COURSES OF STUDIES

5-Year integrated M. Sc. (Mathematics)

DEPARTMENT OF MATHEMATICS
VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
BURLA, SAMBALPUR - 768 018
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Course Structure of 5-Year Integrated M.Sc (Mathematics)

First Semester

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
3	MAT-111	Mathematics-I	3-1-0	4
2	CH-111	Cemistry-I	3-1-0	4
2	PH-111	Physics-I	3-1-0	4
4	BIO-111	Biology-I	3-1-0	4
5	HS-111	English-I	3-1-0	4
6	CH-112	Chemistry Lab-I	0-0-3	2
7	PH-112	Physics Lab-I	0-0-3	2
8	HS-112	Language Lab-I	0-0-3	2
9	MAT-112	Mathematics Lab-I (Basic Programming)	0-0-3	2
			Total Credits	28

Second Semester

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
1	MAT-121	Mathematics-II	3-1-0	4
2	PH-121	Physics-II	3-1-0	4
3	CH-121	Chemistry-II	3-1-0	4
4	BIO-121	Biology-II	3-1-0	4
5	CS-121	Computer Science	3-1-0	4
6	CH-122	Chemistry Lab- II	0-0-3	2
7	PH-122	Physics Lab-II	0-0-3	2
8	CS-122	Computing Lab-I	0-0-3	2
9	HS-122	Language Lab-II	0-0-3	2
			Total Credits	28

Third Semester

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
1	MAT-211	Mathematics-III	3-1-0	4
2	CH-212	Environmental Science	3-1-0	4
3	HS-211	Organizational Behavior	3-1-0	4
4	PH-211	Physics-III	3-1-0	4
5	CH-211	Chemistry-III (Basic Physical -I)	3-1-0	4
6	CH-213	Environmental Science Lab-I	0-0-3	2
7	CH-213	Organic Chemistry Lab – I	0-0-3	2
8	PH-212	Physics Lab-III	0-0-3	2
9	CS-211	Computing Lab-II	0-0-3	2
			Total Credits	28

Fourth Semester

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
1	MAT-221	Mathematics-IV	3-1-0	4
2	HS-223	Economics & Costing	3-1-0	4
3	PH-221	Physics-IV	3-1-0	4
4	CH-221	Chemistry-IV	3-1-0	4
5	CH-222	Basic inorganic Chemistry-II	3-1-0	4
6	CH-223	Physical Chem Lab-I	0-0-3	2
7	CH-224	Instrumentation Lab	0-0-3	2

8	PH-222	Physics Lab-IV	0-0-3	2
9	MAT-222	Mathematics Lab-II	0-0-3	2

Total Credits 28

Fifth Semester

1	MAT-511	Introduction to Probability & Statistics	3-1-0	4
2	MAT-512	Introduction to Mathematical Methods	3-1-0	4
3	MAT-513	Hydrodynamics	3-1-0	4
4	MAT-514	Elementary Combinatorics	3-1-0	4
5	MAT-515	Solid Geometry	3-1-0	4
6	MAT-516	Comprehensive Viva	0-0-3	4

Total Credits 24

Sixth Semester

1	MAT-611	Elementary Number Theory	3-1-0	4
2	MAT-612	Fourier Series and PDE	3-1-0	4
3	MAT-613	Introduction to Complex Analysis	3-1-0	4
4	MAT-614	Introduction to Linear Programming	3-1-0	4
5	MAT-615	Elementary Differential Geometry	3-1-0	4
6	MAT-616	Project	0-0-3	2
		Comprehensive Viva		2

Total Credits 24

Seventh Semester

1	BSM-511	Real Analysis	4-0-0	4
2	BSM-512	Complex Analysis	4-0-0	4
3	BSM-513	Modern Algebra	4-0-0	4
4	BSM-514	Probability	4-0-0	4
5	BSM-515	Programming in C	4-0-0	4
6	BSM-516	Programming Lab & Viva	0-0-3	4

Total Credits 24

Eighth Semester

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
1	BSM-521	Measure Theory and Integration	4-0-0	4
2	BSM-522	ODE	4-0-0	4
3	BSM-523	Statistical Method	4-0-0	4
4	BSM-524	Mathematical Modelling	4-0-0	4
5	BSM-525	Numerical Analysis	4-0-0	4
6	BSM-526	Practical & Viva	0-0-3	4

Total Credits 24

Ninth Semester

1	BSM-531	Linear Programming	4-0-0	4
2	BSM-532	Discrete Mathematical Structure	4-0-0	4
3	BSM-533	Functional Analysis	4-0-0	4

4	BSM-534	Partial Differential Equation	4-0-0	4
5	BSM-535	Linear Algebra		4
6	BSM-536	Project Stage –I & Viva		4+4 =8
		Total Credits		28

Tenth Semester

1	BSM-541	General Topology	4-0-0	4
2	BSM-542	Mathematical Methods	4-0-0	4
3	BSM-54E*	Three Electives from Schedule -A		4 x 3 =12
4	BSM-544	Project Stage– II & Viva voce	0-0-3	4 + 4= 8
		Total Credits		28

List of Elective Courses(Theory) for 9th and 10th Semesters

Sl. No.	Course Code	Name of the Course	L-T-P	Credits
1	BSM-545	Advanced Complex analysis	4-0-0	4
2	BSM-546	Analytic Number Theory	4-0-0	4
3	BSM-547	Algebraic number Theory	4-0-0	4
4	BSM-548	Algebraic Topology	4-0-0	4
5	BSM-549	Combinatorics	4-0-0	4
6	BSM-550	Cosmology	4-0-0	4
7	BSM-551	Discrete Dynamical Systems	4-0-0	4
8	BSM-552	Gravitation	4-0-0	4
9	BSM-553	Geometrical Methods in Physics	4-0-0	4
10	BSM-554	Lie Groups and Lie Algebras	4-0-0	4
11	BSM-555	Mechanics	4-0-0	4
12	BSM-556	Operator Theory	4-0-0	4
13	BSM-557	Operation research	4-0-0	4
14	BSM-558	Quantum Mechanics in Hilbert space	4-0-0	4
15	BSM-559	Relativity	4-0-0	4
16	BSM-560	Several Complex Variable	4-0-0	4
17	BSM-561	Stochastic Process	4-0-0	4
18	BSM-562	Wavelet	4-0-0	4
19	BSM-563	Graph Theory	4-0-0	4
20	BSM-564	Applied Fluid dynamics	4-0-0	4

VISION

The department of Mathematics VSSUT since its inception has strived to be a center of excellence in Mathematics. It is vigorously engaged in teaching and research.

MISSION

- To transform young people to competent and motivated professionals.
- To produce PG students with strong foundation to join research or serve in academics.
- To cater to the development of nation particularly in Odisha for research and training.

Programme Educational Objectives (PEO)

- P1: VSSUT Department of Mathematics provides a post graduate course, suitable for students of high ability, combining and relating mathematics, science and technology.
- P2: VSSUT Department of Mathematics prepares students for further study, and research particularly in areas requiring the application of mathematics.
- P3: VSSUT Department of Mathematics provides students with a knowledge of mathematics, its research poential and the interaction between the two.

Programme Outcomes (PO)

The Program Outcomes of Integrated M.Sc. in Mathematics are:

At the end of the programme, the students will be able to:

- Apply knowledge of Mathematics in different field of science and technology.
- To formulate and develop mathematical arguments.
- To acquire knowledge and understanding in advanced areas of mathematics, chosen by the student from the courses.
- Understand, formulate and use mathematical models arising in science, technology and other areas.

Detailed Syllabus

MA-111   Mathematics I (Algebra)   4 Credits [3-1-0]

Module – I
Matrices, Matrix associated with a linear map and linear maps associated with a matrix. Matrix multiplication, rank and nullity of matrix, transpose of a matrix, Elementary row operations, systems of linear equations, Inverse of a matrix, Product of determinants, Application to linear equations, Eigenvalues and eigenvectors
Module-II
Vector Space, Definition and examples, Subspaces, Span of a set, Linear dependence and independence, Dimension and basis.
 Linear Transformations, Range and kernel, Rank nullity, Inverse of linear transformation, Consequences of rank nullity theorem, Composition of linear maps
.*Module – III*
Integers, Definition of groups with examples, subgroups. Normal subgroups, quotient groups
Module – IV
Homomorphism, Definition and examples of rings, Field, Integral domain, Ring homomorphism.
Text Book:
  1. An Introduction to linear Algebra, V Krishna Murty & V.P. Mainra, J.L. Arora (EWP),East West press Pvt. Ltd.

  2. Topics in Algebra, I.N. Herstein, John Wiley & Sons, Inc.

COURSE OUTCOMES:

  • Demonstrate a working knowledge of mathematical applications of eigenvalues and eigenvectors in a variety of applied fields.
  • Demonstrate a working knowledge of fundamental algebraic structures (e.g., groups, rings, and fields).

  • Use of Linear Transformations in a different areas of Mathematics..

MAT-112   Mathematics LAB- I   2 Credits [0-0-3]

Problem to be handled from the following topic using C
  1. Algebraic operation on Matrices

  2. Determinant of a Matrix. Transpose of a matrix, matrix inversion

  3. Row echelon form, reducing a matrix to row echelon form, Finding inverse of a matrix using row echelon form

  4. Solving system of equation

  5. Finding eigenvalues and eigenvectors of a matrix. Diagonalization of a matrix

Text Book

1. E. Balguruswamy, Programming in C

2. Introduction to Matlab

COURSE OUTCOMES:

- Demonstrate eigenvalues and eigenvectors using C Programming.

- Use of C Programming to solve different matrix operations...

SEMESTER-II

MAT-121   Mathematics-II (Analysis-I)   4 Credits [3-1-0]

Module-I
Algebra of real numbers, Order, Completeness, Density, Decimal representation of real numbers, One to One correspondence of sets, Cardinality, Countability, Countability of Q, Uncountability of R, Convergence of sequences, Limits of sequences, Limit theorems, Wierstrass completeness principle, Cantor's completeness principle (statement only).

Module-II
Convergence of series, Series with positive terms, Open sets, Closed sets, Limit points of sets, Bolzano-Wierstrass theorem, Continuity, Properties of continuous functions.

Module – III
Differentiability, Mean value theorems, Taylor's theorem and its application.

Module – IV
Riemann integration, Fundamental theorem of calculus, Improper integral.

Text Book
1. Fundamental of Mathematical Analysis by G.Das & S.Pattnaik. TMH Publishing Co.

2. Mathematical Analysis by S.C. Mallik and S, Arora

COURSE OUTCOMES:

- Demonstrate a working knowledge of analysis and applications in a variety of applied fields.

- Demonstrate a working knowledge of Taylor's theorem and its application

- Able to use Riemann integration.

MAT-211   Mathemetics-III (ODE and Analysis II)   4 Credits [3-1-0]

Module –I
Ordinary differential equation of first order and first degree, Exact equations, Integrating factors, Equation reducible to linear form, First order equations of higher degree, Homogeneous equations Clairaut's and Lagrange's equation.

Module – II
Second order linear equations with constant coefficients and with variable coefficients, second order ordinary differential equation. Euler-Cauchy equation, Method of undetermined coefficients, Method of variation of parameters.

Module – III
Functions of several variables, Limit, Continuity, Partial derivatives, Mean value theorem, Differentiabillity, Partial derivatives of higher order, Young's theorem (statement only), Schwartz theorem (statement only), Derivatives of higher order, Composite functions, Change of variables, Taylor's theorem, Maclaurin's theorem, Extremum values.

Module – IV
Implicit Functions, Derivative of impllicit functions, Jacobians, Stationary values under subsidiary conditions, Lagrange's multipliers, Improper integrals, Gamma, Beta functions , Differential operators, Integral theorems: Line, Surface and volume integrals, Gauss, Stokes and Green's theorem (without proof) with applications.

Text Book:
  1. A course on ordinary and partial differential Equation with Application-J. Sinha Roy & S Padhy (Kalyani Publishers)

  2. Mathematical Analysis by S.C. Mallik and S, Arora

COURSE OUTCOMES:

 * Able to use modelling of physical system using differential equation.

 * Demonstrate a working knowledge of Functions of several variables and

   applications

 * Apply differential equation in many real life problems of physical interest.

MAT-221   Mathematics-IV (BASIC Numerical Analysis– I) 4 Credits [3-1-0]

Module – I
Computer representation of Numbers, Definition and sources of error, Propagation of errors, Errors in summation. Bisection method, Newton's method, Secant method, fixed point iteration method, Roots of polynomials, System of nonlinear equations.

Module – II
Polynomial Interpolation, Newton's divided differences, Forward differences, Backward differences, Central differences, Interpolation formulas using divided difference, forward difference, backward difference, Interpolation error. Numerical intgration: Trapezoidal rule, Simpson's rule, Newton-Cotes Integration formulas, Gaussian quadrature, Errors in Numerical Integration.

Module – III
Existence and Uniqueness of solution of ODE, Euler's method, Midpoint method, Trapezoidal method, Runge-Kutta Methods. LPP- Mathematical formulations, graphical solutions

Module-IV
General LPP, Canonical and standard forms. Simplex method: Introduction, Simplex algorithm, Use of artificial variables, Big-M method or method of penalties, Solution of simultaneous equation using simplex method.
Text Book:
1.   An introduction to numerical analsysis, Kendall E. Atkinson, John Wiley & Sons, Inc.

2.   Operations Research - Kanti Swarup, P.K Gupta & Man Mohan (Sultan Chand & Sons)

COURSE OUTCOMES:

- Able to solve non-linear equations using different numerical methods.

- Demonstrate a working knowledge of Interpolation .
- Use of Solution of simultaneous equation using simplex method.

MAT 222 (Math Lab – II)   2 Credits [0-0-3]

1. Number representation and errors in computation: Representation of integers and fractions, floating point arithmetics, source of errors, loss of significance, error propagation, computation of error estimation.

2. Solution of non-linear equations: Bisection method, secant method, Newton's method, Muller's method (Using Matlab)

3. Interpolations: Polynomial interpolation, Newton divided difference, cubic spline interpolation(Using Matlab).

4. Numerical integration and differentiation: Trapezoidal, Simpson's and Newton-Cotes rule, Guassian quadrature (Using Matlab).

6. Numerical solution of ODE: Euler's method, Runge-Kutta methods, multistep formulas(Using Matlab)

References:

1. Kendell A. Atkinson: An introduction to numerical analysis. John Wiley and Sons.

2. S.D. Conte, C. De Boor: Elementary Numerical Analysis: An Algorithmic Approach. Tata McGraw-Hill.

3. W.H. Press et. al.: Numerical Recipes: The Art of Scientific Computing. Cambridge University press.

COURSE OUTCOMES:

- Demonstrate different numerical methods using C Programming.

- Use of C Programming to solve interpolation problems..

SEMESTER-V

MAT 511 Introduction to Probability & Statistics   4 Credits [3-1-0]

Unit- I
Introduction to probability, random variables, probability distributions, moments, moment generating function, special discrete and continuous distributions
Unit II
Function of a random variable, joint distributions, bivariate normal distribution, transformation of random vectors, central limit theorem, sampling distributions.
Unit III
Method of moments and maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems from normal populations
Unit-IV
Testing of hypotheses, tests for one sample and two sample problems for normal populations.

Books recommended :

1. S. Milton and J.C. Arnold, *Introduction to Probability and Statistics,* McGraw Hill, 1990.
2. S. M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, Academic Press, 2009.

3. S.C.Gupta,V. Kapoor, Statistical Method, Sultan Chand Co. Publisher

COURSE OUTCOMES:

- Demonstrate a working knowledge of probability theory and random variables.
- Use probability and statistical inferences to draw conclusions.

MAT 512   Introduction to Mathematical Methods   4 Credits [3-1-0]

Unit- I
Fourier Series: Expansion of a function in Fourier series for a given range, Fourier series for arbitrary period, Fourier series of Even and odd functions.

Unit- II
Laplace Transform: Laplace Transform, Inverse transform, Shifting, Transforms of derivatives and integrals, Solution of differential equation, convolution, Integral equation

Unit- III
Integral Equations: Classification of Integral equations, Neumann's iterative method for Fredholm's equation of second kind, Volterra type integral equation, Integral equations of first kind.

Unit- IV
Calculus of Variations: Functionals, Variation of functionals, Example of variation problems, Euler's equation, sufficient conditions for the extremum of a functional.
Books recommended :

1. E. Kreyszig, *Advanced Engineering Mathematics*, 9th Edition, John Wiley and Sons.
2. I. M. Gelfand and S. V. Fomin, *Calculus of Variations*, Dover Publications, 1991.
3. I.N. Sneddon, *The Use of Integral Transforms,* Tata McGraw Hill, 1972.

COURSE OUTCOMES:

- Demonstrate a working knowledge of different mathematical methods and applications in a variety of applied fields.
- Able to solve integral equations.

MAT 513 Hydrodynamics   4 Credits [3-1-0]

Unit- I
Lagrangian and Eulerian methods, Equation of continuity, Boundary surfaces, Stream Line, Path lines and streak lines, Velocity potential, Irrotational and rotational motions, Lagrange's and Euler's equations of motion
Unit- II

Pressure equation, Bernoulli's theorem. Impulsive actions. Flow and circulation. Permanence of irrotational motion. Stream function. Irrotational motion in two-dimensions. Complex velocity potential. Sources and Sinks

Unit- III

Two-dimensional irrotational motion produced by motion of circular and elliptic cylinders in a liquid, Kinetic energy of liquid.

Unit- IV

Theorem of Blasius, Stoke's stream function, Vortex motion, Vortex lines, Motion due to circular and rectilinear vortices.

Books recommended :

1.   W.H. Besaint and A.S. Ramsey: A Treatise on Hydrodynamics, Part II, C.B.S. Publishers, Delhi, 1988.

2. M D Raisinghania, Fluid dynamics with complete hydrodynamics and Boundary layer Theory, S Chand Co Publisher, 2014

2.   B.G. Verma: Hydrodynamics, Pragati Prakashan, Meerut, 1995.

COURSE OUTCOMES:

- Able to work with different fluid flow problems.

- Use of stream function, Vortex motion and Motion due to circular and rectilinear vortices..

MAT 514   Elementary Combinatorics   4 Credits [3-1-0]

Unit- I

Principle of counting-I: The rules of sum and product, permutations, combinations, binomial & multinomial theorems, Catalan numbers,Ramsay numbers, Stirling numbers and Bell numbers.

Unit- II

Principle of counting-II: The pigeonhole principle, the principle of inclusion and exclusion, Derangements, Rook polynomials.

Unit- III

Generating functions: Ordinary generating functions, convolution of sequences, a counting technique, partitions of integers, exponential generating function.

Unit- IV

Recurrence relations: First order relations, second & higher order linear homogeneous relations, linear non-homogeneous relations of second & higher orders , method of generating functions.

Books recommended :

1. V. K. Balakrishnan, *Theory and Problems of Combinatorics*, McGraw Hill, 1994

2. J. H. Van Lint and R.M. Wilson, *A Course in Combinatorics*, Cambridge University Press, 2001
3. C.L.Liu, Discrete Mathematics

COURSE OUTCOMES:

- Demonstrate a working knowledge of Recurrence relations and Generating functions in different applied fields.

- Use of pigeonhole principle in different problems of interest.

MAT 515   Solid Geometry   4 Credits [3-1-0]

Unit-I
Introduction to coordinates, Distance between two points, Section formula, Position vectors, Unit vectors i, j, k, Direction cosines of a line, Direction ratios, Projection of a straight line on another, Length of the projection, Angle between two lines, Projection of a plane area.

Unit-II
Intercept form of a plane, Normal form of a plane, Angle between two planes, Perpendicular distance of a point from a plane, Plane through the intersection of two planes, Equation of plane through a given point and parallel to two given vectors, Planes through three given point, Equation of lines, lines through two points, Angle between a line and a plane, Coplanar lines.

Unit-III
Magnitude and equation of shortest distance, Intersection of three planes, Volume of the tetrahedron, Equations involving only one variable, Cylinder, Surface, Curve, Locus of the line intersecting two given lines and a given curve, Change of origin.

Unit-IV
Definitions of a sphere, Sphere through four given points, Plane section of a sphere, Intersection of two spheres, Equation of a circle, Intersection of a line and a sphere, Equation of the tangent at a point.

Books recommended :

1. Coordinate Solid Geometry by B.D. Sharma, B.S. Tyagi, and Brahma Nand, Kedar Nath Ram Nath Publisher, Meerut, India.

COURSE OUTCOMES:

- Demonstrate a working knowledge of three dimensional structure and their mathematical forms.

- Use of coordinate in plane, cylinder and sphere.

SEMESTER-VI

MAT 611 Elementary Number Theory 4 Credits [3-1-0]

Unit- I
Divisibility: Division Algorithm, Prime and composite numbers, Fibonacci and Lucas Numbers, Fermat numbers, Greatest common divisors, Euclidean algorithm, Fundamental theorem of arithmetic, Least common multiple, Linear Diophantine equations

Unit- II
Congruences: Linear congruences, Pollard rho factoring methods, Divisibility test, Complete residue systems, System of linear congruences, The Chinese remainder theorem.

Unit- III
Wilson's theorem, Fermat's little theorem, Euler's theorem, Multiplicative functions, Euler's phi function, Tau and sigma functions, Perfect numbers. Mersenne primes, The Mobius function Primitive roots and indices, Order of a positive integer, Primality test

Unit- IV
Cryptology: Affine ciphers, Hill ciphers, Exponentiation ciphers, The RSA cryptosystem, The Knapsack ciphers.

Books recommended:

1. T. Koshy, *Elementary Theory of numbers with Applications*, 2nd Edition, Academic Press, 2007.

COURSE OUTCOMES

Elementary Number Theory is the study of basic structure and properties of integers. Learning number theory helps improving student ability of mathematical thinking. After successful completion of this elementary number theory course will enable a student to

- Number theory is a charming subject of mathematics because of its wealth of easily accessible and fascinating questions and its intellectual appeal.
- This primary coverage of the subject provides the way to further study of more advanced courses.
- Results from number theory have countless applications in Mathematics as well as in practical applications. One of the most common application of number theory is "Cryptography", a study of secret messages.

MAT 612 Fourier Series and PDE   4 Credits [3-1-0]

Unit- I
Fourier Series: Fourier series, convergence of Fourier series, Fourier series of arbitrary period, Half range sine and cosine expansions, applications in engineering.
Unit- II
Fourier integrals: Fourier transform, Inverse Fourier transform, Convolution theorem, Discrete Fourier transform.
Unit- III
Partial Differential Equations: First and second order partial differential equations, Solutions of wave equation.
Unit- IV
Heat equation and Laplace's equation and their use in problems of vibrating string, one dimensional unsteady heat flow and two dimensional steady state heat flow, Modelling Membrane; Two dimensional wave equation; Rectangular membrane.

Books recommended :

1. E. Kreyszig, *Advanced Engineering Mathematics*, 9th Edition, John Wiley and Sons.
2. N. Sneddon, *Elements of Partial Differential Equations*, Dover Publications, 2006.

COURSE OUTCOMES:

- Demonstrate a working knowledge of mathematical applications of Fourier transform, Inverse Fourier transform.
- Use of PDE and applications in solving heat equation and wave equation.

MAT 613 Introduction to Complex Analysis 4 Credits [3-1-0]

Unit- I
Limit, Continuity and Differentiability, Analytic function, Cauchy Riemann equations, Laplace's equation, Conformal mapping.

Unit- II
Linear fractional transformations, Complex integration, Line integral in the complex plane, Cauchy's Integral Theorem, Cauchy's Integral Formula.

Unit- III
Sequences, Series, Convergence tests, Power series, Functions given by power series, Taylor's, Maclaurin's and Laurent's series, Uniform convergence.

Unit- IV
Zeros, Singularities, Poles, Residue theorem, Evaluation of real integrals.

Books recommended:

1. R. V. Churchil and J. W. Brown, Complex *variables and applications*, Tata McGraw Hill,1990.
2. J. B. Conway, *Functions of one complex variable I*, Springer, 1978.

COURSE OUTCOMES:

- Demonstrate mastery of Taylor series and power series.
- Use of Laurent Series, Residues to solve complex and indefinite integrals.

MAT 614 Introduction to Linear Programming   4 Credits [3-1-0]

Unit- I

Basic linear algebra, Lines and hyper planes, convex sets, convex hull, convex polyhedron, convex cone , simplex and convex function and their properties, fundamental theorem.

Unit-II
Formulation of a Linear Programming Problem, Theorems dealing with vertices of feasible regions and optimality, Graphical method, solution procedure, solution of properly behaved LP problems, solution in some exceptional cases, geometrical properties of LP problems.

Unit-III
Geeral formulation of a Linear Programming Problem, classification of LP problems, standard form, matrix form, Assumptions in LP problems, Advantage and disadvantage of LP problems, applications of LP problems

Unit-IV
Introduction to simplex method, fundamental properties of solutions, infeasible and unbounded LPP's, alternate optima, Dual problem and duality theorem, computational procedure of simplex method.

Books recommended :

1. H. A. Taha, *Operations Research : An Introduction,* Pearson Education Limited, 2011.

2. F. S. Hillier and G. J. Lieberman, *Introduction to Operation Research*, Tsinghua University Press, 2006.
3. K. Swarup, P. K. Gupta, Manmohan, *Operations Research*, Sultan Chand & Sons, 1990.

COURSE OUTCOMES:
- Able to indentify the real life problem.
- Able to Select appropriate goal and the value of different variables.

- Formulation of an appropriate model of the problem

MAT 615 Elementary Differential Geometry 4 Credits [3-1-0]

Unit- I
Arc length, Tangent, Normal, Binormal, Tangent and Osculating Plane, Principal Normal and Binormal, Curvature and Torsion, Serret-Frenet formulae.

Unit- II
Curves on a surface, Contact between curves and Surfaces, Osculating Circle and Osculating Sphere, Tangent Surfaces, Intrinsic equation of space curves.

Unit- III
Fundamental existence theorems for space curves, Surface representation, Regular and Singular points, Tangent plane and normal, Surfaces of Revolution, Metric on a Surface.

Unit- IV
Invariance of the metric, Direction coefficients on a Surface, Isometric correspondence, Intrinsic properties, Canonical Geodesic equations, Geodesics on a surface of revolution

Books recommended:

1. C. E .Weatherburn, Differential Geometry, Cambridge Univ. Press
2. D. Somasundaram, *Differential Geometry: A First Course,* Alpha Science International Ltd, 2004.

COURSE OUTCOMES:

- Able to do Surface representation and metric on a surface.

- Use of equations of Contact between curves and Surfaces..

REAL ANALYSIS

Unit-I
Sets, Relation, Function, Axioms for Real numbers, Axioms of Choice and equivalents (without proof), Cardinality, Countability, elements of set theory for metric space and in particular for R^n including Bolzano-Weiestrass and Heine-Borel theorems, sequences and series of real numbers, convergence, Tests of Convergence, Cauchy criterion for convergence.

Unit-II
Real valued function, Properties of real valued continuous function on R^n, Uniform continuity, Sequences and series of functions, Uniform convergence. Power series, Weiestrass approximation theorem.

Unit-III
Differentiation, Reimann-Stieltjes integral of real valued function w.r.t a monotone function & its properties, Linearity, Integration by parts and change of variables, Term by term integration, Differentiation & integration under the integral sign.

Unit-IV
Function of several variables, Differentiability, Inverse function theorem, Implicit function theorem, constrained maxima and minima.

Books Recommended: -
1. Rudin Walter (1976): Principle of Mathematical Analysis, McGraw Hill, Third edition
2. Apostol T.M. (1985): Mathematical Analysis, Narosa Publishing House, and Indian edition.
3. Hewitt and Stromberg: Real and Abstract Analysis.
4. G. Das and S. Pattanayak: Fundamentals of Analysis, TATA Mc Graw Hill.

COURSE OUTCOMES:

- Demonstrate a working knowledge of sequences and series of real numbers and their convergence .

- Demonstrate a working knowledge of real valued function w.r.t a monotone function

- Demonstrate a basic working knowledge of the properties of real numbers and real-valued functions

COMPLEX ANALYSIS

Unit – I
The complex Number system, The spherical representation , Analytic functions , Power Series, Exponential and trigonometric functions.

Conformal mapping, Mobious transformation, Cross-ratio.
Unit –III
Riemann- stieltjes integral, Power Series representation of Analytic functions, The index of a closed curve, Cauchy's theorem for rectangle, Cauchy theorem for disc, Cauchy's integral formula, Liouville's theorem, Fundamental theorem of Algebra, Morera's theorem, Open mapping theorem.
Unit – IV
Zeros, Poles, Classification of Singularities, Laurent Series, Residues, The Argument Principle, Rouche's theorem, The Maximum Modulus theorem, Schwarz's Lemma.

Books for reference

1.	J. B. Conway	Functions of one Complex Variable, Norosa.
2.	Lars, V. Ahlfors	Complex Analysis, Mc Graw Hill.
3.	E. Titchmarsh	Theory of Functions, OXFORD.

COURSE OUTCOMES:

- Demonstrate mastery of the rigorous development and theory of calculus.
- Demonstrate a basic working knowledge of the properties of complex numbers and complex-valued functions.
- Use of Laurent Series, Residues

MODERN ALGEBRA
Unit – I
Review of Group theory: Groups, Subgroups, Normal Subgroups, Quotient groups, homomorphism, Isomorphism, Cyclic groups, Permutation groups, Symmetric groups, Caylay's Theorem.
Unit – II
Direct products, Series of groups, Groups Action on a set, Sylow theorem, Application of Sylow Theorem, Free Abelian groups, Free Groups.
Unit – III
Vector Spaces, Subspaces, Quotient spaces, Linear independence, bases, Dimension, Projection, Algebra of matrices, Rank of a matrix, Characteristic roots and Vectors.
Unit – IV
The Algebra of Linear transformation, Kernel, range, matrix representation of a linear transformation, Change of bases, Linear functionals, Dual space, eigen values, eigen vectors, Cayley-Hamilltorn theorem, Canonical Forms: Diagonal forms, triangular forms, Jordan form, Quadratic form, Inner Product spaces.

Books for reference

1.	I. N. Herstein	Topics in Algebra, Vikas Publilcation.

2.	J. B. Fraleigh	A first course in Algebra, Norosa.
3.	A. Ramachandra Rao and P. Bhimsankaram.	
		Linear Algebra, Tata Mc Graw Hill.
4.	P.P. Halmos	Finite Dimensional Vector Spaces,
5.	Mirsky	Linear Algebra
6.	Hoffman & Kunze	Linear Algebra.
7.	S. Kumaresan	Linear Algebra.

COURSE OUTCOMES:

- Demonstrate a working knowledge of mathematical applications in a variety of applied fields.

- Demonstrate a working knowledge of fundamental algebraic structures (e.g., groups, rings, and fields).

- Demonstrate mastery of the rigorous development and theory of calculus.

PROBABILITY

Unit-I

Sigma-algebra, Measurable spaces and product spaces, measurable transformations, additive set function, Measures and probability spaces, Induced measures and distribution functions and its decomposition.

Unit-II

Poisson theorem, Interchangeable events and their limiting properties, Bernoulli and Borel theorems, Central limit theorem for binomial random variables.

Unit-III

Independence of sequence of events and random variables, Multiplication properties, random allocation of balls into cells Borel Cantelli theorem and characterization of independence.

Tail-sigma field, 0-1 Law of Borel and Kolmogorov, limits of random variables.

Unit-IV

Convergence of random variables, Convergence in probability, almost surely, in the mean and in distribution,Their relationships.

Books for Recommended:-
1. H.G. Tucker(1967) : A graduate course in probability (A.P)
2. Y.S. Chow and H. Teicher(1979) : Probability theory, Springer-Verlag.

COURSE OUTCOMES:

- Demonstrate a working knowledge of probability theory.

- Use probability and statistical inferences to draw conclusions.

PROGRAMMING LANGUAGE –C-

Unit I :

Overview of C: Introduction, importance of C, sample C programs, Basic structure, Programming style, executing a C-programme.

Constants, Variables and data types: Introduction, character set, C-tokens, key words and identifiers, constants, variables, data types, declaration of variables, assigning values to variables, defining symbolic constants.

Operators and Expressions: Introduction, Arithmetic, Relational, Logical, Assignment, Increment and Decrement and Special operators, arithmetic expressions, evaluations of expressions, precedence of arithmetic operators, type conversions in expressions, operator precedence and mathematical functions. Managing input and output operators: Introduction, reading a character, writing a character, formatted input and formatted output.

Unit II :

Decision making and branding: Introduction, Decision making with IF statement, simple IF statement, the IF-ELSE statement, nesting of IF-ELSE statement, the ELSE-IF ladder, the SWITCH statement, the ? operator, GOTO statement. Decision making and Looping: Introduction, the WHILE statement, the DO statement, FOR statements, jumps in loops.

Unit III :

Arrays: Introduction, One dimensional arrays, two dimensional arrays, initializing Two dimensional arrays, Multi dimensional arrays.

User defined functions: Introduction, need for user defined functions, a multi function program, the form of C-functions, Return values and their types, calling a function, category of functions, no arguments and no return values, arguments but no return values, arguments with return values, handling of non-integer functions, nesting of functions,

Recursion, Function with arrays, the scope and life time of variables in functions, ANSI C functions.

Unit IV :

Structures and Unions: Introduction, Structure definition, giving values to members, Structure initialization, comparison of structures, variables, arrays of structures, structures within structures, structures and functions, Unions, size of structures, Bit fields.

Pointers: Introduction, understanding pointers, accessing the address of variables, declaring and initializing pointers, accessing through its pointers, pointer expression, pointer increments and scale factor, pointers and arrays, pointer and character strings, pointer and function, pointer and structures, pointers on pointers.

Unit V :

Dynamic memory allocation and Linked lists: Introduction, Dynamic memory allocation, concepts of linked lists, advantage of linked lists, types of linked lists, pointers revisited, basic test operators, application of linked lists.

The Preprocessors: Introduction, Macro substitution, file inclusion, compiler control directives, ANSI addition.

Text Book:

1. E. Balagurusamy, "Programming in ANSI C', Tata MCGraw Hill, Publishing Company Ltd., (2nd edition), New Delhi.

   3. Chapters 1 to 7, 9, 11 and 14.

COURSE OUTCOMES

- Demonstrate a basic working knowledge of the concepts of numerical analysis through the use of computers.
- Demonstrate a working knowledge of mathematical applications in a variety of applied fields.

PROGRAMMING LABORATORY
The candidates should be able to handle with DOS, MsOffice, and Windows and do the following programmes by a computer in C

1. Application of Euclidian Algorithm to find gcd of two numbers.
2. Generation of Fibonacci sequence using recursion and find the number that are perfect square.
3. Generate a list of primes between 1 and n. Find the twin primes & count no of primes of the form $4n+1$ & $4n-3$.
4. Test the truth of Bertrand conjecture (Bertrand conjecture is that there is at least one prime between n and 2n)
5. Write a program to find all factors of a number.
6. Construct a magic square dimension n x n (n is odd)
7. Draw Pascal's triangle.
8. Write a program to test $\varphi(mn)=\varphi(m)\varphi(n)$.
9. Investigate the average value of $\varphi(n)$ computing $\sum\varphi(d)$

10. Write a program to multiply two numbers having more than 15 digits each.
11. Determination of Roots by:
    a) Bisection Method.
    b) Regula – Falasi Method.
    c) Newton Raphson Method.
12. Interpolations
    a) Lagrange Interpolation.
    b) Newtonian Interpolation.
13. Numerical Integration
    a) Trapezoidal Rule.
    b) Simpson's 1/3 Rule.
    c) Simpson's 3/8 Rule.
14. Numerical solution of Differential Equation
    a) Ranga Kutta Method.
    b) Euler Method.
15. Matrix Inversion
    a) Gauss Elimination Method.
    b) Gauss Seidal Method.
16. Evaluation of limits.
    a) $\lim_{x\to\infty} (1+1/x)$
    b) $\lim_{x\to\infty} n(a^{1/n}-1)$
    c) $\lim_{x\to 0} (1+x)^{1/x}$

    d) $\lim_{x\to 0} (e^x-1)/x$
    e) $\lim_{x\to 0}\{(1+x)^n-1\}/x$

17. Summation of series
    a) $\sum 1/n! = e$ b) Sine series   c) Cosine series
18. Generation of Logarithmic Table
19. Curve tracing.
    Circle, Ellipse, Parabola, Hyperbola, Sine Curve, Cosine Curve, Cissoid, Cardioids ($r = a(1+\cos(\theta))$), Limacon ($r = a + b \cos(\theta)$), Archimedean Spiral ($r = a$), Equiangular Spiral ($r = A e^{m}$) , Lemniscates ($a(x^2+y^2)=(x^2+y^2)^2$) , Folium of Descartes ($x^3+y^3 - 3axy = 0$), Astroid ($x^{2/3}+y^{2/3} = a^{2/3}$)
20. Find Fourier coefficient of different functions and draw the Fourier graphs.

21. Data Handling.
    Sorting : Bubble sort, Quick sort, Merge sort.
    Searching : Linear search, Binary search
23. Generation of random number.
24. Determination of rank of any n x m matrices.

COURSE OUTCOMES:

- Demonstrate a working knowledge of mathematical applications in a variety of applied fields.

- Demonstrate a basic mastery Data Handling

- Demonstrate Curve tracing

MEASURE THEORY AND INTEGRATION

Unit-I

Sigma Algebra of Sets, Borel sets of **R**, Lebesgue outer measure and its properties, Sigma Algebra of Measurable sets in **R** , Non-measurable sets, Measurable sets which is not a Borel set, Lebesgue measure and its properties, Cantor set and its properties,Measurable functions Simple function, Integration of Nonnegative functions, Riemann and Lebesgue Integration ,.

Unit-II

Abstract measure spaces, Extension uniqueness and completion of a measure,Integration with respect to a measure, properties,Monotone convergence theorem, Fatou's Lemma, and Dominated convergence theorem,

Unit-III

Modes of convergence,Point wise convergence and convergence in Measure, convergence diagrams and counter examples,Egorov's theorem,Differentiation of monotone functions, Lebesgue Differentiation theorem, Absolute continuity.

Unit-IV

Complex and signed measure, Hahn decompositions, Jordan decomposition, Radon-Nikodym theorem ,Product measure, Fubini Theorem.

Books Reference:-
1. Measure Theory and Integration   Debarra. G. (New age International)
2. Real Analysis   Royden. H.L.(Pentice Hall of India)
3. Real and Complex Analysis   Rudin W.(Tata McGraw Hill of India)
4. Real & Abstract Analysis   Hewitt& Stromberg (Springer)
5. Measure Theory & Integration   Rana. I.K. (New Age Publication)

COURSE OUTCOMES:

- Use Lebesgue outer measure to draw conclusions.

- Demonstrate a working knowledge of Complex and signed measure and applications in a variety of applied fields.

ORDINARY DIFFERNTIAL EQUATIONS

A) Quick Review of linear differential Equations of Higher Order, Wronskian.

Unit- I

System of Linear Differential Equations: - System of first order equations, Existence and Uniqueness theorems, Fundamental Matrix, Homogeneous

and Non Homogeneous linear systems with constant Co-efficient, Linear system with periodic Co-efficient.

Unit- II

Existence and Uniqueness of Solutions: - Successive approximation Picard's Theorem, Non Uniqueness of solutions, Continuation and dependence on Initial conditions, Existence of solutions in the large, Existence and uniqueness of solution of systems.

Unit- III

Oscillations of second Order Equations :- Fundamental Results, Sturm's Comparison theorem of Hille wiener Oscillations of $x'' + a(t)x = 0$.

Unit- IV

Boundary Value Problems :- Introduction ; Strum Liouville's Problem green's functions, Picard's throrem.

The course is covered by Chapter 2 (Quick Review) 4,5,6,7 of "**Ordinary Differential Equations and stability theory**" by S. G. Deo and V. Raghavendra TATA Mc Graw Hill Ltd.

Books for Reference: -
1. G. Birkhoff & G. C. Rota   Ordinary Differential Equations
                                     John Wiley & Sons, N.Y.
2. Coddington & Levinson   Ordinary Differential Equations
3. Tyn-Myint-U   Ordinary Differential Equations
4. L. Elsgolts   Differential Equations & calculus
                                     of Variation Mir Publication.

COURSE OUTCOMES:
*   Demonstrate a working knowledge of Strum Liouville's Problem.
*   Demonstrate a working knowledge of eigen value and eigen vector problems.
*   Use of Homogeneous and Non Homogeneous linear systems.

STATISTICAL METHOD

Unit-I

Random variable, Expectations, Moment Generating functions, Characteristic functions, Its properties, Statement of inversion theorem, Derivation of Characteristic function for a given distribution function and characteristic function for a given distribution function.

Unit-II

Basic discrete distributions and their properties. Bernoulli, Binomial, Poisson, Negative Binomial, Geometric, Hypergeometric and uniform distributions, Their Characteristic function and moment generating functions, Sampling distribution of sum of observations for discrete distributions.

Unit-III

Continuous distributions: Rectangular, Gamma, Beta, Normal, Cauchy, Exponential Lognormal distributions and their properties.

Unit-IV

Sampling distributions:- Chi-square distribution, t-distribution, F-distributions and their properties, Inter-relationship between three distributions, Basic concept of testing of hypothesis:- Type I and Type-II errors. Power function and power curve. Neyman-Pearson's lemma for simple hypothesis against simple alternate hypothesis, Application of lemma for testing statistical hypothesis, uses of t-statistics, F-statistics and Chi-square statistics.

Books Recommended:-
1. An introduction to probability theory and Mathematical Statistics
   V.K. Rohatgi. Wiley Eastern.
2. Fundamental of Mathematical Statistics:
   S.C. Gupta and V.K. Kapoor.

COURSE OUTCOMES:

- Use probability and statistical inferences to draw conclusions.
- Demonstrate a working knowledge of statistics and applications in a variety of applied fields.
- Demonstrate a working knowledge of Sampling distributions

MATHEMATICAL MODELLING

Unit- I

Need , Techniques , Classification and Characteristics of Mathematical Modelling , Mathematical Modelling Through 1st order ODE , Linear growth and Decay Model, Compartment model, Modelling of Geometrical Problems.

Unit- II

Mathematical Modelling Through system of First order ODE : Modelling on Population Dynamics, Epidemics compartment Models, Modelling in Economics, Medicine, Arms race, Battles and in duration al trades.

Unit- III

Mathematical Modelling through Second Order O. D.E. : Modelling of Planetary motion, circular motion, Motion of satellite.

Books for Reference : -
1.J. N. Kapur   Mathematical Modelling , Welley Eastern Ltd. 1990
2.D. N. Burghes   Modelling through Differential Equations
                                Ellis Horwood & John Wiley.
3.C. Dyson & e. Levery   Principle of Mathematical Modelling
                                Academic Press New York.
4. F. R. Giord ano & M.D. Weir.   First Course in Mathematical Modelling
                                Books Cole California.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Partial differential equation.
- Demonstrate a working knowledge of Modelling of Geometrical Problems.
- Use different ordinary and Partial differential equation in different models.
- Demonstrate a basic working knowledge of the concepts of simulation and modelling.

NUMERICAL ANALYSIS

Unit-I
Number System and Errors: Introduction, Binary Number, Octal Numbers, Hexadecimal number, Floating point representation, Approximation of numbers, Error and Error propagation.
Root finding for non-linear equations: Bisection method, Iteration methods based on first degree equations(Secant method, Regula-Falsi method, Newton Raphson method), Iteration methods based on second degree equation(Muller method, Chebysev method), Rate of convergence , Iteration methods.

Unit-II
Interpolations: Existence and uniqueness of interpolating polynomial, Lagrange and Newton interpolations, Error in interpolation, Finite differences, Interpolating polynomials using finite differences, Hermite interpolation, Piecewise and Spline interpolation.

Unit-III
Differentiation: Methods based on Interpolation, Methods based on Finite Differentials, Methods based on undetermined coefficients, optimum choice of step length, Interpolation method.
Integration: Methods based on Interpolation(Trapezoidal rule , Simpson's rule), Method based on undetermined coefficiencts(Gausses Legendre Integration method, Lobatto integration method , Radon integration method, Gauss-chebysev Integration method(without derivation), Gauss-Laguerre Integration method (without derivation) , Gauss-Hermite Integration methods(without derivation), Composite integration methods, Error estimate.

Unit-IV
Numerical Solution of system of linear equations: Direct methods, Gauss Elimination methods, Gauss-Jordan Elimination method, Triangularization method, Cholesky method, Iteration methods(Jacobi iteration method, Gauss-siedel iteration method, Iterative method for A^{-1}) Eigen value problems(Jacobi method for symmetric matrices) Givens Method for symmetric matrices, Rutishauser method for arbitrary matrices).
Numerical solution of ordinary differential equation: Euler Method, Backward Euler method, Mid-point method, Single Step methods(Tayler series method, Range-kutta method(Second order, Fourth order method)

Books for Reference:-
1 M.K. Jain , S.R.K Iyengar, R.K. Jain: Numerical Methods for Scientific and

Engineering Computation , Willey Eastern Ltd. New Delhi (1995)

Unit-I : Chapt-I 1.3 ; Chapt-II 2.1,2.2,2.3,2.4,2.5,2.6.;
Unit-II: Chapt-IV 4.1,4.2,4.3,4.4,4.5,4.6,4.8,4.9,4.10;
Unit-III: Chapt-V 5.1,5.2,5.3,5.4,5.6,5.7,5.8,5.9;
Unit-IV: Chapt-III- 3.1,3.2,3.4,3.5;Chapt-VI 6.1,6.2,6.3;

COURSE OUTCOMES:

- Demonstrate a working knowledge of numerical Methods based on Interpolation.
- Demonstrate a working knowledge of Boundary value problems.
- Demonstrate a basic working knowledge of the concepts of numerical analysis through the use of computers.

PRACTICALS

FOLLOWING ADVANCE PROGRAMM SHOULD BE DONE IN C

Matrix Algebra:

1. Matrix addition using function or pointer
2. Matrix multiplication using function or pointer
3. Matrix Inverse
4. Solution of System of linear equation by following method
    a. Gauss Elimination Method
    b. Gauss Seidal iteration Method
    c. Gauss Jordan Elimination Method
5. Rank of a matrix
6. Determination of a Matrix
7. Solution of System of linear equation by Cremmers Rule
8. Eigen value and Eigen vector of a matrix

Differential Equation:

9. Solution of Initial value problem using following method and function
    a. Euler's Method
    b. Backward Euler Method
    c. Eulere-Richardson's Method
    d. Second order Ranga-Kutta Method
    e. Milne's predictor corrector Method
    f. Gauss predictor corrector Method
10. Solution of boundary value problem.
11. Solution of parabolic Partial Differential equation by following method
    a. Schmidt Method
    b. Laasonen Method

Graph of curve in C

12. Following curve should be trace using "graphic.h" in C

(i.) Circle (ii.) Elipse   (iii.) Hyperbola   (iv.) Sine Curve (v.) Cosin curve (vi.) Cissoid (vii.) Cardioid ($r = a(1+\cos(\theta))$) (viii.) Limacon ($r= a+b\cos(\theta)$) (xi) Laminscate ($a(x^2+y^2)=(x^2 + y^2)^2$)

Linear Programming Problem:

13.   Solution of LPP by Simplex Method
14.   Solution of LPP by Revise Simplex Method
15.   Transportation Problem
16.   Assignment Problem
17.   Travel Salesman Problem.

COURSE OUTCOMES:

- Demonstrate a working knowledge of Initial value problem.
- Demonstrate a working knowledge of Transportation problems.
- Demonstrate a basic working knowledge of the concepts of numerical analysis through the use of computers.

LINEAR PROGRAMMING

Unit-I
Mathematical formulation of LPP, Simplex Method, Solution of Simultaneous linear equation using Simplex method ,

Unit-II
Primal and Dual Problem, Duality & Simplex method, Dual Simplex Method, Post optimal Analysis-Changes in the Cost Vector, Changes in the resource vector and Changes in the coefficient matrix.

Unit-III
Transportation Problem, Properties of transportation matrix, N-W corner rule, Vogel's approximation method, and Transportation algorithm, Assignment Problem.

Unit-IV
Theory of Games, Two person zero sum games, Maxmin and Minmax principle, Graphical Solution of 2xn and nx2 games, General Solution of rectangular games by LP method.

Book for reference: -
1. S. K. Gupta   Linear Programming and network Models.
2. S. I. Gass   Linear Programming and its Applications.
3. G. Hardley   Linear Programming.
4. Kanti swarup   Operations Research.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Duality & Simplex method.
- Demonstrate a working knowledge of Transportation problems.
- Demonstrate a basic working knowledge of the concepts of Post optimal Analysis

DISCRETE MATHEMATICAL STRUCTURES

Unit-I
Review of relation functions, Permutation Combination and discrete Probability, Computability and formal language, Russell's Paradox and Noncomputability, Ordered sets, Languages, Phrase Structure grammars, Types of Grammars and Languages.

Unit-II
Graphs: Basic terminology, Multi graph and Weighted graphs, Paths and circuits, Eulerian Paths and circuits, Hamiltonion Paths and circuits, Trees: Rooted trees, binary search trees, Spanning trees, Cut sets,

Unit-III

Finite state machines: Finite state machines as models of physical system, Equivalent machines, Finite state machine as languages recognizers, Recurrence relations and recursive Algorithms.

Unit-IV

Boolean Algebras: Lattices and Algebraic systems, Principle of Duality, Basic Properties of Algebraic systems defined by Lattices, Distributive and complemented Lattices, Boolean lattices and Boolean algebras, Uniqueness of finite Boolean algebras, Boolean function and Boolean expressions. Prepositional Calculus.

Books for Reference:-
C.L Liu   Elements of Discrete Mathematics (second edition)
                          Tata McGraw Hill edition

COURSE OUTCOMES:

The mathematics of modern computer science is built almost on discrete mathematics. Discrete mathematics includes graph theory, Combinatories and theory of computation. After successful completion of this course will enable students to

- Help in thinking mathematical reasoning and proof techniques.
- To study and describe objects and problems such as computer algorithms, programming languages, cryptography, automated theory and software development etc.
- Choice of career path, to receive some instruction in discrete mathematics so that they will be able to function as informed citizens of an increasing technological society.

FUNCTIONAL ANALYSIS

Unit – I

Review of Metric spaces, L^p – spaces, Inequalities in L^p – spaces, Completeness of L^p. Normed linear spaces, inner product spaces examples, properties of Normed linear spaces and inner product spaces, Continuity of linear maps.

Unit –II

Hilbert spaces, Examples, orthonormal sets, Gram-Schist orthonormalizations, orthonormal polynomials, Bessel's inequality, Riesz-Fisher Theorem, Orthonormal basis, Fourier Expansion, Parseval's formula, Projection theorem, Riesz Representation Theorem.

Unit – III

Banach Spaces "Hahn Banach Theorem" Baire's category theorem ,Open mapping Theorem ,Closed graph theorem, Uniform boundedness Principle, duals and transpose dual of L^p [a,b] and C [a,b] , Reflexivity.

Unit – IV

Bounded Linear Operators on Banach Spaces, Banach algebra, definition, Examples, Spectrum of a bounded operator, Resolvant , Set, Compact operators on Banach spaces, spectrum of a Compact operator, Elementary ideas on integral equations, Unbounded Operators and fixed point theorems.

Books for reference:-
1. Kreyszig   Functional Analysis   John Wiley
2. Limaye   Functional Analysis   Narosa
3. Goffman & Pedrick   A first Course in Functional Analysis   Wiley Eastern
4. Bachman & Narici   Functional Analysis.

COURSE OUTCOMES:
*   Demonstrate a working knowledge of Metric spaces and Hilbert spaces.
*   Demonstrate a working knowledge of Banach Spaces.
*   Use Bounded Linear Operators.

PARTIAL DIFFERENTIAL EQUATION

Unit – I

Meaning of Partial differential equation, Classification of first order Partial differential equations, Semi-linear and quasi-linear equations, Pfaffian differential equations, Lagrange's method, Compatible systems, Charpit's method, Jacobi's method,

UnitII

Integral surfaces passing through a given curve, Cauchy problem, method of characteristics for quasi-linear and non linear partial differential equation, Monge cone, characteristic strip. First order non-liner equations in two independent variables ,Complete integral.

Unit – III

Linear Second order partial Differential Equations : Origin of second order p.d.e's, Classification of Second order Partial Differential Equations., One dimensional Wave equation, Vibration of an infinite string, origin of the equation, D'Alembert's solution, Vibrations of a semi finite string, Vibrations of a string of finite length, existence and uniqueness of solution, Riemann method,

Unit – IV

Laplace equation , Boundary value problems, Maximum and minimum principles, Uniqueness and continuity theorems, Dirichilet problem for a circle, Dirichlet problem for a circular annulus, Neumann problem for a circle, Theory of Green's function for Laplace equation, Heat equation, Heat conduction problem for an infinite rod, Heat conduction in a finite rod, existence and uniqueness of the solution, Classification in higher dimension, Kelvin's inversion theorem , Equipotential surfaces.

Books for Reference:-
1. Phoolan Prasad and Renuka Ravindran   Partial Differential Equations, Wiley Eastern Ltd.
2. F. John   Partial Differential Equations, Springer-Verlag, New York.
3. Tyn-Myint-U   Partial Differential Equations North Holland Publication, New York
4. Amarnath   An elementary course in partial differential equation NAROSA

COURSE OUTCOMES:

- Demonstrate a working knowledge of Partial differential equation.
- Demonstrate a working knowledge of Boundary value problems.
- Use different techniques to solve Partial differential equation.
- Use of Neumann problems.

Linear Algebra

Vector spaces over fields, subspaces, bases and dimension.

Systems of linear equations, matrices, rank, Gaussian elimination.

Linear transformations, representation of linear transformations by matrices, rank-nullity theorem, duality and transpose.

Determinants, Laplace expansions, cofactors, adjoint, Cramer's Rule.

Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation, diagonal-lization, rational canonical form, Jordan canonical form.

Inner product spaces, Gram-Schmidt orthonormalization, orthogonal projections, linear functionals and adjoints, Hermitian, self-adjoint, unitary and normal operators, Spectral Theorem for normal operators, Rayleigh quotient, Min-Max Principle.

Bilinear forms, symmetric and skew-symmetric bilinear forms, real quadratic forms, Sylvester's law of inertia, positive definiteness.

Texts / References

M. Artin, Algebra, Prentice Hall of India, 1994.

K. Hoffman and R. Kunze, Linear Algebra, Pearson Education (India), 2003. Prentice-Hall of India, 1991.

S. Lang, Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989.

P. Lax, Linear Algebra, John Wiley & Sons, New York,. Indian Ed. 1997

H.E. Rose, Linear Algebra, Birkhauser, 2002.

S. Lang, Algebra, 3rd Ed., Springer (India), 2004.

O. Zariski and P. Samuel, Commutative Algebra, Vol. I, Springer, 1975.

COURSE OUTCOMES:
- Demonstrate a working knowledge of vector space and applications.
- Demonstrate a working knowledge of eigen value and eigen vector problems.
- Use of Inner product spaces
- Use different operators like symmetric, normal and self adjoint operators.

TOPOLOGY

Unit – I

Basic concepts of Topology, Examples, Bases, Subbases, Countability, closed sets, Limit Points, Continuous functions.

Unit – II

New topologies from old: - Subspace topology, Product topology, and Quotient topology.

Unit – III

Connectedness, Local connectedness, Path-connectedness, compact Spaces, compactness in metric spaces, locally compacts spaces, T_1, T_2 – axioms, Regular and completely regular space, normal spaces, Urysohn Lemma,

Unit – IV

Tychonoff Theorem, Homotopy equivalences, Fundamental Group of a space, fundamental Group of S^1.

Books for reference:-

1.   J.R. Munkres   Topology – A First Course in Topology
2.   Dugundji   Topology
3.   Kelly   General Topology

COURSE OUTCOMES:
- Demonstrate a working knowledge of Connectedness.
- Demonstrate a working knowledge of Subspace topology.
- Use Fundamental Group of a space

MATHEMATICAL METHODS

Unit-I

INTEGRAL TRANSFORMS:-

Laplace transforms: Definitions, Properties, Laplace transforms of some elementary functions, Convolution Theorem, Inverse Laplace transformation, Applications.

Fourier transforms, Definitions, Properties, Fourier transforms of some elementary functions, Convolution, Fourier transforms as a limit of Fourier Series, Applications to PDE.

Unit-II

INTEGRAL EQUATIONS:

Volterra Integral Equations: Basic concepts, Relationship between Linear differential equations and Volterra integral equations, Resolvent Kernel of Volterra Integral equations, Solution of Integral equations by Resolvent Kernel, The Method of successive approximations, Convolution type equations, Solutions of integral differential equations with the aid of Laplace transformations.

Unit-III

Fredholm Integral equations: Fredholm equations of the second kind Fundamental, Iterated Kernel, Constructing the resolvent Kernel with the aid of iterated Kernels, Integral equations with degenerate Kernels, Characteristic numbers and eigen functions, solution of homogeneous integral equations with degenerate Kernel- non homogeneous symmetric equations Fredholm alternative.

Unit-IV
CALCULUS OF VARIATIONS:
Extremal of Functionals : The variation of a functional and its properties , Euler's equations, Field of extremals, Sufficient conditions for the Extremum of a Functional conditional Extremum Moving boundary problem, Discontinuous problems, one sided variations, Ritz method.

Books Recommended:-
1. Sneddon I., The use of Integral Transformations (Tata McGraw Hill)
2. Schaum's Series, Laplace Transforms.
3. Gelfand and Fomin, Calculus of Variations (Prentic Hall, Inc)
4. Krasnov, Problems and Exercises in Calculus of Variations(Mir Publ)
5. Ram P Kanwa, Linear Integral Equations (Academic Press)

COURSE OUTCOMES:
- Demonstrate a working knowledge of different transforms.
- Demonstrate a working knowledge to solve integral equations.
- Use Fredholm and Voltera Integral equations

LIST OF ELECTIVES
(EACH ELECTIVE IS OF 4 CREDITS)
How ever if necessary the academic council can frame a new course and offer it and it will be ratified in the next academic council.

ADVANCED COMPLEX-ANALYSIS

Unit- I
Harmonic functions (Definition and basis properties), The mean-value Property, Poisson's formula, Functions with the mean-value Property, Harnack's Principle, Sub harmonic function.

Unit- II
Weierstrass theorem, Partial fraction and factorization, The Riemann – Zeta function, The Gamma function, Entire functions (Jensen's formula, Hadamard's theorem).

Unit- III
Normal families, The Riemann-mapping theorem,

Unit- IV
Elliptic functions, Picard's theorem

Books for reference:-
1.   Lars, V. Ahlfors   : Complex Analysis , Mc Graw Hill.
2.   Conway, J.B.   : Functions of one Complex Variables, Narosa.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Elliptic functions.
- Demonstrate a working knowledge of Riemann-mapping theorem.
- Use of Harnack's Principle.

ANALYTIC NUMBER THEORY

Unit-I
Fundamental Theorem of arithmetic, Arithmetical functions and Dirichlet Multiplication

Unit-II
Average of arithmetical function, Elementary theorem in distribution of primes numbers

Unit-III
Congruences, quadratic residues and Reciprocity law.

Unit-IV
Ramanujan Sum. Reimann zeta function

Books for Reference: -
1.   Tom. M. Apostal   An Introduction to Analytic Number Theory.
                                        Chapter 1,2,3ͺ4,5,8,9,12 .

2.   Chandra Shekharan K.   Introduction to Analytic Number Theory.
3.   G.H. Hardy & E.W. Wright. Theory of Numbers.
4.   I. Niven & H.S. Zukerman   An Introduction to Theory of Numbers
5.   Richard Guy   Unsolved Problems in Number Theory.
                                        Springer Verlag

COURSE OUTCOMES:
 After successful completion of the course "Analytic Number Theory" will enable a student to
- Understand the problems in number theory through the study of analytic objects.

- Apply different methods from mathematical analysis to solve problems.
- Gain an understanding and appreciation of analytic number theory and some of it's most important achievements.

ALGEBRAIC NUMBER THEORY

Unit-I
Algebraic Numbers, Class field Theory.
Unit-II
Quadratic Fields, diaphantine equations.
Unit-III
Density of Sequence of Integers, Warring Problem.
Unit-IV
Fermat's Theorems, Representation of a numbers a sum of two & Four squares.

Books for Reference: -
1.   G.H. Hardy and Wright   Theory of Numbers
2.   I. Niven and H. S. Zukerman An Introduction to Theory of Number
3.   S. Lang   Algebraic Number Theory
4.   P. Ribenboim   Algebraic Number Theory

COURSE OUTCOMES:
After successful completion of the course "Algebraic Number Theory" will enable a student to
- Apply different methods from mathematical analysis to solve problems.
- Gain an understanding and appreciation of algebraic number theory and some of it's most important achievements.
- Apply the techniques of complex analysis to study a range of specific problems in number theory.

ALGEBRAIC TOPOLOGY

Unit-I
Motivation and Historical background. Geometric complexes and Polyhedra, Orientation of simplex, simplicial Complexes and Simplicial maps. Review of Abelian Grourps, chains, Cycles, Boundary , Homology groups of simplicial

complexes,examples of Homology groups, Structure of Homology groups, Relative Homology groups,Euler Poincare theorem.

Unit-II

Homology Groups of S^n , Homology of cone, relative Homology, Simplicial Approximation, Barycentric Subdivision, induced Homomorphism, Exact homolgy sequences, Mayer Vietories sequences, Eilenberg Steenrod Axioms.Singular Homology theory ,Axioms of singular theory,Excision in homology theory

Unit-III

Cohomology,Simplicial cohomology groups,Relative cohomology,cohomology theory,Cohomology of free chain complexes,Cup products,CW complexes the cohomology of CW complexes,Join of two complexes, Homology manifolds, Poincare duality, cap products

Homotopic path , fundamental Groups, Covering Homotopy property for S' Examples of Fundamental groups, Relation between $H_1(K)$ and $\pi 1(\lvert K \rvert)$, Definition of covering spaces classification of covering spaces, Basic Properties of Covering Spaces.

Unit-IV

Books for Reference: -
1.	Munkres		Elements of Algebraic Topology
			Addition Wesley Publishing
2.	Rotman		Algebraic Topology Springer Verlag.
3.	Croom		Basic Concepts of Algebraic Topology. Springer
4.	Spanier		Algebraic Topology Springer Verlag
5.	Vick		Homology theory Academic Press.
6.	Massy		Algebraic Topology.
7.	Mounds		Algebraic Topology .

COURSE OUTCOMES:
- Demonstrate a working knowledge of Homology Groups of S^n.
- Demonstrate a working knowledge of Cohomology.
- Use of Homotopy property'

COMBINATORICS
Unit-I

Introduction and basis principles of permutations and combination.Pigeonhole Principle and inclusion and exclusive principle.

Unit-II
Linear equations.
Unit-III
Recurrence relations.
Unit-IV
Generation functions.

Text Books

1. G. Berman   Introduction to Combinatorics
Books for Reference: -
1. V. K. Krishnamurty   Combinatorics
2. Conen   Applied Combinatorics

COURSE OUTCOMES:

- Demonstrate a working knowledge of Generation functions.
- Demonstrate a working knowledge of Recurrence relations.
- Use of inclusion and exclusive principle.

COSMOLOGY

Unit-I
Field Equations, Exterior and Interior solutions, Crucial tests.

Unit-II
Electromagnetism :   Transformation formulae for density , electric charge, electric current, Electromagnetism in general Relativity, Propagation of electric and magnetic intensities. Transformation of differential operators. Tensor forms of Maxwell Equations.

Unit-III
Static Cosmological Models, Geometrical and physical properties of the models, Comparison of models, Redshift Nonstatic Cosmological models, cosmological principles, derivation of Robertson walker line element, Friedman-Robertson-Walker cosmological models, Particle Horizons.

Books for Reference: -
1. R.C. Tolman   Relativity, Themodynamics and Cosmology   OXFORD
2. J. V. Narlikar   Introduction to Cosmology,   Cambridge Publication.
3. E. A. Lord   Tensor, Relativity, Cosmology ,   TATA Mc Graw Hill.
4. S. Weinberg   Gravitation and Cosmology,   John Wiley New York.
5. M. R. Robonson   Cosmology   Oxford Univ. Press.
6. P. T. Landsberg & D. A. Evens   Mathematical Cosmology (OXFORD)
7. M. Berry   Principle of Cosmology   Cambridge.
8. H. Bondi   Cosmology,   Cambridge Univ. Press.
9. Islam   Mathematical Cosmology.
10. Weilnberg, S.   Cosmology.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Cosmological Models.
- Demonstrate a working knowledge of Exterior and Interior solutions.
- Use of Transformation of differential operators.

DISCRETE DYNAMICAL SYSTEMS

Unit-I

Phase Portraits, Periodic Points and Stable Sets, Sarkovskii's Theorem, Hyperbolic, Attracting and Repelling Periodic Points.

Families of Dynamical Systems, Bifurcation, Topological Conjugacy. The Logistic Function, Cantor Sets and Chaos, Period-Doubling Cascade

Unit-II

More examples,Rotations, Horse shoes ,solenoid

Limit sets and recurrence, topological transitivity, topological mixing, expansiveness

Unit-III

Topological entropy, examples

. Symbolic Dynamics. Sub shifts and codes, subshifts of finite type,topological entropy of an SFT , Newton's Method.

Numerical Solutions of Differential Equations

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Unit-IV

Complex Dynamics, Quadratic Family, Julia Sets, Mandelbrot Set.

Topological Entropy, Attractors and Fractals, Theory of Chaotic Dynamical System.

Books Reference:-
1. Richard M. Holmgren: A First Course in Discrete Dynamical Systems,Springer Verlag(1996). For Unit-I to Unit-IV.
2. Devaney : Introduction to Chaotic Dynamical Systems.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Families of Dynamical Systems.
- Demonstrate a working knowledge of Topological entropy.
- Use of Numerical Solutions of Differential Equations

.GRAVITATION

Pre requirements Differential Geometry and Riemannian Geometry

Unit – I

Gravitational Field Equations Einstein field Equs from variational Principle.

Unit – II

Classical Tests of Einstein Theory Schwarz child interior and exterior Solutions.

Unit – III

Electromagnetism, Einstein Maxwillfield equations from action principle.

Books for Reference: -

1. B. A. Lord (Tata Mc Grow Hill)   Tensor Relativity and Cosmology.
2. A Papa Petrou   Lectures notes on General Relativity.
3. J. Foster(Riedel Pub.)   Short Course in General Relativity.
4. R. C. Tolman   Relativity, Thermo Dynamics and Cosmology.

COURSE OUTCOMES:

- Demonstrate a working knowledge of Riemannian Geometry.
- Demonstrate a working knowledge of Maxwillfield equations.
- Use of Classical Tests of Einstein Theory.

GEOMETRICAL METHODS IN PHYSICS

Unit – I

Differentiable manifolds and tensors :-   Definition and Example of manifolds, Sub Manifolds, Global considerations, Fibre Bundles, Lie Brackets and forms, Metric tensor, Tensor fields on manifolds , Frobenius Theorem.

Unit – II

Lie Derivative & Lie Groups :- Lie dragging, killing Vector Lie Groups & theor Lie Algebras, Representation of rotation group.

Unit – III

Differential Forms :-   Algebra and integral calculus of forms, Geometrical Role of differential forms, Differential calculus of forms and its applications.

Unit – IV

Application of Geometric method to Thermo dynamics and Cosmology.

Books for Reference: -

1. B. F. Schutz   Geometrical Methods of Mathematical Physics.
    Cambridge University Press, 1980.
1. Ychoquet- Bruht, C. D. Moretle and M. D. Bleick
    Analysis, Manifolds and Physics.
    Northholoand, Amesterdam, 1977.
3. K. Yano   Theory of Lie derivatives and its applications
    North Holland, Amesterdam, 1955.
4. R. Hermann, Benjamin Vector bundles in Mathematical Physics.
    Vols. I, II. 1970.
5.   Varaeharajan   Lie Groups & Lie Algebra, Springer

6. H. Flanders   Differential Forms with Applications to the physical
                      Science ,   Academic Press N. Y. 1963.
7. M. Schreiber   Differential Forms,   Springer, 1977.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Differentiable manifolds.
- Demonstrate a working knowledge of Thermo dynamics and Cosmology.
- Use of Representation of rotation group.

LIE GROUPS AND LIE ALGEBRAS

Unit- I
Differentiable manifolds , Analysis manifolds, Frobenius Theorem, Definition and example of Lie groups, Lie algebra, Lie algebra of a Lie group. Enveloping algebra of a Lie group. Subgroup , Sub algebras.

Unit- II
Locally Isomorphic groups, homomorphism, Fundamental Theorem of Lie , Closed Lie subgroups and Homogeneous Spaces, Orbits and spaces of orbits , Exponential map. Taylor series expansion of a lie group . Adjoint representation, Differential of the Exponential map. Baker-Campbell Housdorff Formula.

Unit- III
Lie theory of transformation groups representations Representations of abelian groups , representation of Lie algebras, Some analysis of Compact groups, The Theorem of Peter and Weyl and its applications. Structure theorem (Elementary Ideas).

Books for Reference : -
1.Vardrajan, V.S.   Lie Groups, Lie Algebra and their representation
                              Springer- Verlag.
2.Brocker, T. , Deeck, T. T.   Representations of compect Lie grpups
                              Springer- Varlag.

COURSE OUTCOMES:

- Demonstrate a working knowledge of Lie algebra.
- Demonstrate a working knowledge of Lie theory of transformation groups.
- Use of abelian groups.

MECHANICS

Unit- I

Newtonian Mechanics : Experimental facts, Investigation of Equation of Motion.

Unit- II

Lagrangian Mechanics : Variational Principles, Lagrangian Mechanics on Manifolds,

Unit- III

Oscillations, Rigid Bodies.

Unit- IV

Himiltonian Mechanics : Differential forms, Simplcetic structure on manifolds

The course is covered by " Mathematical Methods in Classical Mechanics" by V.I. Arnold. Springer Verlag.

Books for Reference : -
1. Ordinary Differential Equations V. I. Arnold.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Simplcetic structure on manifolds.
- Demonstrate a working knowledge of Lagrangian Mechanics on Manifold.
- Use of Equation of Motion.

OPERATOR THEORY

Unit- I

Banach Algebra : Introduction , Complex homomorphism Basic properties of spectra, Commutative Banach Algebra : Ideals, Gelfand transform, Involution, Bounded operator .

Unit-II

Bounded Operator : Invertibility of bounded operator, Adjoints, Spectru;m of bounded operatoer, Fundamentals of spectral Theory, Self adjoint operators, Normal, Unitary operators, Projection Operator.

Unit- III

Resolution of the Identity, Spectral Theorem, Eigen Values of Normal Operators, Positive Operators, Square root of Positive operators, Partial Isometry, Invariant of Spaces, Compact and Fredholm Operators, Integral Operators.

Unit- IV

Unbounded Operators : Introduction, Closed Operators, Graphs and Symmetric Operators, Cayley transform, Deficiency Indices, Resolution of Identity, Spectral Theorem of normal Operators, Semi group of Operators.

Books for Reference : -
1.Walter Rudin   Functional Analysis   Tata McGraw Hill.
2.Gohberg and Goldberg   Basic Operator Theory.
3.M. Schecter   Principle of Functional Analysis
4.Akhietzer and Glazeman   Theory of Linear Operator, Vol I, II
                                     Pitman Publishing House.
5.Donford and Schwarz   Linear Operator, vol.   1. 2. 3.
6.Weidman   J   Linear Operators on Hilbort Speces, Speringer.

COURSE OUTCOMES:

- Demonstrate a working knowledge of Unbounded Operators.
- Demonstrate a working knowledge of Compact and Fredholm Operators.
- Use of Bounded Operator.

OPERATIONS RESEARCH

Unit- I
Games and Strategies, Sequencing Problems

Unit- II
Dynamic Programming.

Unit- III
Integer Programming   : --   Gomory's All - IPP Method and Bnach and Bound Algorithm. Network programming

Unit- IV
Nonlinear Programming   : --   Kuhn Tucker Conditions, Quadratic Programming , Wolfe's modified Simplex method, Beale's method.

Books for Reference : -
1.Kanti Swarup et al Operation Research
                          Sultan Chand & Sons.
2.J. C. Pant   Introduction to Optimization and Operation Research.
                        Jain Brothers, NEW DELHI.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Games and Strategies.
- Demonstrate a working knowledge of Dynamic Programming.
- Use of Nonlinear Programming.

QUANTUM MECHANICS IN HILBERT SPACE

Unit- I

Physical and Electromagnetic bases of quantum mechanics probabilistic interpretation of quantum mechanics, schrodinger's equation, Linear Harmonic Oscillator and other one dimensional Problems, Hilbert space of systems of n-different particles in wave mechanics.

Unit- II

Basic Operator theory, spectral measures spectral theorem for unitary operatrors.

Unit- III

Basic postulates of Quantum Mechanics Function of compatible observable, Schrodinger, Heisenberg and Interaction pictures, State Vectors, Complete set of observable, Canonical Commutation relations,

Unit- IV

Formalism of Wave mechanics, Completely continuous operators and the statistical operator, Basic concepts of scattering theory of two particles.

Books for Reference : -
1.Prugovecki, M.   Quantum mechanics in Hilbert Spece.
2.Schecter, M.   Operator Theory and Quantum Mechanics .
3.Schiff. L. I.   Quantum Mechanics.
4.Mackey, J.   Mathematical Foundation of Quantum Mechanics.

COURSE OUTCOMES:

- Demonstrate a working knowledge of Electromagnetic bases of quantum mechanics.
- Demonstrate a working knowledge of Wave mechanics.
- Use of Basic Operator theory.

RELATIVITY

Unit- I

Classical Theory   :   -   Space time, Newtonian Theory, Galilean Transformation of Velocity and Acceleration Electromagnetism and Galilean Transformation and Development of special theory of Relativity .

Unit- II

Special Theory Relativity   :   -   Special and   General Lorentz Transformations, Consequences of Lorentz Transformations. Composition of Velocities, Proper Time, Transformation of Velocity and acceleration.

Unit- III

Relativistic Mechanics   :   -   Variation of mass with velocity, Equivalence of mass and energy and its applications , Relation between momentum and energy, mass, density, Force, Langragian and Hamiltonian.

Unit- IV

Minkowski-Spaces : - Relativity and Causality, Null Cone, World Line of a Particles, Relativities Laws of Motion, Energy-momentum tensor.

Unit- V

General Theory of Relativity : - Principles of Equivalence and Connivances, Field Equations, Schwarz-child Interior and Exterior solutions.

Books for Reference : -
1.Eric a. Lord   Tensors Relativity and Cosmology
                                    TATA Mc Graw Hill Ltd., New Delhi
2.Synge J. L. (1956)   Relativity : The Special Theory
                                    North Holland Publishing Company, Amsterdam.
3.Synge J. L . (1960)   Relativity   : The General Theory
                                    North Holland Publishing Company, Amsterdam
4.Alder, R., Bazin, M and Schiffer, M. (1975)
                                    Introduction to General Relativiety,   Mc Graw Hill.
5.Eddington, A. S. (1954)   The Methematical theory of Relativity
                                    Cambridge University Press.
6.Resnick, R. (1968)   Introduction to Special Relativity
                                    Cambridge University Press.

COURSE OUTCOMES:
- Demonstrate a working knowledge of Galilean Transformation.
- Demonstrate a working knowledge of Langragian and Hamiltonian.
- Use of Principles of Equivalence and Connivances.

SEVERAL COMPLEX VARIABLES

Unit- I

Analytic functions of one complex variable, Elementary properties of functions of several complex Variables.

Unit- II

Applications to commutative Banach Algebras, L^2 estimates and existence theorem for the Operator , Stein Manifolds, Local properties of analytic sheaves on stein manifolds.

Books for Reference : -
1.Lars Hormander   An Introduction to Complex Analysis in several
                                    variables.
2.Gunning is Rossi   Several Complex Variables,   Springer Verlag.
3.Garner   Several Complex Variables,   Springer Verlag.
4.Bochner & Martin   Functions of Several Complex Variables
                                         University Press.

COURSE OUTCOMES:

- Demonstrate a working knowledge of Analytic functions of one complex variable.
- Demonstrate a working knowledge of Banach Algebras.
- Use of stein manifolds.

STOCHASTIC PROCESS

Unit-I
Fluctuation in coin tossing and random walk: The reflection principle, random walks, Basic concept of stochastic process, examples of stochastic process, classification of stochastic process according to state space and time domain, Gambler's ruin problem.

Unit-II
Countable state Markov chains: Champman-Kolmogorov's equation, classification of n step transition probability and its limits, classification of states , period of Markov-chain.

Unit-III
Stationary distributions of M.C. recurrence, Transient states, Probabilities. Birth and death process, Kolmogorov's differential equations, Poisson processes.

Books for Recommended:-
1. Samuel Karlin and H.M. Taylor   A first course in stochastic process
2. W. Fellor   An Introduction to probability theory and
its   applications(Vol. I)

COURSE OUTCOMES:
- Demonstrate a working knowledge of Markov chains.
- Demonstrate a working knowledge of concept of stochastic process.
- Use of Birth and death process,.

WAVELET

Unit- I
Review of Fourier Analysis, Elementary ideas of signal processing, From Fourier Analysis to wavelet Analysis, Windowed Fourier Transforms : Time frequency localization, The reconstruction formulae.

Unit- II
Multiresolution analysis, Construction of Wavelets from MRA construction of compactly supported wavelets, Band limited Wavelets, Franklin wavelets on real line, Introduction to spline analysis, spline wavelets on real line, Orthonormal Wavelets, Examples.

Unit- III

Discrete transforms and algorithms, Discrete Fourier transform and the fast Fourier transform, Discrete cosine transform and the fast cosine transform, Decomposition and reconstruction algorithm for Wavelets, Wavelets and applications.

Books for reference : -
2. Harnandez, E.   A first Course in waveletes, CRC
3. Daubechies Ingrid   Ten Lectures on Wavetets.
4. Chui   An Intruduction to Wavetets, Academic Press.
5. Kaiser, G.   A friendly guide to Wavelets, Bikhauser 1994.
6. Kahane & Lemaire Rieusset   Fourier Series & Wavelets Gordon & Breach.

COURSE OUTCOMES:
*   Demonstrate a working knowledge of wavelet Analysis.
*   Demonstrate a working knowledge of Multiresolution analysis.
*   Use of Discrete transforms and algoriths.

GRAPH THEORY

Unit- I
Definition and Examples, Connectedness, Walk, Path circuits, Euleriar graph, Hamiltonian graph, Some application.

Unit- II
Trees : Elementary proportion of trees, Enumeration of trees, More application.
    Cut sets:- Fundamental circuits and cut-sets, network flows, 1-isomorphism, 2-isomorphism.

Unit- III
Planarity:- Kuratowski two graphs, detection of planarity, geometric dual, thickness and crossing.
Unit- IV
Coloring problems, chromatic number, four color problem.
Unit- V
Directed graph: Digraphs and binary relations, Euler digraphs.

Text Books
1. R. J. Wilson   Introduction to Graph Theory

Books for Reference: -
1. N. Deo   Graph Theory and its Application to Engineering and
                 Computer Science.
2. F. Harary   Graph Theory.

COURSE OUTCOMES:

- Demonstrate a working knowledge of Euleriar and Hamiltonian graph.
- Demonstrate a working knowledge of Trees.
- Use of graphs in discrete mathematics.

APPLIED FLUID DYNAMICS

Unit-I   Introduction to fluid flow: Viscous and inviscid fluids, Laminar and turbulent flows, Steady and unsteady flows, Rotational and irrotational flows, orthogonal curvilinear coordinates.

Unit-II   Kinematics of fluids in motion: Lagrangian and Eulerian method of fluid motion, Equation of continuity by Euler method, Equation of motion of inviscid fluid, Euler's equation of motion in cylindrical and spherical coordinates, Euler's equation of motion under impulsive forces.

Unit-III   Dynamic similarity, Inspection analysis in incompressible viscous fluid flow, Reynolds principle of similarity, Inspection analysis in case of viscous compressible fluid,
 Some useful dimensionless number: Reynold number, Froude number, Mach number, Prandtl number, Eckert number, Grashoff number.

Unit-IV Boundary layer theory: Limitation of ideal fluid, Prandtl's boundary layer theory, Boundary layer thickness, Boundary layer equation in two dimensional flow, Boundary layer flow over a flat plate (Blasius Solution).

Text book
1.   Fluid Dynamics, M.D. Raisinghania, 12th Ed, S. Chand Co. Publisher

Reference books
1. Viscous Fluid Dynamics, J.L. Bansal, Jaipur Publishing House
2.   Foundations of Fluid Mechanics, S.W. Yuan, Prentice Hall of India Publisher

COURSE OUTCOMES:

- Demonstrate a working knowledge of fluid flow.
- Demonstrate a working knowledge of Boundary layer theory
- Use of Lagrangian and Eulerian method of fluid motion.