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यूइंगक्रिश्चियनकॉलेज, प्रयागराज

DEPARTMENT OF MATHEMATICS

EWING CHRISTIAN COLLEGE, PRAYAGRAJ

(An Autonomous Constituent College of University of Allahabad)
(A Christian Minority Institution of Church of North India, Diocese of Lucknow)
711, Gaughat, Mutthiganj, Prayagraj, Uttar Pradesh – 211003

B. A. / B.Sc. SYLLABUS, 2024-2025

B. A. / B.Sc. Semester I

Paper – 1: Ordinary Differential Equations

Unit – 1

Basic concepts, order and degree of differential equation, Differential equations of first order and first degree:variables separable form, differential equations with homogeneous coefficients, differential equations reducible to differential equations with homogeneous coefficients, exact differential equations, integrating factors, linear differential equations, differential equations reducible to linear differential equations,linearly separable differential equations.

Unit – 2

Differential equations of first order but not of first degree: differential equations solvable for p, x or y, Clairaut's equation, singular solution. Geometricalmeaning of a differential equation, orthogonal trajectories, isoclines

Unit – 3

Linear differential equations of higher order, homogeneous and non-homogeneous linear differential equations, linearly dependent and linearly independent solutions, homogeneous linear differential equations with constant coefficients, non-homogeneous linear differential equations with constant coefficients: inverse operator method, method of undetermined coefficients, method of variation of parameters for determining particular integrals.

Unit – 4

Cauchy-Euler's equation, system of linear differential equations with constant coefficients, Mechanical applications: Newton's law of cooling, growth and decay problems, dilution problems.

Books recommended:

1. B. Rai and D. P. Choudhury: Ordinary Differential Equations: An Introduction
2. Gorakh Prasad: Integral Calculus
3. R. S. Senger: Ordinary Differential Equations
4. G. F. Simmons: Differential Equations
5. E. Kreyszig: Advanced Engineering Mathematics

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B. A. / B.Sc. Semester I
Paper – 2: Elementary Analysis-1

Unit-1

Language of Mathematics: Mathematical statement, logical connectives, tautology, quantifiers.

Relation: Definition&examples(including congruence relation), composition of relations.Equivalence relation, equivalence class. Partition of a set,Order relation

Mapping: Definition and examples, Types of maps, Inverse map, composition of maps, direct & inverse image of a set.

Unit- 2

Real number system: Axiomatic definition of Real Number System as complete ordered field. Well ordering principle of **N**(statement only). Archimedean Principle. Rational and Irrational density theorem.

Division in Z: Division Algorithm,Greatest common divisor & Least common multiple, Euclidean Algorithm, Prime integer, Fundamental Theorem of Arithmetic.

Unit- 3

Real Sequences: Convergent and Divergent sequences, Algebra of limits. Monotone, bounded and Cauchy sequences. Cauchy's criterion of convergence of sequence.

Unit- 4

Infinite series: Definition and its convergence,Cauchy's general principle of convergence for an infinite series. Tests of convergence series of positive terms (comparison theorem, comparison test, D' Alembert's ratio test,Root test, comparison of ratios, Raabe's test, Logarithmic ratio test, De-Morgan and Bertrand test, Cauchy's condensation test).

Books Recommended:

1. R.S. Mishra and N.N.Bhattacharya: Fundamental Structures of Modern Algebra
2. Gorakh Prasad: Differential Calculus
3. M.K. Singal and Asha Rani: Real Analysis
4.N.N.Bhattacharya: A First Course in Real Analysis
5. S.C. Malik and Savita Arora: Real Analysis

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B. A. / B.Sc. Semester II

Paper – 1: Analytical Geometry of Three Dimensions

Unit – 1

Planes and Straight Lines: Revision.

Sphere: Equation of sphere, intersection of sphere and plane, intersection of two spheres, sphere passing through a circle, intersection of sphere and a straight line, tangent plane, plane of contact, polar plane.

Unit – 2

Sphere (Contd.): Power of a point, radical plane, co-axal system of spheres, orthogonal system of spheres.

Cylinders: Equation of a cylinder with given base, cylinders with axes parallel to co-ordinate axes, projecting cylinders of a curve, enveloping cylinders, right circular cylinders.

Unit – 3

Cones: Equation of a cone, intersection of a cone and a plane passing through vertex the vertex of the cone, tangent plane, reciprocal cone, enveloping cone, right circular cone.

Unit – 4

Central Conicoids: Standard equation central conicoids, ellipsoid, hyperboloid of one sheet and two sheets, tangent lines and tangent planes, polar planes and polar lines, enveloping cones and cylinders, section with a given centre, diametral planes, normals, normals drawn from a given point, cubic curves through the feet of the normals.

Books recommended:

1. Mata Amber Tiwari and R. S. Senger: A course in Vector Analysis and its Applications.
2. N. Saran and R. S. Gupta: Analytical geometry of three dimensions.

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B. A. / B.Sc. Semester II

Paper – 2: Elementary Analysis - 2

Unit-1

Limit of a function: Definition and examples, one- sided limits, Limit as x approaches infinity, Infinite limits, Algebra of limits.

Unit-2

Continuity of a function: Definition, examples & properties of continuous function (local boundedness, sign preserving property, sequential continuity). Properties of continuous functions on closed interval (statement & geometrical interpretation), Composite of continuous functions

Unit- 3

Differentiability: Differentiability of a function at a point and its interpretation, Algebra of derivatives, Chain rule of differentiation,Sign of derivatives and monotonicity of functions, Rolle's Theorem, Lagarange's Mean Value Theorem, Cauchy's Mean Value Theorem. Indeterminate forms

Unit -4

Higher derivatives: Leibnitz theorem, Taylor's theorem, Maclaurin's theorem, Maxima and Minima of functions of one variable.

Vector Differentiation: Derivatives of a Vector Function of a single Scalar Variable, Scalar and Vector Fields, Gradient, Divergence and Curl, Vector Identities.

Books Recommended:

1. R.S. Mishra and N.N. Bhattacharya: Fundamental Structures of Modern Algebra
2. Gorakh Prasad: Differential Calculus
3. M.K. Singal and Asha Rani: Real Analysis
4. N.N. Bhattacharya: A First Course in Real Analysis
5. S.C. Malik and Savita Arora: Real Analysis
6. Mata Amber Tiwari and R. S. Senger: A course in Vector Analysis and its Applications.

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B. A. / B.Sc. SYLLABUS, 2024-2025

B. A. / B.Sc. Semester III

Paper – 1: Linear Algebra

Unit -1

Definition of field, examples R, C, Q and Z_p of fields. Vector Spaces: definition, examples and basic properties, subspaces, subspaces generated by a subset, Linear dependence and linear independence of a subset, Basis and Dimension of a vector space, Sum and direct sum of subspaces, Quotient spaces.

Unit -2

Linear transformations: definition, examples and properties, isomorphic vector spaces, null space and range space, Rank nullity theorem, Fundamental theorem of vector space homomorphism, Hom (V, W) as a vector space, dual space V^* of a vector space V, transpose of a linear transformation, annihilator of a subset of a vector space.

Unit -3

Matrix representation of a linear transformation, effect of change of basis on matrix representation, non-singular matrices, equivalent and similar matrices, rank of a matrix, elementary row and column operations, inverse of an invertible matrix, reduction of a matrix into normal form and echelon form , system of linear equations, adjoint of a matrix and its properties.

Unit – 4

Inner product space: definition and examples, Cauchy-Swarz inequality, norm of a vector, notion of angle, orthogonality, orthonormal set and basis, Gram Schmidt orthonormalization, Bessel's inequality, orthogonal complement of a subset, Eigen values and Eigen vectors, characteristic polynomial of a linear transformation, Cayley-Hamilton theorem and its applications.

Books recommended:

1. K. Hoffman and R. Kunze : Linear Algebra
2. I. N. Herstein : Topics in Algebra
3. N. N. Bhattacharya : An introduction to Linear Algebra
4. Stephen H. Friedberg: Linear Algebra
5. Ramji Lal: Algebra Vol. 2
6. Pramode Kumar Saikia: Linear Algebra

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B. A. / B.Sc. Semester III

Paper – 2: Advanced Analysis-1

Unit - 1

Step functions and theirintegrals,upper and lower integrals of a bounded function of one variable (through step functions), integrable functions, Riemann condition of integrability, Properties of integrals of a step function.

Unit - 2

Mean Value Theorems for integrals, differentiation of function defined by integral, Fundamental theorem of integral calculus, Primitives of a function, change of variable, Second Mean Value Theorem (statement only).

Unit - 3

Double and Triple integrals, Change of order of integration, line, surface and volume integral and their application in area & volume**.**

Unit - 4

Pointwise and uniform convergence of sequences and series of functions, Necessary and sufficient condition for uniform convergence,Weierstrass's, Dirichlet's and Abel's tests for uniform convergence.

Books Recommended:

1. Alton H. Smith and Walter A. Albrecht: Fundamental Concept of Analysis
2. H.S. Carslaw: Introduction to the Theory of Fourier Series
3. D. Widder: Advance Calculus
4. S. C. Malik and Savita Arora: Real Analysis
5. Sherbert and Bartle: Introduction to Real Analysis

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B. A. / B.Sc. Semester IV

Paper – 1: Mechanics-1

Unit- 1

Introduction: Polar, Pedal and Intrinsic Co-ordinate Systems.

Motion in Plane: Kinematics & Kinetics of motion, Velocities & Accelerations of a moving particle in Cartesian, Polar and Tangential & Normal Coordinates. Determination of path under a given force.

Unit- 2

Rectilinear Motion: Simple Harmonic Motion, Horizontal and Vertical Elastic Strings, Motion under Inverse Square Law.

Unit-3

Motion in Resisting media, Motion of varying mass.

Constrained Motion: Motion in a Vertical Circle, Cycloidal Motion.

Unit-4

Central Motion: Properties of Central Motion, Differential Equation of Central Orbit in Polar(u,θ), Pedal (p, r) Coordinates. Central Orbit, Law of Force, Two Body Central Motion, Kepler's laws of Planetary Motion.

Books Recommended:

1. Mata Amber Tiwari & R.S. Sengar: A Course in Vector Analysis and its Applications

2.P. L. Srivastava: Elementary Dynamics

3. S. L. Loney: Dynamics of a Particle and of Rigid Bodies

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B.A. /B.Sc. Semester – IV

Paper – 2: Advanced Analysis-2

Unit - 1

Term by term integration and differentiation of an infinite series of functions, functions defined by infinite series (sine, cosine, exponential and logarithmic),Power series: Definition, interval of convergence, uniform convergence of power series, Abel's limit theorem.

Unit - 2

Convergence of arbitrary infinite series, Abel's Test and Dirichlet's Tests, Alternating series, conditional and absolute convergence, re-arrangement of series, Dirichlet's and Riemann's theorem on rearrangement of absolutely and conditionally convergent series.

Unit - 3

Convergence of Improper Integrals: Integrals over infinite intervals with bounded integrands, convergence of such integrals, necessary and sufficient conditions, case of positive integrands, comparison test, μ-test, absolute convergence, convergence of integrals of product of two functions, Abel's and Dirichlet's test.

Unit - 4

Metric Spaces: Definition and examples, open and closed balls, interior, exterior and boundary points, limit point, open and closed sets, limit of sequences in metric spaces, Cauchy's sequences.

Books Recommended

1. Alton H. Smith and Walter A. Albrecht: Fundamental Concept of Analysis
2. H.S. Carslaw : Introduction to the Theory of Fourier Series
3. D. Widder: Advanced Calculus
4. S. C. Malik and Savita Arora: Real Analysis

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B. A. / B.Sc. SYLLABUS, 2024-2025

B.A. /B.Sc. Semester – V

Paper – 1: Algebra – 1

Unit -1

Semigroups, groups, abelian groups, examples including Z_m, U_m, the group of the n-th roots of unity, circle group in the complex plane, Hamiltonian eight group, Klein's four group, permutation group, matrix group, dihedral group D_8 subgroups, subgroups of above groups.

Unit - 2

Homomorphism, isomorphism, order of an element of a group and its properties, subgroup generated by a subset of a group, cyclic group, coset decomposition and Lagrange's theorem, Euler's theorem, Fermat's theorem, Wilson's theorem.

Unit - 3

Normal subgroup, normalizer of a subgroup, centre of a group, conjugacy relation in a group, conjugacy classes, class equation, direct product of groups, quotient group.

Unit -4

Linear congruences and algorithm to find solutions of linear congruences, Chinese remainder theorem, quadratic congruences, quadratic residue, Euler's criterion, Legendre symbol, Gauss lemma, Gauss' reciprocity theorem, arithmetic functions, multiplicatively of Euler's phi function, divisor function, sum of divisor function and Moebius function, Moebius inversion formula and its applications.

Books recommended:

1. Ramji Lal: Algebra Vol. 1
2. M. Artin: Algebra
3. N. N. Bhattacharya: Fundamental concepts in modern algebra
4. I. N. Herstein : Topics in Algebra
5. David M. Burton: Elementary Number Theory
6. I. Niven, H. S. Zukerman, H. L. Montgomery: The Theory of Numbers

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B. A. / B.Sc. Semester V

Paper – 2: Advanced Analysis-3

Unit - 1

Limit and continuity of functions between metric spaces, characterization of continuity in terms of open sets, closed sets and closures, Compactness of metric spaces, Bolzano-Weierstrass property, Total boundedness, sequential compactness.

Unit – 2

Uniform continuity, Lebesgue number, complete metric spaces, closure. Complex number as an ordered pair, geometric representation of a complex number, Continuity and differentiability of complex function, Analytic functions, Cauchy-Riemann equations, Harmonic functions.

Unit - 3

Function of several variables: Limits, Continuity, partial derivatives, Directional derivatives, differentiability of functions of several variables, Algebra of differentiable functions, Total derivatives, Differentiability of composite functions.

Unit - 4

Homogeneous functions, Euler's theorem, Mean value theorem, Crossed (mixed) derivatives, Taylor's theorem, Maxima and minima of several variables, Lagrange's multipliers, Jacobians and Jacobian matrix, functional dependence, Implicit function theorem, Inverse function theorem, Expansion of functions of several variables, Young's theorem, Schwartz theorem.

Books Recommended:

1. T.M. Apostol: Mathematical Analysis
2. G.F. Simmons: Topology and Modern Analysis
3. T. Pati: Complex Analysis
4. H.S. Carslaw: Introduction to the Theory of Fourier Series& Integrals
5. D. Widder: Advanced Calculus
6. Gorakh Prasad: Differential calculus
7. Pramila Srivastava: Function of several variables
8. JemesSterwad: Calculus

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B. A. / B.Sc. Semester V

Paper – 3: Mechanics-2

Unit-1

Statics: Common Catenary, Virtual Work.

Unit -2

Statics (VectorTechnique): Forces in Three Dimensions, Line Coordinates of a Line, Central Axis, Wrench, Resultant Wrench of two Wrenches.

Unit-3

Statics (Vector Technique):Nul Line,Nul Plane, Nul Point with respect to a System of Forces, Conjugate Forces and Conjugate Lines.

Unit-4

Orthogonal Curvilinear Coordinates: Cartesian, Spherical Polar & Cylindrical Polar Coordinates, Velocityand Acceleration of a moving Particle in Cylindrical & Spherical Coordinates.

Books Recommended:

1. Mata Amber Tiwari & R.S. Sengar: A Course in Vector Analysis and its Applications

2. R.S. Verma: Text Book on Statics

3. S.L. Loney: Statics

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B. A. / B.Sc. Semester VI

Paper – 1: Algebra -2

Unit - 1

Fundamental theorem of group homomorphism, first and second isomorphism theorems of groups and some of their applications, correspondence theorem, commutator subgroup.

Unit -2

Symmetric group, Cayley's theorem, cycles, transpositions, decomposition of permutations, conjugacy classes of permutations, alternating map, even and odd permutations, alternating groups A_n, normal subgroups of S_n, simplicity of A_n $(n \geq 5)$.

Unit – 3

Rings and sub rings: definition and some examples, ring homomorphisms, embedding, ideals, quotient rings, fundamental theorem of ring homomorphism, correspondence theorem.

Unit – 4

Integral domain, division ring and field, field of fractions of a commutative integral domain with identity (quotient field), polynomial ring over a commutative integral domain with identity, division algorithm, remainder theorem and factor theorem in F[x], ideals of F[x] (F is a field).

Books recommended:

1. Ramji Lal: Algebra Vol. 1
2. M. Artin: Algebra
3. N. N. Bhattacharya: Fundamental concepts in modern algebra
4. I. N. Herstein : Topics in Algebra

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B.A. / B.Sc. III Semester - VI

Paper - 2: NUMERICAL METHODS

Unit – 1

Need for Numerical methods, Errors, Floating Point Representation, Rounding off Rules.
Solution of Arbitrary Equations: Fixed Point Iteration Method, Bisection – Method, Method of False Position (Regula-Falsi), Newton-Raphson's Method, Secant Method, Order of Convergence.
Finite Difference: Operators δ, μ, Δ,, E and D and their relationships, Forward, Backward and Central Difference Tables.

Unit – 2

Interpolation: Gregory – Newton's Forward and Backward Difference Interpolation Formulas, Lagrange's and Newton's Divided Difference Interpolation Formulas, Inverse Interpolation, Cubic Spline Interpolation, Clamped and Natural Cubic Splines, Gauss', Stirling's, Bessel's and Everett'sInterpolation Formulas.

Numerical Differentiation and Integration: Formulae for Numerical Differentiation, Quadrature Formulae, Trapezoidal and Simpson's one-third and three – eight Rules, Weddle's Rule.

Unit – 3

Numerical Methods for O.D.E.: First Order Equations, Picard's Method of Successive Approximations, Incremental Methods, Euler's, Taylor'series and Improved Euler's Methods, Runge – Kutta Method, Multistep Methods, Predictor – Corrector Pairs, Adam – Bashforth – Moulton's and Milne's Formulas, Second Order Equations, Taylor'series, Runge – Kutta – Nystrom Methods, Finite Difference Method, Cubic Spline Method.

Unit – 4

Solution of System of Equations: Gauss Elimination Method, LU – Factorization and Cholesky's Methods, Gauss – Jacobi and Gauss – Seidel Iteration Methods, Curve Fitting by Least Square Method, Estimation of Eigen Values by Gerschgorin Circles, Determination of Eigen Values and Eigen Vectors by Iteration (Power Method).

Books Recommended:

1. E.Kreyszig: Advancedμ Engineering Mathematics
2. S.S.Sastry: Introductory Methods of Numerical Analysis
3. F.B.Hildebrand: Numerical Analysis
4. Jain, Iyengar and Jain: Numerical Methods for Scientific and Engineering Computation
5. K.Sankara Rao: Numerical Methods for Scientist and Engineers

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B.A. /B.Sc. Semester VI

Paper – 3: Mechanics - 3

Unit -1

Moment of Inertia: Moment and Product of Inertia of some standard bodies, Principal axes, Momental Ellipsoid of a body.

Unit-2

D' Alembert's Principle: The general equation of motion, Motion of the Centre of Inertia and Motion relative to the Centre of Inertia.
Motion about a Fixed Axis: Moment of the Effective Forces about the Axis of Rotation,Moment of Momentum about the Axis of Rotation, Kinetic Energy of the body rotating about a Fixed Axis, Equation of Motion about Axis of Rotation, Reactions of the Axis of Rotation.

Unit-3

Equation of Continuity in Different Coordinates System, Boundary Surfaces, Velocity Potential, Stream Lines.
Euler's Equation of Motion, Steady Motion, Bernoulli's Equation, Helmholtz Equation, Impulsive Motion.

Unit-4

Motion in two dimensions, Stream Function, Irrotational Motion, Complex Potential, Sources & Sinks, Doublets, Image System of a Simple Source with respect to a Plane, a Circle, a Sphere, Image System of a Doublet with regard to a Plane, a Circle and a Sphere. Circle Theorem.

Books Recommended:

1. S.L. Loney: Dynamics of a Particle and of Rigid Bodies

2.F. Chorlton: Fluid Dynamics

3. B.G. Verma and B.D. Gupta: Hydrodynamics

4 A.S.Ramsey: A Treatise on Hydrodynamics