

DEPARTMENT OF MATHEMATICS
SARBATI DEVI WOMEN'S COLLEGE, RAJGANGPUR
PO, CO, PSO- NEP-2020

COURSE STRUCTURE FOR UNDER GRADUATE MATHEMATICS

(As per NEP guideline provided by Department of Higher Education, Government of Odisha)

DETAILED SYLLABUS OF THE CORE COURSES

CALCULUS & ANALYTIC GEOMETRY

Objective: The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of mathematical nature as well as practical problems. More precisely, main target of this course is to explore the different tools for higher order derivatives to plot the various curves and to solve the problems associated with differentiation and integration of vector functions.

Learning Outcomes: After completing the course the student will be able to

CO1: trace a curve and find asymptotes.

CO2: calculate integrals of typical type using reduction formulae, etc.

CO3: calculate arc length, surface of revolution and know about conics

CO4: calculate triple products, gradient divergence, curl, etc.

UNIT-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type $e^{ax} + b \sin x$, $e^{ax} + b \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital rule, application in business, economics and life sciences.

UNIT-II

Riemann integration as a limit of sum, integration by parts, reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx dx$, $\int \cos nx dx$, $\int \tan nx dx$, $\int \sec nx dx$, $\int (\log x)^n dx$, $\int \sin nx \cos nx dx$, definite integral, integration by substitution.

UNIT-III

Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

UNIT-IV

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation, partial differentiation, div, curl and integration of vector functions, tangent and normal components of acceleration.

INTRODUCTION TO ALGEBRA & NUMBER THEORY

Objectives: To present a systematic introduction to number theory and a basic course on algebra.

Learning Outcomes: After completing the course the student will be able to

CO1: understand the equivalence relations and concept of group with different examples.

CO2: understand the properties of cyclic groups, rings, and integral domain.

CO3: know divisibility and division algorithm and find gcd using Euclidean Algorithm.

CO4: solve linear Diophantine equations, find least common multiples, solve linear congruence applying the Chinese remainder theorem.

UNIT -I

Integers and equivalence relations, properties of integers, modular arithmetic, mathematical inductions, equivalence relations, Introduction to groups, symmetries of a square, the dihedral groups, definitions and examples of groups, elementary properties of groups, subgroups, examples of subgroups.

UNIT-II

Cyclic groups, properties of cyclic groups, classification of subgroups of cyclic groups, definitions and examples of normal subgroups, Introduction to rings, definition and examples of rings, properties of rings, subrings, definition and examples of integral domain and fields.

UNIT-III

Divisibility, division algorithms, prime and composite numbers, Fibonacci and Lucas numbers, Fermat numbers, greatest common divisor, Euclidean algorithm.

UNIT-IV

Fundamental theorem of arithmetic, least common multiple, linear Diophantine equations, congruence, linear congruence, Chinese remainder theorem, Wilson's theorem, Fermat little theorem, Euler's theorem.

REAL ANALYSIS-I

Objective: The objective of the course is to introduce the basics of real number system and the properties of sequence and series of real numbers. The ideas of completeness, least upper bound property, denseness, limit, continuity and uniform continuity will also be introduced. This is one of the core courses essential to start doing mathematics.

Learning Outcomes: On successful completion of this course, students will be able to

CO1: learn basics of real number system and test countability of a set.

CO2: know on sequence of real numbers and their basic properties.

CO3: test convergence of an infinite series.

CO4: find limit and continuity of functions and test uniform continuity of functions.

UNIT-I

Finite and infinite sets, countable and uncountable sets, examples, algebraic and order Properties of $\mathbb{R}$, uncountability of $\mathbb{R}$, completeness property of $\mathbb{R}$, applications of the supremum property, Intervals, nested interval property, denseness of rationals in $\mathbb{R}$.

UNIT-II

Sequence and their limits, limit theorems, monotone sequences, monotone Convergence theorem, subsequences, divergence criteria, monotone subsequence theorem, Bolzano Weierstrass theorem for sequences, Cauchy sequence, Cauchy's convergence criterion.

UNIT-III

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, Raabe's test, integral test, alternating series, Leibniz test, absolute and conditional convergence.

UNIT-V

Limits of functions, limit theorems, some extensions of limit concept, continuous functions and their combinations, continuous functions on intervals, boundedness theorem, maximum minimum theorem, intermediate value theorem, uniform continuity, examples, uniform continuity theorem.

ALGEBRA-I

Objectives: To present a systematic and rigorous study on algebraic structures like groups, rings and some important results with their applications. After pursuing this course, one can opt for advanced topics in groups, rings and their applications to

problems in physics, computer science and engineering.

Learning Outcomes: After completing this course, students will able to

CO1: understand permutation groups with some results and application in Rubik's cube.

CO2: understand the concept of homomorphisms, isomorphisms, normal subgroups and factor groups.

CO3: explore more properties of rings and ideals rigorously.

CO4: get introduced to the concept of reducibility and irreducibility of polynomials and concept of unique factorization domain.

Unit -I

Permutation groups, definition and notations, cyclic notation, properties of permutations, isomorphisms, definition and examples, Cayley's theorem, properties of isomorphisms, automorphisms, cosets, properties of cosets, Lagrange's theorem and consequences, an application of cosets to permutation groups, an application of cosets to Rubik's cube.

Unit-II

External direct products, definition and examples, properties of external direct products, the group of units modulo n as an external direct product, applications, normal subgroups, factor groups, application of factor groups, internal direct products, group homomorphisms, definition and examples, properties of homomorphisms, the first isomorphism theorem.

Unit-III

Characteristic of a ring, ideals, factor rings, prime ideals and maximal ideals, ring homomorphisms, definition and examples, the field of quotients, polynomial rings, notations and terminology, division algorithm and consequences.

Unit-IV

Factorization of polynomials, reducibility test, irreducibility test, unique factorization in $\mathbb{Z}[x]$, divisibility in integral domains, irreducible, primes, unique factorization domain, Euclidean domain.

PROBABILITY

Objective: The objective of the course is to make the student understand basics of probability which is of use in everyday life.

Learning Outcomes: After completing the course the student will be able to

CO1: learn the basics of probability and random variables with axioms of probability.

CO2: know the discrete and continuous distributions and learn how to calculate mean, variance and moments of them.

CO3: learn on limit theorems with their applications and know about the conditional expectations.

CO4: learn on Markov chains and their applications.

UNIT-I

Sample space and events, probability axioms, probability defined on events, conditional probabilities, Independent events, Bayes formula, real random variables, discrete and continuous random variables, probability distribution function, probability mass/density functions, mathematical expectation, and properties, variance and standard deviation.

UNIT-II

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential, their expectations and variance, moments, moment generating function, characteristic function and computation of these for the

distributions, joint distribution function and its properties, joint probability density functions, marginal and conditional distributions, independent random variables.

UNIT-III

Limit theorems: Markov inequality, Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, application to problems, conditional probability and conditional expectation, discrete case, continuous case, applications, expectation of function of two random variables, conditional expectations, bivariate normal distribution, correlation coefficient, joint moment generating function and calculation of covariance, linear regression for two variables.

UNIT-IV

Central limit theorem for independent and identically distributed random variables with finite variance, Markov chains, Chapman-Kolmogorov equations, classification of states, Gambler Ruin problem.

DIFFERENTIAL EQUATIONS-I

Objective: Differential Equations introduced by Leibnitz in 1676 models almost all Physical, Biological, Chemical systems in nature. The objective of this course is to familiarize the students to various methods of solving differential equations, partial differential equations and to have a qualitative applications through models. The students have to solve problems to understand the methods.

Learning Outcomes: After completing the course the student will be able to

CO1: get the idea to solve first order linear ordinary differential equations of different types those are arising in physical problems.

CO2: get the idea to solve second order linear ordinary differential equations of different types those are arising in physical problems.

CO3: get basic ideas of first order partial differential equations, its formulation in two, three variables and variable separable method for identify the solutions.

CO4: get idea to solve various mathematical models of ODEs and PDEs which may be helpful for simulation process.

UNIT-I

Differential equations and mathematical models, general, particular, explicit, implicit and singular solutions of a differential equation, exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equations and Bernoulli's equation, compartmental model, population model for single species.

UNIT-II

General solution of homogeneous equation of second order, principle of superposition, Wronskian, its properties and applications, method of undetermined coefficients, method of variation of parameters, linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equations.

UNIT-III

Partial Differential Equations - Basic concepts and definitions, origin of first order PDEs, Classification of first order PDEs, Pfaffian differential forms and equations, solution of Pfaffian differential equations in three variables, Cauchy's problem for first order PDEs, linear equations of first order, integral surfaces passing through a given curve, Cauchy's method of characteristics, compatible systems, method of separation of variables for solving first order and second order partial differential equations.

UNIT-IV (PRACTICAL)

The students will implement the following problems in the computer Lab using *Matlab* / *Mathematica* / *Maple* etc.

1. Plotting of second order solution family of differential equations.
2. Plotting of third order solution family of differential equations.
3. Population growth model (exponential case only).
4. Population decay model (exponential case only).
5. Solution of Cauchy problem for first order PDEs.
6. Finding the characteristics for the first order PDEs.
7. Plot the integral surfaces of a given first order PDE with initial data.

LINEAR ALGEBRA

Objective: The objective of this course is to acquaint students with matrix operations, solution of system of equations, vector spaces and linear transformations. In addition, the student will learn about eigenvalues, diagonalization, canonical forms, etc., which has many applications in almost all areas of science and engineering.

Learning Outcomes: After completing the course the student will be able to

CO1: determine basis and the dimension of a finite-dimensional vector space, know the relation between rank and nullity of a linear transformation.

CO2: the relation between matrix and linear transformation.

CO3: to find solution of system of linear equations, compute eigenvalues, eigenvectors of a matrix and linear transformation.

CO4: about orthogonality of vectors and application of it to different form of matrix, introduced to different operators.

UNIT-I

Vector spaces, subspaces, span of a set, more about subspaces, linear dependence, independence, product and quotient space, dimension and basis, linear transformations, range and kernel of a linear map, rank and nullity of linear map.

UNIT-II

Inverse of linear transformation, consequences of rank – nullity theorem, the space $L(U, V)$, composition of linear maps, matrix associated with linear map, linear map associated with matrix, rank and nullity of a matrix, determinant minors and rank of a matrix, transpose of a matrix and special type of matrices, elementary row operations

UNIT-III

System of linear equations, matrix inversion, application of determinant to linear equations, eigenvalues and eigenvectors, similarity of matrices, invariant subspaces, minimal polynomial (eigenvalues and the minimal polynomial), upper triangular matrices, diagonalizable operators (diagonal matrices, conditions for diagonalizability).

UNIT-IV

Inner product space: inner products and norms, orthonormal bases, orthogonal complements, self-adjoint and normal operators, spectral theorems, isometries, unitary operators, characteristic polynomial, Cayley – Hamilton theorem, Jordan form, trace, quadratic form, application to reduction of quadrics.

REAL ANALYSIS-II

Objective: As a second course in real analysis, the objective is to learn on the concept of differentiation, Riemann Integration and their applications. The series of functions and the improper integrals have also been introduced.

Learning Outcomes: After completing the course the student will be able to

CO1: learn working out problems on derivatives of function and their applications.

CO2: learn about Riemann Integration and their properties including Improper Integrals.

CO3: learn on pointwise and uniform convergence of power series.

CO4: learn to calculate value of improper integrals.

UNIT-I

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions, relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorems, Cauchy's mean value theorem, Lagrange mean value theorem, intermediate value property of derivatives, Darboux's theorem, applications of mean value theorem, Taylor's theorem and applications.

UNIT-II

Riemann integration: partitions, conditions of integrability, definition of Riemann integral properties of the Riemann integral, Riemann integral as limit of a sum, mean value theorem for integrals, integration by parts, Fundamental theorems of calculus, Taylor theorem with remainder.

UNIT-III

Pointwise and uniform convergence of sequence of functions, Cauchy criterion for uniform convergence and Weierstrass M-test, uniform convergence and continuity, term by term

integration and differentiation of a series, power series, Abel's theorem, Weierstrass approximation theorem, Taylor series

Unit IV

Improper integrals, integration of unbounded functions with finite limits of integration, comparison tests of convergence, infinite range of integration, integrand as product of functions convergent at infinity, absolutely convergent integral, tests of convergence, convergence of Beta and Gamma functions, applications.

COMPLEX ANALYSIS-I

Objectives: The objective of the course is to introduce the theories for functions of a complex variable. The concepts of analyticity and complex integration and its applications are discussed in detail. This course is prerequisite to many other advanced analysis courses such as advanced complex analysis, geometric functions, theory, potential theory, theory of entire and meromorphic functions, etc.

Learning Outcomes: After completing the course the student will be able to

CO1: understand the geometric aspects of complex numbers system, convergence of series of complex numbers.

CO2: understand the significance of complex differentiability, analyticity and construction of analytic functions from 20

given harmonic functions.

CO3: relate the notion of line integral, Cauchy fundamental theorems on integrals and its applications.

CO4: classify the nature of singularities, properties of zeros and poles and be able to know the applications of residue theorem.

UNIT- I

Basic properties of complex number and, Stereographic projection, power series, absolute convergence, uniform convergence, Cauchy-Hadamard formula for the radius of convergence, circle of convergence, exponential, logarithmic, sine and cosine functions for complex numbers.

UNIT-II

Continuity and differentiability of a complex valued function, analytic function, necessary and sufficient conditions for analytic functions, Cauchy-Riemann equations (Cartesian and polar form), harmonic and conjugate harmonic functions, construction of analytic function (Milne-Thomson's method).

UNIT-III

Line integral, path independence, complex integration, Green's theorem, anti-derivative theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy's inequality, derivative of

analytic function and its generalizations, Liouville's theorem, Morera's theorem, Taylor's and Laurent's theorem, expansion of analytical function in Taylor and Laurent series.

UNIT-IV

Zeroes of an analytic function, singularities of complex functions and its classifications, residues, Cauchy's residue theorem, residue at infinity, residues at poles and its examples, maximum modulus theorem.

ALGEBRA-II

Objectives: To present a systematic study on finite abelian groups, Sylow's theorems and Modules.

Learning Outcomes: After completing the course the student will be able to

CO1: know on finite abelian groups, the class equation and Sylow's theorems.

CO2: know on applications of Sylow's theorems and test the simplicity of groups.

CO3: learn on group action, composition series, nilpotent groups and solvable groups.

CO4: solve problems in modules and related results.

UNIT -I

Fundamental theorem of finite abelian groups, isomorphism classes of abelian groups, proof of the fundamental theorem, Sylow's theorems, conjugacy classes, the class equation, Sylow's first theorem, Cauchy theorem, Sylow's second and third theorems.

UNIT-II

Application of Sylow's theorem, finite simple groups, non-simplicity tests, the simplicity of alternating group A_5 , free groups, classification of groups of order up to 15, characterization of dihedral groups.

UNIT-III

Group actions and permutation representations, composition series and holder programs, nilpotent groups, solvable groups.

UNIT-IV

Introduction to modules, definition and examples, direct sum, free modules, quotient modules, homomorphisms, simple modules, modules over PIDs.

REAL ANALYSIS-III

Objective: After a first course in real analysis in undergraduate program, the ideas of uniform continuity, uniform convergence and approximation by polynomials are crucial in analysis. In addition to the functions of bounded variation and their integrators, the student has to learn differentiating functions from R_n to R_m .. The techniques of integration of a function with respect to another function and the basic ideas of finding a Fourier series are also included.

Learning Outcomes: After completing the course the student will be able to

CO1: find the Fourier series of a function.

CO2: calculate Riemann Stieltjes integrals and know whether a function is of bounded variation or not.

CO3: learn how to define derivatives on $\mathbb{R}^n$ including the existence of partial derivatives, inverse function theorem and implicit function theorem.

CO4: learn about metric spaces and their topological properties.

UNIT-I

Basic concepts of Fourier series, Fourier series of even and odd functions, half range series, Fourier series on other intervals, orthogonal systems of functions, theorem on best approximation, properties of Fourier coefficients, Riesz-Fisher theorem, Riemann-Lebesgue lemma, Dirichlet integral, Integral representation for the partial sum of a Fourier series, convergence of Fourier series.

UNIT-II

Function of bounded variation, examples, total variation, function of bounded variation expressed as difference of increasing functions, rectifiable paths, Riemann-Stieltjes integrals, properties and techniques, necessary and sufficient condition for existence of the integral, mean value theorem for Riemann-Stieltjes integrals, reduction to Riemann integrals.

UNIT-III

Differentiation in $\mathbb{R}^n$, partial derivatives, directional derivatives, sufficient condition for differentiability, chain rule, , mean value theorem, Jacobians, contraction mapping principle, inverse function theorem, implicit function theorem, rank theorem, differentiation of integrals, Taylor theorem in many variables.

UNIT-IV

Metric spaces, definitions and examples, open and closed sets, interior and exterior points, convergence and completeness, continuity and uniform continuity, compactness, connectedness.

DIFFERENTIAL EQUATIONS-II

Objective: The objective of this course is to understand basic methods for solving nonlinear first order ordinary differential equations and existence of solutions along with some special type of second order ordinary differential equations of mathematical physics. Also, students will be exposed to second order partial differential equations arising in thermal physics and thermodynamics.

Learning Outcomes: After completing the course the student will be able to

CO1: understand first order nonlinear ordinary differential equations and existence of solutions

CO2: learn the methods to find solutions of second order linear ordinary differential equations with constant coefficients and variable coefficients.

CO3: the different methods for solving first and second order partial differential equations and can take more courses on wave equation, heat equation, diffusion equation, gas dynamics, nonlinear evolution equations etc. All these courses are important in engineering and industrial applications for solving boundary value problems.

CO4: get idea to solve various mathematical models of ODE and PDE which may be helpful for simulation process.

UNIT-I

Existence and Uniqueness of Solutions: Lipschitz condition, Gronwall type inequality, successive approximations, Picard's theorem, non-uniqueness of solutions, continuation and dependence on initial conditions, existence of solutions in the large.

UNIT-II

Solution of second order ODE with constant coefficients, power series solutions of ordinary and singular points, and special functions of Legendre's differential equations, Bessel's differential equations and their properties.

UNIT-III

Charpit's method, special types of first order PDE, Jacobi's method, Linear second order PDE, canonical forms of second order PDE and characteristics curves, one dimensional wave equation, its origin and elementary solutions, vibration of an infinite string, vibration of a semi finite string, vibration of a string of finite length, existence of unique solution.

UNIT-IV (PRACTICAL)

Laboratory work for the following problems using *MATLAB / Mathematica / Maple* etc.

1) Plot the Fourier series of the following functions:

i. $f(x)=x^2, x \in [-1, 1]$

ii. $f(x)=\begin{cases} 1, & 0 < x < \pi \\ -1, & -\pi < x < 0 \end{cases}$

iii. $f(x)=\sin \sin x, 0 < x < \pi/2$

2) Solution of wave equation $\partial^2 u / \partial t^2 - c^2 \partial^2 u / \partial x^2 = 0$ for the following associated conditions:

(i) $u(x, 0) = \varphi(x), u_t(x, 0) = \sigma(x), x \in R, t > 0$

(ii) $u(x, 0) = \varphi(x), u_t(x, 0) = \sigma(x), u(0, t) = 0, x \in (0, \infty), t > 0$

(iii) $u(x, 0) = \varphi(x), u_t(x, 0) = \sigma(x), u_x(0, t) = 0, x \in (0, \infty), t > 0$

(iv) $u(x, 0) = \varphi(x), u_t(x, 0) = \sigma(x), u(0, t) = 0, u(l, t) = 0, 0 < x < l, t > 0$

3) Solution of one dimensional heat equation $\partial u / \partial t - k \partial^2 u / \partial x^2 = 0$ for the following conditions

(i) $u(x, 0) = \varphi(x), u(0, t) = a, u(l, t) = b, 0 < x < l, t > 0$

(ii) $u(x,0)=\varphi(x), x \in R, 0 < t < T$

(iii) $u(x,0)=\varphi(x), u(0,t)=a, x \in (0,\infty), t \geq 0.$

NUMERICAL ANALYSIS & SCIENTIFIC COMPUTING

Objectives: The objective of this course is to acquaint the students with a wide range of numerical methods to solve algebraic and transcendental equations, linear system of equations, interpolation and curve fitting problems, numerical integration, initial and boundary value problems, etc. Develop adequate skills to apply those methods in real world problems.

Learning Outcomes: After completing the course the student will be able to

CO1: understand the errors in computation, find the roots of algebraic and transcendental equations, familiarize with convergence, advantages and limitations of those numerical techniques, learn to apply Gauss–Jacobi, Gauss–Seidel methods to solve system of linear equations.

CO2: get aware of using interpolation techniques to solve polynomials.

CO3: learn numerical differentiation and integrations by using different techniques.

CO4: understand the techniques to find approximate solutions of ODE and PDE.

UNIT-I

Errors in approximation, absolute, relative and percentage errors, round-off error, solution of algebraic and transcendental equations: bisection method, Regula-Falsi method, secant method, method of iteration, Newton Raphson method, order of convergence, systems of simultaneous equations: Gauss elimination method, Gauss Jordan method, LU decomposition method, Iterative methods: Jacobi method and Gauss-Seidel method.

UNIT-II

Finite differences, interpolation techniques for equal intervals-Newton forward and backward, Gauss forward, Gauss backward, interpolation, interpolation with unequal intervals-Newton's divided difference method, Lagrange method, Hermite interpolation,

Numerical differentiation using Newton forward and backward formulae, numerical integration using Newton-Cotes formulas, trapezoidal rule, Simpson rules, Gauss-Legendre, Gauss-Chebyshev formulas.

UNIT-III

Solution of ordinary differential equations: Taylor series method, Picard's method, Euler method, Euler modified method, Runge–Kutta methods.

UNIT-IV (PRACTICAL)

Practical / Lab work to be perform in Computer Lab:

Use of computer algebra system (CAS) software: Python/ Sage Math / Mathematica/ MATLAB/ Maple/ Maxima/ Scilab/ R or any other (open source) software etc., for developing at least the following numerical programs:

1. Bisection method, Newton-Raphson method and Secant method.
2. LU decomposition method.
3. Gauss–Jacobi method and Gauss–Seidel method.
4. Lagrange interpolation and Newton interpolation.
5. Trapezoidal rule and Simpson's rules.
6. Taylor series method, Picard's method, Euler method, Euler modified method and Runge–Kutta Methods.

MULTIVARIABLE CALCULUS

Objectives: The primary objective of this course is to introduce students, the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables with the geometry and visualization of curves and surfaces. To aware the students about the techniques multiple integrations and higher order derivatives.

Learning Outcomes: After completing the course the student will be able to

CO1: learn the concept of limit, continuity and differentiations of functions of more than one.

CO2: understand the maximization and minimization of multivariable functions with the given constraints on variables.

CO3: learn about inter-relationship amongst the line integral, double, and triple integral formulations.

CO4: familiarize with the Green's, Stokes' and Gauss divergence theorems and their applications.

UNIT-I

Functions of several variables, limit and continuity of functions of two variables: partial differentiation, total differentiability, sufficient condition for differentiability, chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

UNIT-II

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, double integration over rectangular region, double integration over non rectangular region, double integrals in polar co-ordinates.

UNIT-III

Triple integrals, triple integral over a parallelepiped and solid regions, volume by triple integrals, cylindrical and spherical co-ordinates, change of variables in double integrals and triple integrals.

UNIT-IV

Definition of vector field, divergence and curl, line integrals, applications of line integrals: mass and work, fundamental theorem for line integrals, conservative vector fields, independence of path, Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stokes' theorem, the divergence theorem.

DIFFERENTIAL GEOMETRY

Objective: The objective of this course is to explore geometry of curves and surfaces in R^2 and R^3 with their intrinsic properties and curvatures.

Learning Outcomes: After completing the course the student will be able to

CO1: understand the notion of plane curves, space curves, curvature, torsion and the existence of space curves.

CO2: learn the theory of surfaces and learn to calculate first fundamental forms.

CO3: learns on geodesics on a surface and learns to calculate curvatures.

CO4: Learns calculating second fundamental forms, curvatures and discovers minimal surfaces.

UNIT-I

Theory of Space Curves: space curves, arc length, tangent, normal and binormal, osculating plane, curvature, torsion, Serret-Frenet formulae, contact between curves and surfaces, osculating circles and spheres, involute and evolutes, existence of space curves, Helices.

UNIT-II

Theory of surfaces: parametric curves on surfaces, surfaces of revolution, helicoids, metric, direction coefficients. First Fundamental forms.

UNIT-III

Geodesics, canonical geodesic equations, nature of geodesics on a surface of revolution, normal property of geodesics, Torsion of a geodesic: geodesic curvature, Gauss-Bonnet theorem, Gaussian curvature, surfaces of constant curvature.

UNIT-IV

Second Fundamental forms, principal curvatures, lines of curvature, Rodrigue's formula, conjugate and asymptotic lines. Developables, developable associated with space curves and curves on surfaces, minimal surfaces. Fundamental Theory of surfaces.

Multi-Disciplinary Course

SEMESTER-III

Paper-I: Programming C++ (Mathematics/Computer Science)

Course Objective:

The objective of the course is to learn the basics about C++ programming language such as variables, data types, arrays, pointers, functions and classes etc. On successful completion this course, students will acquire a good understanding about the concept of object-oriented programming using C++ and be able to write and read basic C++ code.

Learning Outcome: On the completion of this course, students will be able to

- Learn to understand different types of data by C++ language.
- Learn different symbols used in the programming language representing the text variables and constants.
- Learn to develop various operators, loops and nested control statements.
- Learn to generate functions, local and global variables, 1D and 2D array in C++ programme.

UNIT-I

Introduction to structured programming: data types- simple data types, floating data types, character data types, string data types, arithmetic operators and operator's precedence.

UNIT-II

Variables and constant declarations, expressions, input using the extraction operator >> and cin, output using the insertion operator << and cout, preprocessor directives, increment (++) and decrement (--) operations.

UNIT-III

Creating a C++ program, input output, relational operators, logical operators and logical expressions, if and if-else statement, switch and break statements, for, while and do-while loops, continue statement, nested control statement.

UNIT-IV Functions, value returning functions, value versus reference parameters, local and global variables, one dimensional array, two dimensional array, pointer data and pointer variables.