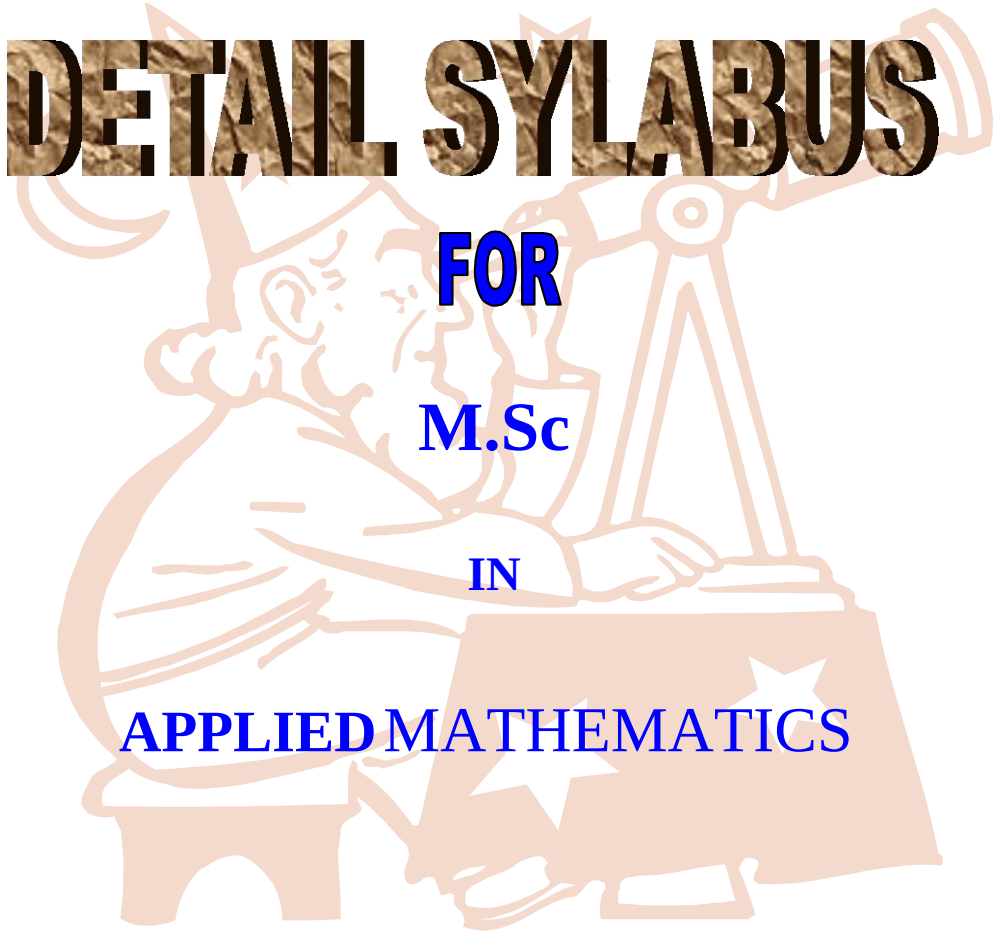
DETAIL SYLABUS

FOR

M.Sc

IN

APPLIED MATHEMATICS



DEPARTMENT OF MATHEMATICS

VSSUT- BURLA

2011-2013

ODISHA, 768018

DEPARTMENT OF MATHEMATICS,
V. S. S. University of Technology, BURLA Odisha, 768018
SEMESTER WISE SYLLABUS FOR MSc PROGRAM
EFFECTIVE FOR THE SESSION 2011-13

	Semester – I	
BSM-511	Real Analysis	4Credits
512	Complex Analysis	4Credits
513	Modern Algebra	4Credits
514	Probability	4Credits
515	Programming in -C-	4Credits
516	Programming Lab & Viva	4Credits
	TOTAL	24 credits
	Semester – II	
521	Measure Theory and Integration	4 Credits
522	Ordinary Differential Equations	4Credits
523	Statistical Methods	4Credits
524	Mathematical Modelling	4Credits
525	Numerical Analysis	4Credits
526	Practical & Viva	4Credits
	TOTAL	24 credits
	Semester –III	
531	Linear Programming	4Credits
532	Discrete Mathematical Structures	4Credits
533	Functional Analysis	4Credits
534	Partial Differential Equations	4 Credits
535	Linear algebra	4 Credits
536	Project stage-I & viva	2+2=4 credits

	TOTAL	24 credits
Semester –IV		
541	General Topology	4 Credits
542	Mathematical Methods	4 Credits
54E*	Three Electives from schedule –A 12Credits(4x3)	12 Credits
544	Project stage-II & viva voce	2+2= 4Credits
	TOTAL	24 credits
	GRAND TOTAL	96 credits

List of Elective Courses(Theory) for 4th Semester

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 **p**rovides students with a knowledge of mathematics, its research poential and the interaction between the two.

Programme Outcomes (PO)

The Program Outcomes of 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.
- Work in multidisciplinary field.
- 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.

Semester –I

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 mathematical applications in a variety of applied fields.

- 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.

Unit – II

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.

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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 $\sum_{d/n}\varphi(d)$
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

Semester – II

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.

Semester – III

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:

The great mathematician Euler remarked that nothing at all takes place in the real world in which some rule of maximum or minimum is not applied. Linear programming problems have wide applications in science, engineering, economics, finance, management etc.
By learning this subject, students can judge a real life model in the following ways:

(i) They can easily indentify the real life problem.
(ii) Selection of an appropriate goal and the value of different variables related to the goals.
(iii) Formulation of an appropriate model of the problem, abstracting the essential information so that a solution at the decision maker's goal can be sought.

Finally, they can formulate the real life problems through linear programming and optimize their goal.

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.

Semester - IV

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 1,2,3¸4,5,8,9,12 .
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 $\pi 1(|K|)$, 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:

- Application of the linear programming problems and formulation of real life problem through linear programming.
- Able to learn about nonlinear programming problems (general mathematical programming problems) and there solution methods.

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 algorithms.

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.