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.

M. Sc. 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. Mathematics

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.

M. Sc. 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. Mathematics

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. Applied Mathematics Syllabus

Semester – I & II

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(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

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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

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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.
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(Page No. 179 to 211).

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Unique factorization domains - Principal ideal domains - Euclidean domains - Polynomial rings over UFD - Rings of Fractions.
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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)

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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.

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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.
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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

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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.

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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. 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.
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Text Book:

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

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3. **Abstract Algebra** by Jeffrey Bergen.
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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.
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Sequences and Series of Functions: Uniform convergence - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation – The Stone-Weierstrass theorem.
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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.

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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.

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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.

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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.

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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.

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.

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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

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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.
