

COURSE & PROGRAM OUTCOMES OF B.SC. (HONOURS) MATHEMATICS UNDER CBCS

DEPARTMENT OF MATHEMATICS,
BAHONA COLLEGE,
JORHAT, ASSAM.

SEMESTER I

Paper Code: C1.1(Calculus)

Learning outcomes: After going through this course the students will be able to:

1. Determine the Derivative and higher derivatives of a function explicitly using differentiation formulas.
2. Apply Calculus in real life problem.
3. Formulate mathematical models.
4. Analyze and sketch the graph of a function, including asymptotes, intervals on which the graph is increasing/decreasing, concave up or concave down, and any local extrema and inflection points by using the first and second derivatives.
5. Identify areas in mathematics and other fields where calculus is useful.
6. Generate solutions to unfamiliar problems.

Paper Code: C1.2(Algebra)

Learning outcomes: After going through this course the students will be able to:

1. Describe various algebraic structures on sets.
2. Identify the algebraic structures present in different branches of sciences.
3. Polar representation of complex numbers.
4. n^{th} roots of unity.
5. Identify numbers for rational indices by using De Moivre's theorem.
6. Understand the concept of relation and functions with their applications.
7. Construct the linear equations and can solve by different methods.
8. Compute linear transformations, kernel and range, and inverse linear transformations, and find matrices of general linear transformations.
9. Find eigenvalues, eigenvectors and Characteristic Equation of a matrix.

Paper Code: GE-1.1 (Differential Calculus)

Learning outcomes: After going through this course the students will be able to:

1. Differentiate functions.
2. Find tangent normal, curvature, asymptotes etc.
3. Apply Rolle's theorem mean value theorems and Taylor's theorem
4. Expand functions in series and different form of remainders.

SEMESTER II

Paper Code: C2.1 (Real Analysis)

Learning outcomes: After going through this course the students will be able to:

1. Identify the properties of the number system.
2. The students will gradually develop analysis skills in sets, sequences, and infinite series of real numbers covered by the three respective units as follows:

Unit-1

- Review of Algebraic and Order Properties of \mathbb{R} ,
- neighborhood of a point in \mathbb{R} ,
- Idea of countable sets, uncountable sets and uncountability of \mathbb{R} .
- Bounded above sets, bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima,
- The Completeness Property of \mathbb{R} , The Archimedean Property, Density of Rational (and Irrational) numbers in \mathbb{R} ,
- Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Unit-2

- Sequences, Bounded sequence, Convergent sequence, Limit of a sequence.
- Limit Theorems, Monotone Sequences, Monotone Convergence Theorem.
- Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences.
- Cauchy sequence, Cauchy's Convergence Criterion.

Unit-3

- Infinite series, convergence and divergence of infinite series,
- Cauchy Criterion,
- Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test,
- Alternating series, Leibniz test, Absolute and Conditional convergence.

Paper Code: C2.2 (Differential Equations)

Learning outcomes: After going through this course the students will be able to:

1. Solve Differential Equations using different techniques.
2. Apply these techniques in various mathematical models used in real life problems.
3. Understand the terms exponential growth/decay proportionate growth rate and doubling/halving time when applied to population models and the terms exponential decay, Decay constant and half life when applied to radioactivity
4. Solve problems involving exponential growth and decay

Paper Code: GE-2.1 (Differential Equation)

Learning outcomes: After going through this course the students will be able to:

1. Describe various methods for solving differential equations.
2. Apply these techniques in various mathematical models used in real life problems.

SEMESTER III

Paper Code: C3.1 (Theory of Real Functions)

Learning outcomes: After going through this course the students will be able to:

1. Discuss limit, Continuity and Differentiability of real valued function
2. Break down a composition of two functions into basic functions by using the chain rule
3. Apply the chain rule to find derivatives of functions raised to a power exponential functions and logarithmic functions
4. Apply of mean value theorem and Taylor's theorem
5. Expand functions in series and different form of remainders

Paper Code: C3.2 (Group Theory I)

Learning outcomes: After going through this course the students will be able to:

1. Describe various group structures on sets.
2. Identify the group structures present in different branches of sciences.
3. Understand the basic concepts of Group Theory in Modern Algebra covered by the following five units:

Unit-1

- Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

Unit-2

- Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Unit-3

- Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Unit-4

- External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit-5

- Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Paper Code: C3.3 (PDE and Systems of ODE)

Learning outcomes: After going through this course the students will be able to:

1. Make mathematical formulations and their solutions of various physical problems;
2. Design mathematical models used in heat, wave.
3. Describe the Laplace equation and their solutions.

Paper Code: GE-3.1 (Real Analysis)

Learning outcomes: After going through this course the students will be able to:

1. Analyses the properties of the number line
2. Describe various analytical properties of the real number system

SEMESTER IV

Paper Code: C4.1 (Numerical Methods)

Learning outcomes: After going through this course the students will be able to:

1. Discuss various Numerical methods and Interpolation Formulae
2. Apply numerical techniques for solving Differential Equations
3. Obtain numerical solutions of algebraic and transcendental equations
4. Application of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions
5. Apply various numerical methods in real life problems

Paper Code: C4.2 (Riemann Integration and Series of Functions)

Learning outcomes: After going through this course the students will be able to:

1. Understand Partition and refinement of partition of a closed and bounded interval.
2. Consider Upper Darboux sum $U(P, f)$ and Lower Darboux sum $L(P, f)$, as well as the associated results. Upper integral and lower integral.
3. Understand Darboux's theorem along with Darboux's definition of integration over a closed and bounded interval.
4. Learn Riemann's definition of integrability and its Equivalence with Darboux definition of integrability along with the Necessary and sufficient condition for Riemann integrability. Riemann integration,
5. Improper integrals; Convergence of Beta and Gamma functions.
6. Differentiation and integration of power series

Paper code: C4.3 (Ring Theory and Linear Algebra I)

Learning outcomes: After going through this course the students will be able to:

1. Describe various ring structures on sets.
2. Solve the system of linear equations.

Paper Code: GE-4.1 (Algebra)

Learning outcomes: After going through this course the students will be able to:

1. Describe various algebraic structures onsets
2. Identify the algebraic structures present in different branches of Sciences

SEMESTER V

Paper C5.1 (Multivariate Calculus)

Learning outcomes: After going through this course the students will be able to:

1. Extend the concepts from one variable calculus to functions of several variables.
2. Demonstrate the ability to think critically and solving application of real-world problems involving double/triple integrals
3. Apply inter relationship amongst the line integral, double integral and triple integral formulations
4. Application of multivariable calculus tools in physics, economics optimization and understand the architecture of curves and surfaces in plane and space etc
5. Realize importance of Green, Gauss and Stoke's theorem in other branches of mathematics
6. This course will enable the students to

Paper Code: C5.2 (Group Theory II)

Learning outcomes: After going through this course the students will be able to:

1. Apply results from preliminary concepts to solve contemporary problems.
2. Apply in communication theory, electrical engineering, computer science and cryptography covered by following three units:

Unit-1

- Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.

Unit-2

- Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

Unit-3

- Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n , p -groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.

Paper Code: DSE-1.1 (Analytical Geometry)

Learning outcomes: After going through this course the students will be able to:

1. Sketch parabola, ellipse and hyperbola
2. Solve various geometrical problems analytically

Paper Code: DSE2.1(Mathematical Modeling)

Learning outcomes: After going through this course the students will be able to:

1. solve differential equations and linear programming problems used in mathematical modeling

SEMESTER VI

Paper Code: C6.1 (Metric Spaces and Complex Analysis)

Learning outcomes: After going through this course the students will be able to:

1. Various properties of metrics spaces
2. Complex number system, its differentiation and integration.

Paper Code: C6.2 (Ring Theory and Linear Algebra II)

Learning outcomes: After going through this course the students will be able to:

1. Create a detailed concept on the Ring Theory of Abstract Algebra.
2. Apply theorems proof/ solution techniques to solve real world problems
3. Find the matrix associated with a linear transformation w.r.t. given bases and can understand the relationship between operations of linear transformations and corresponding matrices.
4. Understand various concepts of Abstract & Linear Algebra covered in details by the following three units:

Unit-1

- Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in $\mathbb{Z}[x]$. Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

Unit-2

- Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.

Unit-3

- Inner product spaces and norms, Gram-Schmidt orthogonalization process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Paper Code: DSE3.2 (Linear Programming)

Learning outcomes: After going through this course the students will be able to:

1. Describe various Optimization techniques pertaining to linear programming
2. Apply linear programming to problem arising out of real-life problems.
3. Understand the Game theory and apply the linear programming solution of game.

Paper Code: DSE4.1(Mathematical Methods)

Learning outcomes: After going through this course the students will be able to:

1. Construct mathematical models or real-world problems
2. Solve real world problems through the studied theories covered by following five units:

Unit- 1

- Fourier Series: Fourier Series, Dirichlet conditions, Fourier series for even and odd functions Half range Fourier series.

Unit -2

- Laplace Transform: Definition of Laplace transform, Existence theorem for Laplace transform. Linearity property of Laplace transform, Laplace transform of some elementary functions. (Algebraic functions, trigonometric functions, exponential functions, hyperbolic functions). First Shifting theorem, second shifting theorem, change of scale property, Laplace transform of derivatives, Laplace transform of Integrals.

Unit – 3

- Inverse Laplace Transform: Definition of Inverse Laplace Transform, Linearity property, first and second shifting theorems, change of scale, Convolution theorem.

Unit – 4

- Fourier Transform, and Inverse Fourier transform: Dirichlet conditions, Definition of Fourier transform, Inverse theorem for Fourier transform, Fourier Sine and Fourier cosine transforms and their inversion formula, Linearity property, change of scale property, shifting property, modulation theorem, convolution theorem.

Unit- 5

- Applications of Fourier and Laplace transform: Solution of Boundary value problems and initial value problems in 1-D and 2-D cases. Solution of Laplace and Poisson equations in 2-D cases.