M.Sc. APPLIED MATHEMATICS (FIRST SEMESTER)

21AM-101: REAL ANALYSIS

(With effect from 2021-2022 Admitted Batch)

Course Code:21AM101

(A total of Ten questions to be set by selecting two questions from each unit with internal choice. Each question carries 16 marks.)

Course outcomes (COs): At the end of the course, the students will be able to

CO1: Apply the knowledge of concepts of real analysis in order to study theoretical development of different mathematical techniques and their applications.

CO2: Understand the nature of abstract mathematics and explore the concepts in further details. Extend their knowledge of real variable theory for further exploration of the subject for going into research.

CO3: Identify challenging problems in real variable theory and find their appropriate solutions.

CO4: Deal with axiomatic structure of metric spaces and generalize the concepts of sequences and series, and continuous functions in metric spaces.

CO5: Use theory of Riemann-Stieltjes integral in solving definite integrals arising in different fields of science and engineering.

Course Specific outcomes (CSOs):

CSO1: Identify challenging problems in real variable theory and find their appropriate solutions.

CSO2: Demonstrate an understanding of the theory of sequences and series, continuity, differentiation and integration; Demonstrate skills in constructing rigorous mathematical arguments.

CSO3: Use multi-variable calculus in solving problems arising in different fields of science and engineering.

Learning Outcomes(LOs): On successful completion of this course, students will be able to:

LO1: Describe the fundamental properties of the real numbers that underpin the formal development of real analysis;

LO2: Demonstrate an understanding of the theory of sequences and series, continuity, differentiation and integration;

LO3: Demonstrate skills in constructing rigorous mathematical arguments;

LO4: Apply the theory in the course to solve a variety of problems at an appropriate level of difficulty;

LO5: Demonstrate skills in communicating mathematics. Read and construct mathematical arguments and proofs.

Mapping of course outcomes with the program outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	

Unit-I

Basic Topology: Finite, countable and uncountable sets, metric spaces, compact sets, perfect sets, connected sets. Continuity: Limits of functions, continuous functions, continuity and compactness, continuity and connectedness, discontinuities, monotone functions, infinite limits and limits at infinity. (Chapters 2 and 4 of Textbook. 1).

Unit-II

The Riemann- Stieltjes integral: Linearity properties, integration by parts, change of variable, reduction to a Riemann integral, monotonically increasing integrators, Riemann's condition, comparison theorems, integrators of bounded variation. (Section 7.1 to 7.7 and 7.11 to7.15 of Textbook. 2)

Unit-III

Sufficient conditions for existence of R-S. integrals, Necessary conditions for existence of R-S integrals, Mean-value theorems for R-S integrals, integral as a function of interval, second fundamental theorem of integral calculus, second mean-value theorem for Riemann integrals. (Section 7.16 to 7.22 of Textbook. 2)

Unit-IV

Multivariable Differential Calculus: Directional derivative, total derivative, Jacobian matrix, chain rule, mean-value theorem for differentiable functions, sufficient conditions for differentiability and for equality of mixed partial derivatives, Taylor's formula for real valued functions in n real variables. (Chapter 12 of Textbook. 2).

Unit-V

Sequences and Series of functions: Uniform convergence, Uniform convergence and Continuity, Uniform convergence and Integration, Uniform convergence and Differentiation. Equicontinuous families of functions, Stone – Weierstrass theorem. (Chapter 7 of Textbook. 1)

Text Books:

1. Principles of Mathematical Analysis by Walter Rudin (3rd edition) McGraw Hill international edition, 1976.
2. Mathematical Analysis by Tom M Apostol (2nd Edition) Addison-Wesley publishing Company.

M.Sc. APPLIED MATHEMATICS (FIRST SEMESTER)

21AM 102: **ORDINARY DIFFERENTIAL EQUATIONS & INTEGRAL EQUATIONS**

(With effect from 2021-2022 Admitted Batch)

Course Code:21AM102

((A total of Ten questions to be set by selecting two questions from each unit with internal choice. Each question carries 16 marks.)

Course Outcome:

CO1: The theory for the solution of linear differential equations with variable coefficients and reducing the order of the equations to find basis will be familiar.

CO2: To be familiar with Series solution of the equations , regular singular points and their solutions.

CO3: Establishing the existence and uniqueness of solutions of initial value problems by method of successive approximations , system of ordinary differential equations and their solutions.

CO4: Integral equations and their relation with differential equation, solution of non-homogeneous Volterra's integral equation are taught.

CO5: To understand iterated kernels as well as Fredholm's integral equations.

Course specific outcome:

CSO1: To develop the methods to solve ODEs.

CSO2: To equip the students to solve differential equations using successive approximations along with Lipschitz condition.

CSO3: To familiarize the students to integral equations and their solutions.

Learning outcomes: On successful completion of this course, students will be able to:

LO1: get familiar with different methods to solve ordinary differential equations.

LO2: find series solutions as well as regular singular points.

LO3: use Lipschitz condition and successive approximations.

LO4: formulate integral equations and classification.

LO5: Fredholm's ,Volterra's type integral equations and various methods to solve them.

Mapping of course outcomes with the program outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	
CO2	✓	✓	✓		
CO3	✓		✓	✓	
CO4	✓	✓	✓	✓	
CO5	✓	✓		✓	

Unit-I

Linear equations with variable coefficients, the Wronskian and linear independence, reduction of the order of homogeneous equations, the non-homogeneous equations. Homogeneous equations with analytic coefficients. (Chapter 3 (excluding section 8 & 9) of Text book 1).

Unit-II

Linear equations with regular singular points, Euler's equations, series solutions, regular singular points at infinity, introduction to existence and uniqueness of solutions of 1^{st} order equations, equations with the variables separated, Exact equations. (Chapter 4 (excluding sections 5, 7 & 8)), (sections 1, 2 & 3 of chapter 5)) of Text book 1.

Unit-III

Picard's method of successive approximations, Lipschitz condition, convergence of the successive approximations, systems as vector equations, existence & uniqueness of solution to systems, (sections 4,5,6,8 & 9 of chapter 5, chapter 6 (sections 1,3,5,6) of Text book 1).

Unit-IV

Integral equations, Differentiation of a function under an integral sign, Relation between differential and integral equation, Solution of non-homogeneous Volterra's integral equation of second kind by the methods of successive substitution and successive approximation. (Chapter 1 & chapter 2 (sections 2.1, 2.2) of Text book 2).

Unit-V

Determination of some resolvent kernels, Volterra integral equation of first kind, Solution of the Fredholm integral equation by the method of successive substitutions, Iterated kernels, Solution of the Fredholm's integral equation by the methods of successive substitution and successive approximation, Reciprocal functions, Volterra's solution of Fredholm's equation. (Chapter 2 (excluding 2.1, 2.2)of Text book 2).

Text books:

1. An Introduction to ordinary differential equations by E.A. Coddington, Prentice Hall of India Pvt. Ltd., New Delhi, 1987.

2. Integral equations by Shanti Swarup, Krishna Prakashan Media (P) Ltd, Meerut, 2003.

M.Sc. APPLIED MATHEMATICS (SECOND SEMESTER)

21AM 103: CLASSICAL MECHANICS

(With effect from 2021-2022 Admitted Batch)

Course Code:21AM103

(A total of ten questions are to be set as internal choice in each unit and the student has to answer one question from each unit. Each question carries 16 marks.)

Course Outcomes(COs): At the end of the course, the students will be able to

CO1: To know what central, conservative and central-conservative forces, mathematically understand the conservative theorems of energy, linear momentum and angular momentum. To know the importance of concepts such as generalized coordinates and constrained motion.

CO2: To know how to impose constraints on a system in order to simplify the methods to be used in solving physics problems in Lagrangian mechanics. To know how to deduce Hamilton's equations from variational principle.

CO3: Understand the concepts of canonical transformations, Poisson and Lagrange brackets.

CO4: To find the linear approximation to any dynamical system near equilibrium and also know how to derive and solve the equations of motion for the dynamical system using Hamilton-Jacobi method.

CO5: To distinguish between 'inertia frame of reference' and 'non-inertial frame of reference'. Also know about Lorentz transformations and consequences of Lorentz transformations.

fundamental problems.

Course Specific Outcomes(CSOs):

CSO1: This course able to develop basic mechanical concepts related to discrete and continuous mechanical systems.

CSO2: Connect concepts and mathematical rigor in order to enhance understanding.

CSO3: Describe and understand the motion of a mechanical system using Lagrange Hamilton formalism.

Learning Outcomes: Upon successful completion of this course, it is intended that a student will be able to

LO1: learn about Lagrangian and Hamiltonian formulation of Classical Mechanics.

LO2: State the conservation principles involving momentum, angular momentum and energy and understand that they follow from the fundamental equations of motion.

LO3: Have a deep understanding of canonical transformations.

LO4: learn about motion of a particle under various constraints.

LO5: Use Euler-Lagrange equation to find stationary paths and its applications in some classical

Mapping of course outcomes with the program outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	√	-	√	√	-
CO2	√	-	√	√	-
CO3	√	√	√	√	-
CO4	√	-	√	√	-
CO5	√	-	√	√	-

Unit-I

Lagrangian Formulation: Mechanics of a particle, mechanics of a system of particles, constraints, generalized coordinates generalized velocity, generalized force and potential. D'Alembert's principle and Lagranges equations, some applications of Lagrangian formulation (scope and treatment as in Art.1.1 to 1.4 and Art 1.6 of Text book.1).

Unit-II

Hamilton's principle, derivation of Lagrange's equations from Hamilton's principle, extension of Hamilton's principle to non-holonomic systems, advantages of variational principle formulation, conservation theorems and symmetry properties (scope and treatment as in Art 2.1 and 2.3 to 2.6 of Text book.1).

Unit-III

Hamiltonian formulation: Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamilton's equations from a variational principle, the principle of least action, the equation of canonical transformation, examples of canonical transformation, the Harmonic Oscillator, the symplectic approach to canonical transformations (scope and treatment as in Art.8.1,8.2,8.5, 8.6 and 9.1 to 9.4 of Text book.1).

Unit-IV

Poisson and Lagrange brackets and their invariance under canonical transformation. Jacobi's identity; Poisson's Theorem. Equations of motion infinitesimal canonical transformation in the Poisson bracket formulation. Hamilton Jacobi Equations for Hamilton's principal function, The harmonic oscillator problem as an example of the Hamilton – Jacobi method, the Hamilton – Jacobi equation for Hamilton's characteristic function (scope and treatment as in Art 9.5,9.6, 10.1, 10.2 and 10.3 of Text book.1)

Unit-V

New concept of space and Time, postulates of special theory of relativity, Lorentz transformation equations, Lorentz contraction, Time dilation, simultaneity, Relativistic formulae for composition of velocities and accelerations, proper time, Lorentz transformations form a group (scope and treatment as in chapters 1 and 2 of Text book.2).

Text books:

1. Classical mechanics by H.Goldstein, 2nd edition, Narosa Publishing House.
2. Relevant topics from Special relativity by W.Rindler, Oliver & Boyd, 1960.

M.Sc. APPLIED MATHEMATICS (FIRST SEMESTER)

21AM104: DISCRETE MATHEMATICAL STRUCTURES

(With effect from 2021-2022 Admitted Batch)

Course Code:21AM104

(A total of five questions are to be set as internal choice with one question from each unit and each question carries 16 marks.)

Course Outcome(COs): At the end of the course, the students will be able to

CO1: familiar to mathematical logic in discrete mathematics and various results.
CO2: Theory of inference and predicate calculus are taught.
CO3:familiarize the students with relations and lattice theory.
CO4: Basic concepts as well as different types of graphs in graph theory are taught.
CO5: understand and use algorithms in graph theory.

Course specific outcome(CSOs):

CSO1:To introduce the students to the topics and techniques of discrete methods and combinatorial reasoning.

CSO2: To introduce a wide variety of applications. The algorithmic approach to the solution of problems is fundamental in discrete mathematics, and this approach reinforces the close ties between this discipline and the area of computer science.

CSO3: To familiarize the students to graph theory and its applications.

Learning outcomes(LOs):

LO1:Student will be able to demonstrate skills in solving mathematical problems
LO2: Student will be able to comprehend mathematical principles and logic
LO3: Student will be able to demonstrate knowledge of mathematical modeling and proficiency in using mathematical software
LO4: Student will be able to manipulate and analyze data numerically and/or graphically using appropriate Software
LO5: Student will be able to communicate effectively mathematical ideas/results verbally or in writing.

Mapping of course outcomes with the program outcomes:

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓
CO3	✓		✓	✓	✓
CO4	✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓

Unit-I

Mathematical logic: statements structures and notation, connectives, well formed formulas, tautologies, equivalences, implications, normal forms – Disjunctive and conjunctive, Principle disjunctive and conjunctive normal forms. (Scope and treatment as in Sections: 1.1 to 1.3 of Text book 1)

Unit-II

Theory of Inference: Theory of inferences for statement calculus, validity using truth tables, rules of Inference. Predicate calculus: predicates, predicate formulas, quantifiers, free and bound variables, Inference theory of predicate calculus. (Scope and treatment as in Sections: 1.4 to 1.6 of Text book 1)

Unit-III

Relations and ordering: partially ordered relations, Partially ordered sets, representation and associated terminology. (Sections 2-3.1, 2-3.2, 2-3.8, 2-3.9 of Chapter 2 in Text book1)
Lattices, Lattices as partially ordered sets, some properties of Lattices, Lattices as algebraic systems, sub-Lattices, direct product and homomorphism some special Lattices.
(Sections: 4-1.1 to 4-1.5 of chapter 4 of Text book.1).

Unit-IV

Graph Theory: Graphs and Multigraphs, Subgraphs, Isomorphism and Homomorphism, Paths, Connectivity, Traversable Multigraph, Labeled and Weighted Graphs, Complete, Regular and Bipartite Graphs, Trees, Planar Graphs. (Scope as in Sections 8.2 to 8.9 of chapter 8 of textbook 2).

Unit-V

Directed Graphs: Rooted Trees, Sequential Representation of Directed Graphs,Warshall's Algorithm, Shortest Path, Binary Trees, Complete and Extended Binary Trees, Representation of Binary Trees, Traversing Binary Trees and Binary Search Trees (Scope as in Sections 9.2 to 9.6 and 9.8 of chapter 9 and 10.1 to 10.6 of chapter 10 of textbook 2).

Text books:

1. Discrete Mathematical structures with Applications to Computer Science by J.P. Trembly and R.Manohar, Tata Mc.Graw hill.

2. Discrete Mathematics, Schaum's outline series, second edition, by Seymour Lipschutz and Marc Lipson Tata Mc Graw-Hill.

M.Sc. APPLIED MATHEMATICS (FIRST SEMESTER)

21AM 105: PROGRAMMING IN C

(With effect from 2021-2022 Admitted Batch)

Course Code:21AM105

(A total of Ten questions to be set by selecting two questions from each unit with internal choice. Each question carries 16 marks.)

Course Outcome(COs):

CO1: All the syntax rules of the programming language C are taught.

CO2: The syntax rules may applied to develop programs for various general problems and mathematical problems.

CO3: The advanced concepts of storing group of homogeneous elements in one name for numerical values and characters.

C04: Handling memory locations and storing heterogeneous group of elements in a common name .

CO5: Scope and extent of variables are taught and using these concepts programs are to be developed.

Course Specific Outcomes(CSOs):

CSO1: Able to develop logic to solve problems and preparing flowchart/algorithm for the solution.

CSO2: Able to apply syntax rules of the language to develop programs.

CSO3: Able to use advanced level techniques like representing group of values with single name, sharing memory and frequently used part as a subprograms.

Learning outcomes(LOs):

LO1: Students may familiar with different syntax rules of the programming language C.

LO2:Students are able to think logically in solving problems.

LO3: Able to develop program on various concepts using control statements.

LO4: Able to develop programs using one dimensional, two dimensional and character arrays.

LO5: Students may familiar to use functions, pointers and structures in developing programs.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2	✓	✓			✓
CO3	✓	✓	✓		
CO4	✓		✓		✓
CO5	✓	✓	✓		✓

Unit-I

Data types, Operators and Some statements: Identifiers and key words, Constants, C operators, Type conversion. Writing a Program in C: Variable declaration, Statements, Simple C Programs, Simple input statement, Simple output statement, Featutre of stdio.h.

Control statements: Conditional expressions: If statement, if-else statement.

Unit-II

Switch statement, Loop statements: For loop, While loop, Do – while loop, Breaking control statements: Break statement, Continue statement, goto statement.

Unit-III

Functions and Program Structures: Introduction, Defining a function, Return statement, Types of Functions, Actual and formal arguments, Local Global variables. The scope of variables: Automatic Variables, Register Variables, Static Variables, External variables, Recursive functions.

Unit-IV

Arrays: Array Notation, Array declaration, Array initialization, Processing with arrays, Arrays and functions, Multidimensional array, Character array.

Pointers: Pointer declaration, Pointer operator, Address Operator, Pointer expressions, Pointer arithmetic.

Unit-V

Pointers: Pointers and functions, Call by value, Call by reference, Pointers and arrays, Pointer and one dimensional array, Pointer and multidimensional array, Pointer and strings, Array of pointers, Pointers to pointers. Structures, Unions: Declaration of Structure, Initializing a structure, Functions and Structures, Arrays of Structures, Arrays within a structure, Structure within a structure, Pointers and structures, Unions.

Text books:

Programming in C by D.Ravichandran, New Age International, 1998 Chapters: 1, 2, 3,4,5,6, and 8.

Reference: Programming in C by E.Balaguruswamy, 6th Edition, McGraw Hill Education.

Lab: Programming in C language

Code: 21AMPR101

Course Outcome:

CO1: Development of programs for computations various problems.

CO2: Editing ,compiling and debuging of the programs.

CO3: Extending the programs with certain modifications.

CO4: Development of programs to compute numerical solutions of differential equations.

CO5: Using pointers and functions developing programs.

Learning Outcome:

LO1: Able to develop and run the programs using control statements

LO2: Able to develop and run programs using loop statements.

LO3: Able to develop programs for group of homogeneous values.

LO4: Able to develop programs using functions.

LO5: Able to develop programs using pointers.

1. Program to solve quadratic equation using switch case structure.
2. Program to convert a given decimal number to octal number.
3. Program to generate prime numbers in a given range.
4. Program to check a given integer is a palindrome.
5. Sorting of numbers using arrays.
6. Compute multiplication of matrices.
7. Compute norm of a matrix using functions

8. Computing numerical integration using Simpson and Tripazodal rules
9. Solving ODE with initial conditions using Adams Bashforth method
10. Solving ODE by fourth Runge-Kutta method.
11. Compute binomial coefficients using recursive function for factorial.
12. Program to check a given string is palindrome .
13. Using pointers copy a string to another string.
14. Using pointers and functions sorting numbers.