FIRST SEMESTER (4 credits)

DSC I: Differential Calculus **Leccture Hours: 4 Hours per week**

Unit I : Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

Unit II : Tangents and normals, 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.

Unit III : 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, ex, log(l+x), (l+x)m, Maxima and Minima, Indeterminate forms.

Unit IV: Asymptotes, Envelopes, Singular points – Multiple points – Cusp, Node and conjugate points, Tracing of standard curves in Cartesian and Polar equations.

PRACTICAL COMPONENT-1

Credit :2 Hour: 4 Hour per week

1. Introduction to Scilab.
2. Operators; trigonometric, inverse trigonometric functions in scilab.
3. Plotting of standard Cartesian curves using Scilab.
4. Plotting of standard polar curves using Scilab.
5. Plotting of standard parametric curves using Scilab.
6. Introduction to Maxima.
7. Creating variables, functions.
8. Creating a Maxima program (simple examples, loops, control sequence).
9. Differentiation and integration using maxima inbuilt functions.
10. Plotting of standard curves- Cartesian, Polar using Maxima.
11. Plotting of standard parametric curves using Maxima.
12. Geometrical meaning of Rolle's theorem of the functions on the given interval.
13. To verify Rolle's theorem , Lagrange's theorem and cauchy's mean value theorem
14. Finding Taylor's theorem for a given function.
15. To illustrate left hand and right hand limits for discontinuous functions.
16. To illustrate continuity of a function.
17. To illustrate differentiability of a function.

Core Course - II (DSC – II)

Differential Equations

Unit I: 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.

Unit II: 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.

Unit III: 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.

Unit IV: Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

PRACTICAL COMPONENTS-II

Credit :2 Hour: 4 Hour per week

1. Obtaining partial derivatives of some standard functions
2. Solution of Differential equation and plotting the solution-I
3. Solution of Differential equation and plotting the solution-II
4. Solution of Differential equation and plotting the solution-III
5. Solution of Differential equation and plotting the solution-IV
6. Finding complementary function and particular integral of constant coefficient second and higher order ordinary differential equations.
7. Solving second order linear partial differential equations in two variables with constant coefficient.
8. Solutions to the problems on total and simultaneous differential equations.
9. Solutions to the problems on different types of partial differential equations.
10. Solution of Cauchy problem for first order partial differential equation.
11. Plotting the characteristics for the first order partial differential equation.
12. Plot the integral surfaces of a given first order partial differential equation with initial data.

Core Course - III (DSC-III)

Real Analysis

Unit I: Finite and infinite sets, examples of countable and uncountable sets.Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals.Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Unit II: 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).

Unit III: 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.

Unit IV: Sequences and series of functions, Pointwise and uniform convergence.Mn-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

Practical components-III

1. Illustration of convergent , divergent and oscillatory sequences.
2. Plotting of recursive sequences.
3. Study of convergence of sequences through plotting
4. Illustration of convergent, divergent and oscillatory series.
5. To study the convergence and divergence of infinite series by plotting their sequences of partial sums.
6. Using Cauchy's criterion on the sequence of partial sums of the series to determine convergence of series.
7. Cauchy's root test by plotting n^{th} roots.
8. Ratio test by plotting the ratio of n^{th} and $(n+1)^{th}$ terms.
9. Testing the convergence of binomial, exponential and logarithmic series and finding the sum.
10. To find the sum of the series and it's radius of convergence.

Core Course - IV (DSC -IV)

Algebra

Unit I: Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.

Unit II: Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Unit III: Definition and examples of rings, examples of commutative and non- commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals.

Unit IV: Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions. Homeomorphisms', Isomorphism'.

Prctical components-IV

1. Verifying whether a given operator is binary or not.

2. To find identity element of a group.

3. To find inverse element of a group.

4. Finding all possible subgroups of a finite group.

5. Examples to verify Lagrange's theorem.

6. Illustrating homomorphism and isomorphism of groups.

7. Verification of normality of a given subgroup.

8. Verifying Cayley's theorem and isomorphism theorems.

9. Examples for finding left and right coset and finding the index of a group.

10. Examples on different types of rings.

11. Examples on integral domains and fields.

12. Examples on subrings, ideals and subrings which are not ideals.

13. Homomorphism and isomorphism of rings – illustrative examples.

14. Solving polynomial equations.

15. Findind G.C.D of polynomials.

16. Finding units and associates.

17. Test for rational roots.

Elective Course - I (DSE - I)

Linear Algebra

Unit I: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Unit II: Inner Product, Inner Product of any two vectors in V (R), Euclidean Vectorspace, Orthogonal Vectors, Orthonormal Basis, Orthogonal Projection, Orthogonal Compliment.

Unit III: 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, Eigen values and Eigen vectors, Characteristic Polynomial.

Unit IV: Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Pracical components -V

1. Vector space, subspace – illustrative examples.
2. Expressing a vector as a linear combination of given set of vectors.
3. Examples on linear dependence and independence of vectors.
4. Basis and Dimension – illustrative examples.
5. Verifying whether a given transformation is linear.
6. Finding matrix of a linear transformation.
7. Problems on rank and nullity.
8. Find characteristics polynomials.
9. To find Eigen values and their multiplicity.
10. Calculation of Eigen vector.
11. Change of basis.
12. Linear transformations to matrices and vice versa.
13. Matrix with respect to change of basis.
14. Orthogonal and orthonormal sets.
15. Gram- Schmidt orthogonalisation of the columns.

Elective Course - II (DSE -II)

Complex Analysis

Unit I: Limits, Limits involving the point at infinity, continuity.Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings.Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Unit II: 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 integrals.Cauchy-Goursat theorem, Cauchy integral formula.

Unit III: Liouville's theorem and the fundamental theorem of algebra.Convergence of sequences and series, Taylor series and its examples.

Unit IV: Laurent series and its examples, absolute and uniform convergence of power series.

Practical components -VI

1. Declaring a complex number and graphical representation.
2. Complex numbers and their representations, operations like addition, multiplication, division, modulus, graphical representations of polar form.
3. To plot the complex functions and analyze the graph

   (i)$f(z)= z$, (ii) $f(z) = z^3$, (iii) $f(z) =(z^4- 1)^{1/4}$
4. Some problems on Cauchy – Riemann equations (polar forms).
5. Implementation of Milne – Thomson method of constructing analytic functions (simple examples).
6. Illustrating orthogonality of the surfaces obtained from the real and imaginary parts of an analytic function.
7. Verifying real and imaginary parts of an analytic function being harmonic (in polar coordinates)
8. Examples connected with Cauchy's integral theorem.
9. To compute the poles and corresponding residues of complex functions.
10. Illustrating the angle preserving property in a transformation.
11. Illustrating the circles are transformed to circles by a bilinear transformation.
12. To perform conformal mapping and bilinear transformations.

Skill Enhancement Course (SEC - II)

Vector Calculus

Unit I: Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors.

Unit II: Gradient, divergence and curl.