

UNIVERSITY DEPARTMENT OF MATHEMATICS
VINOBA BHAVE UNIVERSITY
HAZARIBAG



NEP FYUGP CURRICULUM

**MATHEMATICS HONOURS/
MATHEMATICS HONOURS WITH RESEARCH**

For Undergraduate Courses under Vinoba Bhave University, Hazaribag

Under NEP – 2020

Implemented from academic Session 2025 – 2026

& onwards

FYUGP SYLLABUS OF MATHEMATICS FOR 2025 ONWARDS
V.B.U, HAZARIBAG(PAGE NO. 2-5 ACC, 6-28 PATH-B, 29-54 PATH-A)

SEMESTER	SUBJECT NAME	PAPER CODE (MINOR)	CREDIT	NUMBER OF LECTURES
I	CALCULUS	ASSOCIATED CORE COURSE AC-1	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) Understand the circular and Hyperbolic functions.
- (b) To know the method of finding area and volume of surface of revolution through calculus.
- (c) Learn various integration techniques appearing in Physics, Chemistry and other allied sciences.
- (d) Learn about vector function and its limit, continuity and differentiability.

UNIT-I: Differential calculus

Differentiation of Hyperbolic functions, logarithmic and exponential functions, higher order derivatives, Leibnitz Theorem and its applications, concavity and inflection points, asymptotes, curvature, Singular Points, L'Hospital's rule. (2

Questions)

UNIT-II: Integral calculus

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x \, dx$, $\int \cos^n x \, dx$, $\int \tan^n x \, dx$, $\int \sin^n x \cdot \cos^m x \, dx$, $\int \sin^m x \cos^n x \, dx$, $\int (\log x)^n \, dx$, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, volume and area of surface of revolution. (2

Questions)

UNIT-III: Vector calculus

Triple product of vectors, introduction to vector functions, operations with vector-valued functions, limits, continuity of vector functions. Gradient, Divergence, Curl and Laplacian operators. Statements of Stoke's, Green's and Gauss- Divergence theorems and their applications. (2

Questions)

References:

1. R. K. Dwivedi, Calculus, 1st Edition, Pragati Prakashan, Meerut, India, 2019.
2. Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th edition). Wiley India.
3. Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.
4. Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.
5. Gorakh Prasad (2016). Differential Calculus (19th edition). Pothishala Pvt. Ltd.
6. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). Thomas' Calculus (14th edition). Pearson Education.

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SEMESTER	SUBJECT NAME	PAPER CODE (MINOR)	CREDIT	NUMBER OF LECTURES
III	ALGEBRA	ELECTIVE COURSE ELC – 1	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Learn and apply De-Moivre's theorem.
- b) Understand relation and functions.
- c) Basic concept of theory of Numbers.
- d) Rank of matrix and solution of system of linear equations.
- e) Evaluation of Eigen values and Eigen vectors of a matrix.

UNIT-I: Matrices and Determinants, System of linear equations: Rank of a matrix, row space, column space, row rank, column rank, Matrix form of system of linear equations, augmented matrix, consistent and inconsistent system of linear equations, necessary and sufficient condition consistency of a system of linear equations, method of solving of homogeneous and non-homogeneous linear equations. (2

Questions)

UNIT-II: Basics of Vector spaces and Linear transformation, Matrix associated with linear transformation, Eigen values and Eigen vectors of matrices, Inverse of a matrix, Characterization of invertible matrices, Characteristic polynomial of a matrix, Eigen values and Eigen vectors, Theorems on Eigen values and Eigen vectors. (2

Questions)

UNIT-III: Relations between the roots and coefficients of general polynomial equation in one variable, Solutions of polynomial equations having conditions on roots, Common roots and multiple roots, Transformation of equations, Nature of the roots of an equation, Descarte's rule of signs, Solution of cubic equation (Cardon's method), Biquadratic equations and their solutions. (2

Questions)

References:

1. Pankaj Kumar Manjhi, Algebra, 1st edition, Pragati Prakashan, Meerut, 2018.
2. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
3. Higher algebra by Hall and Knight.
4. Introduction to the Theory of Equations" by L. N. Hand and J. D. Finney.

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SEMESTER	SUBJECT NAME	PAPER CODE (MINOR)	CREDIT	NUMBER OF LECTURES
V	NUMERICAL ANALYSIS	ELECTIVE COURSE ELC - 2	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Note- Use of Scientific Calculator is allowed in the examination

Course Objective & Learning Outcomes: This course will enable the students to:

- Obtain numerical solutions of algebraic and transcendental equations.
- Find numerical solutions of system of linear equations and check the accuracy of the solutions.
- Learn about various interpolating and extrapolating methods.
- Solve initial and boundary value problems in differential equations using numerical methods.

UNIT-I: Expansion of functions and Numerical Methods for Solving Algebraic and Transcendental Equations

Maclaurin's and Taylor's theorem for expansion of a function in an infinite series, Introduction of errors; Algorithms and convergence; Bisection method, Newton- Raphson method and Secant method for solving equations. **(2 Questions)**

UNIT-II: Numerical Methods for Solving Linear Systems

Partial and scaled partial pivoting, Direct methods: Gauss' Elimination, Gauss' Jordan method; Lower and upper triangular (LU) decomposition (Crout's method) of a Matrix and its applications. Iterative methods: Gauss-Jacobi method, Gauss-Seidel method. **(1 Questions)**

UNIT-III: Interpolation

Gregory-Newton forward and backward difference interpolations, Lagrange's interpolation, Newton's divided difference interpolation. **(1 Question)**

UNIT-IV: Numerical Differentiation and Integration

First order and higher order approximation for first derivative, Approximation for second derivative, Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8th rule. **(1 Question)**

UNIT-V: Initial and Boundary Value Problems of Differential Equations

Definition of Initial value problem and Boundary value Problem, Picard's iteration method, Euler's method, Modified Euler's method, Runge-Kutta methods (second and fourth order). **(1 Question)**

References:

- H. K. Mishra and G. K. Jha (2023), An introduction to numerical Analysis and Technique, 1st Ed., Walnut Publication.
- Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
- C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.
- F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.
- M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition). New Age International Publishers.
- Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.
- H. K. Dass & Rama Verma, Engineering Mathematics-I (Calculus)

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SEMESTER	SUBJECT NAME	PAPER CODE MINOR	CREDIT	NUMBER OF LECTURES
VII	DIFFERENTIAL EQUATION	ELECTIVE COURSE ELC - 3	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: The course will enable the students to:

- a) Understand the genesis of ordinary differential equations.
- b) Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
- c) Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.

UNIT-I: First Order Differential Equations: Formation and solutions of differential Equations, Differential equations of first order and first degree, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x , y and p . Clairaut's form and singular solutions.
(2 Questions)

UNIT-II: Higher Order Linear Differential Equations: Linear differential equations and their solutions, Solutions of linear differential equations of second order with constant and variable coefficients, Transformations of the equation by changing the dependent/ independent variable.
(2 Questions)

UNIT-III: Method of variation of parameters and method of undetermined coefficients. Method of reduction of order, Principal of superposition for a homogeneous linear differential equation, linearly dependent and linearly independent solutions, Euler-Cauchy Equation.
(2 Questions)

References:

1. G.K. Jha and Sarita Jha, Undergraduate Differential Equation, 1st Edition, Pragati Prakashan, Meerut, 2019.
2. H. I. Freedman (1980). Deterministic Mathematical Models in Population Ecology. Marcel Dekker Inc.
3. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
4. Daniel A. Murray (2003). Introductory Course In Differential Equations, Orient.
5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). A Course in Ordinary Differential Equations (2nd edition). Narosa.
6. Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India.
7. George F. Simmons (2017). Differential Equations with Applications and Historical Notes.

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Course Objective & Learning Outcomes: This course will enable the students to:

SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
I	CALCULUS	MJ-1	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

- Understand various integration techniques appearing in engineering and research.
- Sketch curves in Cartesian and polar coordinate systems.
- Learn differentiation of several types of functions.

UNIT-I: Differential calculus

Differentiation of Hyperbolic, logarithmic and exponential functions. Higher order derivatives, Leibnitz Theorem and its applications, Concavity and Inflection points, Asymptotes, Curvature of a curve. L'Hospital's rule.

(2 Questions)

UNIT-II: Integral calculus

Reduction formulae, derivations and illustrations of reduction formulae of the types $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sin^n x \cos^m x dx$, $\int \sin^n x \cos^m x dx$, $\int (\log x)^n dx$, parameterizing a curve, arc length, arc length of parametric curves, volume and area of surface of revolution.

(2 Questions)

UNIT-III: Curve tracing and Conics

Curve tracing in Cartesian and polar coordinates. Techniques of sketching conics. Transformation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

(2 Questions)

References:

- R. K. Dwivedi, Calculus, 1st Edition, Pragati Prakashan, Meerut, India, 2019.
- Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th Edition). Wiley India.
- Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.
- Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.
- Gorakh Prasad (2016). Differential Calculus (19th edition). Pothishala Pvt. Ltd.
- George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018).
- Thomas' Calculus (14th edition). Pearson Education.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
II	ALGEBRA	MJ-2	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Learn and apply the application of Complex Number through De Moivre's theorem.
- Basic concept of theory of Numbers.
- Evaluation of Rank, Eigen values and Eigen vectors of a matrix.

UNIT-I: Trigonometry

Polar form of complex number, nth roots of unity, De Moivre's Theorem, Applications of De Moivre's Theorem, Logarithm of complex numbers. **(1 Question)**

UNIT-II: Theory of Equations

Relations between the roots and coefficients of general polynomial equation in one variable, Solutions of polynomial equations having conditions on roots, Common roots and multiple roots, Transformation of equations, Nature of the roots of an equation, Descarte's rule of signs, Solution of cubic equation (Cardon's method), Biquadratic equations and their solutions. **(2 Questions)**

UNIT-III: Theory of numbers

Well-ordering property (WOP) of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, Fundamental Theorem of Arithmetic. **(1 Question)**

UNIT-IV:

Definition and examples of groups, Abelian groups, Permutation groups, Cycle notation for permutations, Even and Odd permutations, Quaternion group and its matrix representation, Elementary properties of groups, Order of a group element and Order of a group, Subgroups and examples, Theorems on subgroups, Cyclic groups and its Properties, Classification of subgroups of Cyclic groups, Cosets and their properties. **(2 Questions)**

References:

- Pankaj Kumar Manjhi, Algebra, 1st Edition, Pragati Prakashan, Meerut, 2018.
- Dr. Manoranjan Kumar Singh, A Text Book of Advanced Trigonometry, 1st Edition, Kedar Nath Ram Nath Publication, 2015.
- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
- W. S. Burnside and A. W. Panton, The Theory of Equations, Dublin University Press, 1954.
- C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc. 1954.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
III	REAL ANALYSIS	MJ-3	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- Understand many properties of the real line \mathbb{R} and learn to define sequence in terms of functions from \mathbb{R} to a subset of \mathbb{R} .
- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
- Learn some of the properties of continuous and uniformly continuous functions.

UNIT-I: Real Number System

Algebraic and order properties of \mathbb{R} , Absolute value of a real number; Bounded above and bounded below sets, Supremum and Infimum of a nonempty subset of \mathbb{R} , The completeness property of \mathbb{R} , Archimedean property, Countable set, Uncountable sets and theorems, Closure of a set, Dense set, Density of Rational numbers in \mathbb{R} , Definition and types of intervals, Nested intervals property; Neighbourhood of a point in \mathbb{R} , Open and closed sets in \mathbb{R} .
(2 Questions)

UNIT-II: Limit and Continuity

$\varepsilon - \delta$ Definition of limit of a real valued function, limit at infinity and infinite limits. Continuity of a real valued function, Properties of continuous functions. Intermediate value theorem, geometrical interpretation of continuity, Types of discontinuity, Uniform continuity.
(2 Questions)

UNIT-III: Differentiability

Differentiability of a real valued function, Geometrical interpretation of differentiability. Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation Darboux's theorem. Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, geometrical interpretation of mean value theorems.
(2 Questions)

References:

- R. K. Dwivedi, Real Analysis, 1st Edition, Pragati Prakashan, Meerut, India, 2020.
- Robert G. Bartle & Donald R. Sherbert, Introduction to Real Analysis (4th edition), Wiley India, 2015.
- Gerald G. Bilodeau, Paul R. Thie & G. E. Keough, An Introduction to Analysis (2nd edition), Jones and Bartlett India Pvt. Ltd., 2015.
- K. A. Ross, Elementary Analysis: The Theory of Calculus, 2nd edition, Springer, 2013.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
III	DIFFERENTIAL EQUATIONS	MJ-4	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: The course will enable the students to:

- a) Understand the genesis of ordinary differential equations.
- b) Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
- c) Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.

UNIT-I: First Order Differential Equations

Differential equations of first order and first degree, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x , y and p . Clairaut's form and singular solutions. (2 Questions)

UNIT-II: Higher Order Linear Differential Equations

Linear differential equations of second order with constant and variable coefficients. Transformations of the equation by changing the dependent/ independent variable. Method of variation of parameters and method of undetermined coefficients. Principal of superposition for a homogeneous linear differential equation. Method of reduction of order. Euler-Cauchy Equation. (2 Questions)

UNIT-III: Series Solutions of Differential Equations

Definition of power series, radius of convergence, ordinary and singular points; Power Series solution: near ordinary point, near regular singular points (Frobenius methods). Bessel's equation; Bessel's function and its recurrence relations. Legendre's equation; Legendre's polynomial and its recurrence relations. (2 Questions)

References:

1. G.K. Jha and Sarita Jha, Undergraduate Differential Equation, 1st Edition, Pragati Prakashan, Meerut, 2019
2. Belinda Barnes & Glenn Robert Fulford (2015).
4. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
5. Daniel A. Murray (2003). Introductory Course In Differential Equations, Orient.
6. B. Rai, D. P. Choudhury & H. I. Freedman (2013). A Course in Ordinary Differential Equations (2nd edition). Narosa.
7. Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India.
8. George F. Simmons (2017). Differential Equations with Applications and Historical Notes.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
IV	VEDIC MATHEMATICS (Under IKS)	MJ-5	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes

- (a) Help students appreciate ancient Indian Mathematics and its contribution to the world.
- (b) Understand basic tenets of geometry used in ancient India.
- (c) Solve the mathematical problems faster and with ease.
- (d) Appreciate the Mathematical advancements of Ancient India.

UNIT-I: Contribution of Indian Mathematicians

Baudhayana, Apastamba, Aryabhata I,II, Bhaskara I,II, Lilavati, Pingala, Mahavir, Narayan Pandit, Jyesthadev, Parmeshvaran, Madhavan, Gangesh Upadhyay, Vachaspati Mishra, Paksadhar Mishra, Mahesh Thakur.
(1 Question)

UNIT-II: Vedic Maths- High Speed Addition, Subtraction , Multiplication, division, squares, and cubes

History of Vedic Maths and its Features, Vedic Maths formulae: Sutras and Upsutras, Addition in Vedic Maths: Without carrying, Dot Method, Subtraction in Vedic Maths: Nikhilam Navatashcaramam Dashatah (All from 9 last from 10), Fraction -Addition and Subtraction, Multiplication in Vedic Maths: Base Method (any two numbers upto three digits), Multiplication by Urdhva Tiryak Sutra, Miracle multiplication: Any three-digit number by series of 1's and 9's, Division by Urdhva Tiryak Sutra (Vinculum method), Squares of any two-digit numbers: Base method, Square of numbers ending in 5: Ekadhikena Purvena Sutra, Easy square roots: Dwandwa Yoga (duplex) Sutra, Square root of 2: Baudhayana Shulbasutra, Cubing: Yavadunam Sutra.

(2 Questions)

UNIT-III: Vedic Maths-Enlighten Algebra and Geometry

Factoring Quadratic equation: Anurupyena, Adyamadyenantyamanty Sutra, Concept of Baudhayana (Pythagoras) Theorem, Circling a square: Baudhayana Shulbasutra, Concept of pi: Baudhayana Shulbasutra, Concept angle (8) 0°, 30°, 45°, 60° and 90°: Baudhayana number, Introduction of simple equation, Solutions of simple equations, Solutions of linear equations in two variables, Practical application of linear equations in two variables, Introduction and history of Matrices and Determinants, Matrices and Determinants of third order, Inverse of Matrices.

(2 Questions)

UNIT-IV: Wonder World of Indian Mathematics

Pingal's binary number system, Different types of Meru Prastar(including Pascal Triangle), Applications of Meru Prastar, Introduction to Complex number, Baudhayana form of Complex, Addition & Subtraction of Complex number, Multiplication of Complex numbers, Introduction to differentiation, Application of derivatives, Introduction to Integration, Application of Integrations.

(1 Question)

Reference Books:

1. Vedic Mathematics, Swami Bharati Krishna Trithaji, Motilal Banarsidas, New Delhi.
2. The Essential of Vedic Mathematics, Rajesh Kumar Thakur, Rupa Publications, New Delhi.
3. Vedic Mathematics For All Ages, Vandana Singhal, Motilal Banarsidas Publishers.
4. Elements of Vedic Mathematics, Udayan S. Patankar, Sunil M. Patankar, TTU Press.
5. Vedic Mathematics: The Problem Solver, Ronak Bajaj, Black Rose Publications.
6. Vedic Geometry Course, S. K. Kapoor, Lotus Press.
7. Gardner, Robert and J.F. Staal. Altar of Fire. Documentary. The Film Study Center at Harvard University, 1976.
8. Bimal Kumar Mishra, Vedic Ganit, Techniz Books Pvt. Ltd. New Delhi, 2018.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
IV	MULTIVARIATE CALCULUS	MJ-6	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Learn conceptual variations while advancing from one variable to several variables in calculus.
- Apply multivariable calculus in optimization problems.
- Inter-relationship amongst the line integral, double and triple integral formulations.
- Understanding importance of Green, Gauss and Stokes' theorems.

UNIT-I: Partial Differentiation

Functions of several variables, Limits and continuity, Partial differentiation, Chain rule. Higher order partial derivatives, Total differential & differentiability, Jacobians, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of two variables. **(2 Questions)**

UNIT-II: Extrema of Functions

Extrema of functions of two and more variables, Method of Lagrange's multiplier. **(1 Question)**

UNIT-III: Double and Triple Integrals

Double integral and triple integral, Change of order of integration, Surface area by double integrals, Volume by triple integrals, Change of variables in double and triple integrals, Dirichlet's integral. **(1 Question)**

UNIT-IV: Vector Calculus

Definition of vector field, Vector Differentiation, Directional derivative. Divergence, Curl, Gradient and vector identities, Vector integration. **(1 Question)**

UNIT-V: Green's, Stokes' and Gauss Divergence Theorem

Line integrals, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem. **(1 Question)**

References:

- Jerrold Marsden, Anthony J. Tromba & Alan Weinstein, Basic Multivariable Calculus, Springer India Pvt. Limited, 2009.
- James Stewart, Multivariable Calculus (7th edition). Brooks/ Cole. Cengage, 2012.
- Monty J. Strauss, Gerald L. Bradley & Karl J. Smith, Calculus (3rd Edition), Pearson Education. Dorling Kindersley (India) Pvt. Ltd., 2011.
- George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir, Thomas' Calculus (14th edition). Pearson Education, 2018.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
IV	ANALYTICAL GEOMETRY	MJ-7	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: The course will enable the students to:

- Gain knowledge of the concept of different conic sections, their classification and properties.
- Have knowledge of general form of equation of a sphere and attain procedural knowledge required for solving problem.
- Explore conic sections, lines, planes, and surfaces using equations.
- Use transformations to manipulate geometric figures.
- Analyze the position and intersection of geometric entities in space.
- Learn skills to formulate and solve real life practical problems on sphere, cone and cylinder.

UNIT-I: General equation of second degree

Classification of conic sections; centre, asymptotes, axes, eccentricity, foci and directrices of conics. Tangent at any point to a conic, chord of contact, pole of line to a conic, director circle of a conic. Polar equation of a conic, tangent and normal to a conic, confocal conics. (2 Questions)

UNIT-II: Sphere

General form, Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, tangent plane and line, polar plane and line, orthogonal spheres, radical plane of two spheres and co-axial system of spheres. Cone: Equation of a cone, right circular cone, quadric cone, enveloping cone. Tangent plane and condition of tangency. (2 Questions)

UNIT-III: Cylinder

Right circular cylinder and enveloping cylinder. Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a conicoid, Enveloping cylinder of a conicoid, confocal conicoid, reduction of second degree equations. (2 Questions)

References:

- Robert J. T. Bell (2022). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Legare Street Press.
- D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.
- Shanti Narayan and P.K. Mittal (2007). Analytical Solid Geometry. S. Chand and Company.
- Gordon Fuller and Dalton Tarwater (1992). Analytic Geometry (7th edition). Pearson.
- J.H. Kindle (1990). Analytic Geometry. McGraw-Hill.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
V	PARTIAL DIFFERENTIAL EQUATION (PDE)	MJ-8	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- Apply a range of techniques to solve first and second order partial differential equations.
- Understand problems, methods and techniques of Partial differential equations.
- Learn Heat, Wave and Laplace equations.

UNIT-I: First Order Partial Differential Equations

Basic concepts, definition: order and degree, of a PDE; Concept of linear, quasi-linear and non-linear partial differential equations. Partial differential equations of the first order: Formation, classification and geometrical interpretation. Lagrange's method, method of separation of variables for first order PDE, Canonical forms of first order linear equations, standard forms of Non-linear PDE of first order; Charpit's general method.

(2 Questions)

UNIT-II: Higher order Partial Differential Equations

Classification of second order linear partial differential equations with constant coefficients: Homogeneous and non-homogeneous equations, solution of second and higher order PDE's with constant coefficient. Partial differential equations reducible to equations with constant coefficient, solution of second order PDE with variable coefficients, Monge's method.

(2 Questions)

UNIT-III: Second Order Partial Differential Equations

Classification of second order linear PDE as Hyperbolic, Parabolic or Elliptic. Reduction of second order linear equations to Canonical or Normal forms (working method). Introduction of heat, wave and Laplace equations; Method of separation of variables for solving heat, wave and Laplace equations.

(2 Questions)

References:

- G.K. Jha and Sarita Jha, Partial Differential Equation and System of Ordinary Differential Equation, 1st Edition, Pragati Prakashan, Meerut, 2019.
- Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
- TynMyint-U & Lokenath Debnath (2013). Linear Partial Differential Equation for Scientists and Engineers (4th edition). Springer India.
- S. B. Rao & H. R. Anuradha (1996). Differential Equations with Applications. University Press.
- Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
V	NUMERICAL ANALYSIS	MJ-9	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Note- Use of Scientific Calculator is allowed in the examination

Course Objective & Learning Outcomes: This course will enable the students to:

- Obtain numerical solutions of algebraic and transcendental equations.
- Find numerical solutions of system of linear equations and check the accuracy of the solutions.
- Learn about various interpolating and extrapolating methods.
- Solve initial and boundary value problems in differential equations using numerical methods.

UNIT-I: Numerical Methods for Solving Algebraic and Transcendental Equations

Introduction of errors; Algorithms and convergence; Bisection method, Newton-Raphson method and Secant method for solving equations. **(1 Question)**

UNIT-II: Numerical Methods for Solving Linear Systems

Partial and scaled partial pivoting, Direct methods: Gauss' Elimination, Gauss' Jordan method; Lower and upper triangular (LU) decomposition (Crout's method) of a Matrix and its applications. Iterative methods: Gauss-Jacobi method, Gauss-Seidel method. **(1 Question)**

UNIT-III: Interpolation

Gregory-Newton forward and backward difference interpolations, Lagrange's interpolation, Newton's divided difference interpolation. **(1 Question)**

UNIT-IV: Numerical Differentiation and Integration

First order and higher order approximation for first derivative, Approximation for second derivative, Numerical integration: Trapezoidal rule, Simpson's $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rule. **(2 Questions)**

UNIT-V: Initial and Boundary Value Problems of Differential Equations

Definition of Initial value problem and Boundary value Problem, Picard's iteration method, Euler's method, Modified Euler's method, Runge-Kutta methods (second and fourth order). **(1 Question)**

References:

- H. K. Mishra and G. K. Jha (2023), An introduction to numerical Analysis and Technique, 1st Ed., Walnut Publication.
- Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
- C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.
- F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.
- M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition). New Age International Publishers.
- Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
V	GROUP AND RING THEORY	MJ-10	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Understand the basic concepts of group, ring and their properties.
- Recognize factorization and integral domain.
- Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.
- Learn in detail about polynomial rings, fundamental properties.

UNIT-I: Normal subgroups and Isomorphism

Normal subgroups and their properties, Centralizer (Normalizer) of a group element, Centre of a group. Lagrange's theorem and consequences including Fermat's little theorem. Group homomorphism, Kernel of Homomorphism, Properties of homomorphism, Isomorphism and its properties, Factor groups (Quotient groups). Cauchy's theorem for finite Abelian groups. First, Second and Third Isomorphism theorems, Cayley theorem. (2 Questions)

UNIT-II: Introduction to ring

Definition and examples of rings, elementary properties of rings, Ring with or without Zero divisors, Integral Domain and Field, Divisor ring or skew field, subring, subfield, characteristic of a ring. (2 Questions)

UNIT-III: Ring homomorphism and Polynomial ring

Definition, example and properties of Ring homomorphism; first, second and third Isomorphism theorems of rings; quotient field; polynomial ring over commutative ring, Division algorithm and consequences. (2 Questions)

References:

- Pankaj Kumar Manjhi (2023), Introduction to ring Theory, 1st Ed., Pragati Prakashan Meerut, India.
- P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). Basic Abstract Algebra (2nd edition). Cambridge University Press.
- David S. Dummit & Richard M. Foote (2008). Abstract Algebra (2nd edition). Wiley.
- John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
- Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
- N. S. Gopalakrishnan (1986). University Algebra, New Age International Publishers.
- I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
- Thomas W. Hungerford (2004). Algebra (8th edition). Springer.
- Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
- Serge Lang (2002). Algebra (3rd edition). Springer-Verlag.
- I. S. Luthar & I. B. S. Passi (2013). Algebra: Volume 1: Groups. Narosa.
- I. S. Luthar & I. B. S. Passi (2012). Algebra: Volume 2: Rings. Narosa.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
V	SEQUENCE AND SERIES	MJ-11	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Understand and define the concepts of sequence, sub-sequence, limit and convergence within the framework of real numbers.
- Distinguish between bounded, monotonic and Cauchy sequences and prove related theorems.
- Define and analyze the series of real numbers and the concept of partial sums.
- Determine the convergence or divergence of series using various tests.
- Interpret the geometric and analytical meaning of the remainder terms and its role in approximation accuracy.

UNIT-I: Sequences of Real Numbers

Convergent sequence, limit of a sequence, Bounded sequence, limit theorems, Monotone sequences, Monotone convergence theorem, Subsequence, Bolzano-Weierstrass theorem for sequences, limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy's convergence criterion.

(2 Questions)

UNIT-II: Infinite Series: Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series; Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test, De Morgan and Bertrand test, Integral test, Alternating series, Leibnitz test, Absolute and Conditional convergence. **(2 Questions)**

UNIT-III: Expansions of Functions

Maclaurin's and Taylor's theorem for expansion of a function in an infinite series; Taylor's theorem in finite form with Lagrange, Cauchy and Roche-Schlomilch forms of remainder. **(2 Questions)**

References:

- G.K. Jha and Sarita Jha, Theory of Functions, 1st Edition, Pragati Prakashan, Meerut, 2019.
- Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th edition). Wiley, India.
- Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.
- Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.
- Gorakh Prasad (2016). Differential Calculus (19th edition). Pothishala Pvt. Ltd.
- George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). Thomas' Calculus (14th edition). Pearson Education.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VI	MECHANICS	MJ-12	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Learning various technical notions which explain various states of motion under given forces.
- Understand necessary conditions for the equilibrium of particles.
- Understand Kepler's laws of the planetary motions.

UNIT-I: Statics

Law of parallelogram of forces, Lami's theorem, Equilibrium of a system of particles, External and internal forces, Couples, Reduction of a plane force system, Work, Principle of virtual work, Potential energy and conservative field, Centre of Mass, Centers of gravity, Friction. **(3 Questions)**

UNIT-II: Dynamics

Motion of a particle, Motion of a system, Principle of linear momentum, Principle of angular momentum, Motion relative to mass center, Principle of energy. D' Alembert's principle; Moving frames of reference, Frames of reference with uniform translational velocity, Frames of reference with constant angular velocity; Applications in plane dynamics- Motion of a projectile, Harmonic oscillators, General motion under central forces, Planetary orbits. **(3 Questions)**

References:

- Synge, J. L., & Griffith, B. A. (2017). Principles of Mechanics (3rd Ed.). McGraw-Hill Education. Indian Reprint.
- Ramsey, A. S. (2017). Hydrostatics. Cambridge University Press. Indian Reprint.
- Roberts, A. P. (2003). Statics and Dynamics with Background Mathematics. Cambridge University Press.
- Ramsey, A. S. (1985). Statics (2nd ed.). Cambridge University Press.
- Laxmi Publication Book.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VI	LINEAR PROGRAMMING PROBLEM (LPP)	MJ-13	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Analyze and solve linear programming models of real-life situations.
- Provide graphical solution of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.
- Solve linear programming problems using simplex method.
- Learn techniques to solve transportation and assignment problems.
- Solve two-person zero sum game problems.

UNIT-I: Linear Programming Problem, Convexity and Basic Feasible Solutions

Formulation and examples, Canonical and Standard forms, Convex and polyhedral sets, Extreme points, Basic solutions, Basic Feasible Solutions, Correspondence between basic feasible solutions and extreme points, Graphical solution. **(1 Question)**

UNIT-II: Simplex Method

Optimality criterion, improving a basic feasible solution, Unboundedness, Simplex method, slack variable, surplus variable, artificial variables, Two-phase method, Big-M method. **(2 Questions)**

UNIT-III: Duality

Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, solving the primal problem using duality theory. **(1 Question)**

UNIT-IV: Transportation and Assignment Problems

Formulation of transportation problems, Methods of finding initial basic feasible solutions: North-west corner rule, least cost method, Vogel approximation method, Algorithm for obtaining optimal solution; Formulation of assignment problems, Hungarian method. **(2 Questions)**

References:

- Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). Linear Programming and Network Flows (4th edition). John Wiley & Sons.
- G. Hadley (2002). Linear Programming. Narosa Publishing House.
- Frederick S. Hillier & Gerald J. Lieberman (2015). Introduction to Operations Research (10th edition). Mc Graw-Hill Education.
- Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition). Pearson.
- Paul R. Thie & Gerard E. Keough (2014). An Introduction to Linear Programming and Game Theory (3rd edition). Wiley India Pvt. Ltd.
- B.N. Mishra, B.K. Mishra, Optimization: Linear Programming, ANE Books Pvt. Ltd. New Delhi, 2022, 5th Edition.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VI	LINEAR ALGEBRA	MJ-14	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs.)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Visualize the space \mathbb{R}^n in terms of vectors and their interrelation with matrices.
- b) Understand the concepts of Vector Spaces, subspaces, bases, dimension and their properties.
- c) Relate matrices and linear transformations
- d) Compute Eigen values and Eigen vectors of linear transformations.

UNIT I: Matrices and System of linear equations

Rank of a matrix, Matrix form of system of linear equations, augmented matrix, consistent and inconsistent system of linear equations, necessary and sufficient condition for consistency of a system of linear equations, solution of homogeneous and non-homogeneous linear equations. **(2 Questions)**

UNIT-II: Vector Spaces

Definition and examples, Subspace, Linear span Quotient space and direct sum of subspaces, linearly independent and dependent sets, Bases and dimension. **(2 Questions)**

UNIT-III: Linear Transformations and its properties

Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem. Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and Eigen values of a linear transformation, Characteristic polynomial and Cayley-Hamilton theorem, Minimal polynomial. **(2 Questions)**

References:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). Linear Algebra (4th edition). Prentice-Hall of India Pvt. Ltd.
2. Dr. Manoranjan Kumar Singh, Group Theory II, 1 st Edition, S. Chand, Publication 2022.
3. Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall.
4. I. M. Gel'fand (1989). Lectures on Linear Algebra. Dover Publications.
5. Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
6. Serge Lang (2005). Introduction to Linear Algebra (2nd edition). Springer India.
7. Vivek Sahai & Vikas Bist (2013). Linear Algebra (2nd Edition). Narosa Publishing House.
8. Gilbert Strang (2014). Linear Algebra and its Applications (2nd edition). Elsevier.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VI	PROBABILITY AND STATISTICS	MJ-15	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- Understand distributions in the study of the behavior of random variables.
- Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.
- Understand the fact that many natural populations exhibit normal curves using central limit theorem.

UNIT-I: Discrete Probability Distributions

Sample spaces and events, probability axioms and properties, Conditional probability and independence, Baye's theorem; Discrete Random variables, Probability mass functions, Cumulative distribution function, expected value. Discrete distributions: Uniform, Bernoulli, Binomial, Geometric, Poisson. **(2 Questions)**

UNIT-II: Continuous Probability Distributions

Continuous random variable, probability density function, cumulative distribution functions, expected value; Distributions: Uniform, Gamma, Exponential, Normal; Normal approximation to the binomial distribution. **(2 Questions)**

UNIT-III: Correlation, Regression and Central Limit Theorem

The Correlation coefficient, Covariance, Independent random variables, Linear regression for two variables, The method of least squares, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers. **(2 Questions)**

References:

- Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). Introduction to Mathematical Statistics (7th edition), Pearson Education.
- Irwin Miller & Marylees Miller (2014). John E. Freund's Mathematical Statistics with Applications (8th edition). Pearson. Dorling Kindersley Pvt. Ltd. India.
- Jim Pitman (1993). Probability, Springer-Verlag.
- Sheldon M. Ross (2014). Introduction to Probability Models (11th edition). Elsevier.
- A. M. Yaglom and I. M. Yaglom (1983). Probability and Information. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VII B	DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS	MJ-16	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) Grasp the idea of hyper-geometric function, Ramanujan's theorem.
- (b) Understand Hermite polynomials, orthogonal properties.
- (c) Clear the idea of generating functions.
- (d) Learn about Jacobi polynomials, elliptic functions.

UNIT-I:

Introduction of generalized Hypergeometric function. Differential equation satisfied by pFq. Saalschut 'z' Theorem, Whipples theorem Dixon's theorem. Integrals involving generalized Hypergeometric function. Contiguous function relations. Kummer's Theorem. Ramanujans theorem. **(2 Questions)**

UNIT-II:

Introduction of Hermite Polynomials. Recurrence relation. Orthogonal properties, expansion of polynomials generating funtion. Rodrigues formula for Hermite polynomials. **(1 Question)**

UNIT-III:

Introduction of Laguerre polynomials. Recurrence relations, generating relating. Rodrigues formula and orthogonality. Expamry special results. Laguerre's associated differential equation. More generating function. **(2 Questions)**

UNIT-IV:

Introduction of Jacobi Polynomials generating function. Rodrigues formula and orthogonality. Introduction of Ellipite function. Properties. Weierstrass ellipite. Jacobion theta function zeros of theta function. **(1 Question)**

References:

1. W.T. Reid. Ordinary Differential Equations. John Wiley & Sons. NY. (1971).
2. E.A. Coddington and N. Levinson. Theory of Ordinary Differential Equations. Mc Graw Hill, NY (1955).
3. Sneddon, I. N. (1961) Special Function of Mathematical Physics and Chemistry :Oliver and Boyd.
4. EdinbMorse. P.M. and H. Fasth bach (1953) Methods of theoretical Physics. Part-1, Mc-Graw Hill, Book, Conv. Lue.
5. Labedev, N.N. (1965) Special function and their applications : Printice-Hall, Englewodd cliff. N.J.
6. Bailey, W.N. (1963) Generalised Hyper geometric Cambridge Tracks in Mathematics and Mathematical Physics. Cambridge University, Press London.
7. Bell. W.W. (1966) Special function for Scientific and Engineers; D. Van Nontrand Conv.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VII B	ADVANCED REAL ANALYSIS	MJ-17	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- Understand Riemann integration.
- Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
- Learn the concept of pointwise and uniform convergence of sequence of functions.
- Learn some of the properties of Riemann – Stieltjes integrable functions, and the applications of the fundamental theorems of integration.

UNIT-I: Riemann Integration

Riemann integral, R-Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, first mean value theorem, second mean value theorem. **(2 Questions)**

UNIT-II: Uniform convergence

Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability. **(1 Question)**

UNIT-III: Improper integrals

Convergence of improper integral at end points, point of infinite discontinuity, Comparison test, Dirichlet test and Abel's test for improper integrals. Convergence of Beta and Gamma functions. Test for uniform convergence of the integral of a product, Frullani integral. **(2 Questions)**

UNIT-IV: Riemann – Stieltjes integral

Definition and existence of Riemann – Stieltjes integral, Conditions for R–S integrability, Properties of the R-S integral, R-S integrability of functions of a function Integration and differentiation. **(1 Question)**

References:

- R. K. Dwivedi, Riemann Integral and Series of functions, 1st Edition, Pragati prakashan, Meerut, 2020.
- Robert G. Bartle & Donald R. Sherbert (2015). Introduction to Real Analysis (4th edition). Wiley India.
- Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). An Introduction to Analysis (2nd edition), Jones and Bartlett India Pvt. Ltd.
- K. A. Ross (2013). Elementary Analysis: The Theory of Calculus (2nd edition), Springer.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VII B	ANALYTICAL MECHANICS	MJ-18	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100 PASS MARKS: Th (SIE: 10+ ESE:30)=40				

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Understand the concepts of Generalized coordinates Holonomic and Non-holonomic systems etc.
- b) Understand the concept of Hamiltonian and Lagrangian.
- c) To learn Minimum surface of revolution.
- d) To Understand the stability of a system after vibration.

UNIT-I: Lagrangian Mechanics

Generalized coordinates Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second kind. Energy equation of conservative fields. **(1 Question)**

UNIT-II: Hamiltonian Mechanics

Hamilton's variables, Hamilton canonical equations. Cyclic coordinates, Routh's equations, Jacobi-Poisson Theorem. Fundamental lemma of calculus of variations. Motivating problems of calculus of variations. Shortest distance. Minimum surface of revolution. Brachistochrone problem, Geodesic. **(2 Questions)**

UNIT-III:

Hamilton's Principle, Principle of least action. Jacobi's equations. Hamilton-Jacobi equations. Jacobi theorem. Lagrange brackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations. Canonical transformation and generating function. **(2 Questions)**

UNIT-IV: Theory of Vibrations

The Linearization of the equations of motion, the transformation of quadratic forms, stability and normal modes of vibration. **(1 Question)**

References:

1. H. Goldstein, Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
2. I. M. Gelfand and S. V. Fomin Calculus of variation, prentice Hall.
3. S.L. Loney, An elementary treatise on Statics, Kalyani Publishers, N. Delhi 1979.
4. A. S. Ramsey, Newtonian Gravitation. The English Language Book Society and the Cambridge University Press.
5. N.C. Rana & P. S. Chandra Joag, Classical Mechanics. Tata McGraw Hill 1991.
6. Synge.J.L. and Griffith. B.A. , Principles of Mechanics, International Student Edition, Mcgraw-Hill Kogakusha, Ltd.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VII B	COMPLEX ANALYSIS	AMJ-1	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Visualize complex numbers as points of \mathbb{R}^2 , stereographic projection of complex plane on the Riemann sphere and various geometric properties of linear fractional transformations.
- b) Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.

UNIT-I:

Function of complex variable, Limits, continuity, differentiability and Analyticity. Cauchy-Riemann equations, sufficient conditions for differentiability and analyticity. Harmonic Functions. Exponential function, Logarithmic function, trigonometric function, derivatives of functions, bilinear transformation, cross ratio, conformal mapping. **(2 Questions)**

UNIT-II:

Complex integration, Cauchy-Goursat Theorem, Cauchy's Integral formula, Higher order derivatives, Morera's Theorem, Cauchy's inequality and Liouville's theorem. **(1 Question)**

UNIT-III:

The fundamental theorem of algebra, Maximum modulus principle, Schwarz lemma. Taylor's series, Laurent's series. **(1 Question)**

UNIT-IV:

Isolated singularities. Meromorphic functions. The argument principle Rouché's theorem, Poles and Zeros. Fundamental theorem. Residues. Cauchy's residue theorem. Evaluation of integrals. **(2 Questions)**

References:

1. J. B. Conway, Functions of Complex variables, Springer-Verlag.
2. W. Rudin, Real and Complex analysis, Tata McGraw-Hill.
3. H. A. Priestley, Introduction to Complex Analysis, 2nd edition (Indian), Oxford, 2006.
4. L. V. Ahlfors, Complex Analysis, 3rd edition, McGraw Hill, 2000.
5. J. E. Marsden and M. J. Hoffman, Basic Complex Analysis, 3rd edition, W.H. Freeman, 1999.
6. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 8th edition, McGraw Hill.
7. J. H. Mathews and R.W. Howell, Complex Analysis for Mathematics and Engineering, 3rd edition, Narosa, 1998.
8. T. Needham, Visual Complex Analysis, Oxford, 1997.
9. Daniel Alpay, "A Complex Analysis Problem Book", Birkhauser, Springer Basel AG 2011.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VIII B	TOPOLOGY	MJ-19	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Concepts of Topology, Topological spaces, Open Sets, closed sets, and Subspaces.
- b) To learn Basis, Product Topology and Sub basis.
- c) Concepts of Continuity, and Homeomorphisms Compactness.

UNIT-I:

Definition and examples of topological spaces. Closed sets, Closure. Dense subsets. Neighbourhoods, Interior, exterior and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topologies. **(1 Question)**

UNIT-II:

First and second countable spaces. Lindelof's theorem, separable spaces, second countability and separability. Separation axioms T_1, T_2, T_3, T_4 : their Characterizations and basic properties. Urysohn's Lemma. Tietze extension theorem. **(2 Questions)**

UNIT-III:

Compactness, continuous functions and compact sets, conjugacy of functions, Basic property of compactness, Heine-Borel Theorem, Compactness and finite intersection property, Product of spaces, Tychonoff's Theorem. **(1 Question)**

UNIT-IV:

Connected and disconnected spaces and their basic properties. Connectedness and product spaces. Connectedness and continuity, connectedness of R, R^n and C^n . Intermediate Value Theorem, Fixed Point Theorem. **(2 Questions)**

References :

1. K.D. Joshi. Introduction to General Topology Wiley Eastern Ltd. 1983.
2. Singh and Singh , An Introduction To General Topology, 1 st Ed., Anushandhan Prakashan, Kanpur, 2016.
3. J.L. Kelley, General Topology. Van Nostrand. Reinhold Co, New York 1995.
4. W.J. Pervin. Foundations of General Topology. Academic Press Inc. New York 1964.
5. K.K. Jha, Advanced General Topology, Nav Bharat Prakashan, Delhi.
6. G.F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill, Int.book company.
7. J.R. Munkres, Topology A first course, Prentice hall India Pvt. Ltd.
8. S. Lipschutz, General Topology, Schaum's outline series.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII B	ADVANCED ABSTRACT ALGEBRA	MJ-20	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) Recognize the Mathematical objects called groups.
- (b) Understand various concepts in the study of linear transformations.
- (c) Explain the extensions of Field theory.
- (d) Learn the concepts of Field theory.

UNIT-I:

Groups : Normal and Subnormal series, Isomorphism theorems, Jordan-Holder theorem, Solvable groups. **(2 Questions)**

UNIT-II:

Canonical Forms – Similarity of linear transformations. Invariant subspaces. Eigen values and Eigen vectors, Reduction to diagonal and triangular forms. **(1 Question)**

UNIT-III:

Field theory-Extension fields, finite extension, Algebraic and transcendental extensions, splitting fields-existence and uniqueness, Separable and inseparable extension. Normal extensions. **(2 Questions)**

UNIT IV

Finite fields. Perfect field, Primitive elements. Algebraically closed fields. **(1 Question)**

References :

1. A First Course in Abstract Algebra (4th edition) – J. B. Fraleigh, Narosa Publishing House, New Delhi, 2002.
2. Abstract Algebra – D.S. Dummit, R.M. Foote, John Wiley&Sons (2003).
3. I.N. Herstein. Topics in Algebra Wiley Eastern Ltd., New Delhi, 1975.
4. P.B. Bhattacharya, S. K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
5. M. Artin. Algebra, Prentice-Hall of India, 1991.
6. P.M.Cohn, Algebra, Vols I, II & III John Wiley & Sons. 1982, 1989, 1991.
7. N. Jacobson, Basic Algebra, Vols I & II, W.H.Freeman, 1980 (Also published by Hindustan Publishing Company).
8. S. Lagn, Algebra, 3rd edition, Addison-Wesley, 1993.
9. I.S.Luther and I.B.S. Passi, Algebra, Vol. I- Groups, Vol.II – Rings, Narosa Publishing House (Vol. I-1996, Vol. II -1999).
10. D.S. Malik, J.N. Mordeson, and M.K.Sen, Fundamentals of Abstract Algebra. Mc Graw Hill, International Edition, 1997.
11. University Algebra, N.S. Gopala Krishnan. 12. Modern Algebra, Singh and Zamiruddin.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII B	MATHEMATICAL MODELLING	AMJ-2	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) To understand Mathematical models as the representation of a system by a set of mathematical relations or equations.
- (b) To learn Mathematical epidemiological models susceptible-infectious-recovered (SIR) and its methodology.
- (c) To learn Monte Carlo simulation techniques, and simplex method for solving linear programming problems.
- (d) Learn significance of dieting model.
- (e) Understand nonlinear systems and phenomena with stability analysis ranges from phase plane analysis to ecological and mechanical systems.
- (f) Use Monte Carlo simulation technique to approximate area under a given curve, and volume under a given surface.

UNIT-I:

Mathematical modelling definition, Need, Classification, Simple situations requiring mathematical modelling, Techniques of mathematical modelling, Classification of mathematical models, Characteristics of mathematical models, Latest development in Mathematical Modelling, Merits and Demerits of Mathematical Modelling, Quantitative and Qualitative approach of modelling, Conceptual and Physical models, Models in real world problem.

(2 Questions)

UNIT-II:

Mathematical modelling through ordinary differential equations of first order, Mathematical modelling in population dynamics, Mathematical modelling of epidemic and compartment models through system of ordinary differential equations.

(2 Questions)

UNIT-III:

Mathematical modelling in Economics, Medicines, Arms race, Battle, International trade and dynamics through ordinary differential equations, Mathematical modelling through ordinary differential equation of second order.

(1 Question)

UNIT-IV:

Mathematical modelling through difference equation: Need, Basic theory, Economics and Finance, Population dynamics and Genetics, Discrete dynamical systems, Linear models, Growth models, Decay models, Drug delivery problems.

(1 Question)

References:

1. J.N. Kapur (2021). Mathematical Modelling (2nd Edition). New Age International Pvt. Ltd.
2. B. Barnes and G.R. Fulford (2016). Mathematical Modelling with Case Studies: Using MAPLE and MATLAB (3rd Edition). Chapman and Hall/CRC.
3. L. Edsberg (2008). Introduction to Computation and Modeling for Differential Equations. Wiley.
4. F.R. Marotto (2005). Introduction to Mathematical Modeling using Discrete Dynamical Systems. Thomson Brooks/Cole.
5. C.L. Dym (2004). Principles of Mathematical Modeling (2nd Edition). Academic Press.
6. E.A. Bender (2003). An Introduction to Mathematical Modeling. Dover Publications.
7. G. Fulford, P. Forrester and A. Jones (1997). Modelling with Differential and Difference Equations. Cambridge University Press.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII B	DIFFERENTIAL GEOMETRY AND TENSORS	AMJ-3	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) Learn the concepts of curves, space curves.
- b) Understand the parametric curves, curvatures.
- c) Recognize the envelope and torsion.
- d) Study about tensors.

UNIT I:

Space curves-curvature and torsion. Serret-Frenet formula. Circular helix, the circle of curvature. Osculating sphere, Bertrand curves. **(2 Questions)**

UNIT II:

Curves on a surface-parametric curves. fundamental magnitude, curvature of normal section. Principal directions and principal curvatures, lines of curvature, Rodrigue's formula. Dupin's theorem, theorem of Euler, Conjugate directions and Asymptotic lines. **(2 Questions)**

UNIT III:

One parameter family of surfaces – Envelope the edge of regression, Developables associated with space curves. Geodesics-differential equation of Geodesic. Torsion of a Geodesic. **(1 Question)**

UNIT IV:

Tensors, Tensor Algebra, Quotient theorem. Metric Tensor, Angle between two vectors. **(1 Question)**

References:

1. J. N. Sharma and A.R. Vasistha, Differential Geometry.
2. C.E. Weatherburn. Differential geometry of three dimensions.
3. P.P. Gupta & G.S.Malik. Three dimensional differential geometry.
4. C.E. Weatherburn. Tensor calculus.
5. R.S. Mishra, Tensor Calculus and Riemanian Geometry.

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Course Objective & Learning Outcomes: This course will enable the students to:

SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
I	CALCULUS	MJ-1	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

- Understand various integration techniques appearing in engineering and research.
- Sketch curves in Cartesian and polar coordinate systems.
- Learn differentiation of several types of functions.

UNIT-I: Differential calculus

Differentiation of Hyperbolic, logarithmic and exponential functions. Higher order derivatives, Leibnitz Theorem and its applications, Concavity and Inflection points, Asymptotes, Curvature of a curve. L'Hospital's rule.

(2 Questions)

UNIT-II: Integral calculus

Reduction formulae, derivations and illustrations of reduction formulae of the types $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sin^n x \cos^m x dx$, $\int \sin^n x \cos^m x dx$, $\int (\log x)^n dx$, parameterizing a curve, arc length, arc length of parametric curves, volume and area of surface of revolution.

(2 Questions)

UNIT-III: Curve tracing and Conics

Curve tracing in Cartesian and polar coordinates. Techniques of sketching conics. Transformation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

(2 Questions)

References:

- R. K. Dwivedi, Calculus, 1st Edition, Pragati Prakashan, Meerut, India, 2019.
- Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th Edition). Wiley India.
- Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.
- Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.
- Gorakh Prasad (2016). Differential Calculus (19th edition). Pothishala Pvt. Ltd.
- George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018).
- Thomas' Calculus (14th edition). Pearson Education.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
II	ALGEBRA	MJ-2	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Learn and apply the application of Complex Number through De Moivre's theorem.
- Basic concept of theory of Numbers.
- Evaluation of Rank, Eigen values and Eigen vectors of a matrix.

UNIT-I: Trigonometry

Polar form of complex number, nth roots of unity, De Moivre's Theorem, Applications of De Moivre's Theorem, Logarithm of complex numbers. **(1 Question)**

UNIT-II: Theory of Equations

Relations between the roots and coefficients of general polynomial equation in one variable, Solutions of polynomial equations having conditions on roots, Common roots and multiple roots, Transformation of equations, Nature of the roots of an equation, Descarte's rule of signs, Solution of cubic equation (Cardon's method), Biquadratic equations and their solutions. **(2 Questions)**

UNIT-III: Theory of numbers

Well-ordering property (WOP) of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, Fundamental Theorem of Arithmetic. **(1 Question)**

UNIT IV:

Definition and examples of groups, Abelian groups, Permutation groups, Cycle notation for permutations, Even and Odd permutations, Quaternion group and its matrix representation, Elementary properties of groups, Order of a group element and Order of a group, Subgroups and examples, Theorems on subgroups, Cyclic groups and its Properties, Classification of subgroups of Cyclic groups, Cosets and their properties.

(2 Questions)

References:

- Pankaj Kumar Manjhi, Algebra, 1st Edition, Pragati Prakashan, Meerut, 2018.
- Dr. Manoranjan Kumar Singh, A Text Book of Advanced Trigonometry, 1st Edition, Kedar Nath Ram Nath Publication, 2015.
- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
- W. S. Burnside and A. W. Panton, The Theory of Equations, Dublin University Press, 1954.
- C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc. 1954.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
III	REAL ANALYSIS	MJ-3	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- Understand many properties of the real line \mathbb{R} and learn to define sequence in terms of functions from \mathbb{R} to a subset of \mathbb{R} .
- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
- Learn some of the properties of continuous and uniformly continuous functions.

UNIT-I: Real Number System: Algebraic and order properties of \mathbb{R} , Absolute value of a real number; Bounded above and bounded below sets, Supremum and Infimum of a nonempty subset of \mathbb{R} , The completeness property of \mathbb{R} , Archimedean property, Countable set, Uncountable sets and theorems, Closure of a set, Dense set, Density of Rational numbers in \mathbb{R} , Definition and types of intervals, Nested intervals property; Neighbourhood of a point in \mathbb{R} , Open and closed sets in \mathbb{R} .
(2 Questions)

UNIT-II: Limit and Continuity

$\varepsilon - \delta$ Definition of limit of a real valued function, limit at infinity and infinite limits. Continuity of a real valued function, Properties of continuous functions. Intermediate value theorem, geometrical interpretation of continuity, Types of discontinuity, Uniform continuity.
(2 Questions)

UNIT-III: Differentiability

Differentiability of a real valued function, Geometrical interpretation of differentiability. Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation Darboux's theorem. Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, geometrical interpretation of mean value theorems.
(2 Questions)

References:

- R. K. Dwivedi, Real Analysis, 1st Edition, Pragati Prakashan, Meerut, India, 2020.
- Robert G. Bartle & Donald R. Sherbert, Introduction to Real Analysis (4th edition), Wiley India, 2015.
- Gerald G. Bilodeau, Paul R. Thie & G. E. Keough, An Introduction to Analysis (2nd edition), Jones and Bartlett India Pvt. Ltd., 2015.
- K. A. Ross, Elementary Analysis: The Theory of Calculus, 2nd edition, Springer, 2013.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
III	DIFFERENTIAL EQUATIONS	MJ-4	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: The course will enable the students to:

- Understand the genesis of ordinary differential equations.
- Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order.
- Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations.

UNIT-I: First Order Differential Equations

Differential equations of first order and first degree, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x , y and p . Clairaut's form and singular solutions. (2 Questions)

UNIT-II: Higher Order Linear Differential Equations

Linear differential equations of second order with constant and variable coefficients. Transformations of the equation by changing the dependent/ independent variable. Method of variation of parameters and method of undetermined coefficients. Principal of superposition for a homogeneous linear differential equation. Method of reduction of order. Euler-Cauchy Equation. (2 Questions)

UNIT-III: Series Solutions of Differential Equations

Definition of power series, radius of convergence, ordinary and singular points; Power Series solution: near ordinary point, near regular singular points (Frobenius methods). Bessel's equation; Bessel's function and its recurrence relations. Legendre's equation; Legendre's polynomial and its recurrence relations. (2 Questions)

References:

- G.K. Jha and Sarita Jha, Undergraduate Differential Equation, 1st Edition, Pragati Prakashan, Meerut, 2019
- Belinda Barnes & Glenn Robert Fulford (2015).
- Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
- Daniel A. Murray (2003). Introductory Course In Differential Equations, Orient.
- B. Rai, D. P. Choudhury & H. I. Freedman (2013). A Course in Ordinary Differential Equations (2nd edition). Narosa.
- Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India.
- George F. Simmons (2017). Differential Equations with Applications and Historical Notes.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
IV	VEDIC MATHEMATICS (Under IKS)	MJ-5	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				
PASS MARKS: 40				

Course Objective & Learning Outcomes

- Help students appreciate ancient Indian Mathematics and its contribution to the world.
- Understand basic tenets of geometry used in ancient India.
- Solve the mathematical problems faster and with ease.
- Appreciate the Mathematical advancements of Ancient India.

UNIT-I: Contribution of Indian Mathematicians

Baudhayana, Apastamba, Aryabhata I, II, Bhaskara I, II, Lilavati, Pingala, Mahavir, Narayan Pandit, Jyesthadev, Parmeshvaran, Madhavan, Gangesh Upadhyay, Vachaspati Mishra, Paksadhar Mishra, Mahesh Thakur.

(1 Question)

UNIT-II: Vedic Maths- High Speed Addition, Subtraction, Multiplication, division, squares, and cubes

History of Vedic Maths and its Features, Vedic Maths formulae: Sutras and Upsutras, Addition in Vedic Maths: Without carrying, Dot Method, Subtraction in Vedic Maths: Nikhilam Navatashcaramam Dashatah (All from 9 last from 10), Fraction -Addition and Subtraction, Multiplication in Vedic Maths: Base Method (any two numbers upto three digits), Multiplication by Urdhva Tiryak Sutra, Miracle multiplication: Any three-digit number by series of 1's and 9's, Division by Urdhva Tiryak Sutra (Vinculum method), Squares of any two-digit numbers: Base method, Square of numbers ending in 5: Ekadhikena Purvena Sutra, Easy square roots: Dwandwa Yoga (duplex) Sutra, Square root of 2: Baudhayana Shulbasutra, Cubing: Yavadunam Sutra.

(2 Questions)

UNIT-III: Vedic Maths-Enlighten Algebra and Geometry

Factoring Quadratic equation: Anurupyena, Adyamadyenantyamanty Sutra, Concept of Baudhayana (Pythagoras) Theorem, Circling a square: Baudhayana Shulbasutra, Concept of pi: Baudhayana Shulbasutra, Concept angle (8) 0° , 30° , 45° , 60° and 90° : Baudhayana number, Introduction of simple equation, Solutions of simple equations, Solutions of linear equations in two variables, Practical application of linear equations in two variables, Introduction and history of Matrices and Determinants, Matrices and Determinants of third order, Inverse of Matrices

(2 Questions)

UNIT-IV: Wonder World of Indian Mathematics

Pingal's binary number system, Different types of Meru Prastar(including Pascal Triangle), Applications of Meru Prastar, Introduction to Complex number, Baudhayana form of Complex, Addition & Subtraction of Complex number, Multiplication of Complex numbers, Introduction to differentiation, Application of derivatives, Introduction to Integration, Application of Integrations.

(1 Question)

Reference Books:

- Vedic Mathematics, Swami Bharati Krishna Trithaji, Motilal Banarsidas, New Delhi.
- The Essential of Vedic Mathematics, Rajesh Kumar Thakur, Rupa Publications, New Delhi.
- Vedic Mathematics For All Ages, Vandana Singhal, Motilal Banarsidas Publishers.
- Elements of Vedic Mathematics, Udayan S. Patankar, Sunil M. Patankar, TTU Press.
- Vedic Mathematics: The Problem Solver, Ronak Bajaj, Black Rose Publications.
- Vedic Geometry Course, S. K. Kapoor, Lotus Press.
- Gardner, Robert and J.F. Staal. Altar of Fire. Documentary. The Film Study Center at Harvard University, 1976.
- Bimal Kumar Mishra, Vedic Ganit, Techniz Books Pvt. Ltd. New Delhi, 2018.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
IV	MULTIVARIATE CALCULUS	MJ-6	4	60
FULL MARKS: 25 (5 Att'd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Learn conceptual variations while advancing from one variable to several variables in calculus.
- b) Apply multivariable calculus in optimization problems.
- c) Inter-relationship amongst the line integral, double and triple integral formulations.
- d) Understanding importance of Green, Gauss and Stokes' theorems.

UNIT-I: Partial Differentiation

Functions of several variables, Limits and continuity, Partial differentiation, Chain rule. Higher order partial derivatives, Total differential & differentiability, Jacobians, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of two variables. **(2 Questions)**

UNIT-II: Extrema of Functions

Extrema of functions of two and more variables, Method of Lagrange's multiplier. **(1 Question)**

UNIT-III: Double and Triple Integrals

Double integral and triple integral, Change of order of integration, Surface area by double integrals, Volume by triple integrals, Change of variables in double and triple integrals, Dirichlet's integral. **(1 Question)**

UNIT-IV: Vector Calculus

Definition of vector field, Vector Differentiation, Directional derivative. Divergence, Curl, Gradient and vector identities, Vector integration. **(1 Question)**

UNIT-V: Green's, Stokes' and Gauss Divergence Theorem

Line integrals, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem. **(1 Question)**

References:

1. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein, Basic Multivariable Calculus, Springer India Pvt. Limited, 2009.
2. James Stewart, Multivariable Calculus (7th edition). Brooks/ Cole. Cengage, 2012.
3. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith, Calculus (3rd Edition), Pearson Education. Dorling Kindersley (India) Pvt. Ltd., 2011.
4. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir, Thomas' Calculus (14th edition). Pearson Education, 2018.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
IV	ANALYTICAL GEOMETRY	MJ-7	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: The course will enable the students to:

- (g) Gain knowledge of the concept of different conic sections, their classification and properties.
- (h) Have knowledge of general form of equation of a sphere and attain procedural knowledge required for solving problem.
- (i) Explore conic sections, lines, planes, and surfaces using equations.
- (j) Use transformations to manipulate geometric figures.
- (k) Analyze the position and intersection of geometric entities in space.
- (l) Learn skills to formulate and solve real life practical problems on sphere, cone and cylinder.

UNIT-I: General equation of second degree

Classification of conic sections; centre, asymptotes, axes, eccentricity, foci and directrices of conics. Tangent at any point to a conic, chord of contact, pole of line to a conic, director circle of a conic. Polar equation of a conic, tangent and normal to a conic, confocal conics. **(2 Questions)**

UNIT-II: Sphere

General form, Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, tangent plane and line, polar plane and line, orthogonal spheres, radical plane of two spheres and co-axial system of spheres. Cone: Equation of a cone, right circular cone, quadric cone, enveloping cone. Tangent plane and condition of tangency. **(2 Questions)**

UNIT-III: Cylinder

Right circular cylinder and enveloping cylinder. Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a conicoid, Enveloping cylinder of a conicoid, confocal conicoid, reduction of second degree equations. **(2 Questions)**

References:

6. Robert J. T. Bell (2022). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Legare Street Press.
7. D. Chatterjee (2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House.
8. Shanti Narayan and P.K. Mittal (2007). Analytical Solid Geometry. S. Chand and Company.
9. Gordon Fuller and Dalton Tarwater (1992). Analytic Geometry (7th edition). Pearson.
10. J.H. Kindle (1990). Analytic Geometry. McGraw-Hill.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
V	PARTIAL DIFFERENTIAL EQUATION (PDE)	MJ-8	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- Apply a range of techniques to solve first and second order partial differential equations.
- Understand problems, methods and techniques of Partial differential equations.
- Learn Heat, Wave and Laplace equations.

UNIT-I: First Order Partial Differential Equations

Basic concepts, definition: order and degree, of a PDE; Concept of linear, quasi-linear and non-linear partial differential equations. Partial differential equations of the first order: Formation, classification and geometrical interpretation. Lagrange's method, method of separation of variables for first order PDE, Canonical forms of first order linear equations, standard forms of Non-linear PDE of first order; Charpit's general method. **(2 Questions)**

UNIT-II: Higher order Partial Differential Equations

Classification of second order linear partial differential equations with constant coefficients: Homogeneous and non-homogeneous equations, solution of second and higher order PDE's with constant coefficient. Partial differential equations reducible to equations with constant coefficient, solution of second order PDE with variable coefficients, Monge's method. **(2 Questions)**

UNIT-III: Second Order Partial Differential Equations

Classification of second order linear PDE as Hyperbolic, Parabolic or Elliptic. Reduction of second order linear equations to Canonical or Normal forms (working method). Introduction of heat, wave and Laplace equations; Method of separation of variables for solving heat, wave and Laplace equations. **(2 Questions)**

References:

- G.K. Jha and Sarita Jha, Partial Differential Equation and System of Ordinary Differential Equation, 1st Edition, Pragati Prakashan, Meerut, 2019.
- Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
- TynMyint-U & Lokenath Debnath (2013). Linear Partial Differential Equation for Scientists and Engineers (4th edition). Springer India.
- S. B. Rao & H. R. Anuradha (1996). Differential Equations with Applications. University Press.
- Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
V	NUMERICAL ANALYSIS	MJ-9	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Note- Use of Scientific Calculator is allowed in the examination

Course Objective & Learning Outcomes: This course will enable the students to:

- Obtain numerical solutions of algebraic and transcendental equations.
- Find numerical solutions of system of linear equations and check the accuracy of the solutions.
- Learn about various interpolating and extrapolating methods.
- Solve initial and boundary value problems in differential equations using numerical methods.

UNIT-I: Numerical Methods for Solving Algebraic and Transcendental Equations

Introduction of errors; Algorithms and convergence; Bisection method, Newton- Raphson method and Secant method for solving equations. **(1 Question)**

UNIT-II: Numerical Methods for Solving Linear Systems

Partial and scaled partial pivoting, Direct methods: Gauss' Elimination, Gauss' Jordan method; Lower and upper triangular (LU) decomposition (Crout's method) of a Matrix and its applications. Iterative methods: Gauss-Jacobi method, Gauss-Seidel method. **(1 Question)**

UNIT-III: Interpolation

Gregory-Newton forward and backward difference interpolations, Lagrange's interpolation, Newton's divided difference interpolation. **(1 Question)**

UNIT-IV: Numerical Differentiation and Integration

First order and higher order approximation for first derivative, Approximation for second derivative, Numerical integration: Trapezoidal rule, Simpson's $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rule. **(2 Questions)**

UNIT-V: Initial and Boundary Value Problems of Differential Equations

Definition of Initial value problem and Boundary value Problem, Picard's iteration method, Euler's method, Modified Euler's method, Runge-Kutta methods (second and fourth order). **(1 Question)**

References:

- H. K. Mishra and G. K. Jha (2023), An introduction to numerical Analysis and Technique, 1st Ed., Walnut Publication.
- Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson.
- C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.
- F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.
- M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and Engineering Computation (6th edition). New Age International Publishers.
- Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
V	GROUP AND RING THEORY	MJ-10	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Understand the basic concepts of groups, rings and their properties.
- Recognize factorization and integral domain.
- Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.
- Learn in detail about polynomial rings, fundamental properties.

UNIT-I: Normal subgroups and Isomorphism

Normal subgroups and their properties, Centralizer (Normalizer) of a group element, Centre of a group. Lagrange's theorem and consequences including Fermat's little theorem. Group homomorphism, Kernel of Homomorphism, Properties of homomorphism, Isomorphism and its properties, Factor groups (Quotient groups). Cauchy's theorem for finite Abelian groups. First, Second and Third Isomorphism theorems, Cayley theorem. (2 Questions)

UNIT-II: Introduction to ring

Definition and examples of rings, elementary properties of rings, Ring with or without Zero divisors, Integral Domain and Field, Divisor ring or skew field, subring, subfield, characteristic of a ring. (2 Questions)

UNIT-III: Ring homomorphism and Polynomial ring

Definition, example and properties of Ring homomorphism; first, second and third Isomorphism theorems of rings; quotient field; polynomial ring over commutative ring, Division algorithm and consequences. (2 Questions)

References:

- Pankaj Kumar Manjhi (2023), Introduction to ring Theory, 1st Ed., Pragati Prakashan Meerut, India.
- P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). Basic Abstract Algebra (2nd edition). Cambridge University Press.
- David S. Dummit & Richard M. Foote (2008). Abstract Algebra (2nd edition). Wiley.
- John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
- Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
- N. S. Gopalakrishnan (1986). University Algebra, New Age International Publishers.
- I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
- Thomas W. Hungerford (2004). Algebra (8th edition). Springer.
- Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
- Serge Lang (2002). Algebra (3rd edition). Springer-Verlag.
- I. S. Luthar & I. B. S. Passi (2013). Algebra: Volume 1: Groups. Narosa.
- I. S. Luthar & I. B. S. Passi (2012). Algebra: Volume 2: Rings. Narosa.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
V	SEQUENCE AND SERIES	MJ-11	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Understand and define the concepts of sequence, sub-sequence, limit and convergence within the framework of real numbers.
- b) Distinguish between bounded, monotonic and Cauchy sequences and prove related theorems.
- c) Define and analyze the series of real numbers and the concept of partial sums.
- d) Determine the convergence or divergence of series using various tests.
- e) Interpret the geometric and analytical meaning of the remainder terms and its role in approximation accuracy.

UNIT-I: Sequences of Real Numbers

Convergent sequence, limit of a sequence, Bounded sequence, limit theorems, Monotone sequences, Monotone convergence theorem, Subsequence, Bolzano-Weierstrass theorem for sequences, limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy's convergence criterion.

(2 Questions)

UNIT-II: Infinite Series

Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series; Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test, De Morgan and Bertrand test, Integral test, Alternating series, Leibnitz test, Absolute and Conditional convergence.

(2 Questions)

UNIT-III: Expansions of Functions

Maclaurin's and Taylor's theorem for expansion of a function in an infinite series; Taylor's theorem in finite form with Lagrange, Cauchy and Roche-Schlomilch forms of remainder.

(2 Questions)

References:

1. G.K. Jha and Sarita Jha, Theory of Functions, 1st Edition, Pragati Prakashan, Meerut, 2019.
2. Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th edition). Wiley, India.
3. Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.
4. Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.
5. Gorakh Prasad (2016). Differential Calculus (19th edition). Pothishala Pvt. Ltd.
6. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). Thomas' Calculus (14th edition). Pearson Education.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VI	MECHANICS	MJ-12	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- (d) Learning various technical notions which explain various states of motion under given forces.
- (e) Understand necessary conditions for the equilibrium of particles.
- (f) Understand Kepler's laws of the planetary motions.

UNIT – I: Statics

Law of parallelogram of forces, Lami's theorem, Equilibrium of a system of particles, External and internal forces, Couples, Reduction of a plane force system, Work, Principle of virtual work, Potential energy and conservative field, Centre of Mass, Centers of gravity, Friction. **(3 Questions)**

UNIT – II: Dynamics

Motion of a particle, Motion of a system, Principle of linear momentum, Principle of angular momentum, Motion relative to mass center, Principle of energy. D' Alembert's principle; Moving frames of reference, Frames of reference with uniform translational velocity, Frames of reference with constant angular velocity; Applications in plane dynamics- Motion of a projectile, Harmonic oscillators, General motion under central forces, Planetary orbits. **(3 Questions)**

References:

1. Synge, J. L., & Griffith, B. A. (2017). Principles of Mechanics (3rd Ed.). McGraw-Hill Education. Indian Reprint.
2. Ramsey, A. S. (2017). Hydrostatics. Cambridge University Press. Indian Reprint.
3. Roberts, A. P. (2003). Statics and Dynamics with Background Mathematics. Cambridge University Press.
4. Ramsey, A. S. (1985). Statics (2nd ed.). Cambridge University Press.
5. Laxmi Publication Book.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VI	LINEAR PROGRAMMING PROBLEM (LPP)	MJ-13	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Analyze and solve linear programming models of real-life situations.
- Provide graphical solution of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.
- Solve linear programming problems using simplex method.
- Learn techniques to solve transportation and assignment problems.
- Solve two-person zero sum game problems.

UNIT-I: Linear Programming Problem, Convexity and Basic Feasible Solutions

Formulation and examples, Canonical and Standard forms, Convex and polyhedral sets, Extreme points, Basic solutions, Basic Feasible Solutions, Correspondence between basic feasible solutions and extreme points, Graphical solution. **(1 Question)**

UNIT-II: Simplex Method

Optimality criterion, improving a basic feasible solution, unboundedness, Simplex method, slack variable, surplus variable, artificial variables, Two-phase method, Big-M method. **(2 Questions)**

UNIT-III: Duality

Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, solving the primal problem using duality theory. **(1 Question)**

UNIT-IV: Transportation and Assignment Problems

Formulation of transportation problems, Methods of finding initial basic feasible solutions: North-west corner rule, least cost method, Vogel approximation method, Algorithm for obtaining optimal solution; Formulation of assignment problems, Hungarian method. **(2 Questions)**

References:

- Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). Linear Programming and Network Flows (4th edition). John Wiley & Sons.
- G. Hadley (2002). Linear Programming. Narosa Publishing House.
- Frederick S. Hillier & Gerald J. Lieberman (2015). Introduction to Operations Research (10th edition). Mc Graw-Hill Education.
- Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition). Pearson.
- Paul R. Thie & Gerard E. Keough (2014). An Introduction to Linear Programming and Game Theory (3rd edition). Wiley India Pvt. Ltd.
- B.N. Mishra, B.K. Mishra, Optimization: Linear Programming, ANE Books Pvt. Ltd. New Delhi, 2022, 5th Edition.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VI	LINEAR ALGEBRA	MJ-14	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr.) + 75 (ESE: 3 Hrs.)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- Visualize the space \mathbb{R}^n in terms of vectors and their interrelation with matrices.
- Understand the concepts of Vector Spaces, subspaces, bases, dimension and their properties.
- Relate matrices and linear transformations.
- Compute Eigen values and Eigen vectors of linear transformations.

UNIT I: Matrices and System of linear equations

Rank of a matrix, Matrix form of system of linear equations, augmented matrix, consistent and inconsistent system of linear equations, necessary and sufficient condition for consistency of a system of linear equations, solution of homogeneous and non-homogeneous linear equations. **(2 Questions)**

UNIT-II: Vector Spaces

Definition and examples, Subspace, Linear span Quotient space and direct sum of subspaces, linearly independent and dependent sets, Bases and dimension. **(2 Questions)**

UNIT-III: Linear Transformations and its properties

Definition and examples, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates, Rank and nullity of a linear transformation and rank-nullity theorem. Isomorphism of vector spaces, Isomorphism theorems, Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and Eigen values of a linear transformation, Characteristic polynomial and Cayley-Hamilton theorem, Minimal polynomial. **(2 Questions)**

References:

- Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). Linear Algebra (4th edition). Prentice-Hall of India Pvt. Ltd.
- Dr. Manoranjan Kumar Singh, Group Theory II, 1 st Edition, S. Chand, Publication 2022.
- Kenneth Hoffman & Ray Kunze (2015). Linear Algebra (2nd edition). Prentice-Hall.
- I. M. Gel'fand (1989). Lectures on Linear Algebra. Dover Publications.
- Nathan Jacobson (2009). Basic Algebra I & II (2nd edition). Dover Publications.
- Serge Lang (2005). Introduction to Linear Algebra (2nd edition). Springer India.
- Vivek Sahai & Vikas Bist (2013). Linear Algebra (2nd Edition). Narosa Publishing House.
- Gilbert Strang (2014). Linear Algebra and its Applications (2nd edition). Elsevier.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VI	PROBABILITY AND STATISTICS	MJ-15	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Understand distributions in the study of the behavior of random variables.
- b) Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.
- c) Understand the fact that many natural populations exhibit normal curves using central limit theorem.

UNIT-I: Discrete Probability Distributions

Sample spaces and events, probability axioms and properties, Conditional probability and independence, Baye's theorem; Discrete Random variables, Probability mass functions, Cumulative distribution function, expected value. Discrete distributions: Uniform, Bernoulli, Binomial, Geometric, Poisson. **(2 Questions)**

UNIT-II: Continuous Probability Distributions

Continuous random variable, probability density function, cumulative distribution functions, expected value; Distributions: Uniform, Gamma, Exponential, Normal; Normal approximation to the binomial distribution. **(2 Questions)**

UNIT-III: Correlation, Regression and Central Limit Theorem

The Correlation coefficient, Covariance, Independent random variables, Linear regression for two variables, The method of least squares, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers. **(2 Questions)**

References:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). Introduction to Mathematical Statistics (7th edition), Pearson Education.
2. Irwin Miller & Marylees Miller (2014). John E. Freund's Mathematical Statistics with Applications (8th edition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). Probability, Springer-Verlag.
4. Sheldon M. Ross (2014). Introduction to Probability Models (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). Probability and Information. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	Number of Lectures
VII A	RESEARCH METHODOLOGY	MJ-16	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) To enable the students to know about the information needed for research.
- (b) To learn the statistical tools for data analysis.
- (c) To equip the students with the concept of scientific research.

UNIT – I: Introduction to Research

Research: Concept, Need, and Purpose, Research Problem and Research Design, Literature Review, Hypothesis: Definition, Types, Sources, and Functions. **(2 Questions)**

UNIT –II: Types and techniques of Research Methods

Historical, Survey, and Experimental, Case Study, Scientific Research and Statistical Research, etc. Research Techniques and Tools: Questionnaire, Interview, Observation, Schedule and Check-list, etc. Library Records and Reports. **(2 Questions)**

UNIT–III: Basic Statistics

Descriptive Statistics – Measures of Central Tendency and Dispersion, Correlations and linear regression, Chi-Square test, t-test, Presentation of Data: Tabular, Graphic, Bar Diagram and Pie Chart.

(2 Questions)

References:

1. Alvesson (M) and Skoldberg (K). Reflexive methodology: new vistas in qualitative research. Ed. Rev. 2009. Sage Publication, London.
2. Busha (C H). Research methods in librarianship. 1990. Academic Press, New York.
3. Goode (W J) and HATT (PK). Methods in social research. 1982. McGraw-Hill, New York.
4. Greenfield (T). Research methods: guidance for postgraduates. 1996. Hodder Arnold, London.
5. Kothari (C R). Research Methodology Methods and Techniques (2nd Revised Edition), New Age International Publishers (P) Ltd. New Delhi.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VII A	ADVANCED REAL ANALYSIS	MJ-17	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- e) Understand Riemann integration.
- f) Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
- g) Learn the concept of pointwise and uniform convergence of sequence of functions.
- h) Learn some of the properties of Riemann – Stieltjes integrable functions, and the applications of the fundamental theorems of integration.

UNIT-I: Riemann Integration

Riemann integral, R-Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, first mean value theorem, second mean value theorem. **(2 Questions)**

UNIT-II: Uniform convergence

Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability. **(1 Question)**

UNIT-III: Improper integrals

Convergence of improper integral at end points, point of infinite discontinuity, Comparison test, Dirichlet test and Abel's test for improper integrals. Convergence of Beta and Gamma functions. Test for uniform convergence of the integral of a product, Frullani integral. **(2 Questions)**

UNIT-IV: Riemann – Stieltjes integral

Definition and existence of Riemann – Stieltjes integral, Conditions for R–S integrability, Properties of the R-S integral, R-S integrability of functions of a function Integration and differentiation. **(1 Question)**

References:

5. R. K. Dwivedi, Riemann Integral and Series of functions, 1st Edition, Pragati prakashan, Meerut, 2020.
6. Robert G. Bartle & Donald R. Sherbert (2015). Introduction to Real Analysis (4th edition). Wiley India.
7. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). An Introduction to Analysis (2nd edition), Jones and Bartlett India Pvt. Ltd.
8. K. A. Ross (2013). Elementary Analysis: The Theory of Calculus (2nd edition), Springer.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VII A	ANALYTICAL MECHANICS	MJ-18	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Understand the concepts of Generalized coordinates Holonomic and Non-holonomic systems etc.
- b) Understand the concept of Hamiltonian and Lagrangian.
- c) To learn Minimum surface of revolution.
- d) To Understand the stability of a system after vibration.

UNIT-I: Lagrangian Mechanics

Generalized coordinates Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems. Generalized potential. Lagrange's equations of first kind. Lagrange's equations of second kind. Energy equation of conservative fields. **(1 Question)**

UNIT-II: Hamiltonian Mechanics

Hamilton's variables, Hamilton canonical equations. Cyclic coordinates, Routh's equations, Jacobi-Poisson Theorem. Fundamental lemma of calculus of variations. Motivating problems of calculus of variations. Shortest distance. Minimum surface of revolution. Brachistochrone problem, Geodesic. **(2 Questions)**

UNIT-III:

Hamilton's Principle, Principle of least action. Jacobi's equations. Hamilton-Jacobi equations. Jacobi theorem. Lagrange brackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations. Canonical transformation and generating function. **(2 Questions)**

UNIT-IV: Theory of Vibrations

The Linearization of the equations of motion, the transformation of quadratic forms, stability and normal modes of vibration. **(1 Question)**

References:

1. H. Goldstein, Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
2. I. M. Gelfand and S. V. Fomin Calculus of variation, prentice Hall.
3. S.L. Loney, An elementary treatise on Statics, Kalyani Publishers, N. Delhi 1979.
4. A. S. Ramsey, Newtonian Gravitation. The English Language Book Society and the Cambridge University Press.
5. N.C. Rana & P. S. Chandra Joag, Classical Mechanics. Tata McGraw Hill 1991.
6. Synge.J.L. and Griffith. B.A. , Principles of Mechanics, International Student Edition, Mcgraw-Hill Kogakusha, Ltd.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VII A	RESEARCH PROPOSAL- PLANNING AND TECHNIQUES	RC-1	4	60
FULLMARKS: END SEM. EXAM-50, TERM PAPER-25, INTERNAL EXAM- 20 MARKS WRITTEN + 5 MARKS DAY TO DAY ASSESMENTS. PASS MARKS: 40				

Course Objective & Learning Outcomes: This course will enable the students to

- (a) Develop a basic understanding of how to pursue research in mathematics.
- (b) Introduce some open source softwares to carry out mathematical research.
- (c) Impart the knowledge of journals, their rankings and the disadvantages of rankings.
- (d) Write a basic mathematical article and a research project.
- (e) Gain knowledge about publication of research articles in good journals.

UNIT-I: How to Learn, Write, and Research Mathematics

How to learn mathematics, How to write mathematics: Goals of mathematical writing, general principles of mathematical writing, avoiding errors, writing mathematical solutions and proofs, the revision process, What is mathematical research, finding a research topic, Literature survey, Research Criteria, Format of a research article (including examples of mathematical articles) and a research project (report), publishing research.

(2 Questions)

UNIT-II: Mathematical Typesetting and Presentation using LaTeX

How to present mathematics: Preparing a mathematical talk, Oral presentation, Use of technology which includes LaTeX, PSTricks and Beamer; Poster presentation.

(2 Questions)

UNIT-III: Mathematical Web Resources and Research Ethics

Web resources- MAA, AMS, SIAM, arXiv, ResearchGate; Journal metrics: Impact factor of journal as per JCR, MCQ, SNIP, SJR, Google Scholar metric; Challenges of journal metrics; Reviews/Databases: MathSciNet, zbMath, Web of Science, Scopus; Ethics with respect to science and research, Plagiarism check using software.

(2 Questions)

References:

1. Bindner, Donald, & Erickson Martin (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group.
2. Committee on Publication Ethics- COPE (<https://publicationethics.org/>)
3. Declaration on Research Assessment. https://en.wikipedia.org/wiki/San_Francisco_Declaration_on_Research_Assessment
4. Evaluating Journals using journal metrics; (<https://academicguides.waldenu.edu/library/journalmetrics#s-lg-box-13497874>)
5. Gallian, Joseph A. (2006). Advice on Giving a Good PowerPoint Presentation (<https://www.d.umn.edu/~jgallian/goodPPtalk.pdf>). MATH HORIZONS.
6. Lamport, Leslie (2008). LaTeX, a Document Preparation System, Pearson.
7. Locharoenrat, Kitsakorn (2017). Research Methodologies for Beginners, Pan Stanford Publishing Pte. Ltd., Singapore.
8. Nicholas J. Higham. Handbook for writing for the Mathematical Sciences, SIAM, 1998.
9. Steenrod, Norman E., Halmos, Paul R., Schiffer, M. M., & Dieudonné, Jean A. (1973). How to Write Mathematics, American Mathematical Society. 61
10. Tantau, Till, Wright, Joseph, & Miletić, Vedran (2023). The BEAMER class, Use Guide for Version 3.69. TeX User Group. (<https://tug.ctan.org/macros/latex/contrib/beamer/doc/beameruserguide.pdf>)
11. University Grants Commission (Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutions) Regulations 2018 (The Gazette of India: Extraordinary, Part-iii-Sec.4)

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII A	TOPOLOGY	MJ-19	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- Concepts of Topology, Topological spaces, Open Sets, closed sets, and Subspaces.
- To learn Basis, Product Topology and Sub basis.
- Concepts of Continuity, and Homeomorphisms Compactness.

UNIT-I

Definition and examples of topological spaces. Closed sets, Closure. Dense subsets. Neighbourhoods, Interior, exterior and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topologies. **(1 Question)**

UNIT-II

First and second countable spaces. Lindelof's theorem, separable spaces, second countability and separability. Separation axioms T_1, T_2, T_3, T_4 : their Characterizations and basic properties. Urysohn's Lemma. Tietze extension theorem. **(2 Questions)**

UNIT-III

Compactness, continuous functions and compact sets, conjugacy of functions, Basic property of compactness, Heine-Borel Theorem, Compactness and finite intersection property, Product of spaces, Tychonoff's Theorem. **(1 Question)**

UNIT-IV

Connected and disconnected spaces and their basic properties. Connectedness and product spaces. Connectedness and continuity, connectedness of \mathbb{R}, \mathbb{R}^n and \mathbb{C}^n . Intermediate Value Theorem, Fixed Point Theorem. **(2 Questions)**

References :

- K.D. Joshi. Introduction to General Topology Wiley Eastern Ltd. 1983.
- Singh and Singh , An Introduction To General Topology, 1 st Ed., Anushandhan Prakashan, Kanpur, 2016.
- J.L. Kelley, General Topology. Van Nostrand. Reinhold Co, New York 1995.
- W.J. Pervin. Foundations of General Topology. Academic Press Inc. New York 1964.
- K.K. Jha, Advanced General Topology, Nav Bharat Prakashan, Delhi.
- G.F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill, Int.book company.
- J.R. Munkres, Topology A first course, Prentice hall India Pvt. Ltd.
- S. Lipschutz, General Topology, Schaum's outline series.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII A	COMPLEX ANALYSIS	MJ-19	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- a) Visualize complex numbers as points of \mathbb{R}^2 , stereographic projection of complex plane on the Riemann sphere and various geometric properties of linear fractional transformations.
- b) Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.

UNIT-I

Function of complex variable, Limits, continuity, differentiability and Analyticity. Cauchy-Riemann equations, sufficient conditions for differentiability and analyticity. Harmonic Functions. Exponential function, Logarithmic function, trigonometric function, derivatives of functions, bilinear transformation, cross ratio, conformal mapping. **(2 Questions)**

UNIT-II

Complex integration, Cauchy-Goursat Theorem, Cauchy's Integral formula, Higher order derivatives, Morera's Theorem, Cauchy's inequality and Liouville's theorem. **(1 Question)**

UNIT-III

The fundamental theorem of algebra, Maximum modulus principle, Schwarz lemma. Taylor's series, Laurent's series. **(1 Question)**

UNIT-IV

Isolated singularities. Meromorphic functions. The argument principle Rouché's theorem, Poles and Zeros. Fundamental theorem. Residues. Cauchy's residue theorem. Evaluation of integrals. **(2 Questions)**

References:

10. J. B. Conway, Functions of Complex variables, Springer-Verlag.
11. W. Rudin, Real and Complex analysis, Tata McGraw-Hill.
12. H. A. Priestley, Introduction to Complex Analysis, 2nd edition (Indian), Oxford, 2006.
13. L. V. Ahlfors, Complex Analysis, 3rd edition, McGraw Hill, 2000.
14. J. E. Marsden and M. J. Hoffman, Basic Complex Analysis, 3rd edition, W.H. Freeman, 1999.
15. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 8th edition, McGraw Hill.
16. J. H. Mathews and R.W. Howell, Complex Analysis for Mathematics and Engineering, 3rd edition, Narosa, 1998.
17. T. Needham, Visual Complex Analysis, Oxford, 1997
18. Daniel Alpay, "A Complex Analysis Problem Book", Birkhauser, Springer Basel AG 2011.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII A	ADVANCED ABSTRACT ALGEBRA	MJ-19	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100			PASS MARKS: 40	

Course Objective & Learning Outcomes: This course will enable the students to:

- (e) Recognize the Mathematical objects called groups.
- (f) Understand various concepts in the study of linear transformations.
- (g) Explain the extensions of Field theory.
- (h) Learn the concepts of Field theory.

UNIT-I

Groups: Normal and Subnormal series, Isomorphism theorems, Jordan-Holder theorem, Solvable groups.

(2 Questions)

UNIT-II

Canonical Forms – Similarity of linear transformations. Invariant subspaces. Eigen values and Eigen vectors, Reduction to diagonal and triangular forms.

(1 Question)

UNIT-III

Field theory-Extension fields, finite extension, Algebraic and transcendental extensions, splitting fields-existence and uniqueness, Separable and inseparable extension, Normal extensions.

(2 Questions)

UNIT-IV

Finite fields, Perfect field, Primitive elements, Algebraically closed fields.

(1 Question)

References :

1. A First Course in Abstract Algebra (4th edition) – J. B. Fraleigh, Narosa Publishing House, New Delhi, 2002.
2. Abstract Algebra – D.S. Dummit, R.M. Foote, John Wiley&Sons (2003).
3. I.N. Herstein. Topics in Algebra Wiley Eastern Ltd., New Delhi, 1975.
4. P.B. Bhattacharya, S. K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
5. M. Artin. Algebra, Prentice-Hall of India, 1991.
6. P.M.Cohn, Algebra, Vols I, II & III John Wiley & Sons. 1982, 1989, 1991.
7. N. Jacobson, Basic Algebra, Vols I & II, W.H.Freeman, 1980 (Also published by Hindustan Publishing Company).
8. S. Lagn, Algebra, 3rd edition, Addison-Wesley, 1993.
9. I.S.Luther and I.B.S. Passi, Algebra, Vol. I- Groups, Vol.II – Rings, Narosa Publishing House (Vol. I-1996, Vol. II -1999).
10. D.S. Malik, J.N. Mordeson, and M.K.Sen, Fundamentals of Abstract Algebra. Mc Graw Hill, International Edition, 1997.
11. University Algebra, N.S. Gopala Krishnan. 12. Modern Algebra, Singh and Zamiruddin.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII A	MATHEMATICAL MODELLING	MJ-20	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) To understand Mathematical models as the representation of a system by a set of mathematical relations or equations.
- (b) To learn Mathematical epidemiological models susceptible-infectious-recovered (SIR) and its methodology.
- (c) To learn Monte Carlo simulation techniques, and simplex method for solving linear programming problems.
- (d) Learn significance of dieting model.
- (e) Understand nonlinear systems and phenomena with stability analysis ranges from phase plane analysis to ecological and mechanical systems.
- (f) Use Monte Carlo simulation technique to approximate area under a given curve, and volume under a given surface.

UNIT-I

Mathematical modelling definition, Need, Classification, Simple situations requiring mathematical modelling, Techniques of mathematical modelling, Classification of mathematical models, Characteristics of mathematical models, Latest development in Mathematical Modelling, Merits and Demerits of Mathematical Modelling, Quantitative and Qualitative approach of modelling, Conceptual and Physical models, Models in real world problem.

(2 Questions)

UNIT-II

Mathematical modelling through ordinary differential equations of first order, Mathematical modelling in population dynamics, Mathematical modelling of epidemic and compartment models through system of ordinary differential equations.

(2 Questions)

UNIT-III

Mathematical modelling in Economics, Medicines, Arms race, Battle, International trade and dynamics through ordinary differential equations, Mathematical modelling through ordinary differential equation of second order.

(1 Question)

UNIT-IV

Mathematical modelling through difference equation: Need, Basic theory, Economics and Finance, Population dynamics and Genetics, Discrete dynamical systems, Linear models, Growth models, Decay models, Drug delivery problems.

(1 Question)

References:

1. J.N. Kapur (2021). Mathematical Modelling (2nd Edition). New Age International Pvt. Ltd.
2. B. Barnes and G.R. Fulford (2016). Mathematical Modelling with Case Studies: Using MAPLE and MATLAB (3rd Edition). Chapman and Hall/CRC.
3. L. Edsberg (2008). Introduction to Computation and Modeling for Differential Equations. Wiley.
4. F.R. Marotto (2005). Introduction to Mathematical Modeling using Discrete Dynamical Systems. Thomson Brooks/Cole.
5. C.L. Dym (2004). Principles of Mathematical Modeling (2nd Edition). Academic Press.
6. E.A. Bender (2003). An Introduction to Mathematical Modeling. Dover Publications.
7. G. Fulford, P. Forrester and A. Jones (1997). Modelling with Differential and Difference Equations. Cambridge University Press.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII A	DIFFERENTIAL GEOMETRY AND TENSORS	MJ-20	4	60
FULL MARKS: 25 (5 Attd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) To introduce the fundamental concept of differential geometry such as curves, surfaces, metrics and curvature.
- b) To develop understanding of tensor algebra and calculus as essential tool for advanced studies in applied mathematics.
- c) Students will be able to apply geometric concepts to analyze curves, surfaces, and their properties.
- d) Students will be able to use tensor techniques to solve problems in geometry, relativity and continuum mechanics.

UNIT-I

Space curves-curvature and torsion. Serret-Frenet formula. Circular helix, the circle of curvature. Osculating sphere, Bertrand curves. **(2 Questions)**

UNIT-II

Curves on a surface-parametric curves. fundamental magnitude, curvature of normal section. Principal directions and principal curvatures, lines of curvature, Rodrigue's formula. Dupin's theorem, theorem of Euler, Conjugate directions and Asymptotic lines. **(2 Questions)**

UNIT-III

One parameter family of surfaces – Envelope the edge of regression, Developables associated with space curves. Geodesics-differential equation of Geodesic. Torsion of a Geodesic. **(1 Questions)**

UNIT-IV

Tensors, Tensor Algebra, Quotient theorem. Metric Tensor, Angle between two vectors. **(1 Questions)**

References:

6. C.E. Weatherburn. Differential geometry of Three Dimensions.
7. P.P. Gupta & G.S.Malik. Three dimensional differential geometry.
8. C.E. Weatherburn. Tensor calculus.
9. R.S. Mishra, Tensor Calculus and Riemanian Geometry.
10. B. B. Chaudhuri- Elements of Differential Geometry.
11. B. B. Sinha-An Introduction to Modern Differential Geometry.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII A	INTEGRAL TRANSFORMS	MJ-20	4	60
FULL MARKS: 25 (5 Attnd +20 SIE: 1 Hr) + 75 (ESE: 3 Hrs)=100				PASS MARKS: 40

Course Objective & Learning Outcomes: This course will enable the students to:

- (a) To introduce the concept and importance of Integral transforms in applied mathematics.
- (b) To develop students' ability to use Laplace, Fourier and Z transforms for solving differential and difference equations.
- (c) Define and explain the concept of Integral transform.
- (d) Solve ODE and difference equations.

UNIT-I: Laplace Transform

Definition of Laplace Transform, Region of convergence, abscissa of convergence, Linearity property, Laplace Transform of elementary functions, Laplace Transform of derivatives and integrals, Laplace Transform of periodic functions.

Inverse Laplace Transform

Definition, Two shifting theorems, Convolution theorem, Solving ordinary differential equations using Laplace Transform, Evaluation of integrals using Laplace Transform. **(2 Questions)**

UNIT-II: Fourier Transform

Definition of Fourier Transform, Fourier Sine and Cosine Transforms, Linearity property, Fourier Transform of elementary functions, Fourier Transform of derivatives, Convolution theorem.

Inverse Fourier Transform

Definition, Fourier Sine and Cosine Inverse Transforms, Solving ordinary differential equations using Fourier Transform, Evaluation of integrals using Fourier Transform. **(2 Questions)**

UNIT-III: Z-Transform

Definition, Linearity property, Inversion of Z-Transform, Solving difference equations using Z-Transform, Evaluation of sums using Z-Transform. **(2 Questions)**

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley, Edition 11.
2. B. Ss. Grewal, Higher Engineering Mathematics.
3. LokenathDebnath& Dambaru Bhatta- Integral transforms and their applications.
4. Murray R. Spiegel, Laplace transform Schaum's Outline series.
5. Murray R. Spiegel, Fourier analysis, Schaum's Outline series.

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SEMESTER	SUBJECT NAME	PAPER CODE	CREDIT	NUMBER OF LECTURES
VIII A	RESEARCH INTERNSHIP/FIELD WORK/ PROJECT/ DISSERTATION/ THESIS	RC - 2	8	60
Assessment of Project synopsis: 50 Marks Viva Voce: 50 Marks.		Assessment of Project Thesis: 100 Marks Total Marks: 200 Marks		