IV. MAJOR COURSE- MJ 15:
NUMERICAL ANALYSIS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **Theory: 60 Lectures**

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Obtain numerical solutions of algebraic and transcendental equations.
2. Find numerical solutions of system of linear equations and check the accuracy of the solutions.
3. Learn about various interpolating and extrapolating methods.
4. Apply various numerical methods to differentiation and integration.

Course Content:

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

Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, False position method, Fixed point iteration method, Newton's method and secant method for solving equations.

Unit-II: Numerical Methods for Solving Linear Systems

Partial and scaled partial pivoting, Lower and upper triangular (LU) decomposition of a matrix and its applications, Thomas method for tridiagonal systems; Gauss–Jacobi, Gauss–Seidel and successive over-relaxation (SOR) methods.

Unit-III: Interpolation

Lagrange and Newton interpolations, Piecewise linear interpolation, Cubic spline interpolation, Finite difference operators, Gregory–Newton forward and backward difference interpolations.

Unit-IV: Numerical Differentiation and Integration

First order and higher order approximation for first derivative, Approximation for second derivative; Derivative using forward, backward and central difference interpolation formulae, General quadrature formula, Trapezoidal rule, Simpson's rules and error analysis, Weddle's rule, Newton-Cote's method. Solution of ordinary differential equations: Picard's method of successive approximations.

Reference Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
2. Wiley Brian Bradie (2006), *A Friendly Introduction to Numerical Analysis*. Pearson.
3. P.P. Gupta, G.S. Malik, J.P. Chauhan (2020). *Calculus of Finite Differences & Numerical Analysis*, Krishna Publication.
4. G. Shankar Rao (2018). *Numerical Analysis*. New Age.

III. MAJOR COURSE- MJ 14:
PROBABILITY & STATISTICS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **Theory: 60 Lectures**

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Understand distributions in the study of the joint behaviour of two random variables.
2. Establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.
3. Understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell-shaped curve.

Course Content:

Unit-I: Probability Functions and Moment Generating Function

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit-II: Univariate Discrete and Continuous Distributions

Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit-III: Bivariate Distribution

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Unit-IV: Sampling and Estimation Theory

Sampling Theory, Random samples and Random numbers, Sampling with and without Replacement, Sampling distribution of Means, Proportions, differences and Sums, Unbiased Estimates, Efficient estimates, Point and Interval estimates, Confidence-interval estimates of population parameters.

Reference Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
2. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, (2013). *Introduction to Mathematical Statistic*. Pearson Education, Asia.
3. Irwin Miller and Marylees Miller, John E. Freund (2014). *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia.
4. S C Gupta & V K Kapoor (2014). *Fundamentals of Mathematical Statistics*. S. Chand.

II. MAJOR COURSE- MJ 13:
ABSTRACT ALGEBRA-II

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **Theory: 60 Lectures**

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

1. Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.
2. Learn about structure preserving maps among Rings and their properties.
3. Deal with the Polynomial Rings over commutative rings and rational fields.
4. Grasp the idea of irreducibility of polynomials in a Ring.
5. Familiarize with Factorization theory and related algebra.

Unit-I: Rings and Ideals
Definitions and examples of Rings, commutative ring, ring with unity, unit in a ring, Matrix ring, Boolean ring, Ring of continuous functions, Nilpotent element, idempotent element, Integral domain, Division Ring and Field, Properties of ring, Subrings and Ideals, Prime ideal, maximal ideal, Algebra of Ideals, Characteristic of a ring.

Unit-II: Ring Homomorphism and Fields
Quotient rings, Ring Homomorphism and Isomorphism, Properties of Ring Homomorphism, Kernels and related properties, Fundamental theorem of Homomorphism, First and second theorems of Isomorphism, Field of Quotients.

Unit-III: Polynomial Rings
Polynomial rings over commutative ring and their basic properties, The division algorithm; Remainder theorem, Factor theorem, Polynomial rings over rational field, Irreducible and Reducible Polynomial, Primitive polynomial, Gauss lemma and Eisenstein's criterion.

Unit-IV: Factorization Theory
Divisibility, Euclidean Domains, Principal Ideal domain, Unique Factorization domain. Relationship among Euclidean domain, Principal Ideal domain, Unique factorization domain.

Reference books:

1. S. Singh & Q. Zamiruddin (2008). *Modern Algebra*. Vikas Publishing House.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). *Basic Abstract Algebra* (2nd edition). Cambridge University Press.
3. John B. Fraleigh (2007). *A First Course in Abstract Algebra* (7th edition). Pearson.
4. Joseph A. Gallian (2017). *Contemporary Abstract Algebra* (9th edition). Cengage.
5. N. S. Gopalakrishnan (1986). *University Algebra*. New Age International Publishers.
6. I. N. Herstein (2006). *Topics in Algebra* (2nd edition). Wiley India

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SEMESTER VI

I. MAJOR COURSE- MJ 12: METRIC SPACE

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **Theory: 60 Lectures**

Course Objectives & Learning Outcomes:

This course will enable the students to:

1. Generalize the idea obtained in Real analysis.
2. Develop the concept of metric space and related properties.
3. Learn the idea of completeness of a space with its properties.
4. Understand the compactness of metric space.
5. Assimilate the idea of connectedness in metric space.

Course Content:

Unit-I: Concepts in Metric Spaces

Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space.

Unit-II: Complete Metric Spaces and Continuous Functions

Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

Unit-III: Compactness

Weierstrass property, Compactness and–Compact spaces, Sequential compactness, Bolzano Borel theorem, Totally bounded sets, Equivalence of–finite intersection property, Heine compactness and sequential compactness, Continuous functions on compact spaces.

Unit-IV: Connectedness

Separated sets, Disconnected and connected sets, Components, Connected subsets of $\mathbb{R}$, Continuous functions on connected sets.

Reference books:

1. P. K. Jain & Khalil Ahmad (2019). *Metric Spaces*. Narosa.
2. G. F. Simmons (2004). *Introduction to Topology and Modern Analysis*. McGraw-Hill.
3. Shanti Narayan & M. D. Raisinghania (2020). *Elements of Real Analysis*. S. Chand.
4. Satish Shirali & Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.