Gondwana University, Gadchiroli

Syllabus

for

Master of Science (M.Sc.) Mathematics

Sem - III and IV Based on NEP-2020

(With effect from Academic Year 2024-25)

Board of Studies in Mathematics

Faculty: Science and Technology

Semester III for M.Sc. Program in Mathematics												
Course	Teaching Scheme (Hours/ Week)			Credits			Examination Scheme					
	Theory	Practical	Total	Theory	Internal Assessment	Total	Duration in Hrs.	Maximum Marks				Minimun Passing marks
								External assessment Theory	External assessment Practical	Internal assessment	Total Marks	External assessment + Internal assessment
Major 1	4	— —	4	4	— —	4	3	80	— —	20	100	40
Major 2	4	— —	4	4	— —	4	3	80	— —	20	100	40
Major 3	4	— —	4	4	— —	4	3	80	— —	20	100	40
Elective	4	— —	4	4	— —	4	3	80	— —	20	100	40
Research Project	4	— —	4	4	— —	4	3	80	— —	20	100	40

Semester IV for M.Sc. Program in Mathematics												
Course	Teaching Scheme (Hours/ Week)			Credits			Examination Scheme					
	Theory	Practical	Total	Theory	Internal Assessment	Total	Duration in Hrs.	Maximum Marks				Minimun Passing marks
								External assessment Theory	External assessment Practical	Internal assessment	Total Marks	External assessment + Internal assessment
Major 1	4	— —	4	4	— —	4	3	80	— —	20	100	40
Major 2	4	— —	4	4	— —	4	3	80	— —	20	100	40
Major 3	2	— —	2	2	— —	2	3	80	— —	20	100	40
Elective	4	— —	4	4	— —	4	3	80	— —	20	100	40
Research Project	6	— —	6	6	— —	6	3	80	— —	20	100	40

Guidelines about Internal Assessment for Semester III and IV:

The internal assessment marks shall be awarded by the concerned teacher. The internal assessment marks shall be sent to the University.

In case, the candidate fails in Theory Examination, the Internal Assessment marks will be carried forward for his next supplementary Examination.

There shall be no separate / extra allotment of work load to the teacher concerned. He/ She shall conduct the internal assessment activity during the regular teaching days / periods as a part of regular teaching activity.

The concerned teacher / department / college shall have to keep the record of all the internal assessment activities until six months after the declaration of the results of that semester.

Distribution of marks for Continuous Internal Assessment

Sr. No.	Activities	Max. Marks
1	Attendance	5
2	Home Assignment	5
3	Unit Test	10

Total Marks - 20

Minimum Passing Marks -08

University Question Paper Pattern

A student of M. Sc. Sem-III and Sem-IV in Mathematics has to attempt all five questions in each paper.

Q1 to Q4 are long answer questions with internal choice within unit, whereas Q5 is compulsory question of short answers on all four units. Setting of the question paper is as under:

Total Marks: 80			**Time 3 Hours**
Q 1	(A)	Unit I	08 Marks
	(B)	Unit I	08 Marks
	OR		
	(C)	Unit I	08 Marks
	(D)	Unit I	08 Marks
Q 2	(A)	Unit II	08 Marks
	(B)	Unit II	08 Marks
	OR		
	(C)	Unit II	08 Marks
	(D)	Unit II	08 Marks
Q 3	(A)	Unit III	08 Marks
	(B)	Unit III	08 Marks
	OR		
	(C)	Unit III	08 Marks
	(D)	Unit III	08 Marks
Q 4	(A)	Unit IV	08 Marks
	(B)	Unit IV	08 Marks
	OR		
	(C)	Unit IV	08 Marks
	(D)	Unit IV	08 Marks
Q 5	(A)	Unit I	04 Marks
	(B)	Unit II	04 Marks
	(C)	Unit III	04 Marks
	(D)	Unit IV	04 Marks

2 year PG Program structure under NEP-2020 to be implemented from Academic year 2024-25

	Sem - III	Sem - IV
Major (Mandatory) 4 or 2 credits per course	4 x 3	4 x 2 + 2
Elective (Any one) 4 credits per course	4 x 1	4 x 1
Research Project	4 x 1	6 x 1
Total Credits	**20**	**20**

Basket for the 2 year PG Program under NEP-2020

	Sem - III	Sem - IV
Major (Mandatory)	• Complex Analysis • Partial Differential Equations • Mathematical Methods	• Dynamical Systems • Functional Analysis • Mathematical Modelling
Elective (Any one)	• Advanced Topics in Operations Research • Fluid Dynamics - I • General Relativity • Commutative Algebra • Lattice Theory • Business Mathematics • MATLAB Programming	• Integral Equations • Fluid Dynamics - II • Cosmology • Representation Theory of the Symmetric Group • Matroid Theory • Python Programming • Algebraic Number Theory
Research Project	• Research Project	• Research Project

Note:

1. Mathematical Modelling is a 2 credit Course.
2. Teachers may use relevant software's, if required for teaching contents of a course.
3. Term end Theory examination of 80 marks and 20 marks internal assessment shall be conducted for those courses which have theory and practical components.

SEMESTER-III

Complex Analysis

UNIT-I

The real numbers, the field of complex Numbers, the Complex plane, Polar representation and roots of complex numbers, Lines and half planes the complex plane, The Extended complex plane and stereographic projection. Elementary properties and examples of analytic Functions: Power series, analytic functions.

UNIT-II

Analytic functions as mappings, Mobius transformations. Power series representation of analytic functions, zeros of an analytic function, index of a closed curve.

UNIT-III

Cauchy's theorem and integral formula, the homotopic version of cauchy's theorem and simple connectivity, counting zeros; the open mapping theorem, Goursat's theorem, Classification of singularities, residues, the argument principle.

UNIT-IV

Unit 4: The maximum principle. Schwarz's lemma. convex functions and Hadamards three circles theorem. Phragmen-Lindelof theorem.

Text Book:

Functions of one complex variable: John B. Conway, Second edition, Springer international Student Edition.

Reference Books:

1. Complex Analysis, L.V. Ahlfors. Mc-Graw Hill, 1966.
2. Complex Variables and Applications (Ninth edition): R. V. Churchill and J. W. Brown, Mc Graw Hill Publication.

Partial Differential Equations

UNIT-I

First order Partial Differential Equations :

Curves and Surfaces, Genesis of First Order P.D.E, Classification of Integrals, Linear Equations of First Order, Pfaffian Differential Equations, Compatible Systems, Charpit's Method , Jacobi Method.

UNIT-II

Integral Surfaces Through a Given Curve, Quasi-Linear Equations, Non-linear First Order Partial Differential Equations.

UNIT-III

Second order Partial Differential Equations :

Genesis of Second Order Partial Differential Equations, Classification of Second Order Partial Differential Equations, One Dimensional Wave Equations.

UNIT-IV

Laplace's Equation, Heat Conduction Problem, Duhamel's Principle, Classification in the Case of n variables, Families of Equipotential Surfaces.

Text Book:

An Elementary Course in Partial Differential Equations (Second Edition): T. Amarnath, Narosa Publishing House.

Reference Books:

1.Partial Differential Equations: Phoolan Prasad and Renuka Ravindran; New Age International (P) Limited.

2. Elements of Partial Differential Equations: I. N. Sneddon, McGraw Hill Book Company

Mathematical Methods

UNIT-I

Fourier Transform: Introduction, Classes of functions, Fourier series and Fourier Integral Formula, Fourier Transforms, Linearity property of Fourier Transforms, Change of Scale property, The Modulation theorem, Evaluation of integrals by means of inversion theorems, Fourier Transform of some particular functions, Convolution or Faltung of two integrable functions, Convolution or Falting or Faltung Theorem for FT, Parseval's relations for Fourier Transforms, Fourier Transform of the derivative of a function, Fourier Transform of some more useful functions, Fourier Transforms of Rational Functions, Other important examples concerning derivative of FT.

UNIT-II

Finite Fourier Transform: Introduction, Finite Fourier cosine and sine Transform, Relation between Finite Fourier Transform of the derivatives of a function, Faltung or convolution theorems for Finite Fourier Transform, Multiple Finite Fourier Transform, Double Transforms of partial derivatives of functions, Application of finite Fourier Fourier Transforms to boundary value problems.

UNIT-III

The Laplace Transform: Introduction, Definitions, Sufficient conditions for existence of Laplace Transform, Linearity property of Laplace Transform, Laplace Transforms of some elementary functions, First shift theorem, Second shift theorem, The change of scale property, Examples, Laplace Transform of derivatives of a function, Laplace Transform of integral of a function, Laplace Transform of $t^n f(t)$, Laplace Transform of $f(t)/t$, Laplace Transform of a periodic function, The initial value theorem and the final value theorem of Laplace Transform, Examples, Laplace Transform of some special functions, The Convolution of two functions, Applications, The inverse Laplace Transform and Application: Introduction, Calculation of Laplace inversion of some elementary functions, Method of expansion into partial functions of the ratio of two polynomials, The general evaluation technique of inverse Laplace Transform.

UNIT-IV

Hankel Transforms: Introduction, The Hankel Transform, Elementary properties, Inversion formula for Hankel Transform, The Parseval Relation for Hankel Transforms, Illustrative Examples, The Mellin Transform: Introduction, Definition of Mellin Transform, Mellin Transform of derivative of a function, Mellin Transform of Integral of a function, Convolution theorem of Mellin Transform, Illustrated solved Examples.

Text Book:

An Introduction to Integral Transforms (First Edition): Baidyanath Patra, CRC Press Taylor Francis Group, 2018.

Scope:

Unit I - Chapter 1 (1.1 to 1.16 with Exercices)

Unit II - Chapter 2 (2.1 to 2.7 with Exercices)

Unit III - Chapter 3 (3.1 to 3.19 with Exercices) and Chapter 4(4.1 to 4.4 with Exercises)

Unit IV - Chapter 6 (6.1 to 6.6 with Exercices) and Chapter 8(8.1 to 8.7 with Exercises)

Reference Books:

1. The Use of Integral Transforms: I N. Sneddon, Tata McGraw Hill Publishing Company Ltd.
2. Modern Mathematics for Engineers: Edwin F Beckenbach, Second series, McGraw Hill Book Company.

Advanced Topics in Operations Research

UNIT-I
Integer programming.

UNIT-II
Goal Programming, Linear Programming Problem - Advanced Techniques.

UNIT-III
Sequencing Problem, Queueing Theory.

UNIT-IV
Non - Linear Programming, Non - Linear Programming Methods.

Text Book:
Operations Research: Kanti-Swarup, P.K. Gupta and Man Mohan, Sultan Chand and Sons, New Delhi.

Scope:
Unit I - Chapter 7, Unit II - Chapter 8 and 9, Unit III - Chapter 12 and 21, Unit IV - Chapter 27 and 28

Reference Books:
1. Linear Programming: G. Hadley, Narosa Publishing House,1995.
2. Introduction to Operations Research (Sixth Edition): F. S. Hillier and G. J. Lieberman, Mc Graw Hill International Edition, 1995.
3. Operations Research – In Introduction: H.A Taha, Macmillan publishing company Inc., New York

Fluid Dynamics-I

UNIT-I

Real Fluids and Ideal Fluids, Velocity of a Fluid at a Point, Stream Lines and Path Lines, Steady and Unsteady Flows, Velocity Potential, Vorticity Vector, Local and Particle Rates of Change, The Equation of Continuity, Worked Examples, Acceleration of a Fluid, Condition at a Rigid Boundary, General Analysis of Fluid Motion, Euler's Equation of Motion, Bernoulli's Equation, Worked Examples, Discussion of the Case of Steady Motion Under Conservative Body Forces, Some Further Aspects of Vortex Motion.

UNIT-II

Sources, Sinks and Doublets, Images in a Rigid Infinite Plane, Images in Solid Spheres, Axisymmetric Flows, Stokes' Stream Function. The Complex Potential for Two-Dimensional Irrotational, Incompressible Flow, Complex Velocity Potential for Standard Two Dimensional Flows, Uniform Stream, Line Source and Line Sinks, Line Doublets, Line Vortices, Some Worked Examples, Two Dimensional Image Systems, The Milne-Thomson Circle Theorem, Some applications of Circle Theorem, Extension of the Circle Theorem, The Theorem of Blasius.

UNIT-III

The Equations of State of a Substance, The First Law of Thermodynamics, Internal Energy of a Gas, Functions of State, Entropy, Maxwell's Thermodynamic Relations, Isothermal Adiabatic and Isentropic Processes, Compressibility Effects in Real Fluids, The Elements of Wave Motion, One Dimensional Wave Equation, Wave Equation in Two and Three Dimensions, Spherical Waves, Progressive and Stationary Waves.

UNIT-IV

The Speed of Sound in a Gas, Equation of Motion of a Gas, Subsonic, Sonic, Supersonic Flows, Isentropic Gas Flow, Reservoir Discharge Through a Channel of Varying Section, Investigation of Maximum Mass Flow through a Nozzle, Shock Waves, Formation of Shock Waves, Elementary Analysis of Normal Shock Waves.

Text Book:

Textbook of Fluid Dynamics: F. Chorlton, CBS Publishers, Delhi, 1985.

Reference Books:

1. An Introduction to Fluid Mechanics: G. K. Batchelor, Foundation Books, New Delhi, 1994.
2. Fluid Mechanics: M. D. Raisinghania, S. Chand and Company, Delhi.

General Relativity

UNIT-I

Tensor Algebra: Introduction, Transformation of Coordinate, Tensors, The quotient law or test for Tensor character, Riemannian geometry: Riemannian metric, Christoffel symbols, Derivatives of Tensors, Parallel vector Fields, Geodesic, Special Coordinate System, Curvature Tensor: Curvature Tensor, Properties of curvature Tensor, Ricci Tensor and Einstein Tensor, Geodesic derivation, Riemannian curvature.

UNIT-II

General Theory of Relativity: Introduction, The principle of covariance, The principle of equivalence, Mach principle, The field corresponding to Special Relativity, Useful computational aid, Energy Momentum Tensor, Energy Momentum Tensor T^{mn} for perfect fluid, Energy Momentum Tensor for electromagnetic field, Einstein field equation, Motion of a particle in gravitational filed (Geodesic rule), Einstein field equations from action principle, Newton's theory as first approximation.

UNIT-III

Schwarzschild Space - Time: Introduction, Schwarzschild exterior solution, Schwarzschild singularity, Schwarzschild solution in isotropic coordinates, Equation of planetary orbits, Classical test of general relativity, Advance of perihelion of mercury, Bending of light rays, Gravitational redshift or shift in spectral lines, Schwarzschild interior solution (simple model of star).

UNIT-IV

Linearized Field equations: Linearization of the field equations, The time independent and spherically symmetric field, The Weyl's solution to the linearized Field equations, Structure of Linearized equations, Gravitational waves.

Text Books:

1. Lectures on General Theory of Relativity: T. M. Karade and G. S. Khadekar and Maya S. Bendre, Pub. SONU NILU (Unit I- Chapter1,2 ,3, Unit II- Chapter 5, Unit III - Chapter 6)
2. Introduction to General Relativity: Ronald Adler, Maurice Bezin and Manamen Schiffer, McGraw-Hill Kogakusha Ltd.(Unit IV- Chapter 9)

References Books:

1. Introduction to Theory of Relativity: Rosser W.G.V., ELBS, 1972.
2. Relativity Special: General and Cosmology: Rindler W., Pub. Oxford University Press, 2003.
3. The Classical Theory of Fields: L. D. Landau, and E. M. Lifshitz, Pub. Pergamon Press, 1978.

Commutative Algebra

UNIT-I
Rings and ring homomorphisms, Ideals, Quotient rings, Zero divisors, Nilpotent elements, Units, Prime ideals and Maximal ideals, Nil radical and Jacobson radical, Operations on ideals, Extension and contraction.

UNIT-II
Modules and module homomorphisms, Sub modules and Quotient modules, Operations on sub modules, Direct sum and product, Finitely generated modules, Exact sequences, Tensor product of modules, Restriction and extension of scalars, Exactness properties of the tensor product, Algebras, Tensor product of algebras.

UNIT-III
Local properties, Extended and contracted ideals in ring of fractions, Primary Decomposition. Integral dependence, The going-up theorem, Integrally closed integral domains, The going- down theorem, Chain conditions.

UNIT-IV
Primary decomposition in Noetherian rings, Artin rings, Discrete valuation rings, Dedekind domains, Fractional ideals.

Text Book:
Introduction to Commutative Algebra: M. F. Atiyah and I. G. Macdonald, Addison-Wesley Publishing Company.

Scope:
Chapter 1 to Chapter 9.

Reference Books:
1. Commutative Ring Theory: H. Matsumura, Cambridge University Press.
2. Commutative Algebra: N. S. Gopalakrishnan.
3. Abstract Algebra (Second Edition): D. S. Dummite and R. M. Foote, John Wiley & Sons.

Lattice Theory

UNIT-I
Two Definitions of Lattices, How to Describe Lattices, Some Algebraic Concepts, Polynomials , Identities and Inequalities, Special Elements.

UNIT-II
Characterization and Representations Theorems, Congruence Relations, Boolean Algebras, Pseudocomplementation.

UNIT-III
Weak Projectivity and Congruences, Distributive, Standard and Neutral Elements, Distributive, Standard and Neutral Ideals, Structure Theorems.

UNIT-IV
Modular Lattices, Semimodular Lattices, Geometric Lattices, Partition Lattices.

Text Book:
General Lattice Theory (Second Edition): George Gratzer, Birkhauser Verlag.

Scope:
Unit I - Chapter 1 (1,2,3,4,6)
Unit II - Chapter 2 (1,3,4,6)
Unit III - Chapter 3 (1,2,3,4)
Unit IV - Chapter 4 (1,2,3,4)

Reference Book:
Lattice Theory: Birkhoff G, (American Mathematical Society, Providence, Rhose Island, 1967) Colloquim Publications.

Business Mathematics

UNIT-I

Applications of Matrices: Introduction, Systems of Linear Equations, Input- Output Analysis (Leontief's Models), Hawkins-Simon Conditions for the Viability of the System, Technology Matrix in Value Terms, Closed and Open Input-Output Models, Determination of Equilibrium Prices.

UNIT-II

Applications of Derivatives in Economics: Demand Function, Supply Function, Cost Function, Revenue Function, Profit Function, Market Equilibrium, Tax (Subsidy) and Market Equilibrium, Average Revenue and Marginal Revenue, The Concept of Elasticity, Elasticity of Demand, Elasticity of Supply, Income Elasticity of Demand, Cost Elasticity, Applications of Maxima and Minima.

UNIT-IV

Maximization of Total Revenue, Minimization of Cost, Maximization of Profit, Profit Maximization Under Monopoly, Profit Maximization Under Perfect Competition, Effect of Taxes and Subsidies on Profit, Imposition of Sales Tax, Offer of Subsidy, Maximization of Tax Revenue, Inventory Control.

UNIT-IV

Demand Analysis, Nature of Commodities, Partial Elasticities, Optimisation Problems, Discriminating Monopoly, Price Discrimination and Price Elasticity of Demand, Duopoly, The Utility Function, Price Line or Budget Line (or Budget Constraint), Production Function, Marginal Productivity, Average Productivity, Degree of an Homogenous Production Function, the Linear Homogenous Production function, Isoquants, Elasticity of substitution, Marginal rate of Technical substitution.

Text Book:

Business Mathematics: Dinesh Khattar, Anuradha Gupta, Pearson, 2012.

Reference Book:

Mathematics for Economics and Business (Eighth Edition): Ian Jacques, Pearson.

MATLAB Programming

4 Credit Program (2Theory + 2 Practicals per week)

UNIT-I

Input output of data from MATLAB command, File types, A minimum MATLAB Session, Creating and Working with Array of Numbers, Creating and Printing Simple Plots, Creating, saving and executing the script file, Creating and executing functions file, Working with Array and Matrices, Working with files and directories.

UNIT-II

Matrices and Vectors, Matrix and Array Operations, Determinant of matrix, Eigen values and Eigen vectors, Programming in MATLAB: Script files, function files, sub functions, global variables, loops, branches and control flow, Interactive input, Recursion. Publishing a report, Controlling command windows, Command line editing.

UNIT-III

Linear Algebra and interpolation: Solving the linear equation, Gaussian elimination, matrix factorization, curve fitting, polynomial curve fitting, least squares curve fitting, General non linear fits, Interpolation.

UNIT-IV

Differential equations and graphics: First order and second order ODE, Double integration, Roots of polynomial, Two and three dimensional plots, MATLAB plotting tools, Mesh and surface plots.

Text Book:

Getting Started with MATLAB 7: Rudra Pratap; Oxford Press

Reference books:

1. Applied Numerical Methods using MATLAB: Won Young Yang, Tae-Sang-Chung, John Morris: John Wiley and Sons.
2. Solving ODE's with MATLAB: L. F. Shampine, I. Gladwell and S. Thompson; Cambridge University Press.

Research Project

At the end of the third semester a student will be examined in the Course "Research Project".

a. The Research Project is to be done individually or in groups (Maximum 2 students) . However, in case of a group project, students need to take approval from the Head of Department. Care should be taken to monitor the progress of individual student.

b. The Research Project Work should be completed on the courses covered in M.Sc. (Mathematics) or should be relevant to Mathematics.

c. The project work will carry 100 marks.

d. The external viva-voce examination for Research Project Work would be held as per the Examination Time Table of the second year of study, by a panel of one external and one Internal examiner.

e. Head of Mathematics Department must reject any project title which has been already carried out in any course in the college/department. He/She must maintain a Record that lists the projects along with other detail (like Guide, Session, and Number of students working on project etc.) that was carried out so far and must be shown to external examiner at the time of examination.

f. Maximum 10 students per guide shall be allocated to complete research project.

Project Proposal (Synopsis):

The project proposal should be prepared in consultation with the guide. The project proposal should clearly state the objectives of the proposed project to be undertaken. A Tentative Structure of the Research Project is as follows:

1.Title Page
2.Certificate Page
3.Declaration Page
4.Acknowledgment Page
5.Index or Content Page
6. Introduction
7. Literature Review
8. Results/Theorems
9. Conclusion.
10. References.

However, students and guide may change the flow as per the need and requirement of the project.

SEMESTER-IV

Dynamical Systems

UNIT-I

Dynamical systems and vector fields. The fundamental theorem, Existence and uniqueness, Continuity of solutions in initial conditions, On extending solutions, Global solutions, The flow of a differential equation.

UNIT-II

Nonlinear sinks, Stability, Liapunov function, Gradient systems, Gradients and inner products.

UNIT-III

Limit sets, local sections and flow boxes, monotone sequences in planar dynamical system, The Poincare Bendixson theorem, Applications of Poincare-Bendixson theorem, One species, Predator and prey, Competing species.

UNIT-IV

Asymptotic stability of closed orbits, Discrete dynamical systems, Stability and closed orbits. Existence, Uniqueness and Continuity for Non Autonomous Differential equations, differentiability of the flow of the autonomous equations, Persistence of equilibria, Persistence of closed orbits, Structural stability.

Text Book:

Differential Equations, Dynamical Systems & Linear Algebra: M. W. Hirsch & S. Smale, Academic Press, 1975.

Reference Book:

Dynamical systems: V.I. Arnold, Springer Verlag, 1992.

Functional Analysis

UNIT-I

Definition and Some Examples of Banach Spaces, Continuous Linear Transformations, The Hahn-Banach Theorem, The Natural embedding of N in N**.

UNIT-II

The Open Mapping Theorem, The Conjugate of an Operator, The Definition and Some Simple Properties of Hilbert Spaces, Orthogonal Complements, Orthonormal Sets.

UNIT-III

The conjugate space H*, The adjoint of an Operator, Self-adjoint Operators, Normal and Unitary Operators, Projections.

UNIT-IV

Finite Dimensional Spectral Theory: Introduction, Matrices, Determinants and Spectrum of an Operator, The Spectral Theorem.

Text Book:

Introduction to Topology and Modern Analysis: G. F. Simmons, Mc Graw Hill International Student Edition, New York.

Scope:

Articles 46 to 62.

Reference Books:

1. Introduction to Functional Analysis: A. E. Taylor and D. C. Lay, John Wiley and Sons.
2. Introductory Functional Analysis with Applications: E. Kreyszig, John Wiley and Sons.
3. Foundations of Functional Analysis: S. Ponnusamy, Narosa Publishing House.

Mathematical Modelling

(2 Credit Course)

UNIT-I
Mathematical Modelling: Need, Techniques, Classifications and Simple Illustrations.

UNIT-II
Mathematical Modelling Through Ordinary Differential Equations of First Order

UNIT-III
Mathematical Modelling Through System of Ordinary Differential Equations of First Order

UNIT-IV
Mathematical Modelling Through Difference Equations

Text Book:
Mathematical Modelling: J N Kapoor, New Age International Publisher.

Reference Book:

1. Mathematical Modelling: Meerschaert, M. M., Academic Press, 2013.
2. Rutherford, A. Mathematical Modelling Techniques. Courier Corporation, 2012.

Integral Equations

UNIT-I

Basic Concepts of Integral Equations: Introduction, Types of Kernels, Eigen values and Eigen Functions, Differentiation under the Sign of Integration (Leibnitz's Rule), Connection with Differential Equation, Solution of an Integral Equation, Conversion of Differential Equations to Integral Equations - Initial Value Problems, Boundary Value Problems.

UNIT-II

Solution of Fredholm Integral Equations: Solution of Homogenous Fredholm Integral Equations of the Second Kind with Separable (or Degenerate Kernel), Orthogonality and Reality of Eigen Functions, Fredholm Integral Equations with Separable Kernel.

UNIT-III

Hilbert - Schmidt Theory: Symmetric Kernel: Introduction, Complex Hilbert Space, Othonormal System of Functions, Gram - Schmidt Orthonormalization Process, Riesz - Fischer Theorem, Symmetric Kernel, Expansion of Symmetric Kernel in Eigen Function, Hilbert - Schmidt Theorem, Solution of the Fredholm Integral Equation of First Kind, Schmidt's Solution of the Non-Homogenous Fredholm Integral Equation of Second Kind.

UNIT-IV

Solution of Integral Equations of Second Kind: Successive Approximations and Substitution Methods: Introduction, Solution of the Fredholm Integral Equation of Second Kind by Successive Substitution, Solution of Volterra Integral Equation of Second Kind by Successive Substitution, Solution of the Fredholm Integral Equation of Second Kind by Successive Approximation, Reciprocal Functions, Volterra's Solution of Fredholm Integral Equation of the Second Kind, Solution of Volterra Integral Equation of Second Kind by Successive Approximation: Neumann Series, Some Particular Cases, Reduction of Volterra Integral Equation into Differential Equation, Reduction of Volterra Integral Equation of First Kind to a Volterra Integral Equation of Second Kind.

Text Book:

Mathematical Methods: Sudhir K. Pundir, Rimple Pundir, Pragati Prakashan, Meerut.

Reference Book:

Integral Equations: A Short Course: LI. G. Chambers: International text book company Ltd., 1976.

Fluid Dynamics-II

UNIT-I

Stress components in a real fluid, Relation between Cartesian components of stress, Translation motion of fluid elements, The rate of strain quadric and principal stresses, Some further properties of the rate of the strain quadric, Stress analysis in fluid motion, Relation between stress and rate of strain, The coefficient of viscosity and laminar flow, The Navier-Stokes equations of motion of a viscous fluid, Some solvable problems in viscous flow, Diffusion of vorticity, Energy dissipation due to viscosity, Steady flow past a fixed sphere.

UNIT-II

Nature of magnetohydrodynamics, Maxwell electromagnetic field equations: Medium at rest, Maxwell electromagnetic field equations: Medium in Motion, Equation of motion of conducting fluid, Rate of flow of charge, Simplification of electromagnetic field equations, Magnetic Reynold's number; Alfven's theorem, The magnetic body force, Ferraro's Law of Isorotation.

UNIT-III

Dynamical similarity, Buckingham Theorem. Reynold number. Prandtl's boundary layer, Boundary layer equation in two dimensions, Blasius solutions, Boundary layer thickness, Displacement thickness. Karman integral conditions, Separation of boundary layer flow.

UNIT-IV

Turbulence: Definition of turbulence and introductory concepts. Equations of motion for turbulent flow. Reynolds Stresses Cylindrical coordinates. Equation for the conservation of a transferable scalar quantity in a turbulent flow. Double correlations between turbulence-velocity components. Change in double velocity correlation with time. Introduction to triple velocity correlations. Features of the double longitudinal and lateral correlations in a homogeneous turbulence. Integral scale of turbulence.

Text Books:

1. Text book of Fluid Dynamics: F. Chorlton; CBS Publishers, Delhi, 1985.
2. Fluid Mechanics: Joseph Spurk, Springer.
3. Turbulence (Second edition): J. O. Hinze, Mc Graw-Hill, chapter 1 sections 1.1 to 1.7

Reference Books:

1. An Introduction to Fluid Mechanics: G. K. Batchelor; Foundation Books, New Delhi, 1994.
2. Boundary Layer Theory: H. Schichting, Mc Graw Hill Book Company, New York, 1971.
3. Fluid Mechanics: M.D. Raisinghania, S. Chand and Company, Delhi.

Cosmology

UNIT-I

Static Cosmology: Introduction, Three types of static universe, Study of Einstein universe, Study of de-Sitter universe, Comparison between Einstein and de-Sitter models.

UNIT-II

Robertson - Walker Metric: Introduction, Derivation of Robertson - Walker Metric, Properties of Robertson - Walker Metric, Motion of a particle and light rays in FRW model, The Red shift, Deceleration parameter and Hubble's constant.

UNIT-III

Robertson - Walker Metric: Fundamental equation of dynamical cosmology, Friedmann models, Steady State cosmology.

UNIT-IV

Measure of Distance: Light paths, Parallax and parallax distance, Apparent luminosity and luminosity distance, Angular diameter and angular diameter distance, Proper motion and proper motion distance, Relations among the measures of distance, Sources with smooth edges, Sources with smooth spectra.

Text Books:

1. Lectures on General Theory of Relativity: T. M. Karade and G. S. Khadekar and Maya S. Bendre, Pub. SONU NILU

Scope:

Unit I-Chapter7

Unit II-Chapter 8 - 1,2,3,4,5,6

Unit III - Chapter 8 - 7,8,9

2. Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity by Steven Weinberg (Unit IV - Part Five Cosmology Point 4)

References Books:

1. The Classical Theory of Fields: L. D. Landau and E. M. Lifshitz, Pub. Pergamon Press, 1978.
2. The Theory of Relativity: Moller C, Pub. Oxford University Press, 1982.
3. Introduction to Theory of Relativity: Rosser W. G. V. , ELBS, 1972.
4. Relativity Special, General and Cosmology: Rindler W., Pub. Oxford University Press, 2003.
5. Relativity: The General Theory, Synge J. L., North Holland Pub. Comp., 1971.

Representation Theory of the Symmetric Group

UNIT-I

Matrix Representations, G-modules and the Group Algebra, Reducibility, Complete Reducibility and Maschke's Theorem, G-homomorphisms and Schur's Lemma, Commutant and Endomorphism Algebras.

UNIT-II

Group Characters, Inner Products of Characters, Decomposition of Group Algebra, Tensor Products Again, Restricted and Induced Representations.

UNIT-III

Young Subgroups, Tableaux, and Tabloids, Dominance and Lexicographic ordering, Specht modules, The Submodule Theorem, Standard Tableaux and a Basis for S^{λ}, Garnir elements, Young's Natural Representation, The Branching Rule, The Decomposition of M^{μ}, The Semistandard basis for Hom(S^{λ}, M^{μ}), Kostka numbers and Young's Rule.

UNIT-IV

The Robinson Schensted Algorithm, Column Insertion, Increasing and Decreasing Subsequences, The Knuth Relations, Subsequences Again, Viennot's Geometric Construction, Schutzenberger's Jeu de Taquin, Dual Equivalence, Evacuation, The Hook Formula, The Determinantal Formula.

Text Book:

The Symmetric Group Representations, Combinatorial Algorithms, and Symmetric Functions: Bruce E. Sagan, Second Edition 2001, Springer Science + Buisness Media, LLC.

Reference Books:

1. Representation Theory: A First Course: William Fulton, Joe Harris, Springer New York, 2004.
2. Representation theory of Finite Groups: An Introductory approach: Benjamin Steinberg, Springer, 2012.

Matroid Theory

UNIT-I

Basic Definitions and Examples: Independent Sets and Circuits, Bases, Rank, Closure, Geometric Representations of Matroids of Small Rank, Transversal Matroids, The Lattice of Flats, The Greedy Algorithm.

UNIT-II

Duality: The Definition and Basic Properties, Duals of Representable Matroids, Duals of Graphic Matroids, Duals of Transversal Matroids.

UNIT-III

Minors: Contraction, Minors of Certain Matroids, The Scum Theorem, Projections, and Flats.

UNIT-IV

Connectivity: Connectivity for Graphs and Matroids, Properties of Matroid Connectivity, More Properties of Connectivity.

Text Book:

Matroid Theory: James G. Oxley, Science Publications, Oxford,1992.

Reference Books:

1. Theory of Matroids: Neil White, Cambridge University Press, 2008. 2. Matroid Theory and It's Applications: Barlotti A., Springer, 2010.

Python Programming

4 Credit Program (2Theory + 2 Practicals per week)

UNIT-I
The way of the program, Variables, expressions and statements, Program flow.

UNIT-II
Functions, Data Types, Numpy.

UNIT-III
Files, Modules, More datatypes, Recursion, Classes and Objects.

UNIT-IV
Exceptions, Fitting, PyGame, Plotting data with matplotlib.

Text Book:
How to Think Like a computer Scientist: Learning with Python 3 Documentation: J N Kapoor, Downey, A. et al, Release 3rd Edition.

Reference Book:
Fundamentals of Python - First Programs: Lambert K. A., Cengage Learning India, 2015.

Algebraic Number Theory

UNIT-I
A Special Case of Fermat's Conjecture, Number Fields and Number Rings.

UNIT-II
Prime Decomposition in Number Rings, Galois theory Applied to Prime Decomposition.

UNIT-III
The Ideal class Group and the Unit Group, The Distribution of Ideals in a Number Ring.

UNIT-IV
The Dedekind Zera Function and the Class Number Formula, The Distribution of Primes and an Introduction to Class Field Theory.

Text Book:
D. A. Marcus, Number Fields, SpringerVerlag, 1977

Reference Book:

1. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, 2nd Edition, Springer-Verlag, Berlin, 1990.
2. S. Lang, Algebraic Number Theory, AddisonWesley, 1970.
3. D. A. Marcus, Number Fields, SpringerVerlag, 1977.
4. G. J. Janusz, Algebraic Number fields,(chapter 1-4), AMS(1996).
5. I. Stuart and D.Tall, Algebraic Number Theory and Fermat's last theorem,A.K.Peters(2001)
6. E. Weiss, Algebraic number theory, Dover Publications, 1998.

Research Project

At the end of the fourth semester a student will be examined in the Course "Research Project".

a. The Research Project is to be done individually or in groups (Maximum 2 students) . However, in case of a group project, students need to take approval from the Head of Department. Care should be taken to monitor the progress of individual student.

b. The Research Project Work should be completed on the courses covered in M.Sc. (Mathematics) or should be relevant to Mathematics.

c. The project work will carry 100 marks.

d. The external viva-voce examination for Research Project Work would be held as per the Examination Time Table of the second year of study, by a panel of one external and one Internal examiner.

e. Head of Mathematics Department must reject any project title which has been already carried out in any course in the college/department. He/She must maintain a Record that lists the projects along with other detail (like Guide, Session, and Number of students working on project etc.) that was carried out so far and must be shown to external examiner at the time of examination.

f. Maximum 10 students per guide shall be allocated to complete research project.

Project Proposal (Synopsis):

The project proposal should be prepared in consultation with the guide. The project proposal should clearly state the objectives of the proposed project to be undertaken. A Tentative Structure of the Research Project is as follows:

1.Title Page
2.Certificate Page
3.Declaration Page
4.Acknowledgment Page
5.Index or Content Page
6. Introduction
7. Literature Review
8. Results/Theorems
9. Conclusion.
10. References.

However, students and guide may change the flow as per the need and requirement of the project.