GONDWANA UNIVERSITY
GADCHIROLI

Proposed Syllabus For

M.Sc. Mathematics

Semester-III and Semester-IV

Under Choice Based Credit System

(C.B.C.S.)

With effect from

Academic Year: 2021-22

(Considered and approved by B.O.S. in Mathematics)

M.Sc. Mathematics
Semester wise Syllabus

M.Sc. Semester- III

CORE COURSES

PSCMTH11: Complex Analysis
PSCMTH12 : Functional Analysis
PSCMTH13 : Mathematical Methods

PSCMTH14: CORE ELECTIVE COURSE (Opt any one of the following)

(a) Fluid Dynamics - I
(b) General Relativity
(c) Graph Theory
(d) Commutative Algebra
(e) Lattice Theory

PSCMTH15: FOUNDATION COURSE (Opt any one of the following)

Students from any post graduate program may opt any one of the following:

(a) Operations Research – I
(b) Business Mathematics
(c) MATLAB Programming
(d) Statistics

M.Sc. Semester- IV

CORE COURSE

PSCMTH16: Dynamical Systems
PSCMTH17: Partial Differential Equations
PSCMTH18: Integral Equations

PSCMTH19: CORE ELECTIVE COURSE (Opt any one of the following)

(a) Fluid Dynamics - II
(b) Cosmology
(c) Combinatorics
(d) Representation Theory of the Symmetric Group
(e) Matroid Theory

PSCMTH20: FOUNDATION COURSE (Opt any one of the following)

Students from any post graduate program may opt any one of the following:

(a) Operations Research – II
(b) Elementary Discrete Mathematics
(c) Financial Mathematics
(d) C Programming

Semester III for M.Sc. Program in Mathematics										
Code	Teaching Scheme (Hours/Week)		Credits			Examination Scheme				
	Theory	Total	Theory	Internal assessment	Total	Duration in Hrs.	Maximum Marks		Total Marks	Minimum passing marks
							External assessment	Internal assessment		External assessment + Internal assessment
PSCMTH11	5	5	4	1	5	3	100	25	125	50
PSCMTH12	5	5	4	1	5	3	100	25	125	50
PSCMTH13	5	5	4	1	5	3	100	25	125	50
CORE ElectivePSCMTH14	5	5	4	1	5	3	100	25	125	50
ELECTIVE COURSE PSCMTH15	5	5	4	1	5	3	100	25	125	50
	25	25	20	5	25		500	125	625	250

Semester IV for M.Sc. Program in Mathematics										
Code	Teaching Scheme (Hours/Week)		Credits			Examination Scheme				
	Theory	Total	Theory	Internal assessment	Total	Duration in Hrs.	Maximum Marks		Total Marks	Minimum passing marks
							External assessment	Internal assessment		External assessment + Internal assessment
PSCMTH16	5	5	4	1	5	3	100	25	125	50
PSCMTH17	5	5	4	1	5	3	100	25	125	50
PSCMTH18	5	5	4	1	5	3	100	25	125	50
CORE ElectivePSCMTH19	5	5	4	1	5	3	100	25	125	50
ELECTIVE COURSE PSCMTH20	5	5	4	1	5	3	100	25	125	50
	25	25	20	5	25		500	125	625	250

Guidelines about Internal Assessment for all Semesters:

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 INTERNAL ASSESSMENT

Sr. No.	Activities	Max. Marks
1	Attendance	05(Compulsory)
	Any Two of the Following Activities	
1	Seminar	10
2	Unit Tests	10
3	Home Assignments	10

Total Marks -25

Minimum Passing Marks -10

SEMESTER-III

Core Course Code - PSCMTH11 **Credit - 05**

Complex Analysis

UNIT-I

Functions and Mappings, The Mappings $u' = z^2$, Limits, Theorems on Limits, Limits Involving the Point at Infinity, Continuity, Derivatives, Rules for Differentiation, Cauchy–Riemann Equations, Sufficient Conditions for Differentiability, Polar Coordinates, Analytic Functions, Harmonic Functions, Uniquely Determined Analytic Functions, Reflection Principle, The Exponential Function, The Logarithmic Function, Branches and Derivatives of Logarithms, Some Identities involving Logarithms, The Power Function, Trigonometric Functions, Zeros and singularities of Trigonometric Functions, Hyperbolic Functions, Inverse Trigonometric and Hyperbolic Functions.

UNIT-II

Derivatives of Functions, Definite Integrals of Functions, Contours, Contour Integrals with Examples, Examples involving Branch Cuts, Upper Bounds for Moduli of Contour Integrals, Antiderivatives, Cauchy–Goursat Theorem, Simply Connected Domains, Multiply connected Domains, Cauchy Integral Formula, An Extension of Cauchy Integral Formula, Liouville's Theorem and the Fundamental Theorem of Algebra, Maximum Modulus Principle, Schwarz's lemma(from Ponnusammy's book) Convergence of Sequences, Convergence of Series, Taylor Series with Examples, Laurent Series with Examples, Absolute and Uniform Convergence of Power Series.

UNIT-III

Isolated Singular Points, Residues, Cauchy's Residue Theorem, Residue at Infinity, The Three Types of Isolated Singular Points with Examples, Residues at Poles with Examples, Zeros of Analytic Functions, Zeros and Poles, Behaviour of functions near isolated singular points, Evaluation of Improper Integrals with Examples, Jordan's Lemma, Definite Integrals Involving Sines and Cosines, Argument Principle, Rouche's Theorem.

UNIT-IV

Linear Transformations, The Transformation w = 1/z, Mappings by 1/z, Linear Fractional Transformations, An Implicit Form, Mappings of the Upper Half Plane with Examples, Mapping Vertical Line Segments by w = sin z, Mapping Horizontal Line Segments by w = sin z, Mappings by z^2, Mapping by Branches of $z^{1/2}$.

Text Books:

1. Complex Variables and Applications (Ninth edition): R. V. Churchill and J. W. Brown, Mc Graw Hill Publication.

Scope:

Unit I – Chapter 2 and 3

Unit II - Chapter 4 and Chapter 5(excluding Continuity of Sums of Power Series, Integration and Differentiation of Power Series, Uniqueness of Series Representations, Multiplication and Division of Power Series)

Unit III - Chapter 6 and Chapter 7(excluding Improper Integrals from Fourier Analysis, An Indented Path, An Indentation Around a Branch Point, Integration along a branch cut, Inverse Laplace Transforms)

Unit IV – Chapter 8 (excluding Mapping by The Exponential Function, Square Roots of Polynomials, Riemann surfaces, Surfaces for Related Functions)

2. Foundation of Complex Analysis (Second Edition): S.Ponnusamy, Narosa Publication.

Reference Books:

1. Functions of One Complex Variable (Second edition): John B. Conway, Springer international Student Edition.
2. Complex Analysis: L. V. Ahlfors, Mc-Graw Hill, 1966.

Core Course Code - PSCMTH12 **Credit - 05**

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.

Core Course Code - PSCMTH13 **Credit - 05**

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)

References 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.

Core Elective Course Code - PSCMTH14 (Opt any one of the following)

Credit - 05

(a) 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.

(b) 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.

(c) Graph Theory

UNIT-I

The Definition of a Graph, More Definitions, Vertex Degrees, Subgraphs, Paths and Cycles, The Matrix Representation of Graphs, Fusion, Definition and Simple Properties of Trees, Bridges, Spanning Trees.

UNIT-II

Connector Problems, Shortest Path Problems, Cut Vertices and Connectivity, Euler Tours, The Chinese postman problem.

UNIT-III

Hamiltonian Graphs, Travelling Salesman Problem, Plane and Planar Graphs, Euler's formula, Kuratowski's Theorem, Non-Hamiltonian Plane Graphs, The Dual of a Plane Graph.

UNIT-IV

Definitions and More Definitions on Directed Graphs, Indegree and Outdegree, Tournaments, Traffic flow, Flow and Cuts, The Ford and Fulkerson Algorithm, Separating sets.

Text Book:

A First Look at Graph Theory: John Clark and Derek Allan Holton, Allied Publishers Ltd., 1995.

Reference Books:

1. Graph Theory with Applications to Engineering and Computer Science: Narsing Deo, Prentice Hall of India.
2. Graph Theory: F. Harare, Addison Wesley.
3. Introduction to Graph Theory: Douglas B. West, Prentice- Hall, New Delhi, 1999.
4. Basic Graph Theory: K. R. Parthasarthy, TataMc Graw- Hill Pub. Comp. Limited, Delhi.

(d) 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.

(e) 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.

Foundation Course Code - PSCMTH15 (Opt any one of the following)

Credit - 05

(a) Operations Research - I

UNIT-I

Linear Programming Problem - Simplex method, Duality in Linear Programming.

UNIT-II

Transportation Problem , Assignment problems.

UNIT-III

Dynamic programming.

UNIT-IV

Games and Strategies.

Text Book:

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

Scope:

Unit I - Chapter 4 and 5
Unit II - Chapter 10 and 11
Unit III - Chapter 13
Unit IV - Chapter 17

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

(b) 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

Limits and Continuity: Limit of a function, Algebra of Limits, Evaluation of Limits, Infinite Limits, Continuity on an Interval, Continuous Functions.
Differentiation: Derivative of a Function, Geometrical Interpretation of the Derivative, Derivative of Implicit Functions, Logarithmic Differentiation, Differentiation of Parametric Forms, Applications of Derivatives, Maxima and Minima, Concavity and Convexity.

UNIT-III

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.

Text Book:

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

Reference Book:

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

(c) MATLAB Programming

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.

(d) Statistics

UNIT-I

Data Classification, Tabulation and Presentation

Classification of Data, Organizing Data Using Data Array, Tabulation of Data, Graphical Presentation of Data, Types of Diagrams, Exploratory Data Analysis.

UNIT-II

Measures of Central Tendency

Introduction, Measure of Central Tendency, Mathematical Averages, Geometric Mean, Harmonic Mean, Averages of Position, Mode, Relationship Between Mean, Median and Mode.

UNIT-III

Measures of Dispersion

Introduction, Classification of Measures of Dispersion, Distance Measures, Average Deviation Measures.

UNIT-IV

Skewness, Moments and Kurtosis

Introduction, Measures of Skewness, Moments, Kurtosis, Miscellaneous Solved Examples.

Text Book:

Business Statistics: J. K. Sharma, Pearson Education India, 2012.

Scope:

Unit I - Chapter 1
Unit II - Chapter 2
Unit III - Chapter 3
Unit IV - Chapter 4

Reference Books:

1. Statistics: A Very Short Introduction: David J. Hand, Oxford University Press, USA.
2. Statistics: The Art and Science of Learning from Data: Christine A. Franklin, Bernhard Klingenberg, Alan Agresti, Pearson, 2017.

SEMESTER-IV

Core Course Code - PSCMTH16 **Credit - 05**

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.

Core Course Code - PSCMTH17 **Credit - 05**

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

Core Course Code – PSCMTH18 **Credit - 05**

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.

Core Elective Course - PSCMTH19 (Opt any one of the following) Credit - 05

(a) 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.

(b) 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.

(c) Combinatorics

UNIT-I

General Counting Methods for Arrangements and Selections: Two Basic counting Principles, Simple Arrangements and Selections, Arrangements and Selections with Repetitions, Distributions, Binomial Identities

UNIT-II

Generating Functions: Generating Function Models, Calculating Coefficients of Generating Functions, Partitions, Exponential Generating Functions, A Summation Method.

UNIT-III

Recurrence Relations: Recurrence Relation Models, Divide and Conquer Relations, Solution of Linear Recurrence Relations, Solution of Inhomogeneous Recurrence Relations, Solution with Generating Functions.

UNIT-IV

Inclusion-Exclusion: Counting with Venn Diagrams, Inclusion - Exclusion formula, Restricted Positions and Rook polynomials.

Text Book:

Applied Combinatorics (Third edition): Alan Tucker,, John Wiley & Sons, New York, 1995.

Reference Books:

1. Combinatorial Theory and Applications: V. Krishnamurthy, East West Press, New Delhi.
2. How to Count: An Introduction to Combinatorics and Its Applications: Robert A. Beeler, Springer, 2015.
3. Principles and Techniques in Combinatorics: Chen Chuang-Chong, Koh Khee-Meng, World Scientific, 1992.

(d) 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.

(e) 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.

Foundation Course Code - PSCMTH20 (Opt any one of the following)

Credit - 05

(a) Operations Research - II

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 – An Introduction: H.A Taha, Macmillan publishing Company inc, New York

(b) Elementary Discrete Mathematics

UNIT-I

Mathematical Logic: Introduction, Proposition, Compound Proposition, Proposition and truth tables, Logical equivalence, Algebra of Proposition, conditional Proposition, Converse, contrapositive & Inverse, Bi-conditional statement, Negation of compound statements, Tautologies & contradictions, normal forms, Logic in proof.

UNIT-II

Lattice: Lattice as partially ordered sets, Their properties, Lattices as algebraic systems, Sub lattices, and Some special lattices eg. Complete, Complemented and Distributive lattices.

UNIT-III

Boolean algebra and Logic Circuits: Boolean algebra, Basic operations, Boolean functions, De-Morgan's theorem, Logic gate, Sum of products and Product of sum forms, Normal form, Expression of Boolean function as a canonical form, Simplification of Boolean expression by algebraic method, Boolean expression form logic & Switching network.

UNIT-IV

Graph Theory: Basic terminology, Simple graph, Multigraph, Degree of a vertex, Types of a graph, Sub graphs of isomorphic graphs, Matrix representation of graphs, Euler's theorem on the existence of Eulerian path & Circuits, Directed graph, Weighted graphs, Strong connectivity, Chromatic number.

Text Book:

Discrete Mathematical structures with applications to computer science by J. P. Tremblay and R. Manohar, McGraw-Hill book company, 1997.

Reference Book:

1. Discrete Mathematics and Its Applications (Eighth Edition): Kenneth Rosen, McGraw - Hill Higher Education, 2018.
2. Essential Discrete Mathematics for Computer Science: Harry Lewis, Rachel Zax, Princeton University Press, 2019.
3. A Beginner's Guide to Discrete Mathematics (Second Edition): W. D. Wallis, Birkhauser Basel, 2012.

(c) Financial Mathematics

UNIT-I

The Measurement of Interest and Solution of Problems in Interest: Introduction, The accumulation and amount functions, The effective rate of interest, Simple interest, Compound interest, Present value, The effective rate of discount, Nominal rates of interest and discount, Forces of interest and discount, Varying interest, Summary of results. Introduction, The basic problem, Equation of value, Unknown time, Unknown rate of interest, Determining time periods, Practical examples.

UNIT-II

Basic Annuities and More General Annuities:

Introduction, Annuity-immediate, Annuity-due, Annuity values on any date, Perpetuities, Unknown time, Unknown rate of interest, Varying interest, Annuities not involving compound interest. Introduction, Differing payment and interest conversion periods, Annuities payable less frequently than interest convertible, Annuities payable more frequently than interest convertible, Continuous annuities, Payments varying in arithmetic progression, Payments varying in geometric progression, More general varying annuities, Continuous varying annuities, Summary of results.

UNIT-III

Amortization Schedules and Sinking Funds:

Introduction, Finding the outstanding loan balance, Amortization schedules, Sinking funds, Differing payment periods and interest conversion periods, Varying series of payments, Amortization with continuous payments, Step-rate amounts of principal.

UNIT-IV

Bonds and Other Securities and Yield Rates:

Introduction, Types of securities, Price of a bond, Premium and discount, Valuation between coupon payment dates, Determination of yields rates, Callable and putable bonds, Serial bonds, Some generalizations, Other securities, Valuation of securities. Introduction, Discounted cash flow analysis, Uniqueness of the yield rate, Reinvestment rates, Interest measurement of a fund, Time-weighted rates of interest, Portfolio methods and investment year methods, Short sales, Capital budgeting basic technique and other technique.

Text Book:

The Theory of Interest (Third Edition): Stephen G. Kellison, McGraw Hill International Edition , 2009.

Reference Book:

Mathematics of Financial Markets: R. J. Elliott and P. E. Kopp, Springer, 1999.

(d) C Programming

UNIT-I
Getting Started, The Decision Control Structure

UNIT-II
The Loop Control Structure, The Case Control Structure

UNIT-III
Functions & Pointers, Data Types Revisited

UNIT-IV
Arrays, Puppetting On Strings, Structures

Text Book:
Let Us C, Yashvant P. Kanetkar, Fifth Edition, BPB Publications.

Reference Book:
The C Programming Language (Second Edition): Brian W. Kernighan, Dennis Ritchie, Pearson.