS 202 L **Semester-II**

Computer Networks Lab

1. Program to identify the category of the IP address for the given IP address
2. Program to implement sliding window protocol
3. Program for Socket pair system call usage in IPC
4. Program for Socket options using signals
5. Program to implement Echo concurrent Stream Server
6. Program to implement Echo concurrent stream client
7. Program to implement Listener and Talker
8. Program to implement TCP time service
9. Program to implement UDP time service
10. Program to implement Ping service
11. Program to implement Route tracing program
12. Program to implement File Transfer Protocol
13. Program to implement any Shortest path routing Algorithm
14. Program to implement Distance Vector Routing Implementation
15. Program to implement ICMP Error Message simulations
16. Program to implement Reverse Address Resolution Protocol

M. Sc. Mathematics with Computer Science

MCS 204 L **Semester-II**

Programming in Python Lab

1. Write a program that displays the following information: Your name, Full address, Mobile number, College name, Course subjects.
2. Write a program to find the largest three integers using if-else and conditional operator.
3. Write a program that asks the user to enter a series of positive numbers (The user should enter a negative number to signal the end of the series) and the program should display the numbers in order and their sum.
4. Write a program to find the product and sum of two matrices [A]mxp and [B]pxr using Numpy
5. Write recursive and non-recursive functions for the following:
   a. To find GCD of two integers.
   b. To find the factorial of positive integer
   c. To print Fibonacci Sequence up to given number n
6. Write a program to display two random numbers that are to be added, such as: 247 + 129, the program should allow the student to enter the answer. If the answer is correct, a message of congratulations should be displayed. If the answer is incorrect, a message showing the correct answer should be displayed.
7. Write a function to demonstrate variable length arguments.
8. WAP to Demonstrate about Fundamental Data types(sequential and non-sequential) in Python Programming using type function.
9. Write a program to create file, write the content and display the contents of the file.
10. In a program, write a function that accepts two arguments: a list and a number n. The function displays all of the numbers in the list that are greater than the number n.
11. Write a program with a function that accepts a string as an argument and returns the no. of vowels that the string contains. Another function to return number of consonants.
12. Write a program that opens a specified text file and then displays a list of all the unique words found in the file. (Store each word as an element of a set.)
13. Write a program to analyze the contents of two text files using set operations.
14. Write a program to implement the inheritance and dynamic polymorphism.
15. Write a GUI program that converts Celsius temperatures to Fahrenheit temperatures.
16. Write a GUI program that displays your details when a button is clicked.

Note: Handle the Exceptions raised from File Operations.

DEPARTMENT OF MATHEMATICS

OSMANIA UNIVERSITY

M.Sc. Mathematics with Computer Science Syllabus

Semester – III & IV

(Choice Based Credit System)
(w.e.f. the academic year 2024-2025)

M.Sc. Mathematics with Computer Science Course Structure

(Choice Based Credit System)
(w.e.f. the academic year 2024-2025)

SEMESTER – III

Subjects	Code	Paper Title	THPW	T	P	Credits	IA	ESE	Total
Core	MCS 301	**Differential Equations**	4	1		5	30	70	100
Core	MCS 302	**Advanced RDBMS**	4	0		4	30	70	100
Elective	MCS 303(A)	**Network Security**	4	1		5	30	70	100
	MCS 303(B)	**Data Science with R**							
	MCS 303(C)	**Block Chain and Crypto currency technologies**							
Elective	MCS 304(A)	**Operations Research**	4	1		5	30	70	100
	MCS 304(B)	**Discrete Mathematics**							
	MCS 304(C)	**Elementary Number Theory**							
Lab	MCS302 L	**Advanced RDBMS Lab**			2	1		25	25
			16	3	2	20			425

SEMESTER – IV

Subjects	Code	Paper Title	THPW	T	P	Credits	IA	ESE	Total
Core	MCS 401	**Integral Equations and Calculus of Variations**	4	1		5	30	70	100
Core	MCS 402	**Computer Organization**	4	0		4	30	70	100
Elective	MCS 403(A)	**Cloud Computing**	4	1		5	30	70	100
	MCS 403(B)	**Natural Language Processing**							
	MCS 403(C)	**Internet of Things**							
Lab	MCS 402 L	**Computer Organization Lab**			2	1		25	25
Project	MSC 404	**Project**	5			5			100
			17	2	2	20			425

T – Tutorial class: Each batch consists of 20 students and will be allotted to a teacher (Demonstrating the theory through a numerical example and practicing through mathematical software)
P - Practical
THPW = Teaching Hours Per Week.
IA = Internal Assessment (IA Test 20 Marks + Assignment 10 Marks).
ESE = End-Semester Examination.
End-Semester Examination Duration - 3 Hrs.

M. Sc. Mathematics with Computer Science

MCS 301 **Semester-III**

Paper-I: Differential Equations

Unit- I

Existence and Uniqueness of Solution: Picard's method of successive approximations - Picard's theorem.

Power Series Solution of O.D.E.: Ordinary and singular points - Series solution about an ordinary point - Series solution about singular point - Frobenius method.

Unit- II

Lagendre's Polynomials: Lengendre's equation and its solution - Lengendre's function of the first kind and its properties - Generating function - Orthogonal properties - Recurrance relations - Laplace's definite integrals for $P_n(x)$, Rodrigue's formula.

Bessel's Functions: Bessel's equation and its solution – Bessel's function of the first kind and its properties – Recurrence relations - Generating function- Orthogonality.

Boundary Value Problems: Sturm – Liouville problem.

Unit- III

Non-Linear PDE of Order One:Charpit's method-Cauchy's method of characteristics for solving nonlinear partial differential equations -Higher order linear partial differential equations with constant coefficients.

Unit- IV

Partial Differential Equations of order two with variable coefficients - Canonical forms - Classification of second order partial differential equations - Separation of variables method of solving the one dimensional heat equation, wave equation and Laplace equation.

Text Book:

- **Ordinary and Partial Differential Equations** by M.D. Raisingania, S. Chand Company Ltd., NewDelhi, 19th edition.

References:

1. **Differential Equations with Application and Historical Notes** by George F Simmons 2nd edition, Tata Mc.Graw-Hill Edition.
2. **Textbook of Ordinary Differential Equations** by S.G.Deo, V.LakshmiKantham, V.Raghavendra, TataMc.Graw Hill Pub. Company Ltd.
3. **Elements of Partial Differential Equations** by Ian Sneddon, Mc.Graw-Hill International Edition.

M. Sc. Mathematics with Computer Science

MCS 302 **Semester-III**

Paper-II: Advanced RDBMS

Unit- I Introduction: Database System Applications, Purpose of database systems, View of Data, Database Languages,Relational Databases, Database Design, Database Architecture, Database Users and Administrators, Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, The Relational Algebra, The Tuple Relational Calculus, The Domain Relational Calculus.
Unit- II Overview of the SQL Query Language, SQLData Definition, Basic Structure of SQLQueries, SQLAdditional Basic Operations, Set Operations, Null Values,SQL Aggregate Functions, Nested Sub - queries, Modification of the Database. The Entity - Relationship Model, Constraints, Removing Redundant Attributes in Entity Sets, Entity - Relationship Diagrams, Reduction to Relational Schemas, Entity - Relationship Design Issues, Extended E - R Features.
Unit- III Features of Good Relational Designs – Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, 2NF, 3NF, BCNF, 4NF, 5NF. SQL, views, Integrity constraints, Functions and Procedures, Triggers. File Organization, Organization of Records in Files, Data - Dictionary Storage, Indexing and Hashing, Basic Concepts, Ordered Indices, B+ - Tree Index, Files, B+ - Tree Extensions, Static Hashing, Dynamic Hashing, Bitmaps Indices.
Unit- IV Transaction Concept, a Simple Transaction Model, Transaction Atomicity and Durability, Transaction Iso- lation, Serializabitlity, Transaction Isolation and Atomicity, Transaction Isolation Levels, Implementation of Isolation Levels.Concurrency Control, Lock based Protocols, Deadlock Handling, Multiple Granularity, Time - stamp based protocols, Validation based protocol, Multiversion Schemes. Recovery System, Failure Classification, Storage, Recovery and Atomicity, Recovery Algorithm, Buffer Management.
NoSQL: Need for NoSQL, aggregate data models, more details on data models, distribution models, consistency, version stamps, map-reduce, key-value databases, document databases, column-family stores, graph databases, Schema Migrations.
Text Book:

- **Database System Concepts** by Abraham Silberschatz, HenryF. Korth, S.Sudarshan.
- **Professional NoSQL** by Shashank Tiwari, 1 st Edition , Wiley publishers, 2011.

References:

1. **Database Management Systems** by Raghu Ramakrishnan, Johannes Gehrke.
2. **Fundamentals of Database Systems** by Ramez Elmasri, Shamkant B.Navathe.
3. **Modern Database Management** by Jeffrey A.Hoffer, V.Ramesh, HeikkiTopi.
4. **Database Systems - A Practical Approach to Design, Implementation and Management** by Thomas M. Connolly, Carolyn E. Begg.

MCS 303(A) **Semester-III**

Paper-III(A): Network Security

Unit- I Overview of Network Security: Computer Security Concepts, the OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, a Model for Network Security. Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography. Block Ciphers and the Data Encryption Standard: Traditional Block Cipher Structure, the Data Encryption Standard (DES), A DES Example, Strength of DES.Block Cipher Operation: Double DES, Triple DES, Electronic Code Book, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode.
Unit- II Advanced Encryption Standard (AES): The Origins AES, AES Structure, AES Round Functions, AES Key Expansion, an AES Example AES Implementation. Pseudo random Number Generation and Stream Ciphers: Principles of Pseudo random Number Generation, Pseudo random Number Generators, Pseudo random Number Generation using Block Cipher, Stream Ciphers-RC4. Public-Key Cryptography and RSA: Principles of Public-Key Crypto systems, the RSA Algorithm. Key Management and Distribution: Symmetric Key Distribution Using Symmetric Encryption and Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, DiffieHellman Key Exchange.
Unit- III Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Secure Hash Algorithm (SHA) & MD5 Algorithm. Message Authentication Codes: Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, Security of MACs, MACs Based on Hash Functions: HMAC, MACs Based on Block Ciphers:DAA and CMAC. Digital Signatures: Digital Signatures, NIST Digital Signatures Algorithm.
Unit- IV Transport-Level Security: Web Security Considerations, Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS, Secure Shell (SSH), E-Mail Security: Pretty Good Privacy, S/MIME. IP Security: IP Security Overview, IP Security Architecture, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange. Intruders, Virus and Firewalls: Intruders, Intrusion Detection, Password Management, Virus and Related Threats, Countermeasures, Firewall Design Principles, Types of Firewalls.

Text Book:

- **Cryptography and Network Security – Principles and Practice** by William Stallings, (6e).

References:

1. Zhenfu Cao, New Directions of Modern Cryptography
2. Douglas R. Stinson, Cryptography Theory and Practices
3. Tom St Denis, Simon Johnson, Cryptography for Developers
4. Joseph MiggaKizza, A Guide to Computer Network Security
5. A. Menezes, P. Van Oorschot, S. Vanstone, Handbook of Applied Cryptograph
6. Henk C.A. van Tilborg, SushilJajodia, Encyclopedia of Cryptography and Security

M. Sc. Mathematics with Computer Science

MCS 303(B) **Semester-III**

Paper-III(B): Data Science with R

Unit- I

Data Science: Introduction to Data Science – Digital Universe – Sources of Data – Information Commons – Data Science Project Life Cycle: OSEMN Framework Data Preprocessing: Introduction to Data Preprocessing – Reading, Selecting, Filtering Data – Filtering Missing Values – Manipulating, Sorting, Grouping, Rearranging, Ranking Data.

Unit- II

Concept Learning:Formulation of Hypothesis – Probabilistic Approximately Correct Learning - VC Dimension –Hypothesis elimination – Candidate Elimination Algorithm Essentials Of R:R Basics - data types and objects - control structures – data frame -Feature Engineering - scaling, Label Encoding and One Hot Encoding, Reduction.

Unit- III

Model Fit Using R:Regression Models- Linear and Logistic Model, Classification Models – Decision Tree, Naïve Bayes, SVM and Random Forest, Clustering Models – K Means and Hierarchical clustering. Visualization:Data visualization: Box plot, histogram, scatter plot, heat map – Working with Tableau – Outlier detection – Data Balancing.

Unit- IV

Performance Evaluation: Loss Function and Error: Mean Squared Error, Root Mean Squared Error – Model Selection and Evaluation criteria: Accuracy, Precision, F1 score, Recall Score – Binary Predictive Classification –Sensitivity – Specificity. Recent Trends And Challenges In Data Science.

Text Book:

- **Introduction to Machine Learning** by Ethem Alpaydin, Fourth Edition, MIT Press, 2020.
- Hadley Wickham, Garrett Grolemund, R for data science : Import, Tidy, Transform, Visualize, And Model Data Paperback, 2017.

References:

1. Han, J., Kamber, M., Pei, J. Data mining concepts and techniques. Morgan Kaufmann. 2011.
2. Carl Shan, Henry Wang, William Chen, Max Song. The Data Science Handbook: Advice and Insight from 25 Amazing Data Scientists. The Data Science Bookshelf. 2016.
3. James, G., Witten, D., T., Tibshirani, R. An Introduction to statistical learning with applications in R. Springer. 2013.

M. Sc. Mathematics with Computer Science

MCS 303(C) **Semester-III**

Paper-III(C): Block Chain and Crypto Currency Technologies

Unit- I

Introduction to Cryptography and Cryptocurrencies: Foundations of Cryptography and security: Ciphers and secret messages, security attacks and services. Mathematical tools for cryptography: substitution techniques, modular arithmetic, Euclid's algorithm, finite fields, polynomial arithmetic. Design Principles of Block Ciphers: Theory of Block Cipher Design, Feistel cipher network structure, DES and Triple DES, modes of operation (ECB, CBC, OFB,CFB), strength of DES.

Unit- II

Block chain Achieves: Decentralization - Centralizations. Decentralization- Distributed consensus, Consensus with - out identity using a block chain, Incentives and proof of work. Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

Unit- III

Mechanics of Bitcoin: Bitcoin transactions, Bitcoin Scripts, Applications of Bitcoin scripts, Bitcoin blocks, The Bit- coin network, Limitations and improvements. BitcoinMining :The task of Bitcoinminers, Mining Hardware, Energy consumption and ecology, Mining pools, Mining incentives and strategies. Bitcoin and Anonymity: Anonymity Basics, How to De-anonymize Bitcoin, Mixing, Decentralized Mixing, Zerocoin and Zerocash.

Unit- IV

Community, Politics, and Regulation:Consensus in Bitcoin, Bitcoin Core Software, Stakeholders: Who sinCharge, Roots of Bitcoin, Governments Notice on Bitcoin, Anti Money Laundering Regulation, NewYork's BitLicense Proposal. Bitcoin as a Platform: Bitcoin as an Append only Log, Bitcoins as Smart Property, Secure MultiParty Lotteries in Bitcoin, Bitcoin as Public Randomness,Source-Prediction, Markets, and Real World Data Feeds.

Text Book:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder, S. (2016). Bitcoin and crypto currency technologies: a comprehensive introduction. Princeton University Press.
2. William Stallings, Cryptography and Network Security, Pearson 2004.

References:

1. Antonopoulos, A. M. (2014). Mastering Bitcoin: unlocking digital cryptocurrencies. OReilly Media, Inc.
2. Franco, P. (2014). Understanding Bitcoin: Cryptography, engineering and economics. John Wiley and Sons.

M. Sc. Mathematics with Computer Science

M/AM/MCS 304(A) **Semester-III**

Paper-IV(A): Operations Research

Unit- I

Formulation of Linear Programming problems, Graphical solution of Linear Programming problem,Convex set,General formulation of Linear Programming problems, Standard and Matrix forms of Linear Programming problems,Simplex Method, Two-phase method, Big-M method, Method to resolve degeneracy in Linear Programming problem, Alternative optimal solutions.

Unit- II

Solution of simultaneous equations by Simplex Method, Inverse of a Matrix by Simplex Method,Revised Simplex Method,Concept of Duality in Linear Programming, Comparison of solutions of the Dual and its primal

Unit- III

Mathematical formulation of Transportation problem, Tabular representation, Methods to find initial basic feasible solution, North West corner rule, Lowest cost entry method, Vogel's approximation method, Optimality test, Method of finding optimal solution, Degeneracy in transportation problem, Method to resolve degeneracy, Unbalanced transportation problem. Mathematical formulation of Assignment problem, Reduction theorem, Hungarian Assignment Method, Travelling salesman problem, Formulation of Travelling Salesman problem as an Assignment problem, Solution procedure

Unit- IV

Concept of Dynamic programming, Bellman's principle of optimality, characteristics of Dynamic programming problem,Backward and Forward recursive approach,Minimum path problem,Single Additive constraint and Multiplicatively separable return, Single Additive constraint and Additively separable return, Single Multiplicatively constraint and Additively separable return.

Text Book:

- **Operations Research** by S.D.Sharma, 18th Revised Edition 2017, KedarNath Ram Nath Publications.

References:

1. **Operations Research – An Introduction** by Hamdy A. Taha, 10th Edition.
2. **Linear Programming** by G.Hadley.

M. Sc. Mathematics with Computer Science

MCS 304(B) **Semester-III**

Paper-IV(B) : Discrete Mathematics

Unit- I

Propositional logic, Propositional Equivalences, Predicates and Quantifiers, Rules of Inference– Valid Arguments in Propositional Logic.Rules of Inference for Quantified Statements.Introduction to Proofs – Direct Proofs, Proofs by Contraposition, Proofs by Contradiction.NormalForms–Disjunctive Normal Form, Conjunctive Normal Forms, Principal Disjunctive Normal Form, Principal Conjunctive Normal Form. Boolean Algebra – Boolean Functions and Boolean Expressions, Identities of Boolean Algebra, Representing Boolean Functions. Logic Gates, Minimization of Circuits–K-maps. (1.1 *to* 1.3, 1.5 *to* 1.7, 10.1 *to* 10.4 *of* [1])

Unit- II

Elementary Combinatorics – Basics of Counting, Two Basic Counting Principles, IndirectCounting.Combinations and Permutations – Enumeration of Combinations and Permutations, Enumerating Combinations and Permutations with Repetitions, Enumerating Permutations with Constrained Repetitions. Binomial Coefficients – Pascal's Identity, Pascal's Triangle. Multinominal Theorem, The Principle of Inclusion–Exclusion and its Applications. (2.1 *to* 2.8 *of* [2])

Unit- III

Recurrence Relations – Generating Functions of Sequences, Generating Function Models, Calculating Coefficients of Generating Functions. Solutions of Recurrence Relations, the Fibonacci Relation. Solving Recurrence Relations by Substitution and by Generating Functions, Method of Characteristic Roots. Solution of Inhomogeneous Linear Recurrence Relations, the Method of Undetermined Coefficients: Solving Nonlinear Recurrence Relations. (3.1 *to* 3.6 *of* [2])

Unit- IV

Graphs – Graphs and Graph Models, Graph Terminology and Special Types of Graphs, The Hand shaking Theorem, Representing Graphs and Graph Isomorphism. Connectivity, Euler and Hamiltonian Paths and Circuits,Shortest Path Problems,Dijkstra's Algorithm,Planar Graphs,Euler formula. Trees – Introduction to Trees, Tree Traversal. Spanning Trees, DFS, BFS Algorithms, Minimum Spanning Trees. Prim's and Kruskal's Algorithms. (8.1 *to* 8.7, 9.1, 9.3, 9.5 *of* [1])

Text Book:

- **Discrete Mathematics and its Applications** by Kenneth HRosen, Seventh Edition, Mc GrawHill Education (India)Private Ltd, New Delhi.
- **Discrete Mathematics for Computer Scientists** & **Mathematicians** by JoeL.Mott, Abraham Kandel and Theodore P. Baker, Second Edition, Prentice Hall of India, Private Ltd, NewDelhi.

References:

1. **Elements of Discrete Mathematics** by C L Liu and D P Mohapatra, Third Edition, The McGraw-Hill Companies.
2. **Discrete and Combinatorial Mathematics** by Ralph P. Grimaldi and B. V. Ramana, 5th Edition,PEARSON education.

M. Sc. Mathematics with Computer Science

MCS 304(C) **Semester-III**

Paper - IV(C): Elementary Number Theory

Unit- I

The Fundamental Theorem of Arithmetic: Divisibility- GCD- Prime numbers, Fundamental theorem of arithmetic- the series of reciprocal of the primes- The Euclidean algorithm.
(Page No. 13 - 23)

Unit- II

Arithmetical Functions and Dirichlet Multiplication: The functions $\phi(n)$, $\mu(n)$ and a relation connecting them- Product formula for $\phi(n)$ - Dirichlet product- Dirichlet inverse and Mobius inversion formula -The Mangoldt function $\wedge(n)$- Multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function- Liouville's function $\lambda(n)$- The divisor functions $\sigma_\alpha(n)$.
(Page No. 24-39 & 46-51)

Unit- III

Congruences: Properties of congruences- Residue classes and complete residue system- Linear congruences-Reduced residue systems and Euler-Fermat theorem- Polynomial congruence modulo p - Lagrange's theorem- Application of Lagrange's theorem- Chinese remainder theorem and its applications.
(Page No. 106-120 & 126-128)

Unit- IV

Quadratic Residues and The Quadratic Reciprocity Law: Quadratic residues- Legendre's symbol and its properties- Evaluation of $(-1|p)$ and $(2|p)$ - Gauss' lemma- The quadratic reciprocity law and its applications-The Jacobi symbol.
(Page No. 178-190 & 201-203)

Text Book:

- **Introduction to Analytic Number Theory** by Tom M. Apostol. *Narosa publishing house*

References:

1. **Number Theory** by Joseph H. Silverman.
2. **Theory of Numbers** by K.Ramchandra.
3. **Elementary Number Theory** by James K Strayer.
4. **Elementary Number Theory** by James Tattusall.

M. Sc. Mathematics with Computer Science

MCS 302 L **Semester-III**

Advanced RDBMS Lab

1. E-R Model: Analyze the problem with the entities which identify data persisted in the database which contains entities,attributes.
2. Concept design with E-R Model: Apply cardinalities for each relationship, identify strong entities and weak entities for relationships like generalization, aggregation, specialization.
3. Relation Model: Represent attributes as columns in tables and different types of attributes like Composite, Multi-valued, and Derived.
4. Installation of MySql/Oracle/MONGO DB
5. Practicing DDL commands
6. Practicing DML commands SELECT, INSERT, UPDATE, DELETE.
7. Queries using ANY, ALL, IN, INTERSECT, UNION
8. Querying Using aggregate functions COUNT, SUM using GROUPBY and HAVING.
9. TRIGGER
10. Procedures and Stored Procedures Creation, Execution and Modification of stored Procedure
11. DCL Commands
12. CASE STUDY 1 : Hospital Management System
13. CASE STUDY 2 :Railway Reservation System

Note :The aim of these case studies is to design and develop a database for the hospital/Railway to maintain the records of various departments, rooms, and doctors in the hospital or the rail reservations. It also maintains records of the regular patients, patients admitted in the hospital, the check up of patients done by the doctors, the patients that have been operated, and patients discharged from the hospital.

M. Sc. Mathematics with Computer Science

M/AM/MCS 401 **Semester-IV**

Paper-I: Integral Equations and Calculus of Variations

Unit- I

Volterra Integral Equations: Basic concepts - Relationship between Linear differential equations and Volterra Integral equations - Resolvent Kernel of Volterra Integral equation. Differentiation of some resolvent kernels - Solution of Integral equation by Resolvent Kernel - The method of successive approximations - Convolution type equations - Solution of Integro-differential equations with the aid of the Laplace Transformation – Volterra integral equation of the first kind-Euler integrals-Abel's problem-Abel's integral equation and its generalizations.

Unit- II

Fredholm Integral Equations : Fredholm integral equations of the second kind – Fundamentals – The Method of Fredholm Determinants - Iterated Kernels constructing the Resolvent Kernel with the aid of Iterated Kernels - Integral equations with Degenerated Kernels. Hammerstein type equation – Characteristic numbers and Eigen function and its properties.

Green's function :Construction of Green's function for ordinary differential equations-Special case of Green's function –Using Green's function in the solution of boundary value problem.

CALCULS OF VARIATIONS:

Unit- III

Introduction – The Method of Variations in Problems with fixed Boundaries: Definitions of Functionals –Variation and Its properties - Euler's'equation- Fundamental Lemma of Calculus of Variation – The problem of minimum surface of revolution - Minimum Energy Problem Brachistochrone Problem - Variational problems involving Several functions - Functional dependent on higher order derivatives - Euler Poisson equation.

Unit- IV

Functional dependent on the functions of several independent variables - Euler's equations in two dependent variables – Variational problems in parametric form-Applications of Calculus of Variation-Hamilton's principle - Lagrange's Equation,Hamilton's equations.

Text Book:

- **Problems and Exercises in Integral Equations** by M.KRASNOV, A.KISELEV, G.MAKARENKO, (1971).
- **Integral Equations** by S.Swarup, (2008).
- **Differential Equations and The Calculus of Variations** by L.ELSGOLTS, MIR Publishers, MOSCOW.
- **Analytical Mechanics** by Grant R. Fowles and George L. Cassiday, 7Th Edition.

Paper-II: Computer Organization

Unit- I

Digital Logic Circuits: Digital Computers, Logic Gates, Boolean algebra, Map Simplification, Combinational Circuits,Flip-Flops,Sequential Circuits.

Digital Components: Integrated Circuits, Decoders, Multiplexers, Registers, Shift Registers, Binary Counters, Memory Unit.

Data Representation: Data Types, Complements, Fixed Point Representations, Floating Point Representation, Binary Codes, and Error Detection Codes.

Unit- II

Register Transfer and Micro operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, and Shift Micro operations.

Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input - Output and Interrupt, Design of Accumulator Logic.

Unit- III

Programming the Basic Computer: Machine Language, Assembly Language, The Assembler Program Loops, Programming Arithmetic and Logic Operations, Subroutines, Input - Output Programming.

Central Processing Unit: Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer.

Computer Arithmetic: Addition and Subtraction, Multiplication Algorithms, Division Algorithms, and Floating Point Arithmetic Operations, Decimal Arithmetic Unit, Decimal Arithmetic Operations.

Unit- IV

Input - Output Organization: Peripheral Devices, Input - Output Interface,Asynchronous Data Transfer,Modes of Transfer, Priority Interrupt, Direct Memory Access (DMA), Input - Output Processor, Serial Communication. **Pipeline and Vector Processing**: Parallel Processing, Pipelining, Arithmetic Pipelines, Instruction Pipelines and RISC Pipelines, Vector Processing.

Text Book:

- **Computer System Architecture (3e)** by M.MorrisMano.

References:

1. Andrew S.Tanenbaum, Structured Computer Organization.
2. William Stallings, Computer Organization and Architecture.
3. ZviKohavi, NirajK.Jha, Switching and Finite Automata Theory.

M. Sc. Mathematics with Computer Science

MCS 402 L **Semester-IV**

Computer Organization Lab

1. Implementation of various logic gates using NAND gate.
2. Implementationofthehalfadderandfulladder.
3. Implementation of the sub - tractor.
4. Demonstrate of the RS flip - flop, D flip - flop, T flip - flop and JK flip - flop.
5. Implementation of the shift registers.
6. Implementation of the decoders and encoders
7. Implementation of the multiplexers and de-multiplexers
8. Design of counters.
9. Implementation of the addition algorithm
10. Implementation of the subtraction algorithm
11. Implementation of the multiplication algorithm
12. Implementation of the booths multiplication algorithm
13. Implementation of the division algorithm
14. Implementation of the simple ALU.
15. Simulation of direct memory access technique
16. Simulation of associative memory technique

Note : Using any simulator perform the following functions

MCS 403(A) **Semester-IV**

Paper-III(A): Cloud Computing

Unit- I Era of Cloud Computing (CC): Introduction, cloud and other similar configurations, CC vs. peer-to-peer architecture, CC vs client-server architecture, CC vs GC, components of CC, impact of CC on businesses. **Virtualization**: Introduction, virtualization benefits, implementation levels of virtualization, virtualization at the OS level, virtualization structure, open source virtualization technology, Xen virtualization architecture, binary translation with full virtualization, para-virtualization with compiler support, virtualization of CPU, memory, I/O devices, hardware support for virtualization, virtualization in multicore processors. **Cloud Computing Services**: IaaS, PaaS, leveraging PaaS for productivity, guidelines for selecting a PaaS provider, concerns with PaaS, languages and PaaS, SaaS, DBaaS. **Cloud Computing and Business Value**: key drivers for CC, CC and out sourcing, types of scalability, use of load balancers to enhance scalability, variable operating costs using CC, time-to-market benefits of CC, distribution over the internet, levels of business values from CC. **Cloud Types and Models**: private cloud, public cloud, hybrid cloud.
Unit- II Adoption and Use of Cloud by Small and Medium Businesses: place of adoption, benefits, adoption phases, vendor roles and responsibilities, selection phases, provider liability, provider capabilities, success factors for CC Adoption process of public clouds by enterprises. Cloud migration techniques, Phases during the migration of an application to the cloud. **IT Service Management for Cloud Computing**: ITIL based service management, service strategy, service design, service transition, service operations, continual service improvement. **SLA with Cloud Service Providers**: concept, aspects and requirements of SLA, credit calculation, samples 1 and 3. Risks, Consequences and **Costs for Cloud Computing**: Introduction, risk assessment and management, risk of vendor lock-in, loss of control, not meeting regulatory compliances, resource scarcity, multitenant environment, failure, inadequate SLA, malware and internet attacks, management of cloud resources, network outages, in fracture, legal, licensing, TCO, cloud costs, cost allocations, chargeback models and methodology, billable items.
Unit- III REST-style Web Services: What is REST? HTTP methods, Java API for RESTful Web Services (JAX-RS), JAX-RS with Jersey, CRUD RESTful Web Service, SOAP and REST in Harmony, Interpretability between the Java Platform and WCF, WSIT, Web Services Security, Wire-Level Security, WS-Security.
Unit- IV AAA Administration for Cloud: AAA model, single sign on for clouds, industry implementation for AAA, authentication management in the cloud, SAML, authentication for resource utilization. **Security as a Service**: Benefits of security as a service, concerns with security as a service, security service providers, IdMaaS, attributes of IdMaaS providers. **Cloud Certifications and Audits**: certifications, cloud audit framework, cloud auditing requirements. **Application Security in the Cloud**: cloud application SDLC, cloud service reports by providers, application security in IaaS, PaaS and SaaS environments.
Mobile Cloud Computing (MCC): Architecture of MCC, benefits of MCC, MCC challenges.
Text Book: 1. RajkumarBuyya, Cloud Computing: Principles and Paradigms.
2. ArshdeepBahga, Vijay Madisetti, Cloud Computing – A Hands-On Approach.
3. David E.Y. Sarna, Implementing and Developing Cloud Computing Applications.
4. Kai Hwang, Distributed and Cloud Computing From Parallel Processing to Internet of Things

MCS 403(B) **Semester-IV**

Paper-III(B): Natural Language Processing

Unit- I

Language Processing and Python: Computing with Language: Texts and Words, A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language Understanding Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet.

Unit- II

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting:From Lists to Strings.
Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation- Based Tagging, How to Determine the Category of a Word.

Unit- III

Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers Deep Learning for NLP: Introduction to Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks, Classifying Text with Deep Learning

Unit- IV

Extracting Information from Text: Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction. Analyzing Sentence Structure: Some Grammatical Dilemmas, What's the Use of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar.
NLP applications: Topic modeling, Text classification, Sentiment analysis, Word sense disambiguation, Speech recognition and speech to text, Text to speech, Language detection and translation.

Text Book:

1. Steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python.OReily, 2009.

2. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Apress, 2019

3. Allen James, Natural Language Understanding, Benjamin/Cumming,1995. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

4. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

Paper-III(C): Internet of Things

Unit- I

Introduction to 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 NET CONF - YANG - IoT Platforms Design Methodology.

Unit- II

IoT Architecture: M2M high - level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - in formation model - functional model - communication model - IoT reference architecture. IoT Protocols: Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA andR FID Protocols – Unified Data Standards.

Unit- III

Protocols – IEEE 802.15.4 – BACnet Protocol – Modbus– Zigbee Architecture – Network layer –6 LowPAN - CoAP – Security. Building IoT with RASPBERRY PI & ARDUINO: Building IOT with RASPERRY PI-IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints -IoT Device - Building blocks - Raspberry Pi - Board - Linuxon Raspberry Pi - Raspberry Pi Interfaces.

Unit- IV

Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.Case Studies and Real-World Applications : Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

Text Book:

1. Arshdeep Bahga, Vijay Madisetti — Internet of Things – Ahands - on approach, Universities Press, 2015.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian(Eds) — Architecting the Internet of Things, Springer, 2011.
3. Honbo Zhou — The Internet of Things in the Cloud: A Middle ware Perspective, CRC Press, 2012.
4. Jan Ho ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand.David Boyle, From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence, Elsevier, 2014.
5. Olivier Hersent, David Boswar thick, Omar Elloumi — The Internet of Things – Key applications and Protocols, Wiley, 2012.

M. Sc. Mathematics with Computer Science

MCS 404 **Semester-IV**

PROJECT

With effect from the academic year 2023-2024

Department of Mathematics
Osmania University, Hyderabad
M.Sc. Computer Science
(Course under Choice Based Credit System)

SEMESTER – I

Paper	Code	Paper Title	HpW	Marks	Credits
I	CS101T	Advanced Java Programming	4	30+70=100	4
II	CS102T	Operating Systems	4	30+70=100	4
III	CS103T	Software Engineering	4	30+70=100	4
IV	CS104T	Discrete Mathematics	4	30+70=100	4
V	CS105P	Advanced Java Lab	4	50	2
VI	CS106P	Operating Systems Lab	4	50	2
		Total	**24**	**500**	**20**

SEMESTER – II

Paper	Code	Paper Title	HpW	Marks	Credits
I	CS201T	Programming in Python	4	30+70=100	4
II	CS202T	Computer Networks	4	30+70=100	4
III	CS203T	Design and Analysis of Algorithms	4	30+70=100	4
IV	CS204T	Automata Theory	4	30+70=100	4
V	CS205P	Python Lab	4	50	2
VI	CS206P	Computer Networks Lab	4	50	2
		Total	**24**	**500**	**20**

M.Sc. Computer Science

Semester – I

Paper – I : Advanced Java Programming

CS 101T

Unit–I

AWT: Introduction, AWT Class Hierarchy, Creating Container, Adding Components, Layout, Using Panel, TextField, TextArea, List, Checkbox, CheckBoxGroup, Choice, EventHandling, DialogBoxes, ScrollBar, Menu.

Swing: Containment Hierarchy, Adding Components, JTextField, JPasswordField, JTable, JComboBox, JProgressBar, JList, JTree, JColorChooser, Dialogs.

Overview of Networking: Working with URL, Connecting to a Server, Implementing Servers, Serving multiple Clients, Sending EMail, Socket Programming, Internet Addresses, URL Connections.

Unit–II

Servlet : What Is a Servlet? The Example Servlets, Servlet Life Cycle, advantages, Sharing Information, Initializing a Servlet, Writing Service Methods, Filtering Requests and Responses, Invoking Other Web Resources, Accessing the Web Context, Maintaining Client State, Finalizing a Servlet.

JSP: What Is a JSP Page?, Example of JSP Pages, The Life Cycle of a JSP Page, Creating Static Content, Creating Dynamic Content, JavaBeans Components, JavaBeans Concepts, Using NetBeans GUI Builder Writing a Simple Bean.

Unit–III

Java Database Connectivity (JDBC): Introduction, JDBC Drivers, JDBC Architecture, JDBC Classes and Interfaces, Loading a Driver, Making a Connection, Execute SQL Statement, SQL Statements, Retrieving Result, Getting Database Information, Scrollable and Updatable Resultset, ResultSet Metadata.

Hibernate: Introduction, Architecture, Writing POJO Class, Creating a Table, Writing a Hibernate Application, Compiling and Running Application, Book Application Using Annotation, Object Life Cycle, HQL, Using Native SQL Query, NamedQueries, Generating DDL, Generator Class

Unit–IV

Java Naming and Directory Interface (JNDI): Naming Concepts, Directory Concepts, Java Naming and Directory Interface, Specifying JNDI Properties, Name Servers, Naming Operations, Working with Directory.

Overview of J2EE: Introduction to JavaBeans, Advantages of JavaBeans, Properties of Java Beans with examples, Java Beans API, Introduction to spring and sprint boot

Java Server Faces(JSF): Introduction, Simple Application, Request Processing Life-Cycle, Tracing Phases, Managed Bean, Basic JSF Tags, Expression Language, Event Handling with Example, Page Navigation.

Text Book: Uttam K.Roy, Advanced Java programming, Oxford University Press, 2015

References

1. Herbertt Schildt, Java Complete Reference
2. SharanamShah,VaishaliShah,JavaEE 7 for Beginners
3. CayS.Horstmans,GrayCoronell, CoreJavaVol.II–Advanced Features

Paper – II : Operating Systems

CS 102T

Unit – I

Introduction: Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection-Security, Kernel Data Structures, Computing Environments, Open-Source Operating Systems.

Operating-System Structures: Operating-System Services, User Interface for Operating-System(CLI and GUI), System Calls, Types of System Calls(fork, exec, wait, kill, exit).

Process Management: Process Concept, Process Scheduling, Operations on Processes (Process creation-fork system call, process termination), Inter Process Communication, Types of IPC(Shared memory, message passing, signals, socket, pipes) Zombie and orphan processes.

Threads: Overview, Multithreading Models, Threading Issues.

Process Synchronization: Concept, Critical-Section Problem, Peterson's Solution, Synchronization, Classic Problems of Synchronization, Semaphores, Monitors.

Unit – II

CPU Scheduling: Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Real-Time CPU Scheduling, Algorithm Evaluation.

Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

Unit – III

Memory Management: Main Memory, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table. Virtual Memory: Demand Paging, Page Replacement, Allocation of Frames, Thrashing.

Mass-Storage Structure: Overview, Disk Structure, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure.

Unit – IV

File Systems: File Concept, Access Methods, Directory and Disk Structure, File -System Mounting, Protection. File-System Structure and Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Recovery, Network File System.

Advanced Operating System- Basics of Network Operating System, Server Operating System and Real Time Operating System, Mobile OS – iOS and Android – Architecture, Versions and SDK Framework

Text Book: Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, *Operating System Concepts* (10^{th} edition)

References

1. Thomas W. Doeppner, *Operating systems in depth*
2. Andrew S. Tanenbaum, *Modern Operating Systems*
3. William Stallings, *Operating Systems – Internals and Design Principles*
4. Dhananjay M. Dhandhere, *Operating Systems-A Concept Based Approach*
5. Modern Operating Systems -By Andrew S. Tanenbaum (PHI)

Paper –III : Software Engineering

CS 103T

Unit – I

Software Engineering: The Nature of Software, Changing Nature of Software, Defining the Discipline, Software Process, Software Engineering Practice.

The Software Process: A Generic Process Model, Defining a Framework Activity, Process Assessment and Improvement, Prescriptive Process Models, Specialized Process Models, Unified Process, Personal and Team Process Models. Defining Agility, Agile Process, Extreme Programming, Psychology of Software Engineering, Software Team Structures, Software Engineering Using the Cloud, Global Teams.

Unit – II

Requirements: Core Principles of Modeling, Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Analysis Model, Requirements Analysis, UML Models That Supplement the Use Case, Identifying Analysis Classes, Specifying Attributes, Defining Operations, Class-Responsibility- Collaborator Modeling, Associations and Dependencies, Analysis Packages.

Design Concepts: Design within the Context of SE, Design Process, Design Concepts, Design Model, Software Architecture, Architectural Styles, Architectural Considerations, Architectural Design, Component, Designing Class-Based Components, Conducting Component-Level Design, Component- Based Development, User Interface Design Rules.

Unit – III

Quality Management: Quality, Software Quality, Software Quality Dilemma, Achieving Software Quality, Defect Amplification and Removal, Reviews, Informal Reviews, Formal Technical Reviews, Elements of Software Quality Assurance, SQA Tasks, Goals, and Metrics, Software Reliability, A Strategic Approach to Software Testing, Test Validation Testing, System Testing, Debugging, Software Testing Fundamentals, White- Box Testing, Black-Box Testing, Path Testing, Control Structure Testing, Object-Oriented Testing Strategies & Methods, Security Engineering Analysis, Security Assurance, Security Risk Analysis.

Unit – IV

Software Configuration Management, SCM Process, Product Metrics for Requirements Model, Design Model, Source Code, Testing and Maintenance.

Managing Software Projects: The Project Management Spectrum, W^5HH Principle, Metrics in the Process and Project Domains, Software Measurement, Metrics for Software Quality, Integrating Metrics within the Software Process, Software Project Estimation, Decomposition Techniques, Project Scheduling – basics, scheduling, Software Risks, Risk Mitigation, Monitoring, and Management, Software Maintenance, Software Reengineering, Reverse Engineering, Forward Engineering.

Text Book: Roger S Pressman, B R Maxim, *Software Engineering – A Practitioner's Approach (8th edition)*

References

1. Ian Sommerville, *Software Engineering*
2. Hans Van Vliet, *Software Engineering*
3. D. Bell, *Software Engineering for Students*
4. K.K. Aggarwal, Y. Singh, *Software Engineering*
5. R. Mall, *Fundamentals of Software Engineering*
6. Pankaj Jalote, An Integrated *Approach to Software Engineering*

Paper –IV : Discrete Mathematics

CS 104T

Unit – I

Mathematical Logic: propositional logic, propositional equivalences, predicates & quantifiers, rule of inference, direct proofs, proof by contraposition, proof by contradiction.

Boolean Algebra: Boolean functions and its representation, logic gates, minimizations of circuits by using Boolean identities and K-map.

Unit – II

Basic Structures: Sets representations, set operations, functions, sequences and summations.
Division algorithm, modular arithmetic, solving congruences, applications of congruences.

Recursion: Proofs by mathematical induction, recursive definitions, structural induction, generalized induction, recursive algorithms.

Unit – III

Counting: Basic counting principle, inclusion-exclusion for two-sets, pigeonhole principle, permutations and combinations, Binomial coefficient and identities, generalized permutations and combinations.

Recurrence Relations: introduction, solving linear recurrence relations, generating functions, principle of inclusion-exclusion, applications of inclusion-exclusion.

Relations: relations and their properties, representing relations, closures of relations, equivalence relations, partial orderings.

Unit – IV

Graphs: Graphs definitions, graph terminology, types of graphs, representing graphs, graph isomorphism, connectivity of graphs, Euler and Hamilton paths and circuits, Dijkstra's algorithm to find shortest path, planar graphs–Euler's formula and its applications, graph coloring and its applications

Trees: Trees definitions–properties of trees, applications of trees –BST, Haffman Coding, tree traversals: pre-order, in-order, post-order, prefix, infix, postfix notations, spanning tress–DFS, BFS, Prim's, Kruskal's algorithms.

Text Book: Kenneth H. Rosen, *Discrete Mathematics and its Applications* (7^{th} edition)

References

1. Ralph P. Grimaldi, *Discrete and Combinatorial Mathematics*
2. Stein, Drysdale, Bogart, *Discrete Mathematics for Computer Scientists*
3. J.P. Tremblay, R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*
4. Joe L. Mott, Abraham Kandel, Theoder P. Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*

Paper – V : Advanced Java Lab

CS 105P

1. Create GUI to present a set of choices for a user to select stationary products and display the price of Product after selection from the list.
2. Create GUI to demonstrate typical Editable Table which describes an Employee for a Software Company.
3. Create GUI to demonstrate swing components using student registration form.
4. Create a Remote Object for simple arithmetic operators. Use AWT / SWING to create user interface.
5. Write an RMI application using call back mechanism.
6. Develop Servlet Question-Answer Application using HttpServlet Request and HttpServlet Response interfaces.
7. Develop a Servlet application to accept HTNo. Of a student from client and display the memorandum of marks from the server.
8. JSP Programs
   a. Create a JSP page that prints temperature conversion (fromCelsiustoFahrenheit)chart
   b. Create a JSP page to print current date and time
   c. Create a JSP page to print number of times page is referred after the page is loaded.
9. Write a simple JSP application to demonstrate the use of implicit object (atleast 5).
10. Develop a Hibernate application to Store Feedback of Website Visitors in MySQL Database.
11. Develop the JSP application to accept Registration Details from the user and store in database table.
12. Develop a JSP Application to Authenticate User Login as per the Registration Details. If Login Success then forward User to Index Page otherwise show Login failure Message.
13. Develop a web Application to add items in the inventory using JSF.
14. Write EJB applications using stateless session beans and state-full session beans.
15. Develop a Room Reservation System Application using Entity Beans.
16. Create Three-tire application using Servlets, JSP, EJB.

Paper – VI : Operating Systems Lab

MCS 106P

1. Write shell programs using 'case', 'then' and 'if' & 'else' statements.
2. Write shell programs using while, do-while and for loop statements.
3. Write a program to create a child process using fork(), exec() system calls and use other system calls.
4. Write a program to convert upper case to lower case letters of a given ASCII file.
5. Write a Shell program to check the given number is even or odd.
6. Write a shell program by using a switch case to construct a calculator (add, sub, mul, div).
7. Write a program to simulate UNIX commands like ls, grep, cp.
8. Write a program to demonstrate FCFS and SJF process schedules on the given data.
9. Write a program to demonstrate CPU Priority and Round Robin Scheduling on the given burst time and arrival times.
10. Write a program to simulate Inter Process Communication using pipes.
11. Write a program to implementing Producer and Consumer problem using Semaphores.
12. Write a program to simulate Bankers Algorithm for Dead Lock Avoidance
13. Write a program to simulate Bankers Algorithm Dead Lock Prevention.
14. Write a program to simulate Paging Techniques of memory management.
15. Write a program to simulate FIFO, LRU, LFU Page replacement algorithms.
16. Write a program to simulate Sequential, Indexed, and Linked file allocation strategies.

Note:

- Recommended to use Open Source Software like Fedora, Ubuntu, CentOS etc...
- Recommended to write programs using C/C++ on Linux systems**.**

Semester – II

Paper – I : Programming in Python

CS 201T

Unit – I

Introduction to Python Programming: How a Program Works, Using Python, Why Python, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations (Operators. Type conversions, Expressions), More about Data Output, Indentation.

Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables.

Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops.

Unit – II

Functions: Introduction, Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value -Returning Functions-Generating Random Numbers, Writing Our Own Value-Returning Functions.

Modules-Importing module, creating and exploring modules: math module, Numpy module, time module, random module, OS, calendar, sys., Storing Functions in Modules.

Unit – III

Lists and Tuples: Sequences, Introduction to Lists, List slicing, Finding Items in Lists with the in Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists, Two-Dimensional Lists, Tuples.
Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings.
Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.
Recursion: Introduction, Problem Solving with Recursion, Examples of Recursive Algorithms.

File and Exceptions: Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions.

Unit – IV

OOPs Concept : Introduction to OOP, Classes and objects, Inheritance Method overloading and method overriding, Abstract method and Abstract class, Interfaces in python, Abstract class VS Interfaces, constructor, instance methods ,class methods, static methods.

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Text Book: Tony Gaddis, *Starting Out With Python (4th edition)*

References

1. Kenneth A. Lambert, *Fundamentals of Python*
2. Clinton W. Brownley, *Foundations for Analytics with Python*
3. James Payne, *Beginning Python using Python 2.6 and Python 3*
4. Charles Dierach, *Introduction to Computer Science using Python*
5. Paul Gries, *Practical Programming: An Introduction to Computer Science using Python 3*

Paper – II : Computer Networks

CS 202T

Unit – I

Computer Networks Fundamentals: Overview, Network Hardware, Network Software, Reference models– OSI Model, TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference Model, Example Networks, Network Standardization.

Physical Layer: Guided Transmission Media, Wireless Transmission, Multiplexing, Switching.

Data Link Layer: Design Issues, Error Detection and Correction, Data Link Layer Protocols, Sliding Window Protocol

Unit – II

Multiple Access Sublayer: ALOHA, CSMA, Collision Free Protocols, Ethernet, Wireless LAN-802.11, Data Link Layer Switching –Repeaters, Hubs, Bridges, Switches, Routers, Gateways.

Network Layer: Design Issues, Routing Algorithms – Shortest path, Flooding, Distance Vector Routing, Link state Routing, Hierarchical, Broadcast Routing, Multicast Routing; Congestion Control Algorithms.

Unit – III

Internetworking: Tunneling, Internetwork Routing, Fragmentation, IPv4 Vs IPv6Protocol, IP Addresses, CIDR, Internet Control Protocols–IMCP, ARP, RARP, DHCP.

Transport Layer: Services provided to the upper layers, Transport Protocols, Overview of Congestion Control

.

Unit – IV

The Internet Transport Protocols: Introduction to UDP&RPC, Real Time Transport Protocols, The Internet Transport Protocols–TCP, TCP Service Model, TCP protocol, TCP Segment Header, TCP Connection Establishment, TCP Connection Release, Modeling TCP Connection Management, TCP Sliding Window, TCP Time Management, TCP Congestion Control.

Application Layer: DNS, TELNET, E-Mail, FTP, HTTP, SSH, Overview of WWW.

Text Book: Andrew S. Tanenbaum, David J Wetherall, *Computer Networks (5th edition)*

References

1. William Stallings, *Data and Computer Communications*
2. Behrouz A. Forouzan, *Data Communication and Networking*
3. Behrouz A Forouzan, Firouz Mosharraf, *Computer Networks A Top-Down Approach*

Paper – III : Design and Analysis of Algorithms

CS 203T

Unit – I

Introduction: Algorithm, Fundamentals of Algorithmic Problem Solving, Important Problem Types.
Fundamentals of the Analysis of Algorithm: The Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive & Recursive Algorithms. Brute Force Search: Selection Sort, Bubble Sort, Sequential Search, Brute-Force String Matching, Exhaustive Search, Depth-First Search, Breadth-First Search.

Unit – II

Decrease–&–Conquer: Insertion Sort, Topological Sorting, Binary Search, Interpolation Search
Divide-and-Conquer: Merge Sort, Quick Sort, Multiplication of Large Integers, Strassen's Matrix Multiplication,
Transform-and-Conquer: Presorting, Balanced Search Trees, Heaps and Heap Sort, Problem Reduction. Space
and Time Trade-Offs: Hashing, B-Trees.

Unit – III

Dynamic Programming: Knapsack Problem, Optimal Binary Search Trees, Warshall's and Floyd's Algorithms.
Greedy Technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees and Codes.
Iterative Improvement: Simplex Method, Maximum-Flow Problem.

Unit – IV

Limitations of Algorithm Power: Lower-Bound Arguments, Decision Trees, P, NP, and NP - Complete Problems. Backtracking: n-Queens Problem, Hamiltonian Circuit Problem, Subset- Sum Problem, Branch-and-Bound: Assignment Problem, Knapsack Problem, Traveling Salesman Problem, Approximation Algorithms for the Knapsack Problem.

Text Book: Anany Levitin, *Introduction to the Design and Analysis of Algorithms (3rd edition)*

References

1. Richard Neapolitan, *Foundations of Algorithms*
2. Thomas H. Cormen, *Introduction to Algorithms*
3. E. Horowitz, S. Sahni, *Fundamentals of Computer Algorithms*
4. A.V. Aho, J.V. Hopcroft, J.D. Ullmann, *The Design and Analysis of Computer Algorithms*
5. Donald E Knuth, *The Art of Programming_Volumes–1, 2, 3, 4*

Paper – IV : Automata Theory

CS 204T

Unit – I

Fundamentals – alphabets, strings, languages, problems, graphs, trees, Finite State Systems, definitions, Finite Automaton model, acceptance of strings, and languages, Deterministic finite automaton and Nondeterministic finite automaton, transition diagrams, transition tables, proliferation trees and language recognizers, equivalence of DFA's and NFA's.

Finite Automata with -moves, significance, acceptance of languages, -closure, Equivalence of NFA's with and without - moves, Minimization of finite automata, Two-way finite automata, Finite Automata with output– Moore and Melay machines.

Unit – II

Regular Languages: regular sets, regular expressions, identity rules, constructing finite automata for a given regular expressions, conversion of finite automata to regular expressions. Pumping lemma of regular sets and its applications, closure properties of regular sets.

Grammar Formalism: Regular grammars–right linear and left linear grammars, equivalence between regular linear grammar and finite automata, inter conversion, Context free grammar, derivation trees, sentential forms, right most and leftmost derivation of strings, ambiguity.

Unit – III

Context Free Grammars: Simplification of Context Free Grammars, Chomsky normal form, Greiback normal form, Pumping lemma for context free languages and its applications, closure of properties of CFL (proofs omitted).

Push Down Automata: PDA definition, model, acceptance of CFL, acceptance by final state and acceptance by empty state and its equivalence. Equivalence of PDA's and CFL's, inter-conversion. (Proofs not required).

Unit – IV

Membership Algorithm (CYK Algorithm) for Context Free Grammars.
Turing Machine: TM definition, model, design of TM, computable functions, unrestricted grammars, recursively enumerable languages. Church's hypothesis, counter machine, types of Turing machines (proofs omitted). Linear bounded automata and Context sensitive language.

Computability Theory: Chomsky hierarchy of languages, Introduction to DCFL, DPDA, LR(0) grammar, decidability and undecidable problems. Definitions of P and NP problems, NP complete and NP hard problems.

Text Book: J. E. Hopcroft, J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation (3rd edition)*

References

1. Mishra, Chandrashekaran, *Theory of Computer Science*
2. ZviKohav, Niraj K Jha, *Switching and Finite Automata Theory*
3. Perter Linz, *An Introduction to Formal Languages and Automata*
4. John C. Martin, *Introduction to Languages and the Theory of Computation*

Paper – V : Python Lab

CS 205P

1. Write a program that displays the following information: Your name, Full address, Mobile number, College name, Course subjects.

2. Write a program to find the largest three integers using if-else and conditional operator.

3. Write a program that asks the user to enter a series of positive numbers (The user should enter a negative number to signal the end of the series) and the program should display the numbers in order and their sum.

4. Write a program to find the product and sum of two matrices [A]mxp and [B]pxr using Numpy

5. Write recursive and non-recursive functions for the following:
   a. To find GCD of two integers.
   b. To find the factorial of positive integer
   c. To print Fibonacci Sequence up to given number n

6. Write a program to display two random numbers that are to be added, such as: 247 + 129, the program should allow the student to enter the answer. If the answer is correct, a message of congratulations should be displayed. If the answer is incorrect, a message showing the correct answer should be displayed.

7. Write a function to demonstrate variable length arguments.

8. WAP to Demonstrate about Fundamental Data types(sequential and non-sequential) in Python Programming using type function.

9. Write a program to create file, write the content and display the contents of the file.

10. In a program, write a function that accepts two arguments: a list and a number n. The function displays all of the numbers in the list that are greater than the number n.

11. Write a program with a function that accepts a string as an argument and returns the no. of vowels that the string contains. Another function to return number of consonants.

12. Write a program that opens a specified text file and then displays a list of all the unique words found in the file. (Store each word as an element of a set.)

13. Write a program to analyze the contents of two text files using set operations.

14. Write a program to implement the inheritance and dynamic polymorphism.

15. Write a GUI program that converts Celsius temperatures to Fahrenheit temperatures.

16. Write a GUI program that displays your details when a button is clicked.

Note: Handle the Exceptions raised from File Operations.

Paper –VI : Computer Networks Lab

CS 206P

1. Program to identify the category of the IP address for the given IP address
2. Program to implement sliding window protocol
3. Program for Socket pair system call usage in IPC
4. Program for Socket options using signals
5. Program to implement Echo concurrent Stream Server
6. Program to implement Echo concurrent stream client
7. Program to implement Listener and Talker
8. Program to implement TCP time service
9. Program to implement UDP time service
10. Program to implement Ping service
11. Program to implement Route tracing program
12. Program to implement File Transfer Protocol
13. Program to implement any Shortest path routing Algorithm
14. Program to implement Distance Vector Routing Implementation
15. Program to implement ICMP Error Message simulations
16. Program to implement Reverse Address Resolution Protocol

With effect from the academic year 2023-2024

Department of Mathematics
Osmania University, Hyderabad
M.Sc. Computer Science
Course under Choice Based Credit System

SEMESTER – III

Paper	Code	Paper Title	Hp W	Marks	Credits
I	CS301T	Artificial Intelligence	4	30+70=100	4
II	CS302T	Compiler Design	4	30+70=100	4
III	Elective CS303T(A) CS303T(B) CS303T(C)	Network Security Block chain and Crypto Currency Technologies Big Data Analytics	4	30+70=100	4
IV	Elective CS304T(A) CS304T(B) CS304T(C)	Natural Language Processing Web Mining DEVOPS	4	30+70=100	4
V	CS305P	Artificial Intelligence Lab	4	50	2
VI	CS306P	Compiler Design Lab	4	50	2
		Total	**24**	**500**	**20**

SEMESTER – IV

Paper	Code	Paper Title	HpW	Marks	Credits
I	CS401T	Cloud Computing	4	30+70=100	4
II	CS402T	Data Science with R	4	30+70=100	4
III	Elective CS403T(A) CS403T(B) CS403T(C)	Computer Organization Distributed Systems Machine Learning	4	30+70=100	4
IV	CS404P	Data Science with R Lab	4	50	2
IV	CS405P	Project Work	12	75 + 75= 150	6
		Total	**28**	**500**	**20**

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M.Sc. Computer Science

Semester – III
Paper – I : Artificial Intelligence

CS 301T

Unit – I

Introduction to Artificial Intelligence: introduction, AI techniques, problem solving with AI, AI models, data acquisition and learning aspects in AI.
Problem Solving: problem-solving process, formulating problem, problem types and characteristics, problem analysis and representation, problem space and search, toy problems, real-world problems, problem reduction methods.
Uniformed Search: general search algorithm, uniformed search methods – BFS, uniform cost search, DFS, DLS, IS, bi-directional search, comparison of the uniformed techniques.

Unit – II

Informed Search: generate and test, best first search, greedy search, A* search, memory bounded heuristic search, heuristic function, AO* search, local search algorithms and optimization problems, adversarial search methods (game theory), online search algorithms.
What is an intelligent agent? Types of agent, what is constraint satisfaction problem (CSP), CSP as search problem, local search for CSP, formulating problem structure.
Knowledge and Reasoning: knowledge representation, knowledge-based agents, the wumpus world, logic, propositional logic, predicate logic, unification and lifting: inference in FOL, representing knowledge using rules, semantic networks, frame systems, inference, types of reasoning.

Unit – III

Uncertain Knowledge and Reasoning: uncertainty and methods, Bayesian probability and belief network, probabilistic reasoning, probabilistic reasoning over time, forward and backward reasoning, perception, making simple decisions, making complex decisions, other techniques in uncertainty and reasoning process.
Planning problem, simple planning agent, planning languages, blocks world, goal stack planning, means-ends analysis, planning as a state-space search.
Learning: what is machine learning? Learning paradigms, learning concepts, methods and models, statistical learning methods, artificial neural networks–based learning, support vector machines, reinforcement learning.

Unit – IV

Expert Systems: architecture of expert system, confidence factors, existing expert systems, knowledge acquisition, shell and explanations, self-explaining system, rule-based expert systems, forward and backward chaining, frame-based expert systems, uncertainty management in expert systems, expert system and DSS, pros and cons of expert systems, case study.
Pattern Recognition: machine perception and pattern recognition, feature extraction, classification, object recognition, speech recognition, pattern mining. Game Playing: important concepts of game theory, game playing and knowledge structure, game as search problem, alpha-beta pruning, game theory problems, robotics.
Concepts and terminology of ANN, feed-forward NN, feedback networks, pattern associative networks, Competitive learning, fuzzy sets, fuzzy inference process, neuro-fuzzy systems, range of AI applications, AI applications and examples, case study: agricultural domain – farmer's intelligent assistant.

Text Book: Parag kulkarni, Prachi Joshi, Artificial Intelligence: Building Intelligent Systems

References:

1. Nils J Nilsson, Artificial Intelligence: A New Synthesis
2. Kevin Knight, Elaine Rich, B Nair,Artificial Intelligence
3. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach
4. Eugene Charniak, Drew McDermott, Introduction to Artificial Intelligence
5. Vinod Chandra SS, Anand Hareendran S, Artificial Intelligence and Machine Learning

Paper – II : Compiler Design

CS 302T

Unit – I

Introduction: language processors, phases of a compiler, a model for a compiler front end, syntax-directed translation, parsing, a translator for simple expressions, Lexical Analysis: role of lexical analyzer, input buffering, specification of tokens, Lex lexical analyzer generator, data structures in compilation.

Top-Down Parsing: Introduction, Context free grammars, writing a grammar, recursive-descent parsing, LL(1) grammars, predictive parsing, preprocessing steps required for predictive parsing.

Unit – II

Bottom-Up Parsing: shift reduce parsing, SLR parsing, CLR parsing and LALR parsing, error recovery in parsing, handling ambiguous grammar, parser generator – YACC.

Semantic Analysis: syntax-directed definitions, evaluation order for SDD's, application of SDT.

Unit – III

-Code Generation: syntax trees, three-address code, types and declarations, translation of expressions, type checking. Runtime Environment: storage organization, stack allocation of space, heap management, storage allocation for arrays, strings and records, introduction to garbage collection and trace based collection,

Unit – IV

Code Generation: issues in the design of code generator, target language, addresses in the target code, blocks and flow graphs, optimization of blocks, peephole optimization, register allocation and assignment.

Code Optimization: principal sources of optimization, data flow analysis, constant propagation, partial redundancy elimination, loops in flow graphs.

Text Book : A. V. Aho, Monica S. Lam, Ravi Sethi,J. D. Ullman, Compilers Principles, Techniques, & Tools, (2e)

References

1. Dick Grune, Henry E. Bal, Cariel T. H. Jacobs, Modern Compiler Design
2. Kenneth C. Louden, Compiler Construction Principles and Practice
3. Thomas w. Parsons, Introduction to Compiler Construction
4. Andrew N. Appel, Modern Compiler Implementation in C
5. John R. Levin, Tony Mason, Doug Brown, LEX & YACC
6. Cooper, Linda, Engineering a Compiler

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Paper – III (A) : Network Security

CS 303T(A)

Unit – I

Overview of Network Security: Computer Security Concepts, the OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, a Model for Network Security.
Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography.
Block Ciphers and the Data Encryption Standard: Traditional Block Cipher Structure, the Data Encryption Standard (DES), A DES Example, Strength of DES. Block Cipher Operation: Double DES, Triple DES, Electronic Code Book, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode.

Unit – II

d Encryption Standard (AES): The Origins AES, AES Structure, AES Round Functions, AES Key Expansion, an AES Example AES Implementation. Pseudorandom Number Generation and Stream Ciphers: Principles of Pseudorandom Number Generation, Pseudorandom Number Generators, Pseudorandom Number Generation using Block Cipher, StreamCiphers-RC4. Public-Key Cryptography and RSA: Principles of Public-Key Cryptosystems, the RSA Algorithm.
Key Management and Distribution: Symmetric Key Distribution Using Symmetric Encryption and Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, Diffie-Hellman Key Exchange.

Unit – III

Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Secure Hash Algorithm (SHA) & MD5 Algorithm.
Message Authentication Codes: Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, Security of MACs,
MACs Based on Hash Functions: HMAC,MACs Based on Block Ciphers: DAA and CMAC.
Digital Signatures: Digital Signatures, NIST Digital Signatures Algorithm.

Unit – IV

Transport-Level Security: Web Security Considerations, Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS, Secure Shell (SSH), E-Mail Security: Pretty Good Privacy, S/MIME.
IP Security: IP Security Overview, IP Security Architecture, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange. Intruders, Virus and Firewalls: Intruders, Intrusion Detection, Password Management, Virus and Related Threats, Countermeasures, Firewall Design Principles, Types of Firewalls.

Text Book: William Stallings, Cryptography andNetwork Security – Principles and Practice (6e)

References:

1. Zhenfu Cao, New Directions of Modern Cryptography
2. Douglas R. Stinson, Cryptography Theory and Practices
3. Tom St Denis, Simon Johnson, Cryptography for Developers
4. Joseph Migga Kizza, A Guide to Computer Network Security
5. A. Menezes, P. Van Oorschot, S. Vanstone, Handbook of Applied Cryptography
6. Henk C.A. van Tilborg, Sushil Jajodia, Encyclopedia of Cryptography and Security
7. Keith M. Martin, Everyday Cryptography–Fundamental Principles and Applications

Paper – III (B) : Block chain and Crypto Currency Technologies

CS 303T(B)

Unit- I

Introduction to Cryptography and Crypto currencies: Foundations of Cryptography and security: Ciphers and secret messages, security attacks and services. Mathematical tools for cryptography: substitution techniques, modular arithmetic, Euclid's algorithm, finite fields, polynomial arithmetic. Design Principles of Block Ciphers: Theory of Block Cipher Design, Feistel cipher network structure, DES and Triple DES, modes of operation (ECB, CBC, OFB,CFB), strength of DES.

Unit- II

Block chain Achieves: Decentralization - Centralizations. Decentralization- Distributed consensus, Consensus with - out identity using a block chain, Incentives and proof of work. Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

Unit- III

Mechanics of Bitcoin: Bitcoin transactions, Bitcoin Scripts, Applications of Bitcoin scripts, Bitcoin blocks, The Bit- coin network, Limitations and improvements.
Bitcoin Mining :The task of Bitcoin miners, Mining Hardware, Energy consumption and ecology, Mining pools, Mining incentives and strategies.
Bitcoin and Anonymity: Anonymity s, How to De-anonymize Bitcoin, Mixing, Decentralized Mixing, Zerocoin and Zerocash.

Unit- IV

Community, Politics, and Regulation: Consensus in Bitcoin, Bitcoin Core Software, Stakeholders: Who sin Charge, Roots of Bitcoin, Governments Notice on Bitcoin, Anti Money Laundering Regulation, New York's Bit License Proposal.
Bitcoin as a Platform: Bitcoin as an Append only Log, Bitcoins as Smart Property, Secure Multiparty Lotteries in Bitcoin, Bitcoin as Public Randomness, Source- Prediction, Markets, and Real World Data Feeds.

Text Book:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder, S. (2016). Bitcoin and crypto currency technologies: a comprehensive introduction. Princeton University Press.
2. William Stallings, Cryptography and Network Security, Pearson 2004.

References:

1. Antonopoulos, A. M. (2014). Mastering Bitcoin: unlocking digital cryptocurrencies. OReilly Media, Inc.
2. Franco, P. (2014). Understanding Bitcoin: Cryptography, engineering and economics. John Wiley and Sons.

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Paper – III (C) : Big Data Analytics

CS 303T(C)

Unit – I

Overview of Big Data: What is Big Data? Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics. Exploring the Use of Big Data in Business Context: Use of Big Data in Social Networking, Use of Big Data in Preventing Fraudulent Activities, Use of Big Data in Detecting Fraudulent Activities in Insurance Sector, Use of Big Data in Retail Industry.
Introducing Technologies for Handling Big Data: Distributed and Parallel Computing for Big Data, Introducing Hadoop. Understanding Hadoop Ecosystem: Hadoop Ecosystem, HDFS, Map Reduce, Hadoop YARN, HBase, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie.

Unit – II

Understanding MapReduce Fundamentals and HBase: The MapReduce Framework, Techniques to Optimize MapReduce Jobs, Role of HBase in Big Data Processing. Exploring the Big Data Stack, Virtualization and Big Data, Virtualization Approaches.
Storing Data in Databases and Data Warehouses: RDBMS and Big Data, Non-Relational Database, Integrating Big Data with Traditional Data Warehouses, Big Data Analysis and Data Warehouse, Changing Deployment Models in Big Data Era.

Processing Your Data with MapReduce: Developing Simple MapReduce Application, Points to Consider while Designing MapReduce.
Customizing MapReduce Execution: Controlling MapReduce Execution with InputFormat, Reading Data with Custom RecordReader, Organizing Output Data with OutputFormats, Customizing Data with RecordWriter, Optimizing MapReduce Execution with Combiner, Implementing a MapReduce Program for Sorting Text Data.

Unit – III

Understanding Hadoop YARN Architecture: Introduction YARN, Advantages of YARN, YARN Architecture, Working of YARN.
Exploring Hive: Introducing Hive, Getting Started with Hive, Hive Services, Data Types in Hive, Built-In Functions in Hive, Hive DDL, Data Manipulation in Hive, Data Retrieval Queries, Using JOINS in Hive.
Analyzing Data with Pig: Introducing Pig, Running Pig, Getting Started with Pig Latin, Working with Operators in Pig, Working with Functions in Pig, Debugging Pig, Error Handling in Pig.

Unit – IV

Using Oozie: Introducing Oozie, Installing and Configuring Oozie, Understanding the Oozie Workflow, Simple Application.
NoSQL Data Management: Introduction to NoSQL, Types of NoSQL Data Models, Schema-Less Databases, Materialized Views, Distributed Models, Sharding, MapReduce Partitioning and Combining, Composing MapReduce Calculations.
Understanding Analytics and Big Data: Comparing Reporting and Analysis, Types of Analytics, Developing an Analytic Team. Analytical Approaches and Tools to Analyze Data: Analytical Approaches, History of Analytical Tools, Introducing Analytical Tools, Comparing Various Analytical Tools.

Text Book: DT Editorial Services, Big Data – Black Book (dreamtech)

References:

1. Radha S, M. Vijayalakshmi, Big Data Analytics
2. Arshdeep B and Vijay M, Big Data Science & Analytics – A Hands-On Approach.
3. Frank Ohlhorst, Big Data Fundamentals – Concepts, Drivers, Techniques

Paper – IV (A) : Natural Language Processing

CS 304T(A)

Unit- I

Language Processing and Python: Computing with Language: Texts and Words, A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language Understanding Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet.

Unit- II

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting:From Lists to Strings.

Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation- Based Tagging, How to Determine the Category of a Word.

Unit- III

Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers Deep Learning for NLP: Introduction to Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks, Classifying Text with Deep Learning

Unit- IV

Extracting Information from Text: Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction. Analyzing Sentence Structure: Some Grammatical Dilemmas, What's the Use of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar.
NLP applications: Topic modeling, Text classification, Sentiment analysis,Word sense disambiguation, Speech recognition and speech to text, Text to speech, Language detection and translation.

Text Book:

1. Steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python.OReily, 2009.
2. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Apress, 2019
3. Allen James, Natural Language Understanding, Benjamin/Cumming,1995. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
4. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

25/01/2024

Paper – IV (B) : Web Mining

CS 304T(B)

UNIT – I : Introduction to Web Data Mining and Data Mining Foundations, Introduction – World Wide Web (WWW), A Brief History of the Web and the Internet, Web Data Mining-Data Mining, Web Mining. Data Mining Foundations – Association Rules and Sequential Patterns – Concepts of Association Rules, Apriori Algorithm- Frequent Itemset Generation, Association Rule Generation, Data Formats for Association Rule Mining, Mining with multiple minimum supports – Extended Model, Mining Algorithm, Rule Generation, Mining Class Association Rules, Concepts of Sequential Patterns, Mining Sequential Patterns on GSP, Mining Sequential Patterns on PrefixSpan, Generating Rules from Sequential Patterns.

UNIT – II : Supervised and Unsupervised Learning Supervised Learning – Concepts, Decision Tree Induction – Learning Algorithm, Impurity Function, Handling of Continuous Attributes, Classifier Evaluation, Rule Induction – Sequential Covering, Rule Learning, Classification Based on Associations, Naïve Bayesian Classification , Naive Bayesian Text Classification – Probabilistic Framework, Naive Bayesian Model . Unsupervised Learning – Concepts , K-means Clustering – K-means Algorithm, Representation of Clusters, Hierarchical Clustering – Single link method, Complete link Method, Average link method, Strength and Weakness.

UNIT – III : Information Retrieval and Web Search: Concepts of Information Retrieval, Information Retrieval Methods – Boolean Model, Vector Space Model and Statistical Language Model, Relevance Feedback, Evaluation Measures, Text and Web Page Preprocessing – Stopword Removal, Stemming, Web Page Preprocessing, Duplicate Detection, Inverted Index and Its Compression – Inverted Index, Search using Inverted Index, Index Construction, Index Compression, Latent Semantic Indexing – Singular Value Decomposition, Query and Retrieval, Web Search, Meta Search, Web Spamming.

UNIT – IV : Link Analysis and Web Crawling: Link Analysis – Social Network Analysis, Co-Citation and Bibliographic Coupling, Page Rank Algorithm, HITS Algorithm, Community Discovery-Problem Definition, Bipartite Core Communities, Maximum Flow Communities, Email Communities. Web Crawling – A Crawler Algorithm- Breadth First Crawlers, Preferential Crawlers, Implementation Issues – Fetching, Parsing, Stopword Removal, Link Extraction, Spider Traps, Page Repository, Universal Crawlers, Focused Crawlers, Topical Crawlers, Crawler Ethics and Conflicts.
Sentiment Classification – Classification based on Sentiment Phrases, Classification Using Text Classification Methods.

TEXT BOOK:

- Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by Bing Liu (Springer Publications)

REFERENCES BOOKS:

- Data Mining: Concepts and Techniques, Second Edition Jiawei Han, Micheline Kamber (Elsevier Publications)
- Web Mining:: Applications and Techniques by Anthony Scime
- Mining the Web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti

Paper – IV (C) : DEVOPS

CS 304T(C)

UNIT - I

Introduction: Introduction, Agile development model, DevOps, and ITIL. DevOps process and Continuous Delivery, Release management, Scrum, Kanban, delivery pipeline, bottlenecks, examples.

Software development models and DevOps: DevOps Lifecycle for Business Agility, DevOps, and Continuous Testing.

UNIT - II

DevOps influence on Architecture: Introducing software architecture, The monolithic scenario, Architecture rules of thumb, The separation of concerns, Handling database migrations, Microservices, and the data tier, DevOps, architecture, and resilience.

Introduction to project management: The need for source code control, The history of source code management, Roles and code, source code management system and migrations, Shared authentication, Hosted Git servers, Different Git server implementations, Docker intermission, Gerrit, The pull request model, GitLab.

UNIT - III

Integrating the system: Build systems, Jenkins build server, Managing build dependencies, Jenkins plugins, and file system layout, The host server, Build slaves, Software on the host, Triggers, Job chaining and build pipelines, Build servers and infrastructure as code, Building by dependency order, Build phases, Alternative build servers, Collating quality measures.

UNIT - IV

Testing Tools and automation: Various types of testing, Automation of testing Pros and cons, Selenium - Introduction, Selenium features, JavaScript testing, Testing backend integration points, Test-driven development, REPL-driven development

Deployment of the system: Deployment systems, Virtualization stacks, code execution at the client, Puppet master and agents, Ansible, Deployment tools: Chef, Salt Stack and Docker

Text Books:

1. Joakim Verona. Practical Devops, Second Edition. Ingram short title; 2nd edition (2018). ISBN-10: 1788392574

2. Deepak Gaikwad, Viral Thakkar. DevOps Tools from Practitioner's Viewpoint. Wiley publications. ISBN: 9788126579952

REFERENCE BOOK:

1. Len Bass, Ingo Weber, Liming Zhu. DevOps: A Software Architect's Perspective. Addison Wesley; ISBN-10.

25/01/2024

Paper – V: Artificial Intelligence Lab

CS305P

1 a) Program to print multiplication table for given no.

b) Program to check whether the given no is prime or not.

c) Program to find factorial of the given no and similar programs.

2 Write a program to implement List Operations(Nested list, Length, Concatenation, Membership ,Iteration ,Indexing and Slicing), List Methods(Add, Append, Extend & Delete)

3 Write a program to Illustrate Different Set Operations.

4 Write a program to implement Simple Chatbot.

5 Write a program to implement Breadth First Search Traversal.

6 Write a program to implement Depth First Search Traversal.

7 Write a program to implement Water Jug Problem.

8. Write a Program to Implement Tic-Tac-Toe game using Python.

9. Write a program to implement K -Nearest Neighbor algorithm.

10. Write a Program to Implement 8-Puzzle problem using Python.

11. Write a Program to Implement Travelling Salesman Problem using Python.

12. Write a program to implement Regression algorithm.

13. Write a program to implement Random Forest Algorithm.

14. Write a Program to Implement Tower of Hanoi using Python.

15. Write a Program to Implement Monkey Banana Problem using Python.

16. Write a Program to Implement Alpha-Beta Pruning using Python.

17. Write a Program to Implement 8-Queens Problem using Python.

Paper – III(A): Computer Organization

CS 403T(A)

Unit- I

Digital Logic Circuits: Digital Computers, Logic Gates, Boolean algebra, Map Simplification, Combinational Circuits, Flip-Flops, Sequential Circuits.
Digital Components: Integrated Circuits, Decoders, Multiplexers, Registers, Shift Registers, Binary Counters, Memory Unit.
Data Representation: Data Types, Complements, Fixed Point Representations, Floating Point Representation, Binary Codes, and Error Detection Codes.

Unit- II

Register Transfer and Micro operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, and Shift Micro operations.

Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input - Output and Interrupt, Design of Accumulator Logic.

Unit- III

Programming the Computer: Machine Language, Assembly Language, The Assembler Program Loops, Programming Arithmetic and Logic Operations, Subroutines, Input - Output Programming.
Central Processing Unit: Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer.
Computer Arithmetic: Addition and Subtraction, Multiplication Algorithms, Division Algorithms, and Floating Point Arithmetic Operations, Decimal Arithmetic Unit, Decimal Arithmetic Operations.

Unit- IV

Input - Output Organization: Peripheral Devices, Input - Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, Direct Memory Access (DMA), Input - Output Processor, Serial Communication. Pipeline and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipelines, Instruction Pipelines and RISC Pipelines, Vector Processing.

Text Book:

Computer System Architecture (3e) by M.MorrisMano.

References:

1. Andrew S.Tanenbaum, Structured Computer Organization.
2. William Stallings, Computer Organization and Architecture.
3. ZviKohavi, NirajK.Jha, Switching and Finite Automata Theory.

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Paper – III(B): Distributed Systems

CS 403T(B)

Unit – I

Introduction: definition of a distributed system, goals, types of distributed systems.
Architectures: architectural styles, system architectures, architectures versus middleware, self-management in distributed systems.
Processes: threads, virtualization, clients, servers, code migration.

Unit – II

Communication: Remote Procedure Call, Message-Oriented Communication, Stream-Oriented Communication, Multicast Communication.
Naming: names, identifiers, and addresses, flat naming, structured naming, attribute based naming.
Synchronization: clock synchronization, logical clocks, mutual exclusion, global positioning of nodes, election algorithms.

Unit – III

Consistency and Replication: introduction, data-centric consistency models, client-centric consistency models, replica management, consistency protocols.
Fault Tolerance: introduction, process resilience, reliable client server communication, reliable group communication, distributed commit, recovery.
Security: introduction, secure channels, access control, security management.

Unit – IV

Distributed Object–Based Systems: architecture, processes, communication, naming, synchronization, consistency and replication, fault tolerance, security.
Distributed File Systems: architecture, process, communication, naming, synchronization, consistency and replication, fault tolerance, security.
Distributed Web based Systems: architecture, process, communication, naming, synchronization, consistency and replication, fault tolerance, security.

Text Book: Andrew S.Tanenbaum, Maarten Van Steen, Distributed Systems – Principles and Paradigms (2e)

References:

1. Sukumar Ghosh,Distributed Systems An Algorithmic Approach
2. Joel M. Crichlow, Distributed Systems Computing Over Networks
3. Kai Hwang, Distributed and Cloud Computing From Parallel Processing to Internet of Things
4. Ajay D. Kshemkalyani, Mukesh Singhal, Distributed Computing Principles, Algorithms, and Systems
5. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair,Distributed Systems Concepts and Design

Paper – II: Data Science with R

CS 402T

Unit- I

Data Science: Introduction to Data Science – Digital Universe – Sources of Data – Information Commons – Data Science Project Life Cycle: OSEMN Framework

Data Preprocessing: Introduction to Data Preprocessing – Reading, Selecting, Filtering Data – Filtering Missing Values – Manipulating, Sorting, Grouping, Rearranging, Ranking Data.

Unit- II

Concept Learning: Formulation of Hypothesis – Probabilistic Approximately Correct Learning – VC Dimension –Hypothesis elimination – Candidate Elimination Algorithm

Essentials Of R: R s - data types and objects - control structures – data frame -Feature Engineering - scaling, Label Encoding and One Hot Encoding, Reduction.

Unit- III

Model Fit Using R:Regression Models- Linear and Logistic Model, Classification Models – Decision Tree, Na¨ıve Bayes, SVM and Random Forest, Clustering Models – K Means and Hierarchical clustering.

Visualization: Data visualization: Box plot, histogram, scatter plot, heat map –Working with Tableau – Outlier detection – Data Balancing.

Unit- IV

Performance Evaluation: Loss Function and Error: Mean Squared Error, Root Mean Squared Error – Model Selection and Evaluation criteria: Accuracy, Precision, F1 score, Recall Score – Binary Predictive Classification –Sensitivity – Specificity. Recent Trends And Challenges In Data Science.

Text Book:

. Introduction to Machine Learning by Ethem Alpaydin, Fourth Edition, MIT Press, 2020.

. Hadley Wickham, Garrett Grolemund, R for data science : Import, Tidy, Transform, Visualize, And Model Data Paperback, 2017.

References:

1. Han, J., Kamber, M., Pei, J. Data mining concepts and techniques. Morgan Kaufmann. 2011.

2. Carl Shan, Henry Wang, William Chen, Max Song. The Data Science Handbook: Advice and Insight from 25 Amazing Data Scientists. The Data Science Bookshelf. 2016.

3. James, G., Witten, D., T., Tibshirani, R. An Introduction to statistical learning with applications in R. Springer. 2013.

certifications, cloud audit framework, cloud auditing requirements.Application Security in the Cloud: cloud application SDLC, cloud service reports by providers, application security in IaaS, PaaS and SaaS environments. Mobile Cloud Computing (MCC):architecture of MCC, benefits of MCC, MCC challenges.

Text Book: Kailash J, Jagannath K, Donald J H, Deven Shah.Cloud Computing – Black Book

References:

1. Rajkumar Buyya, Cloud Computing: Principles and Paradigms
2. Arshdeep Bahga, Vijay Madisetti, Cloud Computing – A Hands-On Approach
3. David E.Y. Sarna, Implementing and Developing Cloud Computing Applications
4. Kai Hwang, Distributed and Cloud Computing From Parallel Processing to Internet of Things

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Paper – VI: Compiler Design Lab

CS306P

1. Write a program to design token separator for the given expression.
2. Write a program to implement a symbol table.
3. Write a program to develop a lexical analyzer to recognize a few patterns.
4. Write a program to develop a lexical analyzer using Lex tool.
5. Write a program to recognize a valid arithmetic expression using YACC.
6. Write a program to recognize a valid variable name using YACC.
7. Write a program to implement calculator using Lex and YACC.
8. Write a program for implementing type checking for given expression.
9. Write a program to convert the BNF rules into YACC.
10. Write a program to implement data flow and control flow analysis.
11. Write a program to implement stack storage allocation strategies.
12. Write a program to implement heap storage allocation strategies.
13. Write a program to construct a directed acyclic graph (DAG).
14. Write a program to implement the back end of the compiler.
15. Write a program to implement simple code optimization technique.
16. Write a program to implement simple code optimization technique using do-while.

Note:

- Recommended to use the C/LEX/YACC on Linux systems

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M.Sc. Computer Science

Semester – IV
Paper – I : Cloud Computing

CS 401T

Unit – I

Era of Cloud Computing (CC): introduction, cloud and other similar configurations, CC vs. peer-to-peer architecture, CC vs. client-server architecture, CC vs. GC, components of CC, impact of CC on businesses.

Introduction Virtualization: Introduction, virtualization benefits, implementation levels of virtualization, virtualization at the OS level, virtualization structure, open source virtualization technology, Xen virtualization architecture, binary translation with full virtualization, para-virtualization with compiler support, virtualization of CPU, memory, I/O devices, hardware support for virtualization, virtualization in multicore processors.

Cloud Computing Services: IaaS, PaaS, leveraging PaaS for productivity, guidelines for selecting a PaaS provider, concerns with PaaS, languages and PaaS, SaaS, DBaaS.Cloud Computing and Business Value: key drivers for CC, CC and outsourcing, types of scalability, use of load balancers to enhance scalability, variable operating costs using CC, time-to-market benefits of CC, distribution over the internet, levels of business values from CC.

Cloud Types and Models: private cloud, public cloud, hybrid cloud.

Unit – II

Open Source Cloud Implementation and Administration: Eucalyptus& OpenSatck cloud architectures, CSB (158) Recent Trends in Cloud Computing and Standards: conflicts of interest for public cloud and IT product providers, BYOD and encryption exposures, cloud standards, cloud ratings, CC trends that are accelerating adoption.

Host Security in the Cloud: security for virtualization products, host security for SaaS, PaaS, IaaS.

Data Security in the Cloud: challenges with cloud data and data security, data confidentiality and encryption, data availability, data integrity, CSGs. Cloud application requirements,SOA for cloud applications.

Unit – III

Adoption and Use of Cloud by Small and Medium Businesses: place of adoption, benefits, adoption phases, vendor roles and responsibilities, selection phases, provider liability, provider capabilities, success factors for CC Adoption process of public clouds by enterprises.Cloud migration techniques, Phases during the migration of an application to the cloud.IT Service Management for Cloud Computing: ITIL based service management, service strategy, service design, service transition, service operations, continual service improvement.

SLA with Cloud Service Providers: concept, aspects and requirements of SLA, credit calculation, samples 1 and 3.

Risks, Consequences, and Costs for Cloud Computing: introduction, risk assessment and management, risk of vendor lock-in, loss of control, not meeting regulatory compliances, resource scarcity, multitenant environment, failure, inadequate SLA, malware and internet attacks, management of cloud resources, network outages, in fracture, legal, licensing, TCO, cloud costs, cost allocations, chargeback models and methodology, billable items.

Unit – IV

AAA Administration for Cloud: AAA model, single sign0on for clouds, industry implementation for AAA, authentication management in the cloud, SAML, authentication for resource utilization.

Security as a Service: benefits of security as a service, concerns with security as a service, security service providers, IdMaaS, attributes of IdMaaS providers.Cloud Certifications and Audits:

Paper – III(C): Machine Learning

CS 403T(C)

Unit-I

Overview and Introduction to Bayes Decision Theory: Machine intelligence and applications, pattern recognition concepts classification, regression, feature selection, supervised learning class conditional probability distributions, Examples of classifiers bayes optimal classifier and error, learning classification approaches.
Linear machines: General and linear discriminants, decision regions, single layer neural network, linear separability, general gradient descent, perceptron learning algorithm, mean square criterion and widrow-Hoff learning algorithm; multi-Layer perceptrons: two-layers universal approximators, backpropagation learning, on-line, off-line error surface, important parameters.

Unit-II
Learning decision trees: Inference model, general domains, symbolic decision trees, consistency, learning trees from training examples entropy, mutual information, ID3 algorithm criterion, C4.5 algorithm continuous test nodes, confidence, pruning, learning with incomplete data.
Instance-based Learning: Nearest neighbor classification, k-nearest neighbor, nearest neighbor error probability.

Unit-III
Machine learning concepts and limitations: Learning theory, formal model of the learnable, sample complexity, learning in zero-bayes and realizable case, VC-dimension, fundamental algorithm independent concepts, hypothesis class, target class, inductive bias, occam's razor, empirical risk, limitations of inference machines, approximation and estimation errors, Tradeoff.
Machine learning assessment and Improvement: Statistical model selection, structural risk minimization, bootstrapping, bagging, boosting.

Unit-IV
Support Vector Machines: Margin of a classifier, dual perceptron algorithm, learning nonlinear hypotheses with perceptron kernel functions, implicit non-linear feature space, theory, zero-Bayes, realizable infinite hypothesis class, finite covering, margin-based bounds on risk, maximal margin classifier.

Text Book:
1. E. Alpaydin, **Introduction to Machine Learning**, Prentice Hall of India, 2006.
2. T. M. Mitchell, **Machine Learning**, McGraw-Hill, 1997.

References:
1.. C. M. Bishop, **Pattern Recognition and Machine Learning**, Springer, 2006.
2. R. O. Duda, P. E. Hart, and D.G. Stork, **Pattern Classification**, John Wiley and Sons, 2001.
3. Vladimir N. Vapnik, **Statistical Learning Theory**, John Wiley and Sons, 1998.
4. J. Shawe-Taylor and N. Cristianini, Cambridge, **Introduction to Support Vector Machines**, University Press, 2000.

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Paper – IV: Data Science with R Lab

CS 404P

I. Download and install R-Programming environment and install packages using install.packages() command in R.

II. Learn all the basics of R-Programming (Data types, Variables, Operators, Loops, Conditional Statements etc,.), Write R Scripts to demonstrate the same.

1. a) Perform some arithmetic and logical operations in R.
   b) Write a program to find list of even numbers from 1 to n using R-Loops.
2. a) Write a program to join columns and rows in a data frame using cbind() and rbind() in R.
   b) Implement different String Manipulation functions in R.
3. a) Implement different data structures in R (Vectors, Lists, Data Frames)
   b) Write a program to read a csv file and analyze the data in the file in R
4. a) Create pie chart and bar chart using R.
   b) Create a data set and do statistical analysis on the data using R
5. Demonstrate the process of creating a user defined function in R.
6. a) Write an R script to change the structure of a Data frame.
   b) Write an R script to expand a data frame.
7. a) Write an R script to convert a vector to factors.
   b) Write an R script to demonstrate R objects.
8. Demonstrate the following aggregate functions in R: sum, mean, count, min, max.
9. Write an R script to read and write different files.
10. a) Write an R script to find subset of a dataset.
    b) Elucidate the process of data exploration in R using read(),summary(),nrow(),ncol(),str().
11. a) Write an R script to handle missing values in a dataset.
    b) Write an R script to handle outliers.
    c) Write an R script to handle invalid values.
12. a) Visualize iris dataset using mosaic plot.
    b) Visualize correlation between sepal length and petal length in iris data set using scatter plot.
13. Linear Regression: Consider the following mice data:
Height:140,142,150,147,139,152,154,135,148, 147.
Weight: 59, 61, 66, 62, 57, 68, 69, 58, 63, 62.
Derive relationship coefficients and summary for the above data.
14. Consider the above data and predict the weight of a mouse for a given height and plot the results using a graph.
15. Perform Logistic Regression analysis on the above mice data(Sl.No.13) and plot the results.
16. Time Series: Write R script to decompose time series data Into random, trend and seasonal data.

CS 405P

Paper – V: Project Work

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