PANSKURA BANAMALI COLLEGE
(AUTONOMOUS)

Syllabus and Scheme of Examination

for

B.Sc. (Hons.) Mathematics

Under Choice Based Credit System

(CBCS)

[w.e.f.: 2018-19]

Scheme for Choice Based Credit Systemin**B.Sc. (Hons.) Mathematics**

Semester	Core course(14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC)(2)	Discipline Specific Elective (DSE)(4)	Generic Elective (GE)(4)
I	**C1:** Calculus, Geometry& Differential Equation	AECC1 : English			GE 1: Calculus & Geometry
	C2: Algebra				
II	**C3:** Real Analysis	AECC2 : ENVS			GE 2 : Algebra -I
	C4: Differential Equations & Vector Calculus				
III	**C5:** Theory of Real Functions		SEC1 : Logic and Sets		GE3: Differential Equations and Vector Calculus
	C6: Group Theory I				
	C7 : Numerical Methods (P)				
IV	**C8** Riemann Integration and series Functions		SEC2 : Graph Theory		GE4 : Partial Differential Equations and Numerical Methods
	C9 Multivariate Calculus				
	C10 : Ring Theory and Linear Algebra I				
V	**C11:** Partial Differential Equations & Applications			DSE1: Linear Programming	
	C12: Group Theory II			DSE2 : Probability and Statistics	
VI	**C13:** Matrix space & Complex analysis			DSE3: Mechanics	
	C14: Ring Theory and Linear Algebra II			DSE4 : Mathematical Modeling / project work	

(P) means course with practical

Discipline Specific Elective (DSE)

Choice for DSE1 (Choose one)

1. Theory of Equations
2. Number Theory

Choice for DSE2 (Choose one)

1. Linear Programming
2. Boolean Algebra & Automata Theory

Choice for DSE3 (Choose one)

1. Probability and Statistics
2. Mathematical Modelling

Choice for DSE4 (Choose one)

1. Mechanics
2. Bio- Mathematics

Skill Enhancement Course (SEC)

Choice for SEC1 (Choose one)

1. Logic and Sets
2. Object Oriented Programming C++

Choice for SEC2 (Choose one)

1. Operating System Linux
2. Graph Theory
3. Introduction to Fuzzy sets

Generic Electives (GE)

Choice for GE (Choose any two)

1. Calculus& Geometry
2. Algebra -I
3. Differential Equations and Vector Calculus
4. Partial Differential Equations and Numerical Methods
5. Real Analysis
6. Algebra -II

PanskuraBanamali College (Autonomous)

Curriculum for B.Sc. Honours in Mathematics [Choice Based Credit System]

Semester-I

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit
				L	T	P	
C1	C1: Calculus , Geometry & Differential Equation	Core Course-1		5	1	0	6
C2	C2: Algebra	Core Course-2		5	1	0	6
GE-1	GE-1 (Calculus & Geometry)	GE					4/5
	GE-1 (Calculus & Geometry)	GE					2/1
AECC1	Environmental Science	AECC					4
				Total Credits = 22			

Semester-II

C3	C3: Real Analysis	Core Course-3		5	1	0	6
C4	C4:Differential Equations & Vector Calculus	Core Course-4		5	1	0	6
GE-2	GE-2 (Algebra -I)	GE					4/5
	GE-2 (Algebra - I)	GE					2/1
AECC2	English Communication	AECC					2
				Total Credits = 20			

Semester-III

C5	**C5:**Theory of Real Functions	Core Course-5		5	1	0	6
C6	**C6:** Group Theory I	Core Course-6		5	1	0	6
C7	**C7 :** Numerical Methods	Core Course-7		4	0	2	6
GE-3	GE-3 (Differential Eqn. & Vector Calculus)	GE					4/5
	GE-3 (Differential Eqn. & Vector Calculus)	GE					2/1
SEC1	SE – 1 (Logic and Sets)	SEC					2
				Total Credits = 26			

Semester-IV							
C8	**C8:** Riemann integration and Series of Function	Core Course-8		5	1	0	6
C9	**C9:** Multivariate Calculus	Core Course-9		5	1	0	6
C10	**C11 :** Ring Theory and Linear Algebra - I	Core Course-10		5	1	0	6
GE-3	GE-4:	GE					4/5
	GE-4	GE					2/1
SEC2	SE - 2	SEC					2
				Total Credits = 26			
Semester-V							
C11	**C11:** Partial Differential Equations & Applications	Core Course-11		5	1	0	6
C12	**C12:** Group theory - II	Core Course-12		5	1	0	6
DSE1	DSE1	DSE					4/5
	DSE1	DSE					2/1
DSE2	DSE2	DSE					4/5
	DSE2	DSE					2/1
				Total Credits = 24			
Semester-VI							
C13	**C13:** Metric space & Complex analysis	Core Course-13		5	1	0	6
C14	**C14:** Ring theory and Linear Algebra - II	Core Course-14		5	1	0	6
DSE3	DSE3	DSE					4/5
	DSE3	DSE					2/1
DSE4	DSE4	DSE					4/5
	DSE4	DSE					2/1
				Total Credits = 24			

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language/Environmental Science. Optional Dissertation or project work in place of one Discipline Specific Elective Paper (6 credits) in 6th Semester

Interdisciplinary/Generic Elective (GE) from other Department [Four papers are to be taken and each paper will be of 6 credits]: Two Papers are to be taken from any two of the following discipline:**Physics/Chemistry/Computer Sc.**

Programme Specific Outcomes:

PSO1. Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, analysis,calculus, geometry, differential equations and several other branches of mathematics. Thisalsoleadstostudyofrelatedareaslikecomputerscienceandstatistics.Thus,thisprogramme helps studentsinbuildingasolidfoundationforhigherstudiesinmathematics.

PSO2. This programme will enable the students tocommunicate variousconcepts, notions, theoriesofmathematicseffectivelyusingexamples and theirgeometricalvisualizations and usemathematicsasapreciselanguageofcommunicationinotherbranchesof science.Also, students will be able to present mathematics clearly andprecisely, make vague ideas precise by formulating them in the language of mathematics,describemathematicalideasfrommultipleperspectivesandexplainfundamentalconcep tsof this subject tonon-mathematicians.

PSO3. The skills and knowledge gained has intrinsic beauty, which also leads to proficiency inanalyticalreasoning.Thiscanbeutilisedinmodellingandsolvingreallifeproblems.

PSO4. Students undergoing this programme learn to logically question assertions, to recognisepatterns and to distinguish between essential and irrelevant aspects of problems. They alsoshareideasandinsightswhileseekingandbenefittingfromknowledgeandinsightofothers.Thishel psthemtolearnbehaveresponsiblyinarapidlychanginginterdependentsociety.

PSO5. Students will be abletoworkindependentlyanddoin-depthstudyofvariousnotionsofmathematics.

PSO6. Students will betoidentifyunethicalbehavioursuchasfabrication,falsificationormisrepresentation of data and adopting objective, unbiased and truthful actions in all aspects.

PSO7. This programme will enable the students to think independently, acquire knowledge and skills through logical reasoning and toinculcatethehabitofself-learning.

PSO8. Completion of this programme will also enable the students to join teaching profession in primaryandsecondary schools.

PSO9. This programme will also help students to enhance their employability for governmentjobs,jobsinbanking,insuranceandinvestmentsectors,dataanalystjobsandjobsinvariou sotherpublicandprivateenterprises.

CORE SUBJECT SYLLABUS

CORE - 1 : CALCULUS, GEOMETRY & DIFFERENTIAL EQUATION

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) State and prove Leibnitz rule and apply it to find higher order derivatives and can solve various type of problems.
ii) Calculate Envelope, asymptotes, Curvature of standard curves if exists and interpret point of inflexion.
iii) Apply L'Hospital rule to find limit of functions.
iv) Sketch curves in Cartesian and polar co-ordinate systems and classify the conics and conicoids using some standard methods and explain the properties of three dimensional shapes.
v) Derive reduction formula and apply it in different situations.
vi) Calculate arc length of a curve, area under curve, area and volume of surface of revolution.

vii) Understand the genesis of ordinary differential equations and Picard's theorem and learn various techniques of getting exact solutions of solvable first order ODE and grasp concept of general, particular and singular solution.

UNIT – 1

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of 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, envelopes, asymptotes, Curvature, curve tracing in cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences.

UNIT –2

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sec^n x\,dx$, $\int (\log x)^n\,dx$, $\int \sin^n x \sin^m x\,dx$, parametric equations, parameterizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.

UNIT – 3

Pole and polar. Diameters and Conjugate diameters. System of conics, Polar equation of a conic referred to a focus as pole. Equations of tangent, normal, chord of contact. Rotation of axes and second degree equations, classification of conics using the discriminant.

Sphere: General equation, Great circle, Sphere through the intersection of two spheres. Radical plane, Tangent, Normal. Cone: Right Circular Cone, General homogeneous second degree equation. Section of a cone by a plane as a conic and as pair of lines, Condition for three perpendicular generators, Reciprocal Cone. Cylinder: Generators parallel to either the axes, general form of equation, Right circular cylinder. Ellipsoid, Hyperboloid, Parabolic:Cannonical equations only, Tangent planes, Normal, Enveloping cone, Generating lines of hyperboloid of one sheet and hyperbolic paraboloid.

UNIT - 4

Picard's existence & uniqueness theorem (Statement only). 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 equation and Bernoulli equations, special integrating factors and transformations.

Graphical Demonstration (Teaching Aid)

1. Plotting of graphs of function e^{ax+b}, $\log(ax + b)$, $1/(ax + b)$, $\sin(ax + b)$, $\cos(ax + b)$, $|ax + b|$ and to illustrate the effect of a and b on the graph.
2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves (Eg. trochoid, cycloid, epicycloids, hypocycloid).

4. Obtaining surface of revolution of curves.
5. Tracing of conics in Cartesian coordinates/ polar coordinates.
6. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using Cartesian coordinates.

Text Books :

1. G.B. Thomas and R.L. Finney, Tomas Calculus, 9th Ed., Pearson Education, Delhi, 2012
2. S. L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London
3. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.

Reference Books:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
2. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
3. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer- Verlag, New York, Inc., 1989.
4. Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
5. T. Apostol, Calculus, Volumes I and II.
6. S. Goldberg, Calculus and mathematical analysis.

CORE - 2 :ALGEBRA

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
ii) familiarize with inequality involving A.M.> G.M.> H.M., Cauchy-Schwarz's inequality etc.
iii) familiarize with relations, equivalence relations and partitions.
iv) employ De-Moivre's theorem in a number of applications to solve numerical problems.
v) recognize consistent and inconsistent system of linear equations by the row echelon form of the augmented matrix, using rank.
vi) understand the concepts of vector space, subspaces, bases, dimension and their properties.
vii) find eigen values and corresponding eigen vectors for a square matrix.
viii) relate matrices and linear transformations.

UNIT – 1

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.Theory of equations: Relation between roots and coefficients, transformation of equation, Descartes rule of signs, cubic and biquadratic equation.

Inequality: The inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality.

UNIT –2

Equivalence relations. Functions, composition of functions, Invertible functions, one to one correspondence and cardinality of a set. Well-ordering property of positive integers, division algorithm, divisibility and Euclidean algorithm. Congruence relation between integers. Principles of Mathematical induction, statement of Fundamental Theorem of Arithmetic.

UNIT –3

Properties of Determinant, Linear independence, System of linear equations: row reduction and echelon forms, rank of a matrix, the matrix equation Ax = b, solution sets of linear systems, applications of linear systems.

UNIT –4

Vector space (Real), Subspaces of R^n, dimension of subspaces of R^n,inverse of a matrix, characterizations of invertible matrices.Introduction to linear transformations, matrix of a linear transformation, Eigen values, eigen vectors and characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Text Books:

1. Higher Algebra (Classical Algebra) – S. K. Mapa
2. Linear Algebra – S. Lang
3. Linear Algebra – Bhima Sankaran

Reference Books

1. TituAndreescu and DorinAndrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
4. K.B. Dutta, Matrix and linear algebra.
5. K. Hoffman, R. Kunze, Linear algebra.
6. W.S. Burnstine and A.W. Panton, Theory of equations.

CORE - 3 :REAL ANALYSIS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) The set of real numbers is an ordered field with supremum property.

ii) The set R of real numbers possesses the Archimedian property which will be required to examine the convergence of a sequence and series in next unit.

iii) The concept of neighbourhood of a point in R, open-ness , closed-ness , of a subset of R , Limit point of a set and its various properties and to prove Bolzano – Weirstrass theorem along with its application.

iv) Notion of countability along with countability of Q and uncountability of R.

v) Compactness of a set in R along with Heine – Boral theorem.

vi) Assimilate the notions of limit of a sequence and convergence of a series of real numbers.

vii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequence and to calculate their limit superior, limit inferior and the limit of a bounded sequence.

viii) Apply the ratio, root, alternating series and limit comparison testes for convergence and absolute convergence of an infinite series of real numbers.

UNIT – 1

Review of algebraic and order properties of R, ε-neighborhood of a point in R. Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima. Completeness property of R and its equivalent properties. The Archimedean property, density of rational (and irrational) numbers in R, intervals. Limit points of a set, isolated points, open set, closed set, derived set, illustrations of Bolzano-Weierstrass theorem for sets, compact sets in R, Heine-Borel Theorem.

UNIT –2

Sequences, bounded sequence, convergent sequence, limit of a sequence, liminf, lim sup. Limit theorems. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only), Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion.

UNIT –3

Infinite series, convergence and divergence of infinite series, Cauchy criterion, tests for convergence: comparison test, limit comparison test, ratio test (D'Alembert's ratio test, Raabe's test, De Morgan and Betrand's test), Kumer's test, Guass' test, Logarithmic test, Cauchy's nth root test, integral test. Alternating series, Riemann rearrangement theorem (Statement only), Leibnitz test. Absolute and conditional convergence.

UNIT – 4

Graphical Demonstration (Teaching aid)

1. Plotting of recursive sequences.
2. Study the convergence of sequences through plotting.
3. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.

4. Study the convergence / divergence of infinite series by plotting their sequences of partial sum.
5. Cauchy's root test by plotting nth roots.
6. Ratio test by plotting the ratio of nth and (n+1) th term.

Text Books:

1. Mathematical Analysis – S.C. Malik and Sabita Arora.
2. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. S. Goldberg, Calculus and mathematical analysis

Reference Books:

1. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones& Bartlett, 2010.
2. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis,Prentice Hall, 2001.
3. S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
4. T. Apostol, Mathematical Analysis, Narosa Publishing House
5. Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
6. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
7. Terence Tao, Analysis I, Hindustan Book Agency, 2006.

CORE - 4 :DIFFERENTIAL EQUATIONS & VECTOR CALCULUS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Learn various techniques of getting general solution of homogeneous equation of second order, linear homogeneous and non-homogeneous equation of higher order with constant coefficients.
ii) Learn about systems of linear differential equation with constant coefficients of various types and solving various types of method.
iii) Learn about Equilibrium points giving interpretation of phase plane.
iv) Learn about power series solution of a differential equation and to solve various problem.
v) Calculate triple product and test the continuity of vector function, differentiation and integration of vector functions.

UNIT – 1

Lipschitz condition (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

UNIT – 2

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients,

Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

UNIT – 3

Equilibrium points (center, saddle point, spiral point, node) – stable, asymptotically sable, unstable. Interpretation of the phase plane

Power series solution of a differential equation about an ordinary point, solution about a regular singular point: The method of Frobenious.

UNIT – 4

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions.

UNIT – 5

Graphical demonstration (Teaching aid)

1. Plotting of family of curves which are solutions of second orderdifferential equation.
2. Plotting of family of curves which are solutions of third order differential equation.

Text Books:

1. Differential Equation – S.L. Ross (John Wiley and Sons, India).
2. Differential Equations - G.F.Simmons (Tata Mc Graw Hill).
3. Schaum's outline of Vector Analysis- M.R. Speigel.

Reference Books:

1. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
2. Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
3. Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley.
4. Marsden, J., and Tromba, Vector Calculus, McGraw Hill.
5. Maity,K.C. and Ghosh, R.K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).

CORE - 5:THEORY OF REAL FUNCTIONS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Learn concept of limits and calculate the limit of a function if exists.
ii) Examine the continuity and differentiability of a function at a point / on a given interval and understand the geometrical interpretation of differentiability.
iii) State and prove sign preserving property, Intermediate value theorem, Bolzano's theorem and learn the concept of uniform continuity.
iv) State, prove and apply mean value theorem in unfamiliar situations and understand the consequences of various mean value theorem. Find the infinite series of a function by using Taylors.
v) Learn about Local, Global maximum and minimum of a function and find the extreme values if exists of a given function.

UNIT – 1

Limits of functions (ε - δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

UNIT – 2

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 theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

UNIT – 3

Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, ln (1 + x), 1/(ax + b) and$(x+1)^n$. Application of Taylor's theorem to inequalities.

Text Books:

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.

Reference Books:

1. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
2. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
3. S.R. Ghorpade and B.V. Limaye, a Course in Calculus and Real Analysis, Springer, 2006.
4. T. Apostol, Mathematical Analysis, Narosa Publishing House
5. Courant and John, Introduction to Calculus and Analysis, Vol II, Springer
6. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
7. Terence Tao, Analysis II, Hindustan Book Agency, 2006
8. SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006
9. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House,2011.
10. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill,2004

CORE - 6: GROUP THEORY - I

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

1. Recognize the mathematical objects called groups.
2. Link the fundamental concepts of groups and symmetries of geometrical objects.
3. Explain the significance of notions of Cosets, normal subgroups, and factor groups.
4. Analyze consequences of Lagrange's theorem.
5. Learn about structure preserving maps between groups and their consequences.
6. State and prove Cayley's theorem, 1^{st} ,2^{nd} and 3^{rd} isomorphism theorem.

UNIT – 1
Symmetries of a square, dihedral groups, definition andexamples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

UNIT – 2
Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

UNIT – 3
Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

UNIT – 4
External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

UNIT – 5
Group homomorphisms, properties ofhomomorphisms,Cayley'stheorem, properties ofisomorphisms. First, Second and Third isomorphism theorems.

Text Books:

1. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
2. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
3. M. K. Sen, S. Ghosh & P Mukhopadhyay,Topics in Abstract Algebra , 2nd Edition, University Press.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
3. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
4. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.

CORE - 7: NUMERICAL METHODS

CREDIT HOURS – 4 (55 Marks)

Course Outcomes: This course will enable the students to

i) obtain numerical solutions of algebraic and transcendental equations.
ii) Find numerical solutions of system of linear equations and check the accuracy of the solutions.

iii) Learn about various interpolating methods, the formulas of numerical differentiation and to solve different types of problems.
iv) Learn about numerical integration and to apply it in various problems.
v) Learn about algebraic eigen value problem and approximation and to solve various problems.
vi) Solve initial value problems in differential equations using numerical methods.

UNIT – 1
Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.

UNIT – 2
Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

UNIT – 3
System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition.

UNIT – 4
Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.
Numerical differentiation: Methods based on interpolations, methods based on finite differences

UNIT – 5
Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite trapezoidal rule, composite Simpson's 1/3rd rule, Gauss quadrature formula.
The algebraic eigen value problem: Power method.Approximation: Least square polynomial approximation.

UNIT – 6
Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

CORE - 7: NUMERICAL METHODS LAB

CREDIT HOURS – 2 (20 Marks)

List of practical (using any software) :

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. Enter 100 integers into an array and sort them in an ascending order.
3. Solution of transcendental and algebraic equations by
   i) Bisection method
   ii) Newton Raphson method.
   iii) Secant method.
   iv) Regula Falsi method.
4. Solution of system of linear equations

i) LU decomposition method
ii) Gaussian elimination method
iii) Gauss-Jacobi method
iv) Gauss-Seidel method

5. Interpolation
   i) Lagrange Interpolation
   ii) Newton Interpolation
6. Numerical Integration
   i) Trapezoidal Rule
   ii) Simpson's one third rule
   iii) Weddle's Rule
   iv) Gauss Quadrature
7. Method of finding Eigenvalue by Power method
8. Fitting a Polynomial Function
9. Solution of ordinary differential equations
   i) Euler method
   ii) Modified Euler method
   iii) Runge Kutta method

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Text Books:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.

Reference Books:

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
3. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
4. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
5. Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
6. Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
7. YashavantKanetkar, Let Us C , BPB Publications.

CORE - 8: RIEMANN INTEGRATION AND SERIES OF FUNCTIONS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Learn about Riemann integrality of bounded functions and algebra of R-integrable functions.
ii) Determine various applications of the fundamental theorem of integral calculus.
iii) Relate concepts of point-wise convergence and uniform convergence of sequence and series of functions.
iv) Determine Fourier expansions and summation results for series.
v) Understand the convergence, term by term integration and differentiation of a power series.

UNIT – 1

Riemann integration: inequalities of upper and lower sums, Darbaux integration, Darbaux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions. Riemann integrability of monotone and continuous functions, properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.

Intermediate Value theorem for Integrals; Fundamental theorem of Integral Calculus.

UNIT –2

Improper integrals. Convergence of Beta and Gamma functions.

UNIT – 3

Point wise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions;

Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

UNIT – 4

Fourier series: Definition of Fourier coefficients and series, Reimann Lebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition. Examples of Fourier expansions and summation results for series.

UNIT – 5

Power series, radius of convergence, Cauchy Hadamard theorem. Differentiation and integration of power series; Abel's theorem; Weierstrass approximation theorem.

Text Books:

1. Mathematical Analysis – S.C. Malik and Sabita Arora.
2. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. S. Goldberg, Calculus and Mathematical analysis

Reference Books:

1. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones& Bartlett, 2010.
2. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis,Prentice Hall, 2001.
3. S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
4. T. Apostol, Calculus I, II, Narosa Publishing House
5. Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
6. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill

CORE - 9: MULTIVARIATE CALCULUS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) learn conceptual variations while advancing from one variable to several variables in calculus.
ii) Apply multivariate calculus in optimization problems.
iii) Calculate the line integral, double integral and triple integral formulations.
iv) Apply multivariate calculus tools in physics, economics, optimization and understanding the architecture of curves and surfaces in plane and space etc.
v) Calculate gradient of a scalar function, divergence and curl of a vector function.
vi) Realize importance of Green's, Gauss and Stokes theorems in other branches of mathematics.

UNIT – 1

Functions of several variables, limit and continuity of functions of two or more variables

Partial differentiation, total differentiability and 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, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems

UNIT – 2

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, 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 – 3

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.

UNIT – 4

Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Text Books:

1. Mathematical Analysis – S.C. Malik and Sabita Arora.
2. G.B. Thomas and R.L. Finney, Tomas Calculus, 9th Ed., Pearson Education, Delhi, 2012
3. M.R. Speigel, Schaum's outline of Vector Analysis.

Reference Books:

7. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
8. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
9. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
10. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001
11. T. Apostol, Mathematical Analysis, Narosa Publishing House
12. Courant and John, Introduction to Calculus and Analysis, Vol II, Springer
13. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
14. Marsden, J., and Tromba, Vector Calculus, McGraw Hill.
15. Maity, K.C. and Ghosh, R.K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
16. Terence Tao, Analysis II, Hindustan Book Agency, 2006

CORE - 10: RING THEORY AND LINEAR ALGEBRA - I

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Understand the concepts of ring, integral domain, field and their inter relationship.
ii) Recognize different kinds of ideal such as prime ideal, maximal ideal, principal ideal.
iii) Know about ring homomorphism and isomorphism.
iv) Learn the properties of vector spaces and can find the basis and dimension of vector spaces and subspaces.
v) Know about linear transformation, find its matrix representation, nullity and rank.

UNIT – 1

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals

UNIT – 2

Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients.

UNIT – 3

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

UNIT – 4

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Text Books:

1. Higher Algebra – S. K. Mapa
2. Linear Algebra – S. Lang
3. Linear Algebra – Bhima Sankaran

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
4. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
5. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
6. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
7. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.
8. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra..

CORE - 11: PARTIAL DIFFERENTIAL EQUATIONS & APPLICATIONS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Understand the basic concept of PDE, classify the first order PDE.
(ii) Apply the various methods to solve first order PDE.
(iii) Derive the heat conduction, wave equation and Laplace equation, classify the 2^{nd} order equations, and reduce the 2^{nd} order PDE to canonical forms.
(iv) Solve the Cauchy problem of an infinite string, IVP, Equation with non-homogeneous BC, non-homogeneous wave equations.
(v) Apply the method of separation of variables to solve heat and wave equation.
(vi) Learn about a particle moving under central forces, constrained motion, the Kepler's laws of the planetary motion and motion of the particle when mass varies.

UNIT – 1

Partial differential equations – Basic concepts and definitions. Mathematical problems. First-order equations: classification, construction and geometrical interpretation. Method of characteristics for obtaining general solution of quasi linear equations. Canonical forms of first-order linear equations. Method of separation of variables for solving first order partial differential equations.

UNIT – 2

Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms.

UNIT – 3

The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string. Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Equations with non-homogeneous boundary conditions. Non- homogeneous wave equation. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem

UNIT – 4

Central force. Constrained motion, varying mass, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law.

UNIT – 5

Graphical Demonstration (Teaching aid)

1. Solution of Cauchy problem for first order PDE.
2. Finding the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:

   (a) $u(x,0) = \phi(x),\ u_t(x,0) = \psi(x),\ x \in R,\ t > 0.$

   (b) $u(x,0) = \phi(x),\ u_t(x,0) = \psi(x), u(0,t) = 0\ \ x \in (0,\infty),\ t > 0$
5. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:

   (a) $u(x,0) = \phi(x),\ u\ \ (o,t) = a, u\ \ (l,t) = b,\ \ 0 < x < l, t > 0.$

   $u(x,0) = \phi(x),\ x \in R,\ \ 0 < t < T.$

Text Books:

1. Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.
2. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies,Loney Press.

Reference Books:

1. TynMyint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
4. Miller, F. H., Partial Differential Equations, John Wiley and Sons.

CORE - 12: GROUP THEORY - II

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Understand the fundamental concepts of group automorphism and class eqation and apply it to solve order related problem of a group.
ii) Learn about direct product of groups, fundamental theorem of finite abelian groups.
iii) Know about the operation of group actions, Generalized Cayley's theorem of finite abelian group and index theorem.
iv) Learn in detail about Sylow's theorem and can test the non- simplicity of a finite group by using Sylow's theorem.
v) Understand how groups act on themselves by conjugation, conjugacy in S_n and Cauchy's theorem.

UNIT – 1

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

UNIT – 2

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

UNIT – 3

Group actions, stabilizers and kernels, permutation representation associated with a given group action. Applications of group actions. Generalized Cayley's theorem. Index theorem.

UNIT – 4

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

Text Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.

2. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. J.R. Durbin, Modern Algebra, John Wiley & Sons, New York Inc., 2000.
4. D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998
5. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.
6. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

CORE - 13: METRIC SPACES AND COMPLEX ANALYSIS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Learn basic concepts of metric spaces, like open ness, closed-ness, completeness, connectedness, compactness, Bolzano-weirstrass properties.

(ii) Know about homomorphism in a metric space, Banach's fixed point theorem and can apply this theorem to solve partial differential equation.

(iii) Learn about the fundamental concepts like limits, continuity, derivative of a complex function, Cauchy-Reimann equations.

(iv) Understand the notion of analytic function with its various properties.

(v) Know about some important theorem such as Cauchy-Goursat theorem, Liouvilli's theorem, Cauchy's integral formula etc.

(vi) Expand functions in Taylor series or Laurrent series.

UNIT – 1

Metric Spaces: Definition and examples. Open and closed balls, neighbourhood,open set, interior of a set. Limit point of a set, closed set, diameter of a set, subspaces, dense sets, separable spaces.Sequences in metric spaces, Cauchy sequences. Complete metric spaces, Cantor's theorem.

UNIT – 2

Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Connectedness, connected subsets of R.

Compactness: Sequential compactness, Heine-Borel property, totally bounded spaces, finite intersection property, and continuous functions on compact sets.

Homeomorphism. Contraction mappings. Banach fixed point theorem and its application to ordinary differential equation.

UNIT – 3

Limits, limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings.

Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

UNIT – 4

Analytic functions, examples of analytic functions, exponential function, logarithmic function, trigonometric function, derivatives of functions, and definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.

UNIT – 5

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

UNIT – 6

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

Text Books:

1. J. B. Conway, Functions of One Complex Variable
2. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
3. S. C. Malik & Arora, Mathematical Analysis

Reference Books:

1. SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
2. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
4. Joseph Bak and Donald J. Newman, Complex Analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.
5. S. Ponnusamy, Foundations of complex analysis.
6. E.M.Stein and R. Shakrachi, Complex Analysis, Princeton University Press..

CORE - 14: RING THEORY AND LINEAR ALGEBRA - II

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.

(ii) Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.

(iii) Appreciate the significance of unique factorization in rings and integral domains.

(iv) Understand the concepts of Linear functional, Dual spaces, Dual bases, annihilators and their properties.

(v) Compute the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result

(vi) Learn properties of inner product spaces and determine orthogonality in inner product spaces.

(vii) Realise importance of adjoint of a linear transformation and its canonical form.

UNIT – 1

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, and unique factorization in Z [x]. Divisibility in integral domains, irreducible, primes, unique factorization domains, Euclidean domains

UNIT – 2

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

UNIT – 3

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

Text Books:

1. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
2. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
4. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
5. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
6. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
7. S.H. Friedberg, A.L. Insel and L.E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., 2004.

DISCIPLINE SPECIFIC ELECTIVES

DSE1 : A. LINEAR PROGRAMMING & GAME THERORY
CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Analyze and solve linear programming models of real life situations.
(ii) Provide graphical solutions of linear programming problems with two variables and illustrate the concept of convex set and extreme points.
(iii) Understand the theory of the simplex method used to solve linear programming problems.
(iv) Learn about two-phase and big-M methods to deal with problems involving artificial variables.
(v) Know about the relationships between the primal and dual problems, and to understand sensitivity analysis.
(vi) Learn about the applications to transportation, assignment problems.
(vii) Apply linear programming method to solve two-person zero-sum game problems.

UNIT – 1

Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison.

UNIT – 2

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

UNIT – 3

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, and linear programming solution of games.

Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

DSE1 : B. THEORY OF EQUATIONS
CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
ii) Learn Descarte's rule of sign and apply it to demonstrate the roots of the equation.
iii) Find the relation between roots and coefficient of a equation and solve them.
iv) Learn Strum theorem, Newton's theorem and solution of numerical equations.

UNIT – 1

General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

UNIT – 2

Symmetric functions. Applications of symmetric function of the roots. Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

UNIT – 3

Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

UNIT – 4

Separation of the roots of equations, Strums theorem. Applications of Strum's theorem, conditions for reality of the roots of an equation. Solution of numerical equations.

Reference Books:

1. W.S. Burnside and A.W. Panton, The Theory of Equations, Dublin University Press, 1954.
2. C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc., 1954.

DSE2 : A. PROBABILITY & STATISTICS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Learn about probability density and moment generating functions.

(ii) Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions.

(iii) Learn about distributions to study the joint 28olterra28 of two random variables.

(iv) Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.

(v) Understand central limit theorem, which helps to understand the remarkable fact that: the empirical frequencies of so many natural populations, exhibit a bell-shaped curve, i.e., a normal distribution.

(vi) Learn about Random Samples, Sampling Distributions, Parameter and Statistics, estimator, good estimator, Consistent & Unbiased estimates.

(vii) Learn about Testing of hypothesis, Probability of Type – I error, Probability of Type – II error, Best critical Region, Likelihood ratio testing, examples. Chi-square test of goodness of fit.

UNIT – 1

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

UNIT – 2

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient.

UNIT – 3

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. Central limit theorem for independent and identically distributed random variables with finite variance, Markov chains, Chapman-Kolmogorov equations.

UNIT – 4

Random Samples, Sampling Distributions, Parameter and Statistics, estimator, good estimator, Consistent & Unbiased estimates.

Estimation of parameters: Maximum likelihood estimates, confidence interval.

Testing of hypothesis: Problem, different types of hypothesis, formation of the problem – Probability of Type – I error, Probability of Type – II error, Best critical Region, Likelihood ratio testing, examples. Chi-square test of goodness of fit.

Text Books:

1. A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers.

Reference Books:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.

2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007

DSE2 : B. BOOLEAN ALGEBRA AND AUTOMATA THEORY
CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Understand the notion of ordered sets and maps between ordered sets.
(ii) Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices.
(iii) Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications.
(iv) Learn about basics of graph theory, including Eulerian graphs, Hamiltonian graphs.
(v) Learn about the applications of graph theory in the study of shortest path algorithms.

UNIT – 1

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

UNIT – 2

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, Logic gates, switching circuits and applications of switching circuits.

UNIT – 3

Introduction: Alphabets, strings, and languages. Finite automata and regular languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

UNIT – 4

Context free grammars and pushdown automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

UNIT – 5

Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence.

UNIT – 6

Undecidability: Recursively enumerable and recursive languages, undecidable problems about Turing machines: halting problem. Post correspondence problem, and undecidability problems about CFGs.

Reference Books:

1. B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
4. J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages, and Computation, 2nd Ed., Addison-Wesley, 2001.
5. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, Elements of the Theory of Computation, 2nd Ed., Prentice-Hall, NJ, 1997.
6. J.A. Anderson, Automata Theory with Modern Applications, Cambridge University Press, 2006.

DSE3 :A. MECHANICS
CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions.
(ii) Understand the theory behind friction and center of gravity.
(iii) Calculate moments of inertia of areas and rigid bodies.
(iv) Know about conservation of mechanical energy and work-energy equations.
(v) Learn about translational and rotational motion of rigid bodies.

UNIT – 1

Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work. Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium.

UNIT – 2

Simple Harmonic Motion. Velocities and accelerations in Cartesian, Polar and Intrinsic coordinates. Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law. Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution.

UNIT – 3

Degrees of freedom. Moments and products of inertia. Momental Ellipsoid. Principal axes. D'Alembert's Principle. Motion about a fixed axis. Compound pendulum. Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum and energy.

Reference Books:

1. I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.
3. Chorlton, F., Textbook of Dynamics.
4. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies,Loney Press
5. Loney, S. L., Elements of Staticsand Dynamics I and II.
6. Ghosh, M. C, Analytical Statics.
7. Verma, R. S., A Textbook on Statics,Pothishala, 1962.
8. Matiur Rahman, Md., Statics.
9. Ramsey, A. S., Dynamics (Part I).

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DSE3 :B. NUMBER THEORY
CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
(ii) Know about number theoretic functions and modular arithmetic.
(iii) Solve linear, quadratic and system of linear congruence equations.
(iv) Learn about public key crypto systems, in particular, RSA.

UNIT – 1

Linear 31olterra31ne equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linearcongruences, complete set of residues. Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

UNIT – 2

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

UNIT – 3

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation x2 + y2= z2, Fermat's Last theorem.

Reference Books:

1. David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
2. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007

DSE4 :A. MATHEMATICAL MODELLING
CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Know about power series solution of a differential equation and learn about Legendre's and Bessel's equations.
(ii) Use of Laplace transform and inverse transform for solving initial value problems.
(iii) Learn about various models such as Monte Carlo simulation models, queuing models, and linear programming models.
(iv) Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and knight's tour problem.

UNIT – 1

Power series solution of Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order.

UNIT – 2

Monte Carlo simulation modelling: simulating deterministic behavior (area under a curve, volume under a surface), generating random numbers: middle square method, linear congruence, queuing models: harbor system, morning rush hour, Overview of optimization modelling. Linear programming model: geometric solution algebraic solution, simplex method, sensitivity analysis

UNIT – 3

Graphical demonstration as teaching aid (using any software)

1. Plotting of Legendre polynomial for n = 1 to 5 in the interval [0,1]. Verifying graphically that all the roots of $P_n(x)$ lie in the interval [0,1].
2. Automatic computation of coefficients in the series solution near ordinary points.
3. Plotting of the Bessel's function of first kind of order 0 to 3.
4. Automating the Frobenius Series Method.

5. Random number generation and then use it for one of the following (a) Simulate area under a curve (b) Simulate volume under a surface.

Reference Books:

1. TynMyint-U and Lokenath Debnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
2. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modeling, Thomson Learning, London and New York, 2003.

DSE4 :B. BIO- MATHEMATICS
CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Learn the development, analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models.
(ii) Learn about the mathematics behind heartbeat model and nerve impulse transmission model.
(iii) Appreciate the theory of bifurcation and chaos.
(iv) Learn to apply the basic concepts of probability to molecular evolution and genetics.

UNIT – 1

Mathematical biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, bacterial growth in a chemostat, harvesting a single natural population, Prey predator systems and LotkaVolterra equations, populations in competitions, epidemic models (SI, SIR, SIRS, SIC)

UNIT – 2

Activator-inhibitor system, insect outbreak model: Spruce Budworm. Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria. Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario.

Spatial models: One species model with diffusion. Two species model with diffusion, conditions for diffusive instability, spreading colonies of microorganisms, Blood flow in circulatory system, travelling wave solutions, spread of genes in a population.

UNIT – 3

Discrete models: Overview of difference equations, steady state solution and linear stability analysis. Introduction to discrete models, linear models, growth models, decay models, drug delivery problem, discrete prey-predator models, density dependent growth models with harvesting, host-parasitoid systems (Nicholson-Bailey model), numerical solution of the models and its graphical representation. Case studies. Optimal exploitation models, models in genetics, stage structure models, age structure models.

Reference Books:

1. L.E. Keshet, Mathematical Models in Biology, SIAM, 1988.
2. J. D. Murray, Mathematical Biology, Springer, 1993.
3. Y.C. Fung, Biomechanics, Springer-Verlag, 1990.
4. F. Brauer, P.V.D. Driessche and J. Wu, Mathematical Epidemiology, Springer, 2008.
5. M. Kot, Elements of Mathematical Ecology, Cambridge University Press, 2001.

Graphical demonstration as teaching aid (using any software)

1. Growth model (exponential case only).
2. Decay model (exponential case only).
3. Lake pollution model (with constant/seasonal flow and pollution concentration).
4. Case of single cold pill and a course of cold pills.
5. Limited growth of population (with and without harvesting).
6. Predatory-prey model (basic 34olterra model, with density dependence, effect of DDT, two prey one predator).
7. Epidemic model of infuenza (basic epidemic model, contagious for life,disease with carriers).
8. Battle model (basic battle model, jungle warfare, long range weapons).

SKILL ENHANCEMENT COURSE SYLLABUS

SEC1: A. LOGIC AND SETS
CREDIT HOURS – 2 (50 Marks)

Course Outcomes: This course will enable the students to

i) Learn about propositions, truth table and several types of logical operators and to apply it.
ii) Familiarize with propositional equivalence, predicates and quantifiers.
iii) Learn about set theory, its laws and standard set operations and to apply it into real life problems.
iv) Learn about cartesian products of sets, relation, its several types and to apply in various problems.

UNIT - 1

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations.

UNIT - 2

Sets, subsets, set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. classes of sets. Power set of a set.

UNIT - 3

Difference and Symmetric difference of two sets. Set identities, generalized union and intersections. Relation: Product set. Composition of relations, types of relations, partitions, equivalence Relations with example of congruence modulo relation. Partial ordering relations, n- ary relations.

Reference Books:

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

SEC1: B. OBJECT ORIENTED PROGRAMMING IN C++
CREDIT HOURS – 2 (50 Marks)

Course Outcomes: This course will enable the students to

i) Learn and apply the programming concepts and structure of C++ program.
ii) Learn basic C++ operators, arrays and pointers, objects, classes and several types of function and to apply it.
iii) Understand and apply the use of encapsulation, inheritance, polymorphism, and operators overloading.
iv) Learn about template class, copy constructor, subscript and function call operators, namespace and exception handling.

UNIT – 1

Programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++ program, differences between C and C++, basic C++ operators, Comments, working with variables, enumeration, arrays and pointer.

UNIT –2

Objects, classes, constructor and destructors, friend function, inline function, encapsulation, data abstraction, inheritance, polymorphism, dynamic binding, operator overloading, method overloading, overloading arithmetic operator and comparison operators.

UNIT –3

Template class in C++, copy constructor, subscript and function call operator, concept of namespace and exception handling.

Reference Books:

1. A. R. Venugopal, Rajkumar, and T. Ravishanker, Mastering C++, TMH, 1997.
2. S. B. Lippman and J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley, 2000.
3. Bruce Eckel, Thinking in C++, 2nd Ed., President, Mindview Inc., Prentice Hall.
4. D. Parasons, Object Oriented Programming with C++, BPB Publication.
5. BjarneStroustrup, The C++ Programming Language, 3rd Ed., Addison Welsley.
6. E. Balaguruswami, Object Oriented Programming In C++, Tata McGrawHill
7. Herbert Scildt, C++, The Complete Reference, Tata McGrawHill.

SEC2: A. OPERATING SYSTEM: LINUX
CREDIT HOURS – 2 (50 Marks)

Course Outcomes: This course will enable the students to

i) Learn about the operating system Linux, its features, distributions, relation with Unix and understand its installation technique.
ii) Understand and apply the Ext2 and Ext3 file system, user management, to learn about managing users.

iii) Learn about resource management and apply in several systems.

UNIT – 1

Linux – The operating system: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, overview of Linux architecture, installation, start up scripts, system processes (an overview), Linux security.

UNIT - 2

The Ext2 and Ext3 file systems: General characteristics of the Ext3 file system, file permissions. User management: types of users, the powers of root, managing users (adding and deleting): using the command line and GUI tools.

UNIT - 3

Resource management in Linux: file and directory management, system calls for files process Management, signals, IPC: Pipes, FIFOs, System V IPC, message queues, system calls for processes, memory management, library and system calls for memory.

Reference Books:

1. Arnold Robbins, Linux Programming by Examples The Fundamentals, 2nd Ed., PearsonEducation, 2008.
2. Cox K, Red Hat Linux Administrator's Guide, PHI, 2009.
3. R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.
4. Sumitabha Das, UNIX Concepts and Applications, 4th Ed., TMH, 2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, 6th Ed.,O'Reilly Media, 2009.
6. Neil Matthew, Richard Stones, Alan Cox, Beginning Linux Programming, 3rd Ed., 2004.

SEC2: B. GRAPH THEORY
CREDIT HOURS – 2 (50 Marks)

Course Outcomes: This course will enable the students to

i) Appreciate the definition and basics of graphs along with types and their examples.
ii) Understand the definition of a tree and learn its applications to fundamental circuits.
iii) Learn about the matrix representation of a graph and apply it into the shortest path problems and to understand various algorithms.

UNIT - 1

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs isomorphism of graphs.

UNIT - 2

Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles,theorems

Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,

UNIT - 3

Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm

Reference Books:

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge UniversityPress, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2ndEdition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts inMathematics, Springer (SIE), Indian reprint, 2004.

SEC2: C. INTRODUCTION TO FUZZY SETS
CREDIT HOURS – 2 (50 Marks)

Course Outcomes: This course will enable the students to

i) Learn about the basic concept of fuzzy set and its properties.
ii) Understand several operations on fuzzy sets, decomposition of fuzzy sets and degree of subset hood.
iii) Learn about the product of fuzzy set, power of a fuzzy set.
iv) Understand general properties on fuzzy sets.
v) Learn basic definition of level set, type of fuzzy set and algebraic products and to know the extension principle.
vi) Familiarize with fuzzy relation and fuzzy graphs.

UNIT - 1

Idea of fuzzy set and membership function, Definition of a fuzzy set, membership function, representation of membership function, general definitions and properties of fuzzy sets, support, height of fuzzy sets, equality of two fuzzy sets, containment, examples.

UNIT - 2

Union and intersection of two fuzzy sets, Complement of a fuzzy set, normal fuzzy set, alpha-cut of a fuzzy set, strong alpha cut, convex fuzzy seta necessary and sufficient condition of convexity of a fuzzy set, Decomposition of fuzzy sets, Degree of subset hood, Level set of a fuzzy set, Cardinality, fuzzy cardinality, examples.

UNIT - 3

Other important operations on fuzzy sets, product of two fuzzy sets, product of a fuzzy set with a crisp number, Power of a fuzzy set, Difference of two fuzzy sets, Disjunctive sum of two fuzzy sets, examples.

UNIT - 4

General properties of operations on fuzzy sets, Commutativity, Associativity, Distributivity, Idempotent law, Identities for operations, Transitivity, involution, De'Morgans laws, proofs and examples, Some important theorems on fuzzy sets, set inclusion of fuzzy sets and corresponding alpha cuts and strong alpha cuts.

UNIT - 5

Fuzzy sets - Basic definition a level set. Convex fuzzy sets. Baic operations Fuzzy sets. Type of Fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference t-norms and t-conorms. The extension Principle- The Zadeh's extension principle image and inverse image of Fuzzy arithmetic.

UNIT - 6

Fuzzy Relation and Fuzzy Graphs-Fuzzy equivalence equations. Fuzzy graphs, Similarity relation.

Reference Books:

1. U. Z. Zimmermann ,Fuzzy set theory and its application,Allied publisher,New Delhi (1991)
2. G J Klir& Bo Yuan, Fuzzy set and fuzzy logic, Prentice Hall of India Ltd. New Delhi (1995)

GENERIC ELECTIVE SUBJECTS

GE 1: CALCULUS & GEOMETRY

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) State and prove Leibnitz rule and apply it to find higher order derivatives and can solve various type of problems.
ii) Calculate Envelope, asymptotes, Curvature of standard curves if exists and interpret point of inflexion.
iii) Apply L'Hospital rule to find limit of functions.
iv) Sketch curves in Cartesian and polar co-ordinate systems and classify the conics and conicoids using some standard methods and explain the properties of three dimensional shapes.
v) Derive reduction formula and apply it in different situations.
vi) Calculate arc length of a curve, area under curve, area and volume of surface of revolution.

UNIT – 1

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of 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, envelopes, asymptotes, Curvature, curve tracing in cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences.

UNIT –2

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sec^n x\,dx$, $\int (\log x)^n\,dx$, $\int \sin^n x \sin^m x\,dx$, parametric equations, parameterizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.

UNIT – 3

Pole and polar. Diameters and Conjugate diameters. System of conics, Polar equation of a conic referred to a focus as pole. Equations of tangent, normal, chord of contact. Rotation of axes and second degree equations, classification of conics using the discriminant.

Sphere: General equation, Great circle, Sphere through the intersection of two spheres. Radical plane, Tangent, Normal. Cone: Right Circular Cone, General

homogeneous second degree equation. Section of a cone by a plane as a conic and as pair of lines, Condition for three perpendicular generators, Reciprocal Cone. Cylinder: Generators parallel to either the axes, general form of equation, Right circular cylinder. Ellipsoid, Hyperboloid, Paraboloid (Cannonical equations only).

Text Books:

1. G.B. Thomas and R.L. Finney, Tomas Calculus, 9th Ed., Pearson Education, Delhi, 2012
2. S. L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London

Reference Books:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
2. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
3. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
4. T. Apostol, Calculus, Volumes I and II.

GE 2: ALGEBRA - I

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
ii) familiarize with inequality involving A.M.> G.M.> H.M., Cauchy-Schwarz's inequality etc.
iii) employ De-Moivre's theorem in a number of applications to solve numerical problems.
iv) recognize consistent and inconsistent system of linear equations by the row echelon form of the augmented matrix, using rank.
v) understand the concepts of vector space, subspaces, bases, dimension and their properties.
vi) Findeigen values and corresponding eigen vectors for a square matrix.
vii) relate matrices and linear transformations.

UNIT – 1

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.Theory of equations: Relation between roots and coefficients, transformation of equation, Descartes rule of signs, cubic and biquadratic equation.

Inequality: The inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality.

UNIT –2

Properties of Determinant, Inverse of a matrix, characterizations of invertible matrices, System of linear equations: row reduction and echelon forms, rank of a matrix, the matrix equation Ax = b, solution sets of linear systems, applications of linear systems.

UNIT –3

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Introduction to linear transformations, matrix of a linear transformation, Eigen values, eigen vectors and characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

Text Books:

1. Higher Algebra (Classical , Abstract & Linear) – S. K. Mapa

Reference Books

1. TituAndreescu and DorinAndrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
4. K.B. Dutta, Matrix and linear algebra.
5. K. Hoffman, R. Kunze, Linear algebra.
6. W.S. Burnstine and A.W. Panton, Theory of equations.

GE 3: DIFFERENTIAL EQUATIONS & VECTOR CALCULUS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Understand the genesis of ordinary differential equations and Picard's theorem and learn various techniques of getting exact solutions of solvable first order ODE and grasp concept of general, particular and singular solution.

ii) Learn various techniques of getting general solution of homogeneous equation of second order, linear homogeneous and non-homogeneous equation of higher order with constant coefficients.

iii) Learn about systems of linear differential equation with constant coefficients of various types and solving various types of method.

iv) Calculate triple product and test the continuity of vector function, differentiation and integration of vector functions.

UNIT - 1

Picard's existence & uniqueness theorem (Statement only). 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 equation and Bernoulli equations, special integrating factors and transformations.

UNIT – 2

Lipschitz condition (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

UNIT – 3

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients,

Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

UNIT - 4

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions.

Text Books:

1. Differential Equation – S.L. Ross (John Wiley and Sons, India).
2. Differential Equations - Maity,K.C. and Ghosh, R.K (New Central Book Agency (P) Ltd.)
3. Schaum's outline of Vector Analysis- M.R. Speigel.

Reference Books:

1. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
2. Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
3. Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, Wiley.
4. Marsden, J., and Tromba, Vector Calculus, McGraw Hill.
5. Maity,K.C. and Ghosh, R.K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).

GE 4: PDE & NUMERICAL METHODS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

(i) Understand the basic concept of PDE, classify the first order PDE.

(ii) Apply the various types of method to solve first order PDE.

(iii) Derive the heat conduction, wave equation and Laplace equation, classify the 2^{nd} order equations, and reduce the 2^{nd} order PDE to canonical forms.

(iv) Obtain numerical solutions of algebraic and transcendental equations.

(v) Find numerical solutions of system of linear equations and check the accuracy of the solutions.

(vi) Learn about various interpolating methods, the formulas of numerical differentiation and solve initial value problems in differential equations using numerical methods.

UNIT – 1

Partial differential equations – Basic concepts and definitions. Mathematical problems. First-order equations: classification, construction and geometrical interpretation. Method of characteristics for obtaining general solution of quasi linear equations. Canonical forms of first-

order linear equations. Method of separation of variables for solving first order partial differential equations.

UNIT – 2
Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms.

UNIT – 3
Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.
Transcendental and polynomial equations: Bisection method, Secant method, Regula-falsi method, Fixed point iteration, Newton-Raphson method.

UNIT – 4
System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method.

UNIT – 5
Interpolation: Lagrange and Newton's methods.

UNIT – 6
Numerical Integration: Trapezoidal rule, Simpson's 1/3rd rule.

UNIT – 7
Ordinary differential equations: Euler's method, Runge-Kutta method of orders two.

Text Books:

1. Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
3. S. S. Sastry, Introductory methods of Numerical Analysis, 5th Edition, PHI, 2012.

Reference Books:

1. TynMyint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
2. Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
3. Miller, F. H., Partial Differential Equations, John Wiley and Sons.
4. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
5. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
6. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

7. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

GE 5: REAL ANALYSIS

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) The set of real numbers is an ordered field with supremum property.
ii) The set R of real numbers possesses the Archimedian property which will be required to examine the convergence of a sequence and series in next unit.
iii) The concept of neighbourhood of a point in R, open-ness, closed-ness, of a subset of R, Limit point of a set and its various properties and to prove Bolzano – Weirstrass theorem along with its application.
iv) Notion of countability along with countability of Q and uncountability of R.
v) Compactness of a set in R along with Heine – Boral theorem.
vi) Assimilate the notions of limit of a sequence and convergence of a series of real numbers.
vii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequence and to calculate their limit superior, limit inferior and the limit of a bounded sequence.
viii) Apply the ratio, root, alternating series and limit comparison testes for convergence and absolute convergence of an infinite series of real numbers.

UNIT – 1

Review of algebraic and order properties of R, ε-neighborhood of a point in R. Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima. Completeness property of R and its equivalent properties. The Archimedean property, density of rational (and irrational) numbers in R, intervals. Limit points of a set, isolated points, open set, closed set, derived set, illustrations of Bolzano-Weierstrass theorem for sets, compact sets in R, Heine-Borel Theorem.

UNIT –2

Sequences, bounded sequence, convergent sequence, limit of a sequence, liminf, lim sup. Limit theorems. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only), Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion.

UNIT –3

Infinite series, convergence and divergence of infinite series, Cauchy criterion, tests for convergence: comparison test, limit comparison test, D'Alembert's ratio test, Raabe's test, Guass' test, Logarithmic test, Cauchy's nth root test, integral test. Alternating series, Leibnitz test. Absolute and conditional convergence.

Text Books:

1. Mathematical Analysis – S.C. Malik and Sabita Arora.
2. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. S. Goldberg, Calculus and mathematical analysis

Reference Books:

1. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones& Bartlett, 2010.
2. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis,Prentice Hall, 2001.
3. S.K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
4. T. Apostol, Mathematical Analysis, Narosa Publishing House
5. Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
6. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill

GE 6: ALGEBRA - II

CREDIT HOURS – 6 (75 Marks)

Course Outcomes: This course will enable the students to

i) Recognize the mathematical objects called groups.
ii) Link the fundamental concepts of groups and symmetries of geometrical objects.
iii) Explain the significance of notions of Cosets, normal subgroups, and factor groups.
iv) Analyze consequences of Lagrange's theorem.
v) Understand the concepts of ring, integral domain, field and their inter relationship.
vi) Recognize different kinds of ideal such as prime ideal, maximal ideal, principal ideal.

UNIT – 1

Symmetries of a square, dihedral groups, definition andexamples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

UNIT – 2

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

UNIT – 3

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

UNIT – 4

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

Text Books:

1. Higher Algebra – S. K. Mapa.

Reference Books:

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

2. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
3. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
4. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.