Course Scheme & Syllabus
For
M.Sc. (HONS) MATHEMATICS
(Program ID-37)

1\textsuperscript{st} TO 4\textsuperscript{th} SEMESTER
Examinations 2013–2014 Session Onwards

Syllabi Applicable For Admissions in 2013
### Scheme of Courses M.Sc.
#### M.Sc. (HONS) MATHEMATICS

#### Semester 1

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| A: | Continuous Assessment: | Based on Objective Type & Subjective Type Test |
| B: | Mid-Term Test-1: | Based on Objective Type & Subjective Type Test |
| C: | Mid-Term Test-2: | Based on Objective Type & Subjective Type Test |
| D: | End-Term Exam (Final): | Based on Objective Type |
| E: | Total Marks |

**L: Lectures**  **T: Tutorial**  **P: Practical**  **Cr: Credits**
## Scheme of Courses M.Sc.

### M.Sc. (HONS) MATEHMATICS

#### Semester 2

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<tr>
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**A:** Continuous Assessment: Based on Objective Type & Subjective Type Test

**B:** Mid-Term Test-1: Based on Objective Type & Subjective Type Test

**C:** Mid-Term Test-2: Based on Objective Type & Subjective Type Test

**D:** End-Term Exam (Final): Based on Objective Type

**E:** Total Marks

**L:** Lectures  **T:** Tutorial  **P:** Practical  **Cr:** Credits

Total Marks: 600
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**Weightage:** A: Continuous Assessment: Based on Objective Type & Subjective Type Test
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
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E: Total Marks

**L: Lectures  T: Tutorial  P: Practical  Cr: Credits**
# Scheme of Courses M.Sc.  
## M.Sc. (HONS) MATEHMATICS  

**Semester 4**

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A: Continuous Assessment: Based on Objective Type & Subjective Type Test  
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D: End-Term Exam (Final): Based on Objective Type  
E: Total Marks  
L: Lectures  
T: Tutorial  
P: Practical  
Cr: Credits
Instruction for candidates (Theory Paper)

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.

- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.

- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.

- The books indicated as text-book(s) are suggestive However, any other book may be followed.

* Wherever specific instructions are required these are given at the starting of that particular subject/paper
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Instruction for candidates (Practical Paper)

- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test.
Course Title: Real Analysis-I
Paper Code: MTH 501

Objective:
The aim of this course is to make the students learn fundamental concepts of metric spaces, The Riemann-Stieltjes integral as a generalization of Riemann Integral, the calculus of several variables and basic theorem.

UNIT-I
Basic Topology: Finite, countable and uncountable sets, metric spaces, compact sets, perfect sets, connected sets.
Sequences and series: Convergent sequences, sub sequences, Cauchy sequences (in metric spaces), completion of a metric space, absolute convergence, addition and multiplication of series, rearrangements of series of real and complex numbers.

UNIT-II
Continuity: Limits of functions (in metric spaces), continuous functions, continuity and compactness, continuity and connectedness, monotonic functions.

UNIT-III
Sequences and series of functions: Problem of interchange of limit processes for sequences of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, equicontinuous families of functions, Stone Weierstrass Theorem.

UNIT-IV
Differentiation: Differentiation of vector-valued functions.
Functions of several variables: The space of linear transformations on R^n to R^m as a metric space. Differentiation of a vector-valued function of several variables. The Inverse function theorem. The implicit function theorem Jacobians, extremum problems with constraints, Lagrange’s multiplier method, Differentiation of integrals, Partitions of Unity, Differential forms, Stoke’s Theorem.

Reference Books:

Objective:
This course provides the foundation required for more advanced studies in Algebra. The aim is also to develop necessary prerequisites for Math MTH 507.

UNIT-I 14 Hours
Review of basic property of Groups, Dihedral groups, Symmetric groups and their congruency classes, Simple groups and their examples. Simplicity of $A_n$ (n≥5).

UNIT-II 15 Hours

UNIT-III 13 Hours
Normal and Subnormal Series, Derived Series, Composition Series, Solvable Groups, Zassenhaus Lemma and Jordan-Holder Theorem.

UNIT-IV 15 Hours
Review of Rings, Zero Divisors, Nilpotent Elements and Idempotents, Matrices, Ring of endomorphisms, polynomial rings in many variables, Factorization of polynomials in one variable over a field. Unique factorization domains. Gauss Lemma, Eisenstein’s Irreducibility Criterion, Unique Factorization in $R[x]$, where $R$ is a Unique Factorization Domain. Euclidean and Principal ideal domains.

Reference Books:

Objective:
The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines. The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

UNIT-I 14 Hours
Vector Spaces, Subspaces, Linear dependence, Basis and Dimensions, Algebra of Linear Transformation, Algebra of Matrices, Elementary matrices, Row rank, Column rank and their equality, System of Linear Equations

UNIT-II 14 Hours
Eigen values and Eigenvectors, Characteristic and minimal polynomials, companion matrix, Cayley Hamilton Theorem, Matrix representation of Linear Transformation, Change of Basis, Canonical forms, Diagonal forms, triangular forms, Rational and , Canonical Jordan Forms

UNIT-III 14 Hours
Eigen spaces and similarity, Linear functional, Dual Spaces and dual basis, the double dual, Inner Product Spaces, Norms and Distances, Orthonormal basis, The Gram-Schmidt Orthogonalization, Orthogonal complements.

UNIT-IV 14 Hours
The Adjoint of a Linear operator on an inner product space, Normal and self-Adjoint Operators, Unitary and Normal Operators, Spectral Theorem, Bilinear and Quadratic forms.

Reference Books:

Course Title: Complex Analysis  
Paper Code: MTH 504

Objective:
The objective of the course is to provide foundation for other related branches of Mathematics. Most of the topics covered are widely applicable in Applied Mathematics and Engineering.

UNIT-I  
14 Hours  
Function of Complex variables, continuity and differentiability, Analytic functions, Conjugate function, Harmonic function, Cauchy Riemann equations (Cartesian and Polar form). Construction of analytic functions.

UNIT-II  
14 Hours  
Complex line integral, Cauchy’s theorem, Cauchy’s integral formula and its generalized form. Cauchy’s inequality. Poisson’s integral formula, Morera’s theorem. Liouville’s theorem, conformal transformation, bilinear transformation, critical points, fixed points, Cross ratio problems.

UNIT-III  
14 Hours  
Power series, Taylor’s theorem, Laurent’s theorem, Maximum modulus theorem (Principle), Schwarz’s Lemma, poles and zero’s of meromorphic functions, Argumenta principle, and Fundamental theorem of Algebra and Rouche’s theorem.

UNIT-IV  
14 Hours  

Reference Books:

Objective:
The objective of this course is to equip the students with knowledge of some advanced concepts related to differential equations and to understand some basic approach to mathematical oriented differential equations.

UNIT I 15 Hours
Preliminaries-Initial value problem and equivalent integral equation, mth order equation as a first order system, concepts of local existence, existence in the large and uniqueness of solutions with examples.
Basic Theorems-Ascoli-Arzela Theorem. A theorem on convergence of solutions of a family of initial value problems.

UNIT II 15 Hours
Egres points and Lyapunov functions, Successive approximations.

UNIT III 15 Hours
Linear differential equations-Linear systems, Variation of constants, reduction to smaller systems. Basic inequalities, constant coefficients. Floquet theory, Adjoint systems, higher order equations.
Dependence on initial conditions and parameters, preliminaries, continuity, differentiability, higher order differentiability.

UNIT IV 15 Hours

Reference Books:


Objective:
The objective of this course is to study measure in an abstract setting after having studied Lebesgue measure on real line. The general $L^p$ spaces are also studied.

UNIT-I

UNIT-II
Lebesgue Integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of a non-negative function, The general integral, Convergence and measures.

UNIT-III

UNIT-IV

Reference Books:

Course Title: Algebra-II  
Paper Code: MTH 507

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Objective:
This course is a basic course in Algebra for students who wish to pursue research work in Algebra. Contents have been designed in accordance with the UGC syllabi in mind.

UNIT-I  
14 Hours

UNIT-II  
14 Hours

UNIT-III  
14 Hours

UNIT-IV  
14 Hours
Modules and module homomorphism, sub module and quotient module, operation on sub modules, direct sum and product, finitely generated modules, exact sequences.

Reference Books:

Course Title: Classical Mechanics and Calculus Of Variations  
Paper Code: MTH 508

Objectives:
The objective of this paper is to introduce the concept of variation of a functional and variational techniques. The Calculus of variation helps a lot to understand the Lagrangian and Hamiltonian equations for dynamical systems. Vibrational principles and their applications are introduced at large.

UNIT-I  
Velocity and acceleration of a particle along a curve, Radial & Transverse components (plane motion). Relative velocity and acceleration. Kinematics of a rigid body rotating about a fixed point. Vector angular velocity, Euler’s dynamical equations for the motion of a rigid body about an axis, theory of small oscillations. Composition of angular velocities. Moving axes.

UNIT-II  

UNIT-III  
The cycloid and its dynamical properties. Motion of a particle under a central force, Use of reciprocal polar coordinates, pedal- coordinates and equations. Kepler’s laws of planetary motion and Newton’s Law of gravitation.

UNIT-IV  

Reference Books:
Objective:
To introduce students to Differential Geometry. Surfaces; the shape operator; principal, Gaussian and mean curvatures; minimal surfaces; geodesics.

Unit – I
14 HOURS
Tangent, Principal normal, Curvature, Binormal, Torsion, Serret Frenet formulae, Locus of center of curvature, Spherical curvature, Locus of center of spherical curvature. Theorem: Curve determined by its intrinsic equations, Helices, Involutes & Evolutes.

Unit – II
14 HOURS
Surfaces, Tangent plane, Normal, Curvilinear co-ordinates First order magnitudes, Directions on a surface, The normal, second order magnitudes, Derivatives of n, Curvature of normal section. Meunier’s theorem, Principal directions and curvatures, first and second curvatures, Euler’s theorem. Surface of revolution.

Unit – III
14 HOURS
Gauss’s formulae, Gauss characteristic equation, Mainardi – Codazzi relations, Derivatives of angle w, Geodesic property, Equations of geodesics, Surface of revolution, Torsion of Geodesic, Bonnet’s theorem, vector curvature, Geodesic curvature

Unit – IV
14 HOURS

Reference Books:
Course Title: Number Theory
Paper Code: MTH-510

Objective:
The objectives of this course is to teach the fundamentals of different branches of Number Theory, namely, Geometry of Numbers and Analytic Number Theory.

UNIT-I
Divisibility, Greatest common divisor, Euclidean algorithm, The Fundamental theorem of Arithmetic, Congruences, Residue classes and reduced residue classes, Chinese remainder theorem, Fermat’s little theorem, Wilson’s theorem, Euler’s theorem.

UNIT-II
Arithmetic functions $\sigma(n)$, $d(n)$, $\tau(n)$, $\mu(n)$, Order of an integer modulo $n$, primitive roots for primes, composite numbers having primitive roots, theory of indices. Mobius inversion formula, greatest integer function. Quadratic residues, Legendre symbol, Euler’s criterion, Gauss’s lemma, Quadratic reciprocity law, Jacobi symbol.

UNIT-III
Elementary results on the distribution of primes. Finite Abelian groups and their characters, Dirichlet’s Theorem on primes in Arithmetical progression. Perfect numbers, Characterization of even perfect numbers, Twin primes, Mersenne primes and Fermat numbers Chevalley-Warning Theorem.

UNIT-IV
Representation of an integer as a sum of two and four squares. Diophantine equations $ax + by = c$, $x^2 + y^2 = z^2$, $x^4 + y^4 = z^4$. Farey sequences, continued Fractions, Approximation of reals by rationals, Pell’s equations. The Partitions. Minkowski’s theorem in Geometry of Numbers and its application to Diophantine inequalities. Binary quadratic forms and equivalence of quadratic Forms.

Reference Books:

Course Title: Computational Techniques
Paper Code: MTH 511

Objective:
The objective of this course is to teach the basics of computer and computer programming so that one can develop the computer program in C their own. For the purpose of learning programming skill, some Numerical methods which are extremely useful in scientific research are included. For practising the programmes of the numerical method, the course of practical has also been included in this paper. The contents of the curriculum have been designed keeping in view the UGC guidelines.

UNIT-I 14 Hours
Ms Excel: Introduction, Functions and Formulae, Graphics and Data base. Programming in C: Historical development of C, Character set, Constants Variables, Keywords, Operators, Hierarchy of arithmetic operations, if and if –else statements, logical and computational Operators, Switch structure while structure , do-while and For-Loops, Nested Loops, Break and Continue statements,

UNIT-II 14 Hours

UNIT-III 14 Hours

UNIT-IV 13 Hours

Reference Books :

Writing Programs in C for the Problems based on the methods studied in theory paper and to run the Program on PC

- WAP on Numerical Integration.
- WAP on Trapezoidal and Simpson’s rule
- WAP on Gaussian Quadrature.
- WAP on Taylor Series method.
- WAP on Picard method.
- WAP on Runge-Kutta Methods
- WAP on Finite Difference Methods
- WAP on Predictor-Corrector Methods
- WAP on Approximations of Functions
Course Title: Topology  
Paper Code: MTH 601

Objective:

The course is an introductory course on point-set topology so as to enable the reader to understand further deeper topics in topology like Differential/Algebraic Topologies etc.

UNIT-I  
14 HOURS  
Countable and uncountable sets, infinite sets and Axiom of choice, Cardinal numbers and their arithmetic. Schroeder-Bernstein Theorem, Cantor’s theorem and the continuum hypothesis, Zorn’s Lemma, Well-ordering theorem.

UNIT-II  
14 HOURS  
Topological Spaces, Examples of topological spaces: the product topology, the metric topology, the quotient topology. Bases for a topology, the order topology, the product topology on X ×Y, the subspace topology. Open sets, closed sets and limit points, closures, interiors, continuous functions, homeomorphisms.

UNIT-III  
14 HOURS  
Sequence, Connected spaces, connected subspaces of the real line, components and local connectedness. Connectedness and Compactness: Connected spaces, Connected subspaces of the real line, Components and local connectedness, Compact spaces, Compact space of the real line, limit point compactness, Heine-Borel Theorem, Local -compactness.

UNIT-IV  
14 HOURS  

Reference Books:

Course Title: Probability and Statistics  
Paper Code: MTH 602

Objectives:  
The course is designed to equip the students with various probability distributions and to develop greater skills and understanding of Sampling and estimation.

UNIT-I  
15 Hours  
Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Discrete distributions: uniform, binomial, Poisson, geometric and negative binomial distributions and their properties. Continuous distributions: uniform, normal and exponential distributions and their properties.

UNIT-II  
14 Hours  
Sampling Theory: Types of Sampling, errors in sampling, Parameter and Statistic, Tests of Significance: Null Hypothesis, Alternative Hypothesis, One-tailed, Two-tailed tests. Sampling Attributes: Tests of Significance for single proportion and difference of proportions. Sampling of Variables.

UNIT-III  
14 Hours  
Sampling Distributions: Chi-Square Distribution, Moment generating function of Chi-Square and its applications. Student’s ‘t’ distribution. $F$ and $Z$ distributions.

UNIT-IV  
14 Hours  

Reference Books:

Objective:

To acquaint the students with the application of Laplace and Fourier Transform to Solve the Differential Equations.

UNIT-I
Laplace Transform: Definition, existence and basic properties of the Laplace transform, Inverse Laplace transform, Convolution theorem, Laplace Transform solution of linear differential equation and simultaneous linear differential equation with constant coefficients, Complex inversion formula.

UNIT-II
Fourier Transform: Definition, existence and basic properties, Inversion formula of Fourier transform Convolution theorem, Parseval’s relation. Fourier transform of derivatives and integrals, Fourier sine and cosine transform, Inverse Fourier transform, Solution of linear ordinary differential equations and partial differential equations.

UNIT-III

UNIT-IV
Fredholm Equations: Solution by the method of successive approximations. Solution of Fredholm integral equation for degenerate kernel; Examples, Faltung type(closed cycle type) integral equation, Singular integral equation; Solution of Abel’s integral equation Neumann’s series. Fredholm’s equation with Pincherte-Goursat Kernel’s.

Reference Books:

Course Title: Operational Research-I
Paper Code: MTH 604

Objective:
The objective of this course is to acquaint the students with the concept of convex sets, their properties and various separation theorems so as to tackle with problems of optimization of functions of several variables over polyhedron and their duals. The results, methods and techniques contained in this paper are very well suited to the realistic problems in almost every area.

UNIT-I 14 Hours

UNIT-II 14 Hours

UNIT-III 14 Hours
The General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, linear programming formulation, solution of transportation problem, test for optimality, degeneracy, transportation algorithm(MODI method), time minimization transportation problem. Assignment Problems: Mathematical formulation of assignment problem, the assignment method, typical assignment problem, the traveling salesman problem.

UNIT-IV 14 Hours
Game Theory: Two-person zero sum games, maximin-minimax principle, games without saddle points (Mixed strategies), graphical solution of $2 \times n$ and $m \times 2$ games, dominance property, arithmetic method of $n \times n$ games, general solution of $m \times n$ rectangular games.

Reference Books:
Objective:
The objective of this course is to introduce to the fundamentals of the study of fluid motion and to the analytical approach to the study of fluid mechanics problems.

UNIT-I 15 Hours
Real fluids and ideal fluids, velocity of fluid at a point, streamlines, path lines, streak lines, velocity potential, vorticity vector, local and particle rate of change, equation of continuity, irrigational and rotational motion, acceleration of fluid, conditions at rigid boundary.

UNIT-II 14 Hours
Euler’s equation of motion, Bernoulli’s equation, their applications, Potential theorems, axially symmetric flows, impulsive motion, Kelvin’s Theorem of circulation, equation of vorticity.

UNIT-III 13 Hours
Some three dimensional flows: sources, sinks and doublets, images in rigid planes, images in solid sphere, Stoke’s stream function.

UNIT-IV 13 Hours
Two dimensional flows: complex velocity potential, Milne Thomson Circle Theorem and applications, Theorem of Blasius, vortex rows, Karman Vortex Street.

Reference Books:

Course Title: DISCRETE MATHEMATICS  
Paper Code: MTH-606

Objectives:
The objective of this course is to acquaint the students with the concepts in Discrete Mathematics. It includes the topics like Logics, Graph Theory, Trees and Boolean algebra.

UNIT-I  
13 HOURS

UNIT-II  
14 HOURS

UNIT-III  
15 HOURS

UNIT-IV  
14 HOURS

Reference Books:
Objective:
The aim of this course is to make the students learn fundamental concepts of finite elements so as to enable the students to understand further topics related to solution of differential equations. Finite element analysis is a helpful tool to solve a variety of problems of science and engineering related to fluid flows, structures etc.

UNIT I 13 HOURS
General theory of finite element methods, Difference between finite element and finite difference, Review of some integral formulae, Concept of discretization, Convergence requirements, Different coordinates, One dimensional finite elements, shape functions, stiffness matrix, connectivity, boundary conditions, equilibrium equation, FEM procedure.

UNIT II 15 HOURS
Generalization of the finite element concepts-weighted residual and variational Approaches (Ritz method, Galerkin method, collocation method etc.) Numerical integration, Interpolation formulas and shape functions, Axis symmetric formulations, solving one-dimensional problems.

UNIT III 13 HOURS
Two dimensional finite element methods, Element types: triangular, rectangular, quadrilateral, sector, curved, isoperimetric elements and numerical integration, two dimensional boundary value problems, connectivity and nodal coordinates, theory of elasticity, variational functions, triangular elements and area coordinates, transformations, cylindrical coordinates.

UNIT IV 15 HOURS
Three dimensional finite elements, higher order finite elements, element continuity, plate finite elements, Application of finite element methods to elasticity problems and heat transfer problems, Computer procedures for Finite element analysis.

Reference Books:
Course Title: Fuzzy Sets and Fuzzy Logic
Paper Code: MTH 608

Objective:
The objective of this course is to acquaint the students with the concept of fuzzy logics.

UNIT-I 15 HOURS

UNIT-II 14 HOURS

UNIT-III 13 HOURS

UNIT-IV 14 HOURS
Fuzzy logic- An overview of classical logic, Multivalued logics. Fuzzy propositions. Fuzzy Quantifiers. Linguistic variables and hedges. Inference from conditional fuzzy propositions, the compositional rule of inference.

Reference Books:

Objectives:
This course is designed to enable the readers to understand further deeper topics of Complex Analysis and will provide basic topics needed for students to pursue research in pure Mathematics.

Unit –I
**15 HOURS**
Harmonic function: Definition, Relation between a harmonic function and an analytic function, Examples, Harmonic Conjugate of a harmonic function, Poisson's Integral formula, Mean Value Property, The maximum & minimum principles for harmonic functions, Dirichlet Problem for a disc and uniqueness of its solution, Characterization of harmonic functions by Mean Value Property.

Unit –II
**14 HOURS**

Unit –III
**15 HOURS**
Weierstrass Elliptic functions: Periodic functions, Simply periodic functions, fundamental period, Jacobi’s first and second question, Doubly periodic functions, Elliptic functions, Pair of Primitive Periods, Congruent points, First and Second Liouville’s Theorem, Relation between zeros and poles of an elliptic function, Definition of Weierstrass elliptic function \((z)\) and their properties, The differential equation satisfied by \((z)\) [i.e., the relation between \((z)\) and \((z)\)], Integral formula for \((z)\), Addition theorem and Duplication formula for \((z)\).

Unit –IV
**13 Hours**
Weierstrass Zeta function: Weierstrass Zeta function and their properties, Quasi periodicity of \((z)\), Weierstrass sigma function \((z)\) and their properties, Quasiperiodicity of \((z)\), associated sigma functions.

Reference Books:
Course Title: Advance Theory of Partial Differential Equations and Sobolev Spaces

Paper Code: MTH 610

Objectives:
The objective of this course is to equip the students with knowledge of some basic as well as advanced concepts related to partial differential equations and to understand some basic approach to mathematical oriented PDEs.

UNIT-I 15 HOURS
Distribution-Test Functions and Distributions, Examples, Operations on Distributions, Supports and Singular Supports, Convolution, Fundamental Solutions, Fourier Transform, Schwartz space, Tempered Distributions.
Sobolev spaces-Basic properties, Approximation by smooth functions, Extension theorems, Compactness theorems, Dual spaces, Functional order spaces, Trace spaces, Trace theory, Inclusion theorem.

UNIT-II 14 HOURS
Evolution Equations- Unbounded linear operators, $C_0$ – Semigroups, Hille-Yosida theorem, Contraction Semigroup on Hilbert Spaces, Heat equation, Wave equation, Schrodinger equation, Inhomogeneous equations.

UNIT-III 13 HOURS

UNIT-IV 14 HOURS

Reference Books:

Objective:
The objective of this course is to introduce Banach and Hilbert spaces. The various operators on Hilbert and Banach spaces are also included.

UNIT-I

UNIT-II
Weak convergence and bounded linear transformations, Normed linear spaces of bounded linear transformations, Dual spaces with examples. Three main theorems on Banach space: Uniform boundedness theorem and some of its consequences, Open mapping and closed graph theorems.

UNIT-III
Hahn-Banach theorem for real linear spaces, Complex linear spaces and normed linear spaces, Reflexive spaces, Weak sequential compactness, Compact operators, Solvability of linear equations in Banach spaces, the closed Range Theorem.

UNIT-IV

Reference Books:
Course Title: Differential Geometry of Manifolds
Paper Code: MTH 612

Objective:
This course is designed to enable the readers to understand advanced topics of Topology and will provide basic topics needed for students to pursue research in pure Mathematics.

UNIT-I 14 Hours
Topological groups, Lie groups and lie algebras. Product of two Lie-groups, One parameter subgroups and exponential maps. Examples of Lie groups, Homomorphism and Isomorphism, Lie transformation groups, General Linear groups.

UNIT-II 14 Hours
Principal fibre bundle, Linear frame bundle, Associated fibre bundle, Vector bundle, Tangent bundle, Induced bundle, Bundle homomorphism.

UNIT-III 14 Hours

UNIT-IV 14 Hours
Almost Complex manifolds, Nijenhuis tensor, Contravariant and covariant almost analytic vector fields, F-connection.

Reference Books:
Course Title: Operational Research-II
Paper Code: MTH 613

Objective:
To acquaint the students with the concepts of convex and non-convex functions, their properties, various optimality results, techniques to solve nonlinear optimization problems and their duals over convex and non-convex domains.

UNIT-I 15 HOURS
Queuing Theory: Introduction, Queuing System, elements of queuing system, distributions of Arrivals, inter arrivals, departure service times and waiting times. Classification of queuing models, Queuing Models: (M/M/1): (∞/FIFO), (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process, (M/M/C): (∞/FIFO), (M/M/C) (N/FIFO).

UNIT-II 14 HOURS
Inventory Control: The inventory decisions, costs associated with inventories, factors affecting Inventory control, Significance of Inventory control, economic order quantity (EOQ), and Deterministic inventory problems with-out shortage and with shortages, EOQ problems with Price breaks, Multi item deterministic problems. Processing of n jobs through two machines, The Algorithm, Processing of n jobs through m machines, Processing of two jobs through m machines.

UNIT-III 13 HOURS

UNIT-IV 14 HOURS

Reference Books:

Course Title: Advanced Numerical Analysis
Paper Code: MTH 615

Objective:
The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to do programming in MATLAB and understand the basic concepts in Numerical Analysis of differential equations.

UNIT-I
15 HOURS
Finite difference approximation to partial derivatives, parabolic equations: An explicit method, Crank Nicolson Implicit method, solution of implicit equations by Gauss Elimination, derivative Boundary conditions, local truncation error, Convergence and stability, Multi-dimensional search without using derivatives, the Method of Rosen brock, Cyclic coordinate method, Method of Hooke and Jeeves and their convergence.

UNIT-II
14 HOURS

UNIT-III
14 HOURS
Numerical Differentiation, Trapezoidal and Simpson’s one third, Simpson’s three eight rule for Numerical integration, adaptive Integration, Boole, Weddle rule, Double integration. Multidimensional search using derivatives, Steepest Descent algorithm and its convergence analysis, Newton’s method and modified Newton’s method. Methods using conjugate directions: the method of Davidon-Fletcher- Powell (DFP) method, the Broyden-Fletcher-Goldfarb-Shanno (BFGS) method

UNIT-IV
14 HOURS
Constrained optimization: Indirect methods, the concept of penalty functions, exterior penalty function method (EPF), exact absolute value and augmented Lagrangian Penalty methods and their convergence analysis. Direct methods, successive linear programming approximation (SLP), successive quadratic programming approximation (SQP), gradient project method of Rosen, generalized reduced gradient method (GRG), convex simplex algorithm of Zangwill

Reference Books:

Course Title: Wavelets Analysis
Paper Code: MTH 616

Objectives:
The course is an introductory course on Wavelets so as to enable the students to understand further topics related to solution of differential equations. Wavelets are a helpful tool to solve a variety of problems of science and engineering such as image processing, cloud computing etc.

UNIT I 15 HOURS

UNIT II 15 HOURS

UNIT III 14 HOURS

UNIT IV 13 HOURS
Discrete transforms and algorithms-The discrete and fast Fourier transforms. The discrete and fast cosine transforms. The discrete version of the local sine and cosine bases. Decomposition and reconstruction algorithms for wavelets.

Reference Books:

Course Title: Fluid Mechanics-II
Paper Code: MTH 617

Objective:
This course is designed to make the students learn to develop mathematical models of fluid dynamical systems and use mathematical techniques to find solutions to these models.

UNIT-I 13 HOURS
Stress components, Stress and strain tensor, coefficient of viscosity and Laminar flow, plane Poiseuille flows and Couette flow.

UNIT-II 13 HOURS
Flow through tubes of uniform cross section in the form of circle, Ellipse, equilateral triangle, annulus, under constant pressure gradient.

UNIT-III 15 HOURS
Diffusion of vorticity. Energy dissipation due to viscosity, steady flow past a fixed sphere, dimensional analysis, Reynolds numbers, Prandtl’s boundary layer. Boundary layer equation in two dimensions, Karman integral equation.

UNIT-IV 14 HOURS
Elements of wave motion, waves in fluids, Surface gravity waves, standing waves, group velocity, energy of propagations, path of particles, waves at interface of two liquids.

Reference Books:

Objective:
The objective of this course is to introduce the special function as a solution of specific differential equations.

UNIT-I 14 HOURS
Legendre polynomial it’s generating function; Rodrigue’s formula, recurrence relations and differential equations satisfied by it; its orthogonality, expansion of a function in a series of Legendre Polynomials.

UNIT-II 12 HOURS
Adjoint equation of n-the order: Lagrange’s identity, solution of equation from the solution of its adjoint equation, self-adjoint equation, Green’s function.

UNIT-III 15 HOURS
Hypergoemetric and Generalized Hypergeometric functions: Function 2F1 (a,b;c;z) A simple integral form evaluation of 2F1 (a,b;c;z) Contiguous function relations, Hyper geometrical differential equation and its solutions, F (a,b;c;z) as function of its parameters, Elementary series manipulations, Simple transformation, Relations between functions of z and 1 –z

UNIT-IV 14 HOURS
Series Solution: Ordinary point and singularity of a second order linear differential equation in the complex plane; Fuch’s theorem, solution about an ordinary point, solution of Hermite equation as an example; Regular singularity, Frobenius’ method – solution about a regular singularity, solutions of hypergeometric, Legendre, Laguerre and Bessel’s equation as examples.

Reference Books:
Course Title: Algebraic Topology
Paper Code: MTH 619

Objective:
The objective of this course is to introduce the

UNIT-I

UNIT-II

UNIT-III
Direct sums of Abelian Groups, Free products of groups, uniqueness of free products, least normal subgroup, free groups, generators and relations, The Seifert-Van Kampen theorem, also classical version, The Fundamental group of a wedge of circles.

UNIT-IV
Classification of covering spaces: Equivalence of covering spaces, The general lifting lemma, the universal covering space, covering transformation, existence of covering spaces.

Reference Books:

Course Title: Mathematics for Chemists
Paper Code: MTH-560

Objective: To provide the understanding and use of mathematical techniques for various chemistry concepts.

UNIT-A 15 HOURS

UNIT-B 14 HOURS

UNIT-C 13 HOURS
Basic concepts, Scalar product, Vector product, Vector differentiation, Arc length. Line, Surface and Volume integrals. The gradient, divergence and curl. The Del operator. Green’s, Gauss’ and Stokes’ theorems (statements only)

UNIT-D 14 HOURS
Permutation and Combination: Idea of Factorial notation for natural numbers, Fundamental principle of counting, basic concept of Permutation, Basic concept of Combination

Probability and probability theorems: introduction to probability, addition theorem of probability, multiplication theorem of probability.

Reference Books:

Course Title: Numerical Analysis  
Paper Code: MTH 551

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**Objective:**
The aim of this course is to teach the applications of various numerical techniques for a variety of problems occurring in daily life. At the end of the course, the students will be able to do programming in MATLAB and understand the basic concepts in Numerical Analysis of differential equations.

**UNIT - A**  
15 HOURS
Approximate numbers, Significant figures, rounding off numbers. Error Absolute, Relative and percentage.

**Algebraic and transcendental equations:** Review of some concepts, Solution of algebraic and transcendental equations: Bisection method, Regula Falsi, Newton Raphson, Lin Barstow’s, convergence.


**UNIT – B**  
13 HOURS
Finite Difference Methods: Forward, Backward, Central differences, Newton’s forward, backward and divided difference formulae, Gauss, Stirling, Bessel central difference formulae.

**UNIT – C**  
14 HOURS
Numerical Differentiation and Numerical Integration: Numerical Differentiation, Trapezoidal and Simpson’s one third, Simpson’s three eight rule for numerical integration, adaptive integration, Taylor’s series method, Euler, modified Euler method, Runge-Kutta methods, Boole, weddle rule, Double integration.

**UNIT – D**  
14 HOURS

**Reference Books:**
Course Title: Computer Fundamentals and Office Automation
Course Code: CSA551
Course Duration: 45 Hours

Course Objective: The objective of this course is to develop understanding of different software and hardware systems available in industry among the participants and to build up the experience of computer usage in business organizations with specific reference to commercial data processing systems.

UNIT – A
Computer Fundamentals and Number System
- Block Structure of a Computer
- Characteristics of Computers
- Generations of Computers, Uses of Computers
- Classification of Computers
- Input-Output Devices, Memory and Mass Storage Devices
- Bit, Byte, Binary, Decimal, Hexadecimal, and Octal Systems, Conversion from One System to the other

UNIT – B
Computer Software, Network & Communication
- Application and system software
- Programming languages and their classification
- Assemblers, compilers and interpreters, Process of software development
- Operating systems: functions of operating systems
- Network topologies
- Network communication devices, Physical communication media
- Network protocol (TCP/IP)
- Internet and its applications: e-mail, TELNET, FTP, World Wide Web, Internet chatting

UNIT – C
Word Processing and Spreadsheets
- Editing and Formatting a Document, Text Formatting, Paragraph Formatting, Headers and Footers
- FIND command & REPLACE command, Checking Spelling and Grammar; On-line Spelling and Grammar correction using Auto correct, Auto Text, Using Thesaurus, Using Clip Gallery
- Inserting Graphics From files, Working with Tables - Entering Text in the Table, Creating Table, Changing Format of Text of cells, Changing Column width and Row height, Formatting Table Border
- Using Mail Merge - Mail Merge Procedure, Printing a document
- Basic Operations - Arithmetic operators, Comparison operators, Text operator & (ampersand) Reference operator
- Modifying the worksheet layout - Changing Width of Column, Changing Height of Row, Deleting Rows/Columns/Cells, Moving
and copying contents of cell, Alignment of text in the cell
- Working with functions - Date and time function, Statistical function, Financial function, Mathematical and Trigonometric functions, Lookup and Reference Functions, Data Base functions, Text function, Logical functions
- Printing the workbook - Setting up Print Area, Setting up Margins, Defining Header and Footer, Controlling Gridlines
- Introduction to CHARTS - Formatting Charts

UNIT – D

Presentations and DBMS
- Creating a presentation slide, Design Templates and Blank presentations, Power Point standard toolbar buttons
- Changing Font, Font Size and Bold; Moving the frame and inserting clip art; Different slide layouts; Formatting the Slide Design; Work with the Slide Master; Saving the presentation
- The Auto Content Wizard; Using Existing Slides; Using the different views of a slide, Adding Transitions and Animation, Running Slide Show
- Adding and Deleting Records
- Creating, Saving, Editing, Joining Tables in Queries
- Creating and Using Forms
- Creating and Printing Reports

Reference Books:

Course Title: Computer Fundamentals and Office Automation Laboratory
Course Code: CSA553

- The laboratory will comprise of using commands and tools available in MS Word, PowerPoint, and Excel.
- Assignments based on the applications of above mentioned software packages.