UNIVERSITY OF LUCKNOW

DEPARTMENT OF MATHEMATICS & ASTRONOMY

YEAR WISE SYLLABUS OF FOUR YEAR U.G. PROGRAM IN MATHEMATICS

UNDER

NATIONAL EDUCATION POLICY 2020

(EFFECTIVE FROM SESSION 2024-25 ONWARDS)

UG Semester I

Paper 1: Differential Calculus

Credit: 4 **T: 04**

Course Outcomes:

1. Know the concepts of calculus, namely, limits, continuity, differentiability of functions of one and two variables and their applications in the form of mean value theorem and Taylor's theorem.
2. Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
3. Get knowledge of curvature, asymptotes, envelopes and evolutes.

UNIT I

Limit, continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule, indeterminate forms.

UNIT II

Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems ofhigher order, Taylor's theorem with various forms of remainders, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series,

Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables.

UNIT III

Partial differentiation, Euler's theorem on homogeneous function, Schwarz's and Young theorem, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians, Inverse function theorem and implicit function theorem.

UNIT IV

Tangents and normals, Asymptotes, Curvature, Envelops and evolutes, Tests forconcavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves and tracing of parametric curves, Tracing of curves in Cartesian and Polar forms.

References:

Text Books:

1. T.M. Apostol, Calculus Vol. I, John Wiley & Sons Inc.
2. S. Balachandra Rao, C. K. Shantha, Differential Calculus, New Age Publication.

Suggested Reading:

1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc.,2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

Web References:

1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

Paper 2: Matrices and Algebra

Credit: 4 **T:04**

Course Outcomes:

1. Find the rank and eigen values of matrices.
2. Study the system of linear homogeneous and non-homogeneous equations.
3. Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
4. Link the fundamental concepts of Groups and symmetrical figures.
5. Analyze the subgroups of cyclic groups.
6. Explain the significance of the notion of cosets, normal subgroups, and factor group.
7. Understand the concepts of rings, subrings and fields.

UNIT I

Elementary operations on matrices, Rank of a matrix, Echelon and normal form of a matrix, Inverse of a matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations. Eigen values, Eigen vectors and characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.

UNIT II

Equivalence relations and partitions, Congruence modulo n, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems. Normal subgroups, Quotient groups.

UNIT III

Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism, Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products.

UNIT IV

Rings, types of rings (commutative rings, rings with unity, division rings, Integral domains and fields) with examples, basic properties, sub-rings, Characteristic of a ring, Ideals and quotient rings, Ring homomorphism, Isomorphism theorems, Field of quotient of an integral domain, polynomial rings.

References:

Text Books:

1. Linear Algebra by K. Hoffman and R. Kunze.
2. V. Sahai and V. Bist, Algebra, Narosa

Suggested Readings:

1. J.B. Fraleigh, A First Course in Abstract Algebra, Pearson
2. I.N. Herstein, Topics in Algebra, John Wiley & Sons

Web References:

1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

(For students with Mathematics as a minor subject)

Paper Q1: Applicable Mathematics– I

Credit: 2 **T:02**

Course Outcomes:

1. To compute the rank of a matrix and its applications in finding solutions of system of equations, computing Eigen values and Eigen vectors and their applications.

2. To Know the concepts of calculus, namely, limits, continuity, differentiability of functions and their applications in the form of mean value theorem and Taylor's theorem.

UNIT I

Types of matrices, elementary operations on matrices, rank of a matrix, echelon and normal forms of a matrix, inverse of a matrix by elementary operations, systems of linear homogeneous and non - homogeneous equations, consistency of linear system of equations.

UNIT II

Eigenvalues, eigenvectors and characteristic equation of a square matrix, Cayley-Hamilton theorem and its application in finding the inverse of a matrix.

UNIT III

Limit, continuity and differentiability of functions of single variable, successivedifferentiation, Leibnitz's theorem, Rolle's theorem, Lagrange's and Cauchy's mean value theorems, Taylor's and Maclaurins's series.

UNIT IV

Limit, continuity and differentiability of functions of two variables, partial derivatives, Euler's theorem for homogeneous functions, Jacobian.

References:

Textbooks

1. Linear Algebra by K. Hoffman and R. Kunze.
2. Calculus, Volumes I & II by T. M. Apostol.
3. Mathematical Analysis by S.C. Malik and S. Arora, New Age International Limited, New Delhi.

Suggested Books

1. R. R. Goldberg : Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd.
2. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition.

Co-Curricular Course in Mathematics

Paper CC-1: Elementary Number Theory
(Pre-requisites: Mathematics in Class 12)

Credit: 2 **T:02**

Course Objectives:

1. To introduce the student to basic concepts of number theory.
2. To identify and apply various properties of and relating to the integers.
3. To apply number theoretic algorithms in cryptography.

Course Outcomes:

At the end of this course students will be able to:

1. Solve problems in elementary number theory.
2. Study certain number theoretic functions and their properties.
3. Understand the concept of congruence and related theorems.
4. Apply linear congruences in cryptography.

UNIT I

GCD, Euclid algorithm for finding GCD, Extended Euclid algorithm, Prime numbers and their properties, Prime number theorem.

UNIT II

Congruence and its properties, Linear Congruence, Chinese Remainder theorem, Fermat's theorem, Euler's theorem, Wilson's theorem,

UNIT III

Primality testing algorithm, Discrete logarithm, Some factorization algorithms.

UNIT IV

Some algebraic structure: Group, Ring and Field, Finite fields and their construction.

Recommended Books:

1. Elementary Number Theory, Burton, Mc Graw Hill.

UG Semester II

Paper 3: Integral Calculus

Credit: 4 **T:04**

Course Outcomes:

1. Some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
2. Beta and Gamma functions and their properties.
3. The valid situations for the inter-changeability of differentiability and integrability with infinite sum, and approximation of transcendental functions in terms of power series.
4. Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.

UNIT I

Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration.

UNIT II

Improper integrals, their classification and convergence, Comparison test, μ- test, Abel's test, Dirichlet's test, quotient test, Beta and Gamma functions.

UNIT III

Rectification, Volumes and Surfaces of Solid of revolution, Pappus theorem, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals.

UNIT IV

Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Vector Integration, Theorems of Gauss, Green, Stokes and related problems.

References:

Text Books:

1. T.M. Apostol, Calculus Vol. II, John Wiley Publication.
2. Shanti Narayan, P.K. Mittal, Integral Calculus, S. Chand.

Suggested Readings:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.

Web References:

1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

Paper 4: Geometry

Credit: 4 **T: 04**

Course Outcomes:

1. To learn and visualize the fundamental ideas of coordinate geometry.
2. To describe some surfaces by using analytical geometry.
3. To gain knowledge about regular geometrical figures and their properties.

UNIT I

General equation of second degree, System of conics, Tracing of conics, Confocal conics, Polar equation of conics and its properties.

UNIT II

Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension (Cartesian and vector form).

UNIT III

Sphere, Cone and Cylinder.

UNIT IV

Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids, Reduction of second degree equation.

References:
Text Books:
1. P. R. Vittal, Analytical Geometry
2. S. L. Loney, The Elements of Coordinate Geometry, Macmillan Suggested

Suggested Readings:

1. Robert J.T. Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd

Web References:

1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

(For students with Mathematics as a minor subject)

Paper Q2: Applicable Mathematics– II

Credit: 2 **T:02**

Course Outcomes:

1. To understand the concepts of vector calculus
2. To understand application and techniques of solving various types of ordinary differential equations.
3. To learn sequences and various tests to check convergence of an infinite series.

UNIT I

Vector differentiation, gradient, divergence and curl with their physical interpretations, tangent and normal on a surface, directional derivative, line, surface and volume integrals, applications of Green's, Stoke's and Gauss' divergence theorems (without proofs). Application and properties of Beta and Gamma function, Dirichlet and Liouville theorems.

UNIT II

Ordinary differential equations - Bernoulli's equation, exact differential equations and integrating factors, special integrating factors and transformations, differential equations of order one and degree more than one, Clairaut's equation, singular solutions and orthogonal trajectories.

UNIT III

Linear differential equations with constant coefficients, homogeneous Linear differential equations, series solutions of Legendre's, Bessel's and hypergeometric equations and their basic properties.

UNIT IV

Sequences, limit of a sequence, convergence, divergence and oscillation of a sequence, infinite series and its convergence, geometric and harmonic series, tests for convergence and divergence - comparison test, Cauchy integral test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's logarithmic test, DeMorgan and Bertrand's test, alternating series, absolute and conditional convergence, Leibnitz's theorem (without proof).

References:
Textbooks

1. G.F.Simmons: Differential Equations with Applications and HistoricalN, Tata McGraw Hill.
2. R.G. Bartle : Introduction to Real Analysis, Wiley.
3. M.R. Spiegel: Theory and Problems of Vector Analysis, Schaum Outline Series, MgGraw Hill Book Company.

Suggested books:

1. B. Rai, D.P. Choudhary & H.J. Freedman, A Course in Differential Equations.
2. S. L Ross, Differential Equations, 3rd Edition, Wiley

Vocational Course in Mathematics

Paper VC-1: Vedic Mathematics
(Pre-requisites: Mathematics in Class 12)

Credit: 2 **T:02**

Course Outcomes:

1. To understand the concepts of Vedic arithmetic as in Indian knowledge system.
2. To understand application and techniques of Vedic algebra as in Indian knowledge system.

UNIT I

Vedic Arithmetic: Base and complement, addition and subtraction, some important vedic sutras, Multiplication- Ekadhikenpurven method (multiplication of two numbers oftwo digits), Ekununenpurven method (multiplication of two numbers of three digits), Urdhvatiragbhyam method (multiplication of two numbers of three digits), Nikhilam Navtashchramam Dashtaha (multiplication of two numbers of three digits), Combined Operations.

UNIT II

Division- Nikhilam Navtashchramam Dashtaha (two digits divisor), Paravartya Yojyet method (three digits divisor), Divisibility- Ekadhikenpurven Method (two digits divisor), Eknunenpurven method (two digits divisor), LCM and HCF, Power- Square and Cube of two digit numbers, Square root of four digit numbers and Cube root of six digit numbers, calendar.

UNIT III

Vedic Algebra: Multiplication (Quadratic expressions of single variable)- Urdhvatiragbhyam Method, Combined Operations.

UNIT IV

Division (Divisor: Linear expression of single variable), Factorization (Quadratic expression of single variable), Solution of linear simultaneous expressions.

Recommended Books:

1. Vedic Mathematics, Motilal Banarsi Das, New Delhi.
2. Vedic Ganita: Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi.
3. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi.
4. Vedic Mathematics: Past, Present and Future, Siksha Sanskriti Uthana Nyasa, New Delhi.
5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.
6. Bhartiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.
7. Beejganitam, Chokhambba Vidya Bhavan, Varanasi.

UG Semester III

Paper 5: Linear & Abstract Algebra

Credit: 4 **T:04**

Course Outcomes:

1. The fundamental concept of Rings, Fields, subrings, integral domains and the corresponding morphisms.
2. The concept of linear independence of vectors over a field, the idea of basis and the dimension of a vector space.
3. Basic concepts of linear transformations, the Rank-Nullity Theorem, matrix of a linear transformation and the change of basis.
4. Automorphisms for constructing new groups from the given group.
5. Group actions, Sylow theorems and their applications to check nonsimplicity.
6. Compute inner products and determine orthogonality on vector spaces.

UNIT I

Automorphism, inner automorphism, automorphism groups and their computations, Conjugacy relations, Normaliser, Counting principle and the class equation of a finite group, Center of group of prime power order, simple groups, Group action, Burnside lemma, Sylow theorems and its applications.

UNIT II

Prime and maximal ideals, Euclidean Rings, Principal ideal rings, Polynomial Rings, Polynomial over the Rational Field, The Eisenstein Criterion, Polynomial Rings over Commutative Rings, unique factorization domain.

UNIT III

Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and dimension, Quotient space, Linear transformations, Direct sums, The Algebra of linear transformations, rank nullity theorem, their representation as matrices, Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem.

UNIT IV

Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process, Bilinear and Quadratic forms.

References:

Text books:

1. Topics in Algebra by I. N. Herstein.
2. Algebra by V. Sahai and V. Bist
3. Linear Algebra by V. Sahai and V. Bist

Suggested Readings:

1. Linear Algebra by K. Hoffman and R. Kunze.

Web References:

1. Digital platforms web links : NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

Paper 6: Mechanics

Credit: 4 **T:04**

Course Outcomes:

1. The significance of mathematics involved in physical quantities and their uses.
2. To understanding the various concepts of basic mechanics like simple harmonic motion, motion under other laws and forces.
3. To study and to learn the cause-effect related to these.
4. The applications in observing and relating real situations/structures.

UNIT I

Frame of reference, work energy principle, Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.

UNIT II

Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength.

UNIT III

Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces. Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves.

UNIT IV

Motion of particles of varying mass, Rocket motion, Central orbit, Kepler's laws of motion, Motion of particle in three dimensions, Rotating frame of reference, Rotating Earth, Acceleration in terms of different coordinates systems.

References Text Books:

1. R.C. Hibbeler, Engineering Mechanics-Statistics
2. Nelson, Engineering Mechanics- Dynamics, Tata McGraw Hill

Suggested Readings:

1. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill

Web References:

1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

(For students with Mathematics as a minor subject)

Paper Q3: Applicable Mathematics– III

Credit: 2 **T:02**

Course Outcomes:

1. To understand the concepts of groups, cyclic groups, and homomorphism of groups.
2. To know the concepts of rings, ideals, quotient rings and homomorphism of rings.
3. To know the concept of vector spaces and linear transformations.

UNIT I

Equivalence relations and partitions, congruence modulo n, groups, subgroups, cyclic groups, coset decomposition, Lagrange's theorem, Fermat's & Euler's theorems.

UNIT II

Normal subgroups, quotient groups, homomorphism and homomorphism theorems, permutation group, even and odd permutations.

UNIT III

Rings, types of rings - commutative rings, rings with unity, division rings, integral domains and fields, subrings, ideals and quotient rings, ring homomorphism, characteristic of a ring, Polynomial rings.

UNIT IV

Vector spaces, subspaces, linear independence and dependence, basis and dimension, quotient space, linear transformations.

References:

Textbooks

1. V. Sahai & V. Bist : Algebra, Narosa.
2. J.A. Gallian : Contemporary Abstract Algebra, Narosa.
3. R.G. Bartle : Introduction to Real Analysis, Wiley.

Suggested books:

1. J.B. Fraleigh : A First course in Abstract Algebra, Pearson.
2. D.S. Dummit & R.M. Foote : Abstract Algebra, Wiley International edition.

Co-Curricular Course in Mathematics

Paper CC-2: Elementary Cryptography
(Pre-requisites: Mathematics in Class 12)

Credit: 2 **T:02**

Course Objectives:

1. To provide deeper understanding of mathematics used in cryptography
2. To familiarize with cryptographic techniques for secure communication of two parties over an insecure channel
3. To provide understanding of modern cryptography
4. To explain modern stream and block ciphers
5. To explain asymmetric key cryptography

Course Outcomes:

At the end of this course students will be able to:.

1. Use modern symmetric key algorithms for cryptography
2. Use modern asymmetric key algorithms for cryptography
3. To examine the issues and structure of modern stream and block ciphers

UNIT I

Overview of Cryptography, What is cipher?, Security Attacks, Security Services and Security Mechanisms, A model for Network Security, Symmetric Cipher Modes, Substitute Techniques, Transposition Techniques, Rotor Machines, Steganography.

UNIT II

Historical encryption schemes, Perfect secrecy and One Time Pad, Cryptanalysis of historical ciphers.

UNIT III

General structure of modern stream and block cipher, RC-4 stream cipher, DES and AES block cipher.

UNIT IV

Principles of Public key crypto system, Cryptography using arithmetic modulo primes, Diffie Hellman Key Exchange, the RSA algorithm, square-and-multiply, Key Management, Elliptic key cryptography.

Recommended Books:

1. Cryptography and Network Security, William Stallings, Prentice Hall.
2. Understanding Cryptography, Christof Paar and Jan Pelzl, Springer.

UG Semester IV
Paper 7: Mathematical Methods

Credit: 4 **T:04**

Course Outcomes:

1. To develop mathematical skills in calculus and analysis.
2. To get knowledge of Laplace Transforms and Fourier series.
3. To get acquainted with the essentials of calculus of variations.

UNIT I

Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic test, de Morgan and Bertrand's tests, alternating series, Leibnitz's theorem, absolute and conditional convergence. Sequences and series of functions: point wise and uniform convergence of sequences of functions, consequences of uniform convergence, integration and differentiation of series of functions.

UNIT II

Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms.

UNIT III

Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions, Fourier transforms (finite and infinite), Fourier integral.

UNIT IV

Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives, Functionals dependent on more than one independent variable, Variational problems in parametric form.

References:

Text Books:

1. T.M. Apostol. Mathematical Analysis, Pearson
2. RG Bartle, Introduction to Real Analysis, Wiley India

Suggested Readings:

1. G.F. Simmons, Differential Equations with Applications and Historical Notes, Tata- McGraw Hill
2. A.S. Gupta, Calculus of Variations with Applications Prentice Hall India.

Web References:

1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

Paper 8: Ordinary Differential Equations

Credit: 4 **T:04**

Course Outcomes:

1. Formulate Differential Equations for various Mathematical models.
2. Solve first order non-linear differential equation and linear differential equations of higher order using various techniques.
3. Apply these techniques to solve and analyze various mathematical models.
4. Conceptualize nature of critical points.

UNIT I

Differential Equations of first order and first degree, variable separable equations and equations reducible to this form, linear equations and Bernoulli equations, Exact differential equations and integrating factors, special integrating factors and transformations. Differential Equations of first order and higher degree, Clairaut equation, singular solutions. Orthogonal trajectories.

UNIT II

Linear Differential Equations with constant coefficients, homogeneous linear equation with constant coefficients, Wronskian, its properties and applications. Second order linear differential

equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters.

UNIT III

Systems of first order equations, linear systems, homogeneous linear systems with constant coefficients, Volterra's prey predator equations, The phase plane & its phenomena, types of critical points & Stability, Critical points & stability for linear system, stability by Liapunov's direct method.

UNIT IV

Series solutions of differential equations, Power series method. Bessel, Legendre and Hypergeometric functions and their properties, recurrence and generating relations.

References

Text Books:

3. B. Rai, D.P. Choudhary & H.J. Freedman, A Course in Differential Equations.
4. S. L Ross, Differential Equations, 3rd Edition, Wiley

Suggested Readings:

1. G.F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw Hill

(For students with Mathematics as a minor subject)

Paper Q4: Applicable Mathematics– IV

Credit: 2 **T:02**

Course Outcomes:

1. To understand application and techniques of solving various types of ordinary differential equations.
2. To understand the Laplace transforms and its applications in solving differential equations.
3. To understand Fourier series and Fourier transforms.
4. To understand standard techniques for finding numerical solution of ordinary differential equations.
5. To know the basic concepts of complex analysis including Cauchy's integral formula, derivative of analytic functions, Taylor's and Laurent's series.

UNIT I

Functions of complex variables - analytic functions, Cauchy - Riemann equations, harmonic functions, Cauchy's integral theorem.

UNIT II

Cauchy's integral formula, derivatives of analytic functions, formulae for first, second and nth derivatives, Taylor's and Laurent's series, singularities, zeroes and poles of order n.

UNIT III

Laplace transforms - existence theorem, Laplace transforms of derivatives and integrals, inverse Laplace transform, convolution theorem, applications to simple linear differential equations.

UNIT IV

Periodic functions, Fourier series, Fourier expansion of piecewise monotonic functions, half and full range expansions, Fourier transforms (finite and infinite), Fourier integral.

References:

Textbooks:

1. J.W. Brown and R.V. Churchill : Complex Variables and Applications, Mc Graw Hill.
2. Complex Variables, Schaum's Outline Series
3. G. F. Simmons : Differential Equations with Applications and Historical Notes, Tata McGraw Hill.
4. T. M. Apostol : Mathematical Analysis.

Vocational Course in Mathematics

Paper VC-2: Introduction to LaTeX using Overleaf

Credit: 2 **T:02**

Course Objectives:

1. To provide an introduction to technical writing, complex graphics, and computer presentations with LaTeX
2. To create basic types of LaTeX documents (article, report, letter, book)
3. To format words, lines, and paragraphs, design pages, create lists, tables, references, and figures in LaTeX.
4. To typeset the complicated mathematics: basic formulas (inline), centered and numbered equations, aligning multi-line equations.
5. To list the content and references: creating a table of contents, lists of figures and tables, create bibliographies, and generate the index.
6. To create professional presentation slides using LaTeX.

Course Outcomes:

At the end of this course students will be able to:

1. Having the skill of using high-quality typesetting system.
2. LaTeX for publication of research papers, theses and book chapters.
3. Typesetting of complex mathematical formulae using LaTeX.
4. Create Tables, Graphics and Pictures Lists, Arrays and Bibliography by using LaTeX.
5. Create Slides with Beamer.

UNIT I

Introduction to LaTeX. Online Overleaf access. Structure of LaTeX document. Defining class of the document. Packages and different environments. Writing the first LaTeX content. Creating a Title, chapters and sections and their labeling, basics of LaTeX syntax, page style, fonts, font sizes, font styles.

UNIT II

Labelling Table of Contents, coloured text, boxes, theorems, comments & spacing, special characters, line breaking. Columns, multi-columns and minipages. Page numbering, foot notes, headers and footers. Fancy page styles. Short cuts and definitions.

UNIT III

Introduction to mathematics environment, writing Greek symbols, some basic mathematics type structure: fractions, superscript, subscript, overline, underline etc.Matrix, determinant and other similar structure. Writing Equations and Arrays. Equation references. Introduction to *amsmath* package. Various mathematical operation symbols.Inserting pictures and tables, creating reference database.

UNIT IV

Presentations in LaTeX. Introduction to beamer class. Themes of beamer presentations.

Recommended Books:

1. LaTeX 2e: An Unofficial Reference Manual by Karl Berry, Stephen Gilmore, et al.
2. Latex: A Document Preparation System, 2/E, A Document Preparation System User's Guide and Reference Manual Leslie Lamport
3. https://www.cs.ntua.gr/~sivann/books/LaTeX%20-%20User's%20Guide%20and%20Reference%20Manual-lamport94.pdf
4. https://www.overleaf.com/learn
5. https://www.colorado.edu/aps/sites/default/files/attached-files/latex_primer.pdf