KAKATIYA UNIVERSITY - WARANGAL - TELANGANA

Under Graduate Courses (w.e.f. academic year 2019-20 batch onwards)

B.Sc. MATHEMATICS II Year

SEMESTER – III

REAL ANALYSIS

Theory: 5 credits and Tutorials: 0 credits Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to the foundations of analysis which will be useful in understanding various physical phenomena.

Outcome: After the completion of the course students will be in a position to appreciate beauty and applicability of the course.

UNIT- I

Sequences: Limits of Sequences- A Discussion about Proofs-Limit Theorems for Sequences-Monotone Sequences and Cauchy Sequences -Subsequences-Limit sup's and Limit inf's - Series-Alternating Series and Integral Tests.

UNIT- II

Continuity: Continuous Functions -Properties of Continuous Functions -Uniform Continuity -Limits of Functions

UNIT- III

Differentiation: Basic Properties of the Derivative - The Mean Value Theorem - L'Hospital Rule - Taylor's Theorem.

UNIT- IV

Integration: The Riemann Integral - Properties of Riemann Integral-Fundamental Theorem of Calculus.

Text:

Kenneth A Ross, Elementary Analysis-The Theory of Calculus

References:

1] S.C. Malik and Savita Arora, Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International (P) Limited, New Delhi, 1994.

2] William F. Trench, Introduction to Real Analysis

3] Lee Larson , Introduction to Real Analysis I

4] Shanti Narayan and Mittal, Mathematical Analysis

5] Brian S. Thomson, Judith B. Bruckner, Andrew M. Bruckner; Elementary Real analysis

6] Sudhir R., Ghorpade, Balmohan V., Limaye; A Course in Calculus and Real Analysi

KAKATIYA UNIVERSITY - WARANGAL - TELANGANA

Under Graduate Courses (w.e.f. academic year 2019-20 batch onwards)

B.Sc. MATHEMATICS II Year

SEMESTER – IV

ALGEBRA

Theory: 5 credits and Tutorials: 0 credits Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to learn some basic algebraic structures like groups, rings etc.

Outcome: On successful completion of the course students will be able to recognize algebraic structures that arise in matrix algebra, linear algebra and will be able to apply the skills learnt in understanding various such subjects.

UNIT- I

Groups: Definition and Examples of Groups- Elementary Properties of Groups-Finite Groups - Subgroups -Terminology and Notation -Subgroup Tests - Examples of Subgroups.
Cyclic Groups: Properties of Cyclic Groups - Classification of Subgroups Cyclic Groups.

UNIT- II

Permutation Groups: Definition and Notation -Cycle Notation-Properties of Permutations -A

Check Digit Scheme Based on D5. Isomorphisms ; Motivation- Definition and Examples - Cayley's Theorem Properties of Isomorphisms -Automorphisms-Cosets and Lagrange's Theorem Properties of Cosets 138 - Lagrange's Theorem and Consequences-An Application of Cosets to Permutation Groups -The Rotation Group of a Cube and a Soccer Ball.

UNIT- III

Normal Subgroups and Factor Groups: Normal Subgroups-Factor Groups -Applications of Factor Groups -Group Homomorphisms - Definition and Examples -Properties of Homomorphisms -The Fifirst Isomorphism Theorem.

Introduction to Rings: Motivation and Definition -Examples of Rings -Properties of Rings - Subrings.

Integral Domains: Definition and Examples - Fields Characteristics of a Ring.

UNIT- IV

Ideals and Factor Rings: Ideals -Factor Rings -Prime Ideals and Maximal Ideals.
Ring Homomorphisms: Definition and Examples-Properties of Ring-
Homomorphisms.

Text:

Joseph A Gallian, Contemporary Abstract algebra (9th edition)

References:

1] Bhattacharya, P.B Jain, S.K.; and Nagpaul, S.R,Basic Abstract Algebra 2]
Fraleigh, J.B, A Fifirst Course in Abstract Algebra.
3] Herstein, I.N, Topics in Algebra
4] Robert B. Ash, Basic Abstract Algebra
5] I Martin Isaacs, Finite Group Theory
6] Joseph J Rotman, Advanced Modern Algebra

SEMESTER-V

Linear Algebra

(w.e.f. academic year 2019-20 batch onwards)

DSC-V

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The students are exposed to various concepts like vector spaces,bases, dimension, Eigen values etc.

Outcome: After completion this course students appreciate its interdisciplinary nature.

Unit- I

Vector Spaces: Vector Spaces and Subspaces -Null Spaces, Column Spaces, and Linear Transformations -Linearly Independent Sets; Bases -Coordinate Systems -The Dimension of a Vector Space

Unit- II

Rank-Change of Basis - Eigenvalues and Eigenvectors - The Characteristic Equation

Unit- III

Diagonalization: -Eigenvectors and Linear Transformations -Complex Eigenvalues - Applications to Differential Equations.

Unit- IV

Orthogonality and Least Squares : Inner Product, Length, and Orthogonality -Orthogonal Sets -Orthogonal Projections - The Gram-Schmidt Process.

Text:

David C Lay,Linear Algebra and its Applications 4e

References:

1] S Lang, Introduction to Linear Algebra

2] Gilbert Strang , Linear Algebra and its Applications

3] Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence; Linear Algebra

4] Kuldeep Singh; Linear Algebra.

5] Sheldon Axler; Linear Algebra Done Right

SEMESTER-VI

(A) Numerical Analysis

(w.e.f. academic year 2019-20 batch onwards)

DSE-VI

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: Students will be made to undefirstand some methods of numerical analysis.
Outcome: Students realize the importance of the subject in solving some problems of algebra and calculus.

Unit- I

Errors in Numerical Calculations - Solutions of Equations in One Variable: The Bisection Method - The Iteration Method - The Method of False Position-Newton's Method - Muller's Method - solution of Systems of Nonlinear Equations.

Unit- II

Interpolation and Polynomial Approximation: Interpolation - Finite Differences - Differences of Polynomials - Newton's formula for Interpolation - Gauss's central differences formulae - Stirling's and Bessel's formula - Lagrange's Interpolation Polynomial - Divided differences - Newton's General Interpolation formula - Inverse Interpolation.

Unit- III

Curve Fitting: Least Square Curve Fitting: Fitting a Straight Line-Nonlinear Curve Fitting. **Numerical Differentiation and Integration:** Numerical Differentiation - Numerical Integration: Trapezoidal Rule-Simpson's 1/3rd-Rule and Simpson's 3/8th-Rule - Boole's and Weddle's Rule - Newton's Cotes Integration Formulae.

Unit- IV

Numerical Solutions of Ordinary Differential Equations: Taylor's Series Method - Picard's Method - Euler's Methods - Runge Kutta Methods.

Text:

S.S.Sastry,Introductory Methods of Numerical Analysis, PHI

References:

1] Richard L. Burden and J. Douglas Faires,Numerical Analysis (9e)

2] M K Jain, S R K Iyengar and R K Jain, Numerical Methods for Scientific and Engineering computation

3] B.Bradie , A Friendly introduction to Numerical Analysis

(B) Integral Transforms

(w.e.f. academic year 2019-20 batch onwards)

DSE - VI

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: Students will be exposed to Integral Transforms. The students also learning the Applications of Laplace Transforms to Differential Equations which arises in Physics and Engineering Problems.

Outcome: Students apply their knowledge to solve some problems on special functions and Differential Equations by using the Integral Transforms.

Unit- I

Laplace Transforms-Definition-Existence theorem-Laplace transforms of derivatives and integrals Periodic functions and some special functions.

Unit- II

Inverse Transformations - Convolution theorem - Heaviside's expansion formula.

Unit- III

Applications to ordinary Differential equations - solutions of simultaneous ordinary Differential equations - Applications to Partial Differential equations.

Unit- IV

Fourier Transforms- Sine and cosine transforms-Inverse Fourier Transforms.

Text:

Vasishtha and Gupta, Integral Transforms, Krishna Prakashan Media(P), Ltd, Meerut (2e)

(C) Analytical Solid Geometry

(w.e.f. academic year 2019-20 batch onwards)

DSE - VI

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: Students learn to describe some of the surfaces by using analytical geometry.
Outcome: Students understand the beautiful interplay between algebra and geometry.

Unit- I

Sphere: Definition-The Sphere Through Four Given Points-Equations of a Circle- Intersection of a Sphere and a Line-Equation of a Tangent Plane-Angle of Intersection of Two Spheres-Radical Plane.

Unit- II

Cones and Cylinders: Definition-Condition that the General Equation of second degree Represents a Cone-Cone and a Plane through its Vertex -Intersection of a Line with a Cone.

Unit- III

The Right Circular Cone-The Cylinder- The Right Circular Cylinder.

Unit- IV

The Conicoid: The General Equation of the Second Degree-Intersection of Line with a Conicoid-Plane of contact-Enveloping Cone and Cylinder.

Text:

Shanti Narayan and P K Mittal, Analytical Solid Geometry (17e)

References:

1] Khaleel Ahmed, Analytical Solid Geometry

2] S L Loney , Solid Geometry

3] Smith and Minton, Calculus

2.12 LINEAR ALGEBRA

DSC-1E
BS:503

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours/week and Practicals: 2 hours/week

Objective: The students are exposed to various concepts like vector spaces, bases, dimension, Eigen values etc.

Outcome: After completion this course students appreciate its interdisciplinary nature.

UNIT-I

Vector Spaces : Vector Spaces and Subspaces -Null Spaces, Column Spaces, and Linear Transformations -Linearly Independent Sets; Bases -Coordinate Systems

UNIT-II

The Dimension of a Vector Space, Rank-Change of Basis - Eigenvalues and Eigenvectors .

UNIT-III

The Characteristic Equation, Diagonalization -Eigenvectors and Linear Transformations -Complex Eigenvalues - Applications to Differential Equations .

UNIT-IV

Orthogonality and Least Squares : Inner Product, Length, and Orthogonality -Orthogonal Sets.

TEXT: David C Lay,*Linear Algebra and its Applications 4e*
References:

- S Lang, *Introduction to Linear Algebra*
- Gilbert Strang ,*Linear Algebra and its Applications*
- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence; *Linear Algebra*
- Kuldeep Singh; *Linear Algebra*
- Sheldon Axler;*Linear Algebra Done Right*

2.12 LINEAR ALGEBRA

DSC-1E
BS:503

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours/week and Practicals: 2 hours/week

Objective: The students are exposed to various concepts like vector spaces, bases, dimension, Eigen values etc.

Outcome: After completion this course students appreciate its interdisciplinary nature.

UNIT-I

Vector Spaces : Vector Spaces and Subspaces -Null Spaces, Column Spaces, and Linear Transformations -Linearly Independent Sets; Bases -Coordinate Systems

UNIT-II

The Dimension of a Vector Space, Rank-Change of Basis - Eigenvalues and Eigenvectors .

UNIT-III

The Characteristic Equation, Diagonalization -Eigenvectors and Linear Transformations -Complex Eigenvalues - Applications to Differential Equations .

UNIT-IV

Orthogonality and Least Squares : Inner Product, Length, and Orthogonality -Orthogonal Sets.

TEXT: David C Lay,*Linear Algebra and its Applications 4e*

References:

- S Lang, *Introduction to Linear Algebra*
- Gilbert Strang ,*Linear Algebra and its Applications*
- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence: *Linear Algebra*
- Kuldeep Singh: *Linear Algebra*
- Sheldon Axler:*Linear Algebra Done Right*

2.1 Differential and Integral Calculus

DSC-1A **BS:101**

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to some basic notions in differential calculus.
Outcome: By the time students complete the course they realize wide ranging applications of the subject.

Unit- I
Partial Differentiation: Introduction - Functions of two variables - Neighbourhood of a point (a, b) - Continuity of a Function of two variables, Continuity at a point - Limit of a Function of two variables - Partial Derivatives - Geometrical representation of a Function of two Variables - Homogeneous Functions.

Unit- II
Theorem on Total Differentials - Composite Functions - Differentiation of Composite Functions - Implicit Functions - Equality of $f_{xy}(a, b)$ and $f_{yz}(a, b)$ - Taylor's theorem for a function of two Variables - Maxima and Minima of functions of two variables – Lagrange's Method of undetermined multipliers.

Unit- III
Curvature and Evolutes: Introduction - Definition of Curvature - Radius of Curvature - Length of Arc as a Function, Derivative of arc - Radius of Curvature - Cartesian Equations - Newtonian Method - Centre of Curvature - Chord of Curvature.
Evolutes: Evolutes and Involutes - Properties of the evolute.
Envelopes: One Parameter Family of Curves - Consider the family of straight lines - Definition - Determination of Envelope.

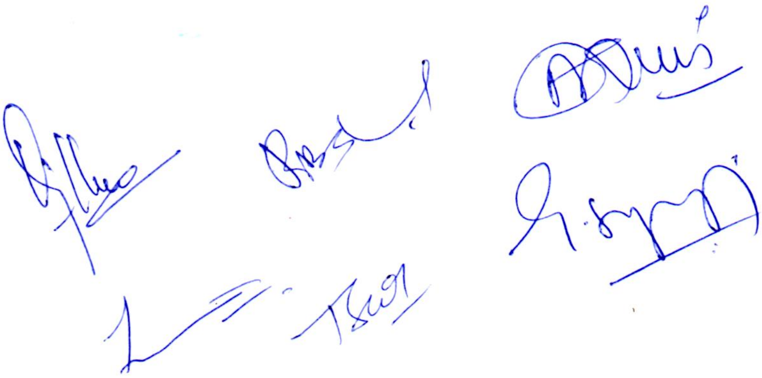
Unit- IV
Lengths of Plane Curves: Introduction - Expression for the lengths of curves $y = f(x)$ - Expressions for the length of arcs $x = f(y)$; $x = f(t)$, $y = \varphi(t)$; $r = f(\theta)$
Volumes and Surfaces of Revolution: Introduction - Expression for the volume obtained by revolving about either axis - Expression for the volume obtained by revolving about any line - Area of the surface of the frustum of a cone - Expression for the surface of revolution - Pappus Theorems - Surface of revolution.

Text:

- Shanti Narayan, P.K. Mittal *Differential Calculus, S.CHAND, NEW DELHI*
- Shanti Narayan *Integral Calculus, S.CHAND, NEW DELHI*

References:

- William Anthony Granville, Percey F Smith and William Raymond Longley; *Elements of the differential and integral calculus*
- Joseph Edwards , *Differential calculus for beginners*
- Smith and Minton, *Calculus*
- Elis Pine, *How to Enjoy Calculus*
- Hari Kishan, *Differential Calculus*



SEMESTER-II

2.2 Differential Equations

DSC-1B **BS:201**

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The main aim of this course is to introduce the students to the techniques of solving differential equations and to train to apply their skills in solving some of the problems of engineering and science.
Outcome: After learning the course the students will be equipped with the various tools to solve few types differential equations that arise in several branches of science.

Unit- I

Differential Equations of first order and first degree: Introduction - Equations in which Variables are Separable - Homogeneous Differential Equations - Differential Equations Reducible to Homogeneous Form - Linear Differential Equations - Differential Equations Reducible to Linear Form - Exact differential equations - Integrating Factors - Change in variables - Total Differential Equations - Simultaneous Total Differential Equations - Equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$.

Unit- II

Differential Equations first order but not of first degree: Equations Solvable for p - Equations Solvable for y - Equations Solvable for x - Equations that do not contain x (or y)- Equations Homogeneous in x and y - Equations of the First Degree in x and y - Clairaut's equation.
Applications of First Order Differential Equations : Growth and Decay - Dynamics of Tumour Growth - Radioactivity and Carbon Dating - Compound Interest - Orthogonal Trajectories

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Unit- III

Higher order Linear Differential Equations: Solution of homogeneous linear differential equations with constant coefficients - Solution of non-homogeneous differential equations $P(D)y = Q(x)$ with constant coefficients by means of polynomial operators when $Q(x) = be^{ax}, b\sin ax/b\cos ax, bx^k, Ve^{ax}$ - Method of undetermined coefficients.

Unit- IV

Method of variation of parameters - Linear differential equations with non constant coefficients - The Cauchy - Euler Equation - Legendre's Linear Equations - Miscellaneous Differential Equations.
Partial Differential Equations: Formation and solution- Equations easily integrable - Linear equations of first order.

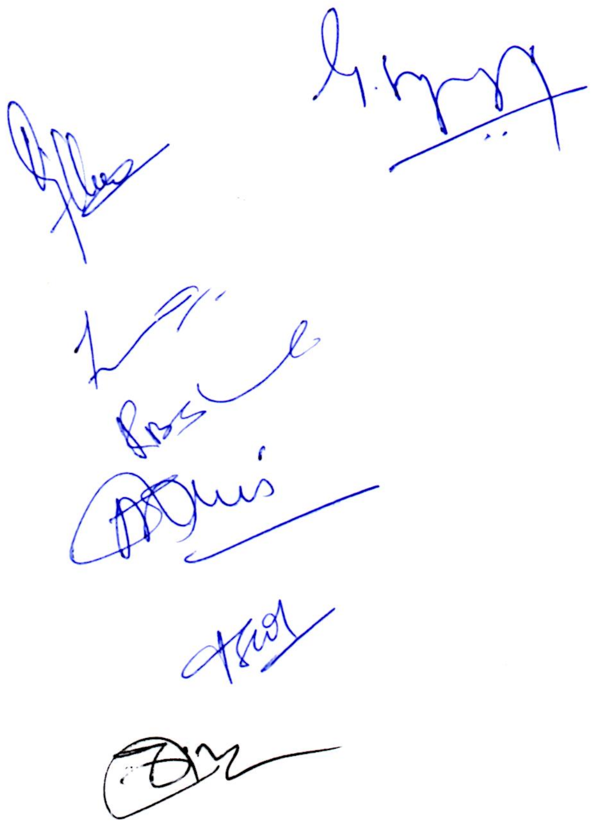
Text:

- Zafar Ahsan, *Differential Equations and Their Applications*

References:

- Frank Ayres Jr, *Theory and Problems of Differential Equations.*

- Ford, L.R ; *Differential Equations.*
- Daniel Murray, *Differential Equations.*
- S. Balachandra Rao, *Differential Equations with Applications and Programs.*
- Stuart P Hastings, J Bryce McLead; *Classical Methods in Ordinary Differential Equations.*



SEONCD YEAR

Paper – II

ABSTRACT ALGEBRA & REAL ANALYSIS

UNIT - I : GROUPS:

Binary operations- Definition and properties, Groups- Definition and examples, Elementary properties of groups, Finite groups and group composition tables, Subgroups and cyclic subgroups, Cyclic groups-Elementary properties of cyclic groups, Subgroups of finite cyclic groups. Permutations-groups of permutations, Cayley's theorem, orbits, cycles, even and odd permutations, the alternative groups, cosets, the theorem of Lagrange and its converse, Homomorphism, Definition and examples, properties of homomorphism. The kernel of a homomorphism, normal subgroup. factor groups, The fundamental homomorphism theorem, Normal subgroups and Inner automorphisms.

UNIT - II : RINGS:

Definitions and basic properties, homomorphism and isomorphism, Fields, divisors of zero and cancellation laws, Integral Domain, The characteristic of a ring. Rings of polynomials. Polynomials in an indeterminate, Ideals and factor rings, Homomorphism and factor rings, Fundamental homomorphism theorem, Maximal and prime ideals.

Prescribed text book.

Scope and treatment as in A first course in Abstract Algebra by John B. Fraleigh, Seventh edition, Pearson education (low price edition), New Delhi

Part-I: Sections: 2,4,5,6.
Part-II: Sections: 8,9,10.
Part-Ill: Sections:13,14.
Part-IV: Sections: 18,19, 22.1, 22.2, 22.3
Part-V: Sections : 26,27.1 to 27.16.

Reference Books

(1) A first course in Abstract Algebra by John B. Fraleigh, Third edition, Narosa Publishing house.

(2) Topics in Algebra by I.N.Herstein, Wiley Estern

(3) Contemporary Abstract Algebra by Joseph A Gallian, Narosa Publishing House.

UNIT - III:

REAL NUMBERS:

The Completeness properties of R, Applications of the supremum property. (No question is to be set from this portion)

Sequences and Series-Sequences and their limits, Limit theorems, Monotone Sequences, Sub-sequences and the Bolzano-Weierstrass theorem, The Cauchy's criterion, Properly divergent sequences, Introduction to series, Absolute convergence, test for absolute convergence, test for non-absolute convergence.

Continuous functions : Continuous functions, combinations of continuous functions, Continuous functions on intervals, Uniform continuity.

UNIT - IV :

DIFFERENTIATION AND INTEGRATION:

The derivative, The Mean value theorem, L'Hospital rules, Taylor's theorem. Riemann integral, Riemann integrable functions, Fundamental theorem.

Prescribed text Book:

Scope as in "Introduction to Real analysis", by Robert G. Bartle and Donald R.Sherbert, John Wiley, third edition, Chapter 2(2.3 to2.4),Chapter 3,(3.1 to 3.7), Chapter 5(5.1 to 5.4),Chapter 6(6.1 to 6.4), Chapter 7(7.1 to 7.3.7), Chapter 9 (9.1 to 9.3.2).

Reference Books:

1. A course of Mathematicl Analysis by Shanthi Narayana and P.K..Mittal, S.Chand & Company.
2. Mathematicl Analysis by S.C.Malik and Savita Arora, Wiley Eastern Ltd.

SEMESTER-III

1.3 Real Analysis

(w.e.f. academic year 2020-21)

DSC-1C **BS:301**

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to the foundations of analysis which will be useful in understanding various physical phenomena.
Outcome: After the completion of the course students will be in a position to appreciate beauty and applicability of the course.

Unit- I
Sequences: Limits of Sequences- A Discussion about Proofs-Limit Theorems for Sequences-Monotone Sequences and Cauchy Sequences -Subsequences-Lim sup's and Lim inf's-Series-Alternating Series and Integral Tests .

Unit- II
Continuity: Continuous Functions -Properties of Continuous Functions -Uniform Continuity -Limits of Functions

Unit- III
Differentiation: Basic Properties of the Derivative - The Mean Value Theorem - * L'Hospital Rule - Taylor's Theorem.

Unit- IV
Integration : The Riemann Integral - Properties of Riemann Integral-Fundamental Theorem of Calculus.

Text:

- Kenneth A Ross,*Elementary Analysis-The Theory of Calculus*

References:

- S.C. Malik and Savita Arora, *Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International (P) Limited, New Delhi, 1994.*
- William F. Trench, *Introduction to Real Analysis*
- Lee Larson , *Introduction to Real Analysis I*
- Shanti Narayan and Mittal, *Mathematical Analysis*
- Brian S. Thomson, Judith B. Bruckner, Andrew M. Bruckner; *Elementary Real analysis*
- Sudhir R., Ghorpade, Balmohan V., Limaye; *A Course in Calculus and Real Analysis*

SEMESTER-III

1.3 Real Analysis

(w.e.f. academic year 2020-21)

DSC-1C **BS:301**

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to the foundations of analysis which will be useful in understanding various physical phenomena.
Outcome: After the completion of the course students will be in a position to appreciate beauty and applicability of the course.

Unit- I
Sequences: Limits of Sequences- A Discussion about Proofs-Limit Theorems for Sequences-Monotone Sequences and Cauchy Sequences -Subsequences-Lim sup's and Lim inf's-Series-Alternating Series and Integral Tests .

Unit- II
Continuity: Continuous Functions -Properties of Continuous Functions -Uniform Continuity -Limits of Functions

Unit- III
Differentiation: Basic Properties of the Derivative - The Mean Value Theorem - * L'Hospital Rule - Taylor's Theorem.

Unit- IV
Integration : The Riemann Integral - Properties of Riemann Integral-Fundamental Theorem of Calculus.

Text:

- Kenneth A Ross,*Elementary Analysis-The Theory of Calculus*

References:

- S.C. Malik and Savita Arora, *Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International (P) Limited, New Delhi, 1994.*
- William F. Trench, *Introduction to Real Analysis*
- Lee Larson , *Introduction to Real Analysis I*
- Shanti Narayan and Mittal, *Mathematical Analysis*
- Brian S. Thomson, Judith B. Bruckner, Andrew M. Bruckner; *Elementary Real analysis*
- Sudhir R., Ghorpade, Balmohan V., Limaye; *A Course in Calculus and Real Analysis*

FINAL YEAR

Paper - III

LINEAR ALGEBRA, MULTIPLE INTEGRALS AND VECTOR CALCULUS

Part A: Linear Algebra

UNIT - I :

Vector spaces, General properties of vector spaces, Vector subspaces, Algebra of subspaces, Linear combination of vectors. Linear span, Linear sum of two subspaces, Linear independence and dependence of vectors, Basis of vector space, Finite dimensional vector spaces, Dimension of a vector space, Dimension of a subspace. Linear transformations, Linear operators, Range and null space of linear transformations, Rank and nullity of linear transformations, Linear transformations as vectors, Product of linear transformations, Invertible linear transformation.

UNIT - II :

The adjoint or transpose of a linear transformation, Sylvester's law of nullity, Characteristic values and characteristic vectors, Cayley-Hamilton theorem, Diagonalizable operators. Inner product spaces, Euclidean and unitary spaces, Norm or length of a vector, Schwartz inequality, Orthogonality, Orthonormal set, Complete orthonormal set, Gram-Schmidt orthogonalisation process.

Prescribed text book:

Linear Algebra by J.N.Sharma and A.R.Vasista, Krishna Prakasham Mandir, Meerut-250002.

Reference Books:

1. Linear Algebra by Kenneth Hoffman and Ray Kunze, Pearson Education (low priced edition), New Delhi.

2. Linear Algebra by Stephen H. Friedberg et.al, Prentice Hall of India Pvt.ltd. 4th edition 2007.

Part B: Multiple integrals and Vector Calculus

UNIT - III :

Multiple integrals: Introduction, The concept of a plane, Curve, Line integral- Sufficient condition for the existence of the integral. The area of a subset of R^2 , Calculation of double integrals, Jordan curve, Area, Change of the order of integration.

Prescribed book:

A Course of Mathematical Analysis by Shanti Narayana and P.K.Mittal, S.Chand Publications. Chapter 16.1 to 16.8

UNIT - IV:

Vector differentiation, Ordinary derivatives of vectors, Continuity, Differentiability, Gradient, Divergence, Curl operators, Formulae involving these operators. Vector integration, Theorems of Gauss and Stokes, Green's theorem in plane and applications of these theorems.

Prescribed text book:

Vector Analysis by Murray.R.Spiegel, Schaum series publishing Company, Chapter 3,4,5,6 and 7.

Reference Books:

1. Text book of Vector Analysis by Shanti Narayana and P.K.Mittal, S.Chand and Company Ltd, New Delhi.
2. Mathematical Analysis by S.C.Mallik and Savitha Arora, Wiley Eastern Ltd.

Paper IV (Elective - 1)

NUMERICAL ANALYSIS

UNIT - I :

Errors in Numerical Computations: Numbers and their Accuracy, Errors and their Computation, Absolute, Relative and Percentage errors , A general error formula, Error in a series approximation. Solution of Algebraic and Transcendental Equations: The bisection method, The iteration method, The method of false position, Newton-Raphson method, Generalized Newton-Raphson method, Ramanujan's method, Muller's method.

UNIT - II :

Interpolation: Errors in polynomial interpolation, Forward differences, Backward differences, Central differences, Symbolic relations, Detection of errors by use of D.Tables, Differences of a polynomial, Newton's formulae for interpolation, Gauss's central difference formula, Stirlings's central difference formula, Interpolation with unevenly spaced points, Lagrange's formula, Derivation of governing equations, End conditions, Divided differences and their properties, Newton's general interpolation.

UNIT - III :

Curve Fitting: Least squares curve fitting procedures, fitting a straight line, Non linear curve fitting, Curve fitting by a sum of exponentials.

Numerical Differentiation and Numerical Integration: Numerical differentiation, Errors in numerical differentiation, Maximum and minimum values of a tabulated function, Numerical integration, Trapezoidal rule, Simpsons' 1/3 -rule, Simpsons' 3/8 -rule, Boole's and Weddle's rule.

UNIT - IV :

Linear system of equations: Solution of linear systems-Direct methods, Matrix inversion method, Gaussian elimination method, Method of factorization, ill-conditioned linear systems. Iterative methods: Jacobi's method, Gauss-Siedal method.

Numerical Solution of Ordinary Differential Equations: Introduction, Solution by Taylor's Series, Picards method of successive approximations, Euler's method, Modified Euler's method, Runge-Kutta methods, Predictor-Corrector method, Milne's method.

Prescribed Text Book:

Scope as in Introductory methods of Numerical Analysis by S.S.Sastri, Prentice Hall India (4thEdition), Chapter-1(1.2, 1.4, 1, 1.5, 1.6); Chapter-2(2.2-2.7); Chapter-3(3.2, 3.3, 3.7.2, 3.9.1, 3.9.2, 3.10.1, 3.10.2); Chapter - 5 (5.2-5.4.5); Chapter - 6 (6.3.2, 6.3.4, 6.3.7, 6.4); Chapter - 7 (7.2-7.5, 7.6.2).

Reference Books:

1. G. Shanker Rao New Age International Publishers, New- Hyderabad.
2. Finite Differences and Numerical Analysis by H.C Saxena S.Chand and Company, New Delhi.

SEMESTER-IV

1.4 Algebra

(w.e.f. academic year 2020-21)

DSC-1D **BS:401**

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to learn some basic algebraic structures like groups, rings etc.
Outcome: On successful completion of the course students will be able to recognize algebraic structures that arise in matrix algebra, linear algebra and will be able to apply the skills learnt in understanding various such subjects.

Unit- I
Groups: Definition and Examples of Groups- Elementary Properties of Groups-Finite Groups - Subgroups -Terminology and Notation -Subgroup Tests - Examples of Subgroups.
Cyclic Groups: Properties of Cyclic Groups - Classification of Subgroups Cyclic Groups.

Unit- II
Permutation Groups: Definition and Notation -Cycle Notation-Properties of Permutations -A Check Digit Scheme Based on D_5. Isomorphisms ; Motivation- Definition and Examples -Cayley's Theorem Properties of Isomorphisms -Automorphisms-Cosets and Lagrange's Theorem Properties of Cosets 138 - Lagrange's Theorem and Consequences-An Application of Cosets to Permutation Groups -The Rotation Group of a Cube and a Soccer Ball.

Unit- III
Normal Subgroups and Factor Groups: Normal Subgroups-Factor Groups -Applications of Factor Groups -Group Homomorphisms - Definition and Examples -Properties of Homomorphisms -The First Isomorphism Theorem.
Introduction to Rings: Motivation and Definition -Examples of Rings -Properties of Rings - Subrings.
Integral Domains: Definition and Examples - Fields –Characteristics of a Ring.

Unit- IV
Ideals and Factor Rings: Ideals -Factor Rings -Prime Ideals and Maximal Ideals.
Ring Homomorphisms: Definition and Examples-Properties of Ring- Homomorphisms.

Text:

- Joseph A Gallian, *Contemporary Abstract algebra (9th edition)*

References:

- Bhattacharya, P.B Jain, S.K.; and Nagpaul, S.R,*Basic Abstract Algebra*
- Fraleigh, J.B, *A First Course in Abstract Algebra*.

- Herstein, I.N., *Topics in Algebra*
- Robert B. Ash, *Basic Abstract Algebra*
- I Martin Isaacs, *Finite Group Theory*
- Joseph J Rotman, *Advanced Modern Algebra*

SEMESTER-IV

1.4 Algebra

(w.e.f. academic year 2020-21)

DSC-1D **BS:401**

Theory: 5 credits and Tutorials: 0 credits
Theory: 5 hours /week and Tutorials: 1 hours /week

Objective: The course is aimed at exposing the students to learn some basic algebraic structures like groups, rings etc.
Outcome: On successful completion of the course students will be able to recognize algebraic structures that arise in matrix algebra, linear algebra and will be able to apply the skills learnt in understanding various such subjects.

Unit- I
Groups: Definition and Examples of Groups- Elementary Properties of Groups-Finite Groups - Subgroups -Terminology and Notation -Subgroup Tests - Examples of Subgroups.
Cyclic Groups: Properties of Cyclic Groups - Classification of Subgroups Cyclic Groups.

Unit- II
Permutation Groups: Definition and Notation -Cycle Notation-Properties of Permutations -A Check Digit Scheme Based on D_5. Isomorphisms ; Motivation- Definition and Examples -Cayley's Theorem Properties of Isomorphisms -Automorphisms-Cosets and Lagrange's Theorem Properties of Cosets 138 - Lagrange's Theorem and Consequences-An Application of Cosets to Permutation Groups -The Rotation Group of a Cube and a Soccer Ball.

Unit- III
Normal Subgroups and Factor Groups: Normal Subgroups-Factor Groups -Applications of Factor Groups -Group Homomorphisms - Definition and Examples -Properties of Homomorphisms -The First Isomorphism Theorem.
Introduction to Rings: Motivation and Definition -Examples of Rings -Properties of Rings - Subrings.
Integral Domains: Definition and Examples - Fields –Characteristics of a Ring.

Unit- IV
Ideals and Factor Rings: Ideals -Factor Rings -Prime Ideals and Maximal Ideals.
Ring Homomorphisms: Definition and Examples-Properties of Ring- Homomorphisms.

Text:

- Joseph A Gallian, *Contemporary Abstract algebra (9th edition)*

References:

- Bhattacharya, P.B Jain, S.K.; and Nagpaul, S.R,*Basic Abstract Algebra*
- Fraleigh, J.B, *A First Course in Abstract Algebra*.

- Herstein, I.N., *Topics in Algebra*
- Robert B. Ash, *Basic Abstract Algebra*
- I Martin Isaacs, *Finite Group Theory*
- Joseph J Rotman, *Advanced Modern Algebra*

DIFFERENTIAL CALCULUS

DSC-1A
BS:104

Theory: 4 credits and Practicals: 1 credit
Theory: 4 hours/week and Practicals: 2 hours/week

Objective: The course is aimed at exposing the students to some basic notions in differential calculus.

Outcome: By the time students completes the course they realize wide ranging applications of the subject.

UNIT-I

Successive differentiation:
Higher order derivatives, Calculation of the nth derivative, Some standard results, Determination of nth derivative of rational functions, The nth derivatives of the products of the powers of sines and cosines, Leibnitzs theorem, The nth derivative of the product of two functions. Expansion of Functions: Maclaurins theorem, Taylors theorem. Mean Value Theorems: Rolles theorem, Lagranges mean value theorem, Meaning of the sign of derivative, Graphs of hyperbolic functions, Cauchys mean value theorem, Higher derivatives, Formal expansions of functions

UNIT-II

Indeterminate Forms:
Indeterminate forms, The indeterminate form 0/0, The indeterminate form ∞/∞, The indeterminate form $0.\infty$, The indeterminate form $\infty - \infty$, The indeterminate forms0^0, 1^∞, ∞^0.
Curvature and Evolutes:
Introduction, Definition of curvature, Length of arc as a function, Derivative of arc, Radius of curvature-cartesian equations, Newtonian method, Centre of curvature, Chord of curvature, Evolutes and involutes, Properties of the evolute.

UNIT-III

Partial Differentiation - Homogeneous Functions - Total Derivative: Introduction, Functions of two variables, Neighbourhood of a point (a, b), Continuity of a Function of two variables, continuity at a point, Limit of a function of two variables, Partial derivatives, Geometrical representation of a function of two variables, Homogeneous functions, Theorem on total differentials; composite functions; differentiation of composite functions; implicit functions.

UNIT-IV

Maxima and Minima:
Maxima and minima of function of two variables, Lagranges method of undetermined multipliers.
Asymptotes: Definition, Determination of asymptotes, Working rules of determining asymptotes, Asymptotes by inspection, Intersection of a curve and its asymptotes, Asymptotes by expansion, Position of a curve with respect to an asymptote, Asymptotes in polar co-ordinates.
Envelopes:

One parameter family of curves. Consider the family of straight lines. Definition. Determination of envelope. Theorem. To prove that, in general, the envelope of a family of curves touches each member of the family. If A, B, C are functions of x and y and m is a parameter then the envelope of $Am^2 + Bm + C = 0$ is $B^2 = 4AC$.
Two parameters connected by a relation. When the equation to a family of curves is not given, but the law is given in accordance with which any member of the family can be determined. Envelopes of polar curves. Envelopes of normals(Evolutes).

Text: Shanti Narayan and Mittal, Differential Calculus
References:

- William Anthony Granville, Percey F Smith and William Raymond Longley, *Elements of the Differential and integral calculus*
- Joseph Edwards, *Differential calculus for beginners*
- Smith and Minton, *Calculus*
- Elis Pine, *How to Enjoy Calculus*
- Hari Kishan, *Differential Calculus*

Practical Question Bank

UNIT-I

1. If $u = tan^{-1}x$ prove that
$(1+x^2)\frac{d^2u}{dx^2} + 2x\frac{du}{dx} = 0$ and hence determine the values of the derivatives of u when $x = 0$
2. If $y = sin(msin^{-1}x)$ show that $(1-x^2)y_{n+2} = (2n+1)xy_{n+1} + (n^2-m^2)y_n$ and find $y_n(0)$
3. If U_n denotes the n^{th} derivative of $\frac{Lx+M}{x^2-2Bx+c}$, prove $\frac{x^2-2Bx+C}{(n+1)(n+2)}U_{n+2} + \frac{2(x-B)}{n+1}U_{n+1} + U_n = 0$
4. If $y = x^2e^x$, then $\frac{d^my}{dx^n} = \frac{1}{2}n(n-1)\frac{d^2y}{dx^2} - n(n-2)\frac{dy}{dx} + \frac{1}{2}n(n-1)(n-2)y$.
5. Determine the intervals in which the function
$(x^4 + 6x^3 + 17x^2 + 32x + 32)e^{-x}$ is increasing or decreasing.
6. Separate the intervals in which the function $\frac{(x^2+x+1)}{(x^2-x+1)}$ is increasing or decreasing.
7. Show that if $x > 0$,
$(i) x - \frac{x^2}{2} < log(1+x) < x - \frac{x^2}{2(1+x)}$.
$(ii) x - \frac{x^2}{2} + \frac{x^3}{3(1+x)} < log(1+x) < x - \frac{x^2}{2} + \frac{x^3}{3}$.
8. Prove that $e^{ax}sinbx = bx + abx^2 + \frac{3a^2b-b^3}{3!}x^3 + ... + \frac{(a^2+b^2)^{\frac{1}{2}n}}{n!}x^n sin(ntan^{-1}\frac{b}{a}) + ...$
9. Show that $cos^2x = 1 - x^2 + \frac{1}{3}x^4 - \frac{2}{45}x^6.......$
10. Show that $e^{mtan^{-1}x} = 1 + mx + \frac{m^2}{2!}x^2 + \frac{m(m^2-2)}{3!}x^3 + \frac{m^2(m^2-8)}{4!}x^4 + ...$

UNIT-II

11. Find the radius of curvature at any point on the curves
    (a) $y = ccosh\frac{x}{c}.(Catenary)$
    (b) $x = a(cost + tsint), y = a(sint - tcost)$
    (c) $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$.(Astroid)
    (d) $x = \frac{(acost)}{t}, y = \frac{(asint)}{t}$.
12. Show that for the curve $x = acos\theta(1+sin\theta), y = asin\theta(1+cos\theta)$ the radius of curvature is a at the point for which the value of the parameter is $-\frac{\pi}{4}$
13. Prove that the radius of curvature at the point (-2a,2a) on the curve $x^2y = a(x^2+y^2) is$ is -2a.
14. Show that the radii of the curvature of the curve $x = a\,e^{\theta}(sin\theta - cos\theta), y = a\,e^{\theta}(sin\theta + cos\theta)$ and its evolute at corresponding points are equal.
15. Show that the whole length of the evolute of the elipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is $4(\frac{a^2}{b} - \frac{b^2}{a})$
16. Show that the whole length of the evolute of the astroid $x = acos^3\theta, y = asin^3\theta$ is $12a$

17. Evaluate the following:

   (a) $\lim_{x\to 0} \frac{xe^x - log(1+x)}{x^2}$
   (b) $\lim_{x\to 0} \frac{xcosx - log(1+x)}{x^2}$
   (c) $\lim_{x\to 0} \frac{e^x sinx - x - x^2}{x^2 + xlog(1-x)}$
   (d) $\lim_{x\to 0}\{\frac{1}{x} - \frac{1}{x^2} log(1+x)\}$

18. If the limit of $\frac{sin2x + asinx}{x^8}$ as x tends to zero, be finite,find the value of a and the limit.

19. Determine the limits of the following functions:

   (a) $xlog(tanx), (x \to 0)$
   (b) $xtan(\frac{\pi}{2} - x), (x \to 0)$
   (c) $(a - x)tan(\frac{\pi x}{2a}), (x \to 0)$

20. Determine the limits of the following functions:

   (a) $\frac{e^x - e^{-x} - x}{x^2 sinx}, (x \to 0)$
   (b) $\frac{logx}{x^3}, (x \to \infty)$
   (c) $\frac{1 + xcosx - coshx - log(1+x)}{tanx - x}, (x \to 0)$
   (d) $\frac{log(1+x)log(1-x) - log(1-x^2)}{x^4}, (x \to 0)$

UNIT-III

21. If $z = xyf(\frac{x}{y})$ then show that $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = 2z$

22. If $z(x + y) = x^2 + y^2$ then show that $(\frac{\partial z}{\partial x} - \frac{\partial z}{\partial y})^2 = 4(1 - \frac{\partial z}{\partial x} - \frac{\partial z}{\partial y})$

23. If $z = 3xy - y^3 + (y^2 - 2x)^{\frac{3}{2}}$, verify that $\frac{\partial^2 z}{\partial x \partial y} = \frac{\partial^2 z}{\partial y \partial x}$ and $\frac{\partial^2 z}{\partial x^2} - \frac{\partial^2 z}{\partial y^2} = (\frac{\partial^2 z}{\partial x \partial y})^2$

24. If $z = f(x + ay) + \varphi(x - ay)$, prove that $\frac{\partial^2 z}{\partial y^2} = a^2 \frac{\partial^2 z}{\partial x^2}$

25. If $u = tan^{-1}(\frac{x^3 + y^3}{x - y})$,find $x^2\frac{\partial^2 u}{\partial x^2} + 2xy\frac{\partial^2 u}{\partial x \partial y} + y^2\frac{\partial^2 u}{\partial y^2}$.

26. If $f(x, y) = 0, \varphi(y, z) = 0$,show that $\frac{\partial f}{\partial y} \cdot \frac{\partial \varphi}{\partial z} \cdot \frac{dz}{dx} = \frac{\partial f}{\partial x} \cdot \frac{\partial \varphi}{\partial y}$

27. If $x\sqrt{1 - y^2} + y\sqrt{1 - x^2} = a$, show that $\frac{d^2 y}{dx^2} = \frac{a}{(1 - x^2)^{\frac{3}{2}}}$

28. Given that $f(x, y) = x^3 + y^3 - 3axy = 0$,show that $\frac{d^2 y}{dx^2} \cdot \frac{d^2 x}{dy^2} = \frac{4a^6}{xy(xy - 2a^2)^3}$

29. If u and v are functions of x and y defined by $x = u + e^{-v} sinu, y = v + e^{-v} cosu$, then prove that $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$

30. If $H = f(y - z, z - x, x - y)$ then prove that, $\frac{\partial H}{\partial x} + \frac{\partial H}{\partial y} + \frac{\partial H}{\partial z} = 0$..

UNIT-IV

31. Find the minimum value of $x^2 + y^2 + z^2$ when

    (a) $x + y + z = 3a$
    (b) $xy + yz + zx = 3a^2$
    (c) $xyz = a^3$

32. Find the extreme value of xy when $x^2 + xy + y^2 = a^2$

33. In a plane triangle, find the maximum value of $cosAcosBcosC$

34. Find the envelope of the family of semi - cubical parabolas $y^2 - (x + a)^3 = 0$

35. Find the envelope of the family of ellipses $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ where the parameters a, b are connected by the relation $a + b = c$; c, being a constant.

36. Show that the envelope of a circle whose centre lies on the parabola $y^2 = 4ax$ and which passes through its vertex is the cissoid $y^2(2a + x) + x^3 = 0$

37. Find the envelope of the family of the straight lines $\frac{x}{a} + \frac{y}{b} = 1$ where a, b are connected by the relation

    (a) $a + b = c$
    (b) $a^2 + b^2 = c^2$
    (c) $ab = c^2$, c is a constant

38. Find the asymptotes of $x^3 + 4x^2y + 4xy^2 + 5x^2 + 15xy + 10y^2 - 2y + 1 = 0$

39. Find the asymptotes of $y^3 + x^3 + y^2 + x^2 - x + 1 = 0$

40. Find the asymptotes of the following curves

    (a) $xy(x + y) = a(x^2 - a^2)$
    (b) $y^3 - x^3 + y^2 + x^2 + y - x + 1 = 0$

2.2 DIFFERENTIAL EQUATIONS

DSC-1B
BS:204

Theory: 4 credits and Practicals: 1 credits
Theory: 4 hours /week and Practicals: 2 hours /week

Objective: The main aim of this course is to introduce the students to the techniques of solving differential equations and to train to apply their skills in solving some of the problems of engineering and science.

Outcome: After learning the course the students will be equipped with the various tools to solve few types differential equations that arise in several branches of science.

UNIT-I

Differential Equations of first order and first degree: Exact differential equations-Integrating Factors-Change in variables-Total Differential Equations-Simultaneous Total Differential Equations-Equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$. Differential Equations first order but not of first degree: Equations Solvable for y -Equations Solvable for x - Equations that do not contain x (or y)-Clairaut$'$s equation.

UNIT-II

Higher order linear differential equations:Solution of homogeneous linear differential equations with constant coefficients-Solution of non-homogeneous differential equations $P(D)y = Q(x)$ with constant coefficients by means of polynomial operators when $Q(x) = be^{ax}$, $bsinax$ or $bcosax$, bx^k, Ve^{ax}.

UNIT-III

Method of undetermined coefficients - Method of variation of parameters - Linear differential equations with non constant coefficients - The Cauchy - Euler Equation.

UNIT-IV

Partial Differential equations- Formation and solution- Equations easily integrable - Linear equations of first order - Non linear equations of first order - Charpits method - Homogeneous linear partial differential equations with constant coefficient - Non homogeneous linear partial differential equations - Separation of variables.

TEXT: Zafar Ahsan, *Differential Equations and Their Applications*
References:

- Frank Ayres Jr, *Theory and Problems of Differential Equations.*
- Ford, L.R, *Differential Equations.*
- Daniel Murray, *Differential Equations.*
- S. Balachandra Rao, *Differential Equations with Applications and Programs.*
- Stuart P Hastings, J Bryce McLead, *Classical Methods in Ordinary Differential Equations.*

Practical Question Bank

UNIT-I

Solve the following differential equations.

(1) $y^{'} = sin(x+y) + cos(x+y)$

(2) $xdy - ydx = a(x^2 + y^2)dy$

(3) $x^2ydx - (x^3 + y^3)dy$

(4) $(y+z)dx + (x+z)dy + (x+y)dz = 0$

(5) $ysin2xdx - (1 + y^2 + cos^2x)dy$

(6) $y + px = p^2x^4$

(7) $yp^2 + (x-y)p - x = 0$

(8) $\frac{dx}{y-zx} = \frac{dy}{yz+x} = \frac{dz}{(x^2+y^2)}$

(9) $\frac{dx}{x(y^2-z^2)} = \frac{dy}{y(z^2-x^2)} = \frac{dz}{z(x^2-y^2)}$

(10) Use the transformation $x^2 = u$ and $y^2 = v$ to solve the equation $axyp^2 + (x^2 - ay^2 - b)p - xy = 0$

UNIT-II

Solve the following differential equations:

(11) $D^2y + (a+b)Dy + aby = 0$

(12) $D^3y - D^2y - Dy - 2y = 0$

(13) $D^3y + Dy = x^2 + 2x$

(14) $y'' + 3y' + 2y = 2(e^{-2x} + x^2)$

(15) $y^5 + 2y''' + y' = 2x + sinx + cosx$

(16) $(D^2+1)(D^2+4)y = cos\frac{x}{2}cos\frac{3x}{2}$

(17) $(D^2+1)y = cosx + xe^{2x} + e^x sinx$

(18) $y'' + 3y' + 2y = 12e^x$

(19) $y'' - y = cosx$

(20) $4y'' - 5y' = x^2e^x$

UNIT-III

Solve the following differential equations:

(21) $y^{''} + 3y^{'} + 2y = xe^x$

(22) $y^{''} + 3y^{'} + 2y = sinx$

(23) $y^{''} + y^{'} + y = x^2$

(24) $y^{''} + 2y^{'} + y = x^2e^{-x}$

(25) $x^2y^{''}$ - $xy^{'} + y = 2logx$

(26) $x^4y^{'''} + 2x^3y^{''}$-$x^2y^{'}$+xy= 1

(27) x^2y'' - xy' + $2y = xlogx$

(28) x^2y'' - xy' + $2y = x$ Use the reduction of order method to solve the following homogeneous equation whose one of the solution is given:

(29) y'' - $\frac{2}{x}y'$ + $\frac{2}{x^2}y = 0$, $y_1 = x$

(30) $(2x^2 + 1)y''$ - $4xy'$ + $4y = 0$; $y_1 = x$

UNIT-IV

(31) Form the partial differential equation,by eliminating the arbitary constants from $z = (x^2 + a)(y^2 + b)$.

(32) Find the differential equation of the family of all planes whose members are all at a constant distance r from the origin.

(33) Form the differential equation, by eliminating arbitrary function F from $F(x^2+y^2, z-xy) = 0$.

Solve the following differential equations:

(34) $x^2(y - z)p + y^2(z - x)q = z^2(x - y)$

(35) $x(z^2 - y^2)p + y(x^2 - z^2)q = z(y^2 - x^2)$

(36) $(p^2 - q^2)z = x - y$

(37) $z = px + qy + p^2q^2$

(38) $z^2 = pqxy$

(39) $z^2(p^2 + q^2) = x^2 + y^2$

(40) $r + s - 6t = cos(2x + y)$

2.18 NUMERICAL ANALYSIS

DSC-1F
BS:603

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours/week and Practicals: 2 hours/week

Objective: Students will be made to understand some methods of numerical analysis.

Outcome: Students realize the importance of the subject in solving some problems of algebra and calculus.

UNIT-I

Solutions of Equations in One Variable : The Bisection Method - Fixed-Point Iteration - Newtons Method and Its Extensions - Error Analysis for Iterative Methods - Accelerating Convergence - Zeros of Polynomials and Mullers Method - Survey of Methods and Software.

UNIT-II

Interpolation and Polynomial Approximation: Interpolation and the Lagrange Polynomial - Data Approximation and Nevilles Method - Divided Differences.

UNIT-III

Hermite Interpolation - Cubic Spline Interpolation. Numerical Differentiation and Integration: Numerical Differentiation - Richardsons Extrapolation

UNIT-IV

Elements of Numerical Integration- Composite Numerical Integration - Romberg Integration - Adaptive Quadrature Methods - Gaussian Quadrature.

TEXT: Richard L. Burden and J. Douglas Faires,*Numerical Analysis (9e)*
References

- M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering computation*
- B. Bradie, *A Friendly introduction to Numerical Analysis*

UNIT-I

(1) Use the Bisection method to find P_3 for $f(x) = \sqrt{x} - cosx$ on [0,1].

(2) Let $f(x) = 3(x+1)(x-1/2)(x-1)$. Use the Bisection method on the following intervals to find P_3.
(a) [-2,1.5]
(b) [-1.25,2.5]

(3) Use the Bisection method to find solutions accurate with in 10^{-5} for the following problems.
(a) $x - 2^{-x} = 0$ for $0 \leq x \leq 1$
(b) $e^x - x^2 + 3x - 2 = 0$ for $0 \leq x \leq 1$
(c) $2xcos(2x) - (x+1)^2 = 0$ for $-3 \leq x \leq -2$ and $-1 \leq x \leq 0$.

(4) Use algebraic manipulation to show that each of the following functions has a fixed point at p precisely when $f(p) = 0$, where $f(x) = x^4 + 2x^2 - x - 3$.
(a) $g_1(x) = (3 + x - 2x^2)^{1/4}$
(b) $g_2(x) = (\frac{x+3-x^4}{2})^{\frac{1}{2}}$

(5) Use a fixed-point iteration method to determine a solution accurate to with in 10^{-2} for $x^4 - 3x^2 - 3 = 0$ on [1,2]. Use $p_0 = 1$.

(6) Use a fixed-point iteration method to determine a solution accurate to within 10^{-2} for $x^3 - x - 1 = 0$ on [1,2] .Use $p_0 = 1$.

(7) Use a fixed-point iteration method to find an approximation to $\sqrt{3}$ that is accurate to within 10^{-4}.

(8) The equation $x^2 - 10cosx = 0$ has two solutions,± 1.3793646. Use Newton's method to approximate the solutions to within 10^{-5} with the following values of P_0.
(a) $P_0 = -100$
(b) $P_0 = -50$
(c) $P_0 = -25$
(d) $P_0 = 25$
(e) $P_0 = 50$
(f) $P_0 = 100$

(9) The equation $4x^2 - e^x - e^{-x} = 0$ has two positive solutions x_1 and x_2.Use Newton's method to approximate the solution to within 10^{-5} with the following values of p_0.
(a) $P_0 = -10$ (b) $P_0 = -5$ (c) $P_0 = -3$
(d) $P_0 = -1$ (e) $P_0 = 0$ (f) $P_0 = 1$
(g) $P_0 = 3$ (h) $P_0 = 5$ (i) $P_0 = 10$

(10) Use each of the following methods to find a solution in [0.1, 1] accurate to within 10^{-4} for $600x^4 - 550x^3 + 200x^2 - 20x - 1 = 0$
(a) Bisection method
(b) Newton method
(c) Secant method
(d) Method of False position
(e) Muller's method

UNIT-II

(11) For the given function $f(x)$, let $x_0 = 0$, $x_1 = 0.6$, and $x_2 = 0.9$. Construct interpolation polynomial of degree at most one and at most two to approximate f(0.45),and find the

absolute error

(a) $f(x) = cosx$ (b) $f(x) = ln(x+1)$

(12) For the given function $f(x)$, let $x_0 = 1$, $x_1 = 1.25$ and $x_2 = 1.6$. Construct interpolation polynomial degree at most one and at most two to approximate f(1.4), and find the absolute error.

(a) $f(x) = sin\pi x$ (b) $f(x) = log(3x-1)$

(13) Let $P_3(x)$ be the interpolating polynomials for the data $(0,0)$,$(0.5,y)$,$(1,3)$ and $(2,2)$. The coefficient of x^3 in $P_3(x)$ is 6. Find y

(14) Neville's method is used to approximate $f(0.4)$, giving the following table.

$x_0 = 0$	$P_0 = 1$			
$x_1 = 0.25$	$P_1 = 2$	$P_{0,1} = 2.6$		
$x_2 = 0.5$	P_2	$P_{1,2}$	$P_{0,1,2}$	
$x_3 = 0.75$	$P_3 = 8$	$P_{2,3} = 2.4$	$P_{1,2,3} = 2.96$	$P_{0,1,2,3} = 3.016$

Determine $P_2 = f(0.5)$.

(15) Neville's method is used to approximate $f(0.5)$, giving the following table.

$x_0 = 0$	$P_0 = 0$		
$x_1 = 0.4$	$P_1 = 2.8$	$P_{0,1} = 3.5$	
$x_2 = 0.7$	P_2	$P_{1,2}$	$P_{0,1,2} = \frac{27}{7}$

Determine $P_2 = f(0.7)$.

(16) Neville's Algorithm is used to approximate $f(0)$ using $f(-2)$,$f(-1)$,$f(1)$ and $f(2)$. Suppose $f(-1)$ was overstated by 2 and $f(1)$ was understated by 3. Determine the error in the original calculation of the value of the interpolating polynomial to approximate $f(0)$.

(17) Compute the divided difference table for the data

x	1.0	1.3	1.6	1.9	2.2
$f(x)$	0.7651977	0.6200860	0.4554022	0.2818186	0.1103623

(18) Use the Newton forward-difference formula to construct interpolating polynomaials of degree one,two,and three for the following data. Approximate the specified value using each of the polynomials.

(a) $f(0.43)$ if $f(0) = 1$, $f(0.25) = 1.64872$, $f(0.5) = 2.71828$, $f(0.75) = 4.48169$

(b) $f(0.18)$ if $f(0.1) = -0.29004986$, $f(0.2) = -0.56079734$, $f(0.3) = -0.81401972$, $f(0.4) = -1.0526302$

(19) Use the Newton backward-difference formula to construct interpolating polynomials of degree one, two, and three for the following data. Approximate the specified value using each of the polynomials.

(a) $f(0.43)$ if $f(0) = 1$,$f(0.25) = 1.64872$,$f(0.5) = 2.71828$,$f(0.75) = 4.48169$

(b) $f(0.25)$ if $f(-1) = 0.86199480$, $f(-0.5) = 0.95802009$, $f(0) = 1.0986123$, $f(0.5) = 1.2943767$

(20) Use Stirling's formula to approximate $f(0.43)$ for the following data

x	0.0	0.2	0.4	0.6	0.8
$f(x)$	1.0000	1.22140	1.49182	1.82212	2.22554

UNIT-III

(21) Use the Hermite Polynomial to find an approximation of $f(1.5)$ for the following data

k	x_k	$f(x_k)$	$f'(x_k)$
0	1.3	0.6200860	-0.5220232
1	1.6	0.4554022	-0.56989959
2	1.9	0.2818186	-0.5811571

(22) A car travelling along a straight road is clocked at a number of points. The data from the observations are given in the following table, where the time is in seconds, the distance is in feet, and the speed is in feet per second.

Time	0	3	5	8	13
Distance	0	225	383	623	993
Speed	75	77	80	74	72

Use Hermites polynomial to predict the position of the car and its speed when $t = 10 second$

(23) Use the following values and five - digit - rounding arithematic to construct the Hermite interpolating polynomial to approximate $sin(0.34)$

x	sin$x$	$D_x sinx = cosx$
0.30	0.29552	0.95534
0.32	0.31457	0.94924
0.35	0.34290	0.93937

(24) Determine the natural cubic spline S that interpolates the data $f(0) = 0, f(1) = 1,$and $f(2) = 2$.

(25) Determine the clamped cubic spline S that interpolates the data $f(0) = 0, f(1) = 1, f(2) = 2$, and satisfies $s'(0) = s'(2) = 1$.

(26) Use the forward-difference formula and backward-difference formula to determine each missing entry in the following tables.

(a)

x	$f(x)$	$f'(x)$
0.5	0.4794	
0.6	0.5646	
0.7	0.6442	

(b)

x	$f(x)$	$f'(x)$
0.0	0.0000	
0.2	0.74140	
0.4	1.3718	

(27) Consider the following table of data

x	0.2	0.4	0.6	0.8	1.0
$f(x)$	0.9798652	0.9177710	0.808038	0.6386093	0.3843735

Use all the appropriate formulas given in this section to approxmate $f'(0.4)$ and $f''(0.4)$.

(28) Derive a method for approximating $f'''(x_0)$ whose error term is of order h^2 by expanding the function f in a fourth Taylor polynomial about x_0 and evaluating at $x_0 \pm h$ and $x_0 \pm 2h$.

(29) The forward-difference formula can be expressed as

$f'(x_0) = \frac{1}{h}[f(x_0+h) - f(x_0)] - \frac{h}{2}f''(x_0) - \frac{h^2}{6}f'''(x_0) + O(h^3)$. Use extrapolation to derive $O(h^3)$ formula for $f^{'}(x_0)$

(30) Show that $lim_{h\longrightarrow 0}(\frac{2+h}{2-h})^{\frac{1}{h}} = e$

UNIT-IV

(31) Approximation the following integrals using the Trapezoidal rule.
(a) $\int_{0.5}^{1} x^4 dx$
(b) $\int_{0}^{0.5} \frac{2}{x-4} dx$
(c) $\int_{1}^{1.5} x^2 lnx dx$
(d) $\int_{0}^{1} x^2 e^{-x} dx$

(32) Approximate the following integral using Trapezoidal Rule
(a) $\int_{-0.25}^{0.25} (cosx)^2 dx$
(b) $\int_{-0.5}^{0} xln(x+1) dx$

(33) The Trapezoidal rule applied to $\int_0^2 f(x)dx$ gives the value 5, and the midpoint rule gives the value 4. What value does Simpson's rule give?

(34) The quadrature formula $\int_0^2 f(x)dx = c_0 f(0) + c_1 f(1) + c_2 f(2)$ is exact for all polynomials of degree less than or equal to 2. Determine c_0, c_1, and c_2.

(35) Find the constants c_0, c_1 and x_1 so that quadrature formula $\int_0^1 f(x)dx = c_0 f(0) + c_1 f(x_1)$
has the highest possible degree of precision.

(36) Use the composite Trapezoidal Rule with the indicated values of n to approximate the following integrals
(a) $\int_1^2 xlnx dx$, n=4
(b) $\int_{-2}^{2} x^3 e^x dx$, n=4.

(37) Suppose that $f(0) = 1, f(0.5) = 2.5, f(1) = 2$ and $f(0.25) = f(0.75) = \infty$. Find ∞ if the Composite Trapezoidal rule with $n = 4$ gives the value 1.75 for $\int_0^1 f(x)dx$

(38) Romberg integration is used to approximate $\int_2^3 f(x)dx$.
If $f(2) = 0.51342, f(3) = 0.36788$ $R_{31} = 0.43687$, $R_{33} = 0.43662$, find $f(2.5)$

(39) Use Romberg integration to compute $R_{3,3}$ for the following integrals.
(a) $\int_1^{1.5} x^2 lnx dx$
(b) $\int_0^1 x^2 e^{-x} dx$

(40) Use Romberg integration to compute $R_{3,3}$ for the following integrals.
(a) $\int_{-1}^{1} (cosx)^2 dx$
(b) $\int_{-0.75}^{0.75} xln(x+1) dx$

2.18 NUMERICAL ANALYSIS

DSC-1F
BS:603

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours/week and Practicals: 2 hours/week

Objective: Students will be made to understand some methods of numerical analysis.

Outcome: Students realize the importance of the subject in solving some problems of algebra and calculus.

UNIT-I

Solutions of Equations in One Variable : The Bisection Method - Fixed-Point Iteration - Newtons Method and Its Extensions - Error Analysis for Iterative Methods - Accelerating Convergence - Zeros of Polynomials and Mullers Method - Survey of Methods and Software.

UNIT-II

Interpolation and Polynomial Approximation: Interpolation and the Lagrange Polynomial - Data Approximation and Nevilles Method - Divided Differences.

UNIT-III

Hermite Interpolation - Cubic Spline Interpolation. Numerical Differentiation and Integration: Numerical Differentiation - Richardsons Extrapolation

UNIT-IV

Elements of Numerical Integration- Composite Numerical Integration - Romberg Integration - Adaptive Quadrature Methods - Gaussian Quadrature.

TEXT: Richard L. Burden and J. Douglas Faires, *Numerical Analysis (9e)*

References

- M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering computation*
- B. Bradie, *A Friendly introduction to Numerical Analysis*

UNIT-I

(1) Use the Bisection method to find P_3 for $f(x) = \sqrt{x} - cosx$ on [0,1].

(2) Let $f(x) = 3(x+1)(x-1/2)(x-1)$. Use the Bisection method on the following intervals to find P_3.
(a) [-2,1.5]
(b) [-1.25,2.5]

(3) Use the Bisection method to find solutions accurate with in 10^{-5} for the following problems.
(a) $x - 2^{-x} = 0$ for $0 \leq x \leq 1$
(b) $e^x - x^2 + 3x - 2 = 0$ for $0 \leq x \leq 1$
(c) $2xcos(2x) - (x+1)^2 = 0$ for $-3 \leq x \leq -2$ and$-1 \leq x \leq 0$.

(4) Use algebraic manipulation to show that each of the following functions has a fixed point at p precisely when $f(p) = 0$, where $f(x) = x^4 + 2x^2 - x - 3$.
(a) $g_1(x) = (3 + x - 2x^2)^{1/4}$
(b) $g_2(x) = (\frac{x+3-x^4}{2})^{\frac{1}{2}}$

(5) Use a fixed-point iteration method to determine a solution accurate to with in 10^{-2} for $x^4 - 3x^2 - 3 = 0$ on [1,2]. Use $p_0 = 1$.

(6) Use a fixed-point iteration method to determine a solution accurate to within 10^{-2} for $x^3 - x - 1 = 0$ on [1,2] .Use $p_0 = 1$.

(7) Use a fixed-point iteration method to find an approximation to $\sqrt{3}$ that is accurate to within 10^{-4}.

(8) The equation $x^2 - 10cosx = 0$ has two solutions,± 1.3793646. Use Newton's method to approximate the solutions to within 10^{-5} with the following values of P_0.
(a) $P_0 = -100$
(b) $P_0 = -50$
(c) $P_0 = -25$
(d) $P_0 = 25$
(e) $P_0 = 50$
(f) $P_0 = 100$

(9) The equation $4x^2 - e^x - e^{-x} = 0$ has two positive solutions x_1 and x_2.Use Newton's method to approximate the solution to within 10^{-5} with the following values of p_0.
(a) $P_0 = -10$ (b) $P_0 = -5$ (c) $P_0 = -3$
(d) $P_0 = -1$ (e) $P_0 = 0$ (f) $P_0 = 1$
(g) $P_0 = 3$ (h) $P_0 = 5$ (i) $P_0 = 10$

(10) Use each of the following methods to find a solution in [0.1, 1] accurate to within 10^{-4} for $600x^4 - 550x^3 + 200x^2 - 20x - 1 = 0$
(a) Bisection method
(b) Newton method
(c) Secant method
(d) Method of False position
(e) Muller's method

UNIT-II

(11) For the given function $f(x)$, let $x_0 = 0$, $x_1 = 0.6$, and $x_2 = 0.9$. Construct interpolation polynomial of degree at most one and at most two to approximate f(0.45),and find the

absolute error

(a) $f(x) = cosx$ (b) $f(x) = ln(x+1)$

(12) For the given function $f(x)$, let $x_0 = 1$, $x_1 = 1.25$ and $x_2 = 1.6$. Construct interpolation polynomial degree at most one and at most two to approximate f(1.4), and find the absolute error.

(a) $f(x) = sin\pi x$ (b) $f(x) = log(3x-1)$

(13) Let $P_3(x)$ be the interpolating polynomials for the data $(0,0)$,$(0.5, y)$,$(1,3)$ and $(2,2)$. The coefficient of x^3 in $P_3(x)$ is 6. Find y

(14) Neville's method is used to approximate $f(0.4)$, giving the following table.

$x_0 = 0$	$P_0 = 1$			
$x_1 = 0.25$	$P_1 = 2$	$P_{0,1} = 2.6$		
$x_2 = 0.5$	P_2	$P_{1,2}$	$P_{0,1,2}$	
$x_3 = 0.75$	$P_3 = 8$	$P_{2,3} = 2.4$	$P_{1,2,3} = 2.96$	$P_{0,1,2,3} = 3.016$

Determine $P_2 = f(0.5)$.

(15) Neville's method is used to approximate $f(0.5)$, giving the following table.

$x_0 = 0$	$P_0 = 0$		
$x_1 = 0.4$	$P_1 = 2.8$	$P_{0,1} = 3.5$	
$x_2 = 0.7$	P_2	$P_{1,2}$	$P_{0,1,2} = \frac{27}{7}$

Determine $P_2 = f(0.7)$.

(16) Neville's Algorithm is used to approximate $f(0)$ using $f(-2)$,$f(-1)$,$f(1)$ and $f(2)$. Suppose $f(-1)$ was overstated by 2 and $f(1)$ was understated by 3. Determine the error in the original calculation of the value of the interpolating polynomial to approximate $f(0)$.

(17) Compute the divided difference table for the data

x	1.0	1.3	1.6	1.9	2.2
$f(x)$	0.7651977	0.6200860	0.4554022	0.2818186	0.1103623

(18) Use the Newton forward-difference formula to construct interpolating polynomaials of degree one,two,and three for the following data. Approximate the specified value using each of the polynomials.

(a) $f(0.43)$ if $f(0) = 1$, $f(0.25) = 1.64872$, $f(0.5) = 2.71828$, $f(0.75) = 4.48169$

(b) $f(0.18)$ if $f(0.1) = -0.29004986$, $f(0.2) = -0.56079734$, $f(0.3) = -0.81401972$, $f(0.4) = -1.0526302$

(19) Use the Newton backward-difference formula to construct interpolating polynomials of degree one, two, and three for the following data. Approximate the specified value using each of the polynomials.

(a) $f(0.43)$ if $f(0) = 1$,$f(0.25) = 1.64872$,$f(0.5) = 2.71828$,$f(0.75) = 4.48169$

(b) $f(0.25)$ if $f(-1) = 0.86199480$, $f(-0.5) = 0.95802009$, $f(0) = 1.0986123$, $f(0.5) = 1.2943767$

(20) Use Stirling's formula to approximate $f(0.43)$ for the following data

x	0.0	0.2	0.4	0.6	0.8
$f(x)$	1.0000	1.22140	1.49182	1.82212	2.22554

UNIT-III

(21) Use the Hermite Polynomial to find an approximation of $f(1.5)$ for the following data

k	x_k	$f(x_k)$	$f'(x_k)$
0	1.3	0.6200860	-0.5220232
1	1.6	0.4554022	-0.56989959
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(22) A car travelling along a straight road is clocked at a number of points. The data from the observations are given in the following table, where the time is in seconds, the distance is in feet, and the speed is in feet per second.

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Use Hermites polynomial to predict the position of the car and its speed when $t = 10 second$

(23) Use the following values and five - digit - rounding arithematic to construct the Hermite interpolating polynomial to approximate $sin(0.34)$

x	sin$x$	$D_x sinx = cosx$
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0.32	0.31457	0.94924
0.35	0.34290	0.93937

(24) Determine the natural cubic spline S that interpolates the data $f(0) = 0, f(1) = 1,$and $f(2) = 2$.

(25) Determine the clamped cubic spline S that interpolates the data $f(0) = 0, f(1) = 1, f(2) = 2$, and satisfies $s'(0) = s'(2) = 1$.

(26) Use the forward-difference formula and backward-difference formula to determine each missing entry in the following tables.

(a)

x	$f(x)$	$f'(x)$
0.5	0.4794	
0.6	0.5646	
0.7	0.6442	

(b)

x	$f(x)$	$f'(x)$
0.0	0.0000	
0.2	0.74140	
0.4	1.3718	

(27) Consider the following table of data

x	0.2	0.4	0.6	0.8	1.0
$f(x)$	0.9798652	0.9177710	0.808038	0.6386093	0.3843735

Use all the appropriate formulas given in this section to approxmate $f'(0.4)$ and $f''(0.4)$.

(28) Derive a method for approximating $f'''(x_0)$ whose error term is of order h^2 by expanding the function f in a fourth Taylor polynomial about x_0 and evaluating at $x_0 \pm h$ and $x_0 \pm 2h$.

(29) The forward-difference formula can be expressed as

$f'(x_0) = \frac{1}{h}[f(x_0+h) - f(x_0)] - \frac{h}{2}f''(x_0) - \frac{h^2}{6}f'''(x_0) + O(h^3)$. Use extrapolation to derive $O(h^3)$ formula for $f^{'}(x_0)$

(30) Show that $lim_{h \longrightarrow 0}(\frac{2+h}{2-h})^{\frac{1}{h}} = e$

UNIT-IV

(31) Approximation the following integrals using the Trapezoidal rule.
(a) $\int_{0.5}^{1} x^4 dx$
(b) $\int_{0}^{0.5} \frac{2}{x-4} dx$
(c) $\int_{1}^{1.5} x^2 lnx dx$
(d) $\int_{0}^{1} x^2 e^{-x} dx$

(32) Approximate the following integral using Trapezoidal Rule
(a) $\int_{-0.25}^{0.25} (cosx)^2 dx$
(b) $\int_{-0.5}^{0} xln(x+1) dx$

(33) The Trapezoidal rule applied to $\int_0^2 f(x)dx$ gives the value 5, and the midpoint rule gives the value 4. What value does Simpson's rule give?

(34) The quadrature formula $\int_0^2 f(x)dx = c_0 f(0) + c_1 f(1) + c_2 f(2)$ is exact for all polynomials of degree less than or equal to 2. Determine c_0, c_1, and c_2.

(35) Find the constants c_0, c_1 and x_1 so that quadrature formula $\int_0^1 f(x)dx = c_0 f(0) + c_1 f(x_1)$
has the highest possible degree of precision.

(36) Use the composite Trapezoidal Rule with the indicated values of n to approximate the following integrals
(a) $\int_1^2 xlnx dx$, n=4
(b) $\int_{-2}^{2} x^3 e^x dx$, n=4.

(37) Suppose that $f(0) = 1, f(0.5) = 2.5, f(1) = 2$ and $f(0.25) = f(0.75) = \infty$. Find ∞ if the Composite Trapezoidal rule with $n = 4$ gives the value 1.75 for $\int_0^1 f(x)dx$

(38) Romberg integration is used to approximate $\int_2^3 f(x)dx$.
If $f(2) = 0.51342, f(3) = 0.36788$ $R_{31} = 0.43687$, $R_{33} = 0.43662$, find $f(2.5)$

(39) Use Romberg integration to compute $R_{3,3}$ for the following integrals.
(a) $\int_1^{1.5} x^2 lnx dx$
(b) $\int_0^1 x^2 e^{-x} dx$

(40) Use Romberg integration to compute $R_{3,3}$ for the following integrals.
(a) $\int_{-1}^{1} (cosx)^2 dx$
(b) $\int_{-0.75}^{0.75} xln(x+1) dx$

2.13 SOLID GEOMETRY

DSE-1E/A
BS:506

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours /week and Practicals: 2 hours/week

Objective: Students learn to describe some of the surfaces by using analytical geometry.

Outcome: Students understand the beautiful interplay between algebra and geometry.

UNIT- I

Sphere: Definition-The Sphere Through Four Given Points - Equations of a Circle - Intersection of a Sphere and a Line - Equation of a Tangent Plane - Angle of Intersection of Two Spheres - Radical Plane.

UNIT- II

Cones : Definition-Condition that the General Equation of second degree Represents a Cone - Cone and a Plane through its Vertex - Intersection of a Line with a Cone. The Right Circular Cone.

UNIT- III

Cylinder: Definition-Equation of a Cylinder-Enveloping Cylinder - The Cylinder - The Right Circular Cylinder.

UNIT- IV

The Conicoid: The General Equation of the Second Degree-Intersection of Line with a Conicoid- Plane of contact-Enveloping Cone and Cylinder.

TEXT: Shanti Narayan and P K Mittal, *Analytical Solid Geometry* (17e)
References:

- Khaleel Ahmed, *Analytical Solid Geometry*
- S L Loney , *Solid Geometry*
- Smith and Minton, *Calculus*

2.13 SOLID GEOMETRY

DSE-1E/A
BS:506

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours /week and Practicals: 2 hours/week

Objective: Students learn to describe some of the surfaces by using analytical geometry.

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UNIT- I

Sphere: Definition-The Sphere Through Four Given Points - Equations of a Circle - Intersection of a Sphere and a Line - Equation of a Tangent Plane - Angle of Intersection of Two Spheres - Radical Plane.

UNIT- II

Cones : Definition-Condition that the General Equation of second degree Represents a Cone - Cone and a Plane through its Vertex - Intersection of a Line with a Cone. The Right Circular Cone.

UNIT- III

Cylinder: Definition-Equation of a Cylinder-Enveloping Cylinder - The Cylinder - The Right Circular Cylinder.

UNIT- IV

The Conicoid: The General Equation of the Second Degree-Intersection of Line with a Conicoid- Plane of contact-Enveloping Cone and Cylinder.

TEXT: Shanti Narayan and P K Mittal, *Analytical Solid Geometry* (17e)
References:

- Khaleel Ahmed, *Analytical Solid Geometry*
- S L Loney , *Solid Geometry*
- Smith and Minton, *Calculus*

2.20 VECTOR CALCULUS

DSE-1F/B
BS:606

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours/week and Practicals: 2 hours/week

Objective: Concepts like gradient, divergence, curl and their physical relevance will be taught.

Outcome: Students realize the way vector calculus is used to addresses some of the problems of physics.

UNIT- I

Line Integrals: Introductory Example : Work done against a Force-Evaluation of Line IntegralsConservative Vector Fields

UNIT- II

Surface Integrals: Introductory Example : Flow Through a PipeEvaluation of Surface Integrals. Volume Integrals: Evaluation of Volume integrals

UNIT- III

Gradient, Divergence and Curl: Partial differentiation and Taylor series in more than one variable-Gradient of a scalar field-Gradients, conservative fields and potentials-Physical applications of the gradient.

UNIT- IV

Divergence of a vector field -Physical interpretation of divergence-Laplacian of a scalar field-Curl of a vector field-Physical interpretation of curl-Relation between curl and rotation-Curl and conservative vector fields.
TEXT: P.C. Matthews,*Vector Calculus*
References:

- G.B. Thomas and R.L. Finney,*Calculus*
- H. Anton, I. Bivens and S. Davis : *Calculus*
- Smith and Minton,*Calculus*

UNIT-I

(1) Evaluate the line integral $\int_c F \times dr$, where F is the vector field $(y, x, 0)$ and C is the curve $y = sinx$, $z = 0$, between $x = 0$ and $x = \pi$.

(2) Evaluate the line integral $\int_c x + y^2 dr$,
where c is the parabola $y = x^2$ in the plane $z = 0$ connecting the points $(0, 0, 0)$ and $(1, 1, 0)$.

(3) Evaluate the line integral $\int_c f.dr$, where F=$(5z^2, 2x, x + 2y)$ and the curve C is given by $x = t, y = t^2, z = t^2$, $0 \le t \le 1$

(4) Find the line integral of the vector field $u = (y^2, x, z)$ along the curve given by $z = y = e^x$ from $x = 0$ and $x = 1$.

(5) Evaluate the line integral of the vector field $u = (xy, z^2, x)$ along the curve given by $x = 1 + t, y = 0, z = t^2, 0 \le t \le 3$.

(6) Find the line integral of $F = (y, -x, 0)$ along the curve consisting of the two straight line segments $y = 1$, $0 \le x \le 1$.

(7) Find the circulation of the vector $F = (y, -x, 0)$ around the unit circle $x^2 + y^2 = 1$, $z = 0$, taken in anticlockwise direction.

(8) Find the line integral $\oint r * dr$,where the curve C is the ellipse $x^2/a^2 + y^2/b^2 = 1$ taken in an anticlockwise direction.What do you notice about the magnitude of the answer?

(9) By considering the line integral of $F = (y, x^2 - x, 0)$ around the square in the x,y plane connecting the four points $(0, 0)$,$(1, 0)$,$(1, 1)$ and $(0, 1)$,show that F cannot be a conservative vector field.

(10) Evaluate the line integral of the vector field $u = (xy, z^2, x)$ along the curve given by $x = 1 + t, y = 0, z = t^2, 0 \le t \le 3$.

UNIT-II

(11) Evaluate the surface integral of $u = (y, x^2, z^2)$,over the surface S,where S is the triangular surface on $x = 0$ with $y \ge 0, z \ge 0, y + x \le 1$,with the normal n directed in the positive x direction

(12) Find the surface integral of $u = r$ over the part of the paraboloid $z = 1 - x^2 - y^2$ with $z > 0$, with the normal pointing upwards.

(13) If S is the entire x,y plane,evaluate the integral $I = \int_s e^{-x^2-y^2} ds$, by transforming the integral into polar coordinates.

(14) A cube $0 \le x, y, z \le 1$ has a variable density given by $\rho = 1 + x + y + z$. what is the total mass of the cube?

(15) Find the volume of the tetrahedron with vertices (0, 0, 0), (a, 0, 0), (0, b, 0) (0, 0, c).

(16) Evaluate the surface integral of $\mathbf{u} = (xy, x, x + y)$ over the surface S defined by $z = 0$ with $0 \le x \le 1$, $0 \le y \le 2$, with the normal $\mathbf{n}$ directed in the positive z direction.

(17) The surface S is defined to be that part of the plane $z = 0$ lying between the curve $y = x^2$ and $x = y^2$. Find the surface integral of $\mathbf{u.n}$ over S where $u = (z, xy, x^2)$ and $\mathbf{n} = (0, 0, 1)$.

(18) Find the surface integral of $\mathbf{u.n}$ over S where S is the part of the surface $z = x + y^2$ with $z < 0$ and$x > -1$, u is the vector field $\mathbf{u} = (2y + x, -1, 0)$ and $\mathbf{n}$ has a negative z component.

(19) Find the volume integral of the scalar field $\phi = x^2 + y^2 + z^2$ over the region V specified by $0 \le x \le 1, 1 \le y \le 2, 0 \le z \le 3$.

(20) Find the volume of the section of the cylinder $x^2 + y^2 = 1$ that lies between the planes $z = x + 1$ and $z = -x - 1$.

(21) Find the unit normal $\mathbf{n}$ to the surface $x^2 + y^2 - z = 0$ at the point $(1, 1, 2)$.

(22) find the gradient of the scalar field $f = xyz$ and evaluate it at the point $(1, 2, 3)$. Hence find the diraction derivative of f at this point in the direction of the vector $(1, 1, 0)$.

UNIT-III

(23) Find the divergence of the vector field **u=r**.

(24) The vector field $\mathbf{u}$ is defined by $\mathbf{u} = (xy, z + x, y)$. Calculate $\bigtriangledown \times u$ and find the point where $\bigtriangledown \times u = 0$.

(25) Find the gradient $\bigtriangledown\phi$ and the Laplacian $\bigtriangledown^2\phi$ for the scalar field $\phi = x^2 + xy + yz^2$.

(26) Find the gradient and the Laplacian of $\phi = \sin(kx)\sin(ly)e^{\sqrt{k^2+l^2}z}$.

(27) Find the unit normal to the surface $xy^2 + 2yz = 4$ at the point (-2, 2, 3).

(28) For $\phi(x, y, z) = x^2 + y^2 + z^2 + xy - 3x$, find $\bigtriangledown\phi$ and find the minimum value of ϕ.

(29) Find the equation of the plane which is tangent to the surface $x^2 + y^2 - 2z^3 = 0$ at the point (1, 1, 1).

(30) Prove that $\nabla^2(\frac{1}{r}) = 0$

UNIT-IV

(31) Find both the divergence and the curl of the vector fields
(a) $\mathbf{u} = (y, z, x)$;
(b) $V = (xyz, z^2, x - y)$.

(32) For what values, if any, of the constants a and b is the vector field $\mathbf{u} = (y\cos x + axz, b\sin x + z, x^2 + y)$ irrotational?

(33) (a) Show that $\mathbf{u} = (y^2z, -z^2\sin y + 2xyz, 2z\cos y + y^2x)$ is irrotational.
(b) Find the corresponding potential function.
(c) Hence find the value of the line integral of $\mathbf{u}$ along the curve
$x = \sin\frac{\pi t}{2}, y = t^2 - t, z = t^4, 0 \leq t \leq 1$.

(34) Find the divergence of the vector field $u = \overrightarrow{r}$.

(35) The vector field u is defined by $u = (xy, x + z, y)$, then calculate $\nabla \times u$ and find the points where $\nabla \times u = 0$.

(36) Show that both the divergence and the curl are linear operators.

(37) Find $\nabla.\nabla\phi$ if $\phi = 2x^3y^2z^4$.

(38) If $A = x^2yi - 2xzj + 2yzk$ then find $curl\ curl\ A$.

(39) Show that $div\ curl\ A = 0$.

(40) If $A = xz^3i - 2x^2yzj + 2yz^4k$ then find $\nabla \times A$ at the point $(1, -1, 1)$.

2.20 VECTOR CALCULUS

DSE-1F/B
BS:606

Theory: 3 credits and Practicals: 1 credits
Theory: 3 hours/week and Practicals: 2 hours/week

Objective: Concepts like gradient, divergence, curl and their physical relevance will be taught.

Outcome: Students realize the way vector calculus is used to addresses some of the problems of physics.

UNIT- I

Line Integrals: Introductory Example : Work done against a Force-Evaluation of Line IntegralsConservative Vector Fields

UNIT- II

Surface Integrals: Introductory Example : Flow Through a PipeEvaluation of Surface Integrals. Volume Integrals: Evaluation of Volume integrals

UNIT- III

Gradient, Divergence and Curl: Partial differentiation and Taylor series in more than one variable-Gradient of a scalar field-Gradients, conservative fields and potentials-Physical applications of the gradient.

UNIT- IV

Divergence of a vector field -Physical interpretation of divergence-Laplacian of a scalar field-Curl of a vector field-Physical interpretation of curl-Relation between curl and rotation-Curl and conservative vector fields.
TEXT: P.C. Matthews, *Vector Calculus*
References:

- G.B. Thomas and R.L. Finney, *Calculus*
- H. Anton, I. Bivens and S. Davis : *Calculus*
- Smith and Minton, *Calculus*

UNIT-I

(1) Evaluate the line integral $\int_c F \times dr$, where F is the vector field $(y, x, 0)$ and C is the curve $y = sinx$, $z = 0$, between $x = 0$ and $x = \pi$.

(2) Evaluate the line integral $\int_c x + y^2 dr$,
where c is the parabola $y = x^2$ in the plane $z = 0$ connecting the points $(0, 0, 0)$ and $(1, 1, 0)$.

(3) Evaluate the line integral $\int_c f.dr$, where F=$(5z^2, 2x, x + 2y)$ and the curve C is given by $x = t, y = t^2, z = t^2$, $0 \leq t \leq 1$

(4) Find the line integral of the vector field $u = (y^2, x, z)$ along the curve given by $z = y = e^x$ from $x = 0$ and $x = 1$.

(5) Evaluate the line integral of the vector field $u = (xy, z^2, x)$ along the curve given by $x = 1 + t, y = 0, z = t^2, 0 \leq t \leq 3$.

(6) Find the line integral of $F = (y, -x, 0)$ along the curve consisting of the two straight line segments $y = 1$, $0 \leq x \leq 1$.

(7) Find the circulation of the vector $F = (y, -x, 0)$ around the unit circle $x^2 + y^2 = 1$, $z = 0$, taken in anticlockwise direction.

(8) Find the line integral $\oint r * dr$,where the curve C is the ellipse $x^2/a^2 + y^2/b^2 = 1$ taken in an anticlockwise direction.What do you notice about the magnitude of the answer?

(9) By considering the line integral of $F = (y, x^2 - x, 0)$ around the square in the x,y plane connecting the four points $(0, 0)$,$(1, 0)$,$(1, 1)$ and $(0, 1)$,show that F cannot be a conservative vector field.

(10) Evaluate the line integral of the vector field $u = (xy, z^2, x)$ along the curve given by $x = 1 + t, y = 0, z = t^2, 0 \leq t \leq 3$.

UNIT-II

(11) Evaluate the surface integral of $u = (y, x^2, z^2)$,over the surface S,where S is the triangular surface on $x = 0$ with $y \geq 0, z \geq 0, y + x \leq 1$,with the normal n directed in the positive x direction

(12) Find the surface integral of $u = r$ over the part of the paraboloid $z = 1 - x^2 - y^2$ with $z > 0$, with the normal pointing upwards.

(13) If S is the entire x,y plane,evaluate the integral $I = \int_s e^{-x^2 - y^2} ds$, by transforming the integral into polar coordinates.

(14) A cube $0 \leq x, y, z \leq 1$ has a variable density given by $\rho = 1 + x + y + z$. what is the total mass of the cube?

(15) Find the volume of the tetrahedron with vertices (0, 0, 0), (a, 0, 0), (0, b, 0) (0, 0, c).

(16) Evaluate the surface integral of $\mathbf{u} = (xy, x, x + y)$ over the surface S defined by $z = 0$ with $0 \leq x \leq 1$, $0 \leq y \leq 2$, with the normal $\mathbf{n}$ directed in the positive z direction.

(17) The surface S is defined to be that part of the plane $z = 0$ lying between the curve $y = x^2$ and $x = y^2$. Find the surface integral of $\mathbf{u.n}$ over S where $u = (z, xy, x^2)$ and $\mathbf{n} = (0, 0, 1)$.

(18) Find the surface integral of $\mathbf{u.n}$ over S where S is the part of the surface $z = x + y^2$ with $z < 0$ and$x > -1$, u is the vector field $\mathbf{u} = (2y + x, -1, 0)$ and $\mathbf{n}$ has a negative z component.

(19) Find the volume integral of the scalar field $\phi = x^2 + y^2 + z^2$ over the region V specified by $0 \leq x \leq 1, 1 \leq y \leq 2, 0 \leq z \leq 3$.

(20) Find the volume of the section of the cylinder $x^2 + y^2 = 1$ that lies between the planes $z = x + 1$ and $z = -x - 1$.

(21) Find the unit normal $\mathbf{n}$ to the surface $x^2 + y^2 - z = 0$ at the point $(1, 1, 2)$.

(22) find the gradient of the scalar field $f = xyz$ and evaluate it at the point $(1, 2, 3)$. Hence find the diraction derivative of f at this point in the direction of the vector $(1, 1, 0)$.

UNIT-III

(23) Find the divergence of the vector field **u=r**.

(24) The vector field $\mathbf{u}$ is defined by $\mathbf{u} = (xy, z + x, y)$. Calculate $\bigtriangledown \times u$ and find the point where $\bigtriangledown \times u = 0$.

(25) Find the gradient $\bigtriangledown\phi$ and the Laplacian $\bigtriangledown^2\phi$ for the scalar field $\phi = x^2 + xy + yz^2$.

(26) Find the gradient and the Laplacian of $\phi = \sin(kx)\sin(ly)e^{\sqrt{k^2+l^2}z}$.

(27) Find the unit normal to the surface $xy^2 + 2yz = 4$ at the point (-2, 2, 3).

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