

( Syllabus w.e.f. 2020-21)

**B.A./B.Sc.( Mathematics) Syllabus  
(Choice Based Credit System)  
H.N.B. Garhwal University, Srinagar (Garhwal) U. K.**

| <b>Semester</b> | <b>Core Course<br/>(04)</b>   | <b>Skill Enhancement<br/>Course<br/>(SEC) (02)</b> | <b>Discipline Specific<br/>Elective<br/>(DSE) (02)</b>  |
|-----------------|---|--|---|
| <b>1</b>        | <b>Differential Calculus<br/>Credit-06 ( Theory-<br/>05+Tutorial-01)</b>  |  |   |
| <b>2</b>        | <b>Differential Equations<br/>Credit-06 ( Theory-<br/>05+Tutorial-01)</b> |  |   |
| <b>3</b>        | <b>Real Analysis<br/>Credit-06 ( Theory-<br/>05+Tutorial-01)</b>          | <b>SEC<br/>Credit-04</b>                           |   |
| <b>4</b>        | <b>Algebra<br/>Credit-06 ( Theory-<br/>05+Tutorial-01)</b>                | <b>SEC<br/>Credit-04</b>                           |   |
| <b>5</b>        |   | <b>SEC<br/>Credit-04</b>                           | <b>DSE1A<br/>Credit-06 (Theory-<br/>05+Tutorial-01)</b> |
| <b>6</b>        |   | <b>SEC<br/>Credit-04</b>                           | <b>DSE1B<br/>Credit-06 (Theory-<br/>05+Tutorial-01)</b> |

**Discipline Specific Electives (DSE)**

**DSE 1A (Choose any one):**

1. Matrices
2. Mechanics
3. Linear Algebra

**DSE 1B (Choose any one):**

1. Numerical Methods
2. Complex Analysis
3. Linear Programming

**Skill Enhancement Course (SEC): (Choose any two):**

1. Integral Calculus
2. Vector Calculus
3. Theory of Equations
4. Analytical Geometry

### **Core 1.1: Differential Calculus**

Limit and Continuity ( $\epsilon$  and  $\delta$  definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder.

Taylor's series, Maclaurin's series of  $\sin x$ ,  $\cos x$ ,  $e^x$ ,  $\log(1+x)$ ,  $(1+x)^m$ , Partial differentiation, Euler's theorem on homogeneous function, Indeterminate forms.

Maxima and Minima of functions of two variables, Tangents and normal, Curvature. Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

### **Books Recommended**

1. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2011.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

### **Core 2.1: Differential Equations**

First order exact differential equations, Integrating factors, Rules to find an integrating factor.

First order higher degree equations solvable for  $x$ ,  $y$ ,  $p$ . Methods for solving higher-order differential equations, Basic theory of linear differential equations, Wronskian, and its properties, Solving a differential equation by reducing its order.

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

### **Books Recommended**

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

### **Core 3.1: Real Analysis**

Finite and infinite sets, Examples of countable and uncountable sets, Real line, Bounded sets, Suprema and infima, Completeness property of  $\mathbb{R}$ , Archimedean property of  $\mathbb{R}$ , intervals, Concept of limit points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences, Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Infinite series. Cauchy convergence criterion for series, Positive term series, Geometric series, Comparison test, Convergence of  $p$ -series, Root test, Ratio test, Alternating series, Leibnitz's test (Tests of Convergence without proof), Definition and examples of absolute and conditional convergence.

Riemann integral : Definition and examples, Properties of Riemann integrals, Necessary and sufficient conditions for integrability, Fundamental theorem.

### **Books Recommended**

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.

2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.

3. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.

#### **Core 4.1: Algebra**

Definition and examples of groups, Examples of abelian and non-abelian groups, the group  $Z_n$  of integers under addition and multiplication modulo  $n$ , Cyclic groups, Complex roots of unity, Circle group, The general linear group  $GL_n(n, R)$ , Groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, Permutation groups, Even and odd permutations, Group of quaternions.

Homomorphism and isomorphism of groups, Subgroups, Necessary and sufficient condition, Examples of subgroups including the center of a group, Order of an element, Cosets, Index of subgroup, Lagrange's theorem, Normal subgroups: Definition and examples and characterizations, Quotient groups.

Definition and examples of rings, Examples of commutative and non-commutative rings: rings from number systems,  $Z_n$  the ring of integers modulo  $n$ , Ring of real quaternions, Ring of matrices, Subrings and ideals, Integral domains and fields, Examples of fields:  $Z_p$ ,  $Q$ ,  $R$ , and  $C$ .

#### **Books Recommended**

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.

2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.

#### **DSE 1A.1: Matrices**

Types of matrices: Symmetric matrix, Hermitian matrix, Orthogonal, Involutory matrix Translation, Dilation, Rotation, Reflection in a point, Line and plane, Matrix form of basic geometric transformations.

Rank of a matrix, Invariance of rank under elementary transformations, Adjoint of matrices, Inverse of matrices, Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four, Solutions of a system of linear equations using matrices.

Matrices in diagonal form, Reduction to diagonal form upto matrices of order 3, Computation of matrix inverses using elementary row operations.

#### **Books Recommended**

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.

2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

3. Richard Bronson, *Theory and Problems of Matrix Operations*, Tata McGraw Hill, 1989.

#### **DSE 1A.2: Mechanics**

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work and potential energy.

Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), Tangential and normal components (space curve), Simple harmonic motion, Simple pendulum.

### **Books Recommended**

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

### **DSE 1A.3: Linear Algebra**

Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces, Linear combination of vectors, Linear span, Linear independence, Basis and dimension, Dimension of subspaces.

Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations, Dual space, Dual basis, Double dual, Characteristic Polynomial, Eigen values and eigen vectors. Isomorphisms, Isomorphism theorems, Invertibility and isomorphisms, Change of coordinate matrix.

### **Books Recommended**

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
3. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.

### **DSE 1B.1: Numerical Methods**

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods.

Lagrange and Newton interpolation: linear and higher order, finite difference operators.

Numerical differentiation: forward difference, backward difference and central Difference.

Integration: trapezoidal rule, Simpson's rule, Euler's method.

### **Recommended Books**

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

### **DSE 1B.2: Complex Analysis**

Limits, Limits involving the point at infinity, Continuity, Properties of complex numbers, Regions in the complex plane, Functions of complex variable, Derivatives, Differentiation formulas, Cauchy-Riemann equations, Sufficient conditions for differentiability.

Analytic functions, Examples of analytic functions, Exponential function, Logarithmic function, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integral, Cauchy-Goursat theorem, Cauchy integral formula.

Liouville's theorem, Examples based on Taylor's and Laurent's series.

### **Books Recommended**

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw-Hill International Edition, 2009.

2. Joseph Bak and Donald J. Newman, *Complex analysis*, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

### **DSE 1B.3: Linear Programming**

Linear Programming Problems, Graphical approach for solving some L.P.P., Convex sets, Supporting and separating hyperplanes, Theory of simplex method, Optimality and unboundedness, The simplex algorithm, Simplex method in tableau format, Introduction to artificial variables, Two-phase method, Big-M method and their comparison.

Duality, Formulation of the dual problem, Primal-dual relationships, Economic interpretation of the dual.

#### **Recommended Books**

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.

### **SEC 1: Integral Calculus**

Integration of rational and irrational functions, Properties of definite integrals.

Reduction formulae for integrals of rational and trigonometric functions, Gamma and Beta functions.

Areas and lengths of curves in the plane, Volumes and surfaces of solids of revolution. Double and triple integrals.

#### **Books Recommended**

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd., 2002.

### **SEC 2: Vector Calculus**

Multiple products, Reciprocal vectors.

Differentiation and partial differentiation of a vector function.

Derivatives of sum, dot product and cross product of two vectors.

Gradient, Divergence and curl, Applications of Green's theorem, Gauss's divergence and Stoke's theorem (without proof)

#### **Books Recommended**

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthews, *Vector Calculus*, Springer Verlag London Limited, 1998.

### **SEC 3: Theory of Equations**

General properties of polynomials, Graphical representation of a polynomial, General properties of equations, Descartes's rule of signs, Positive and negative roots, Relation between the roots and the coefficients of equations.

Symmetric functions, Applications symmetric function of the roots, Transformation of equations.

Solutions of reciprocal and binomial equations, Algebraic solutions of the cubic and biquadratic equations, Properties of the derived function.

#### **Books Recommended**

1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.

2. C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.

#### **SEC 4: Analytical Geometry**

Techniques for sketching parabola, ellipse and hyperbola.

Definition and equation of sphere, Intersection of a sphere and a line, Intersection of two spheres, Tangent plane, Plane of contact, Angle of intersection of two spheres.

Definition and equation of a cone, Guiding curve, Intersection of a line with cone, Tangent line and tangent plane, Reciprocal cone, Right circular cone, The cylinder, Right circular cylinder, Enveloping cylinder, Central conicoids .

#### **Books Recommended**

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd., 2002.
3. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd, 1994.

