M.Sc. APPLIED MATHEMATICS (SECOND SEMESTER)
21AM 201: COMPLEX ANALYSIS
(With effect from 2021-2022 Admitted Batch)
Course Code:21AM201

(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: At the end of the course, the students will be able to

CO1: Represent complex numbers algebraically and geometrically. Define and analyze limits and continuity for complex functions as well as consequences of continuity.

CO2: Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra.

CO3: Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy-Goursat theorem in its extended versions, and the Cauchy integral formula.

CO4: Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

CO5: Describe conformal mapping properties of elementary functions and mapping properties of some special transcendental functions.

Course Specific Outcomes:

CSO1: Understanding of the fundamental axioms in complex analysis and capability of developing ideas based on them.

CSO2: Prepare and motivate students for research studies in mathematical analysis and related fields.

CSO3: Provide knowledge of a wide range of mathematical techniques and application of complex integration methods in other scientific and engineering domains.

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

LO1: Explain the fundamental concepts of complex analysis and their role in modern mathematics and applied contexts.

LO2: Demonstrate accurate and efficient use of complex analysis techniques.

LO3: Demonstrate capacity for mathematical reasoning through analysing, proving and explaining concepts from complex analysis.

LO4: Apply contour integration techniques to diverse situations in physics, engineering and other mathematical contexts.

LO5: Understand relations between conformal mappings and quadratic differentials and how geometric structures are changing under conformal mappings.

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

Unit-I

Analytic and Harmonic functions: Differentiable and analytic functions, Cauchy – Riemann equations, Harmonic functions. Elementary functions: The complex exponential function, The complex logarithm function, Complex exponents, Trigonometric and hyperbolic functions, Inverse trigonometric and hyperbolic functions.

Unit-II

Complex integration: Complex integrals, Contours and contour integrals, The Cauchy – Goursat theorem, The fundamental theorems of integration, Integral representations for analytic functions, The theorems of Morera and Liouville and extensions.

Unit-III

Taylor and Laurent series: Uniform convergence, Taylor series representations, Laurent series representations, singularities, Zeros and poles, Applications of Taylor and Laurent series.

Unit-IV

Residue theory: The residue theorem, Trigonometric integrals, Improper integrals of rational functions, Improper integrals involving trigonometric functions, Indented contour integrals, Integrals with branch point, The Argument principle and Rouche's theorem.

Unit-V

Conformal mapping: Basic properties of conformal mapping, Bilinear transformations, Mappings involving elementary functions, Mapping by trigonometric functions.

Text book: Complex analysis for Mathematics and Engineering–5th Edition by John H. Mathews and Russel W, Howell. Narosa publishing house **(Chapters: 3, 5,6, 7, 8 & 10)**

M.Sc. APPLIED MATHEMATICS (SECOND SEMESTER)

21AM 202: PARTIAL DIFFERENTIAL EQUATIONS & INTEGRAL TRANSFORMS

(With effect from 2021-2022 Admitted Batch)

Course Code:21AM202

(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: Familiar with formulation and solving first order pdes by various methods

CO2:Familiar with classifying, reducing to canonical forms and solving second order pdes.

CO3: Familiar with modelling the vibrating string, wave equation and their solutions its applications by second order pdes.

CO4: Familiar with Laplace transforms, their properties and solving equations using with the transforms.

CO5: Familiar with Fourier transforms, their properties and its applications.

Course Specific Outcome(CSOs):

CSO1: First order and second order partial differential equations their classifications and solving them.

CSO2: Modelling the physical systems by second order partial differential equations and their interpretation.

CSO3: Integral Transforms their validity and its applications to solving various problems.

Learning Outcomes(LOs):

LO1: Able to formulate and solving partial differential equations of first order.

LO2: Able to classify, reducing and solving higher order partial differential equations.

LO3: Able to formulate mathematical models for certain physical systems and computing the solutions.

LO4: Able to understand the existence, definition and properties of Laplace transforms and its applications.

LO5: Able to understand the concept of Fourier transforms and solving initial and boundary value problems.

Mapping of course outcomes with the program outcomes:

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

Unit-I

Partial differential equations: Equations of the form dx/p=dy/q=dz/r, Orthogonal trajectories, Pfaffian differential equations, 1^{st} order partial differential equations; Charpit's method and some special methods. Jacobi's method. (Chapter 1 (excluding sections 7 & 8), Chapter-II (excluding section 14) of Text book 1).

Unit-II

Second order Partial differential equations with constant & variable coefficients, canonical forms, separation of variables method, Monge's method (Chapter III (excluding section 10) of Text book 1).

Unit-III

Partial differential equations – Modeling : vibrating string, one-dimensional wave equation, separation of variables, D'Alembert's solution of the wave equation, one-dimensional heat flow, heat flow in an infinite bar, two-dimensional wave equation. (Chapter 11 – Section 11.2 to 11.7 of Text book 2)

Unit-IV

Laplace Transform definition, conditions for existence, properties, problems, inverse Laplace transforms, convolution theorem, applications of convolution theorems, solutions of ordinary, partial differential equations using Laplace transforms.(Chapters 1,2,3 of Text book 3)

Unit-V

Fourier Transform definition, conditions for existence, properties, problems, inverse Fourier transforms, relation between Laplace and Fourier Transforms, Fourier sine transforms, Fourier Cosine transform, finite Fourier transforms, applications of convolution theorems, solutions of ordinary, partial differential equations using Fourier transforms (Chapters 6 and 8 (sections 8.1 & 8.2 only) of Text book 3)

Text books:

1. I.N. Sneddon, Elements of partial differential equations. Mc Graw Hill International student Edition, 1964.
2. Advanced Engineering Mathematics by Erwin Kreyszig, 5^{th} Edition, New Age International (P) Limited Publishers.
3. A.R.Vasishtha & R.K.Gupta, Integral transforms, Krishna Prakashan Media (P) Ltd, Meerut, 2003.

M.Sc. APPLIED MATHEMATICS(SECOND SEMESTER)
AM 203: STATISTICS AND DISTRIBUTION THEORY
(With effect from 2021-2022 Admitted Batch)
Course Code:21AM203

(A total of ten questions are to be set taking two questions from each unit with internal choice in each unit. Each question carries 16 marks.)

Course Outcome(COs):

CO1: This course introduces some key concepts of probability, random variables and distributions. Provides an in-depth knowledge of understanding the statistical theory with real time examples in various social sciences.

CO2: Knowledge of basic understanding of various statistical processes and related problem solving skills are developed.

CO3: Improves the logical thinking ability of the students and applying the skills using various software packages like SPSS, SAS, etc.

CO4: Increases the subject knowledge that helps in pursuing higher studies as well as getting employment.

Course Specific Outcome(CSOs):

CSO1: Study on the basic concepts ofprobability and statisticaltheory, random variables and various distributions.

CSO2: Introducing the concepts of important probability distributions, correlation and regression analysis and testing of hypothesis.

CSO3: Gain knowledge of finding unknown distribution functions, their properties, problem solving skills.

Learning Outcome:

LO1: After studying the students are expected to learn some basic concepts of probability and statistics.

LO2: Applying the concepts to tests of hypothesis under various situations.

LO3: Knowledge of basic understanding of various statistical processes and related problem solving skills are developed.

LO4: Learns the concepts of correlation and regression analysis and curve fitting.

LO5: Gains knowledge and orientation for applying the knowledge for problem solving through various statistical packages.

Mapping of course outcomes with the program outcomes

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

Unit-I

Random variables, distribution functions, Mathematical expectation and Generating functions:

One and two dimensional random variables (Discrete and Continuous), Distribution functions, joint and conditional distribution functions, probability mass function, probability density function, Transformation of Random variables.

Mathematical expectation, Moments of a distribution function, moment generating functions, characteristic functions and their properties, Chebychev inequality, probability generating functions. (Chapter 5, Chapter 6 except section 6.7 and
Chapter 7-Sections 7.1, 7.2, 7.3, 7.5 and 7.9)

Unit-II

Probability Distributions:

Discrete Distributions-Binomial, Poisson and geometric distributions and their properties with applications. (Sections 8.1-8.5 and 8.7 of Chapter8)

Continuous distributions – Gamma, Beta, Cauchy, Normal distributions and their properties with applications (Sections 9.1, 9.2, 9.5, 9.6,9.7 and 9.12 of chapter 9)

Unit-III

1. **Correlation and Regression:**

Correlation, Karl Pearson's coefficient of correlation, Calculation of correlation coefficient for Bivariate frequency distribution, Spearman's rank correlation coefficient. Linear regression-regression coefficients and their properties, angle between regression lines, standard error of estimate, curvilinear regression (Chapter 10 and Chapter 11)

Unit-IV

2. **Large Sample Theory:** Types of sampling, tests of significance, procedure for testing of hypothesis, tests of significance for large samples, sampling of attributes, sampling of variables (Chapter 14)

Unit-V

5. **Exact Sampling Distributions:**

Exact sampling distributions, χ^2, t, F distributions and their applications. (Chapter 15 up to 15.6.4 and Chapter 16 up to 16.6 except 16.4)

TEXT BOOK: Fundamentals of Mathematical Statistics-S.C.Gupta and V.K.Kapoor,
11 edition Sultan Chand and Sons, New Delhi

REFERENCE: An introduction to probability theory and mathematical statistics –
V.K.Rohatgi Wiley Eastern Ltd, New Delhi

M.Sc. APPLIED MATHEMATICS (SECOND SEMESTER)
21AM 204: Elements of Elasticity and Fluid Dynamics
(With effect from 2021-2022 Admitted Batch)
Course Code:21AM204

(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 Outcomes(COs):

CO1: Familiar with basic concepts on fluid motion and their physical properties.
CO2: Familiar with Euler's equation of motion, Bernoulli's equation and Kelvin's circulation theorem ,their solutions and properties.
CO3: Familiar with two dimensional fluid flow, classification of flows, Milne-Thomson circle theorem, and Blasius theorem.
CO4: Familiar with basic concepts on Analysis of strain and their properties.
CO5: Familiar with basic concepts on stress and their properties.

Course specific Outcomes(CSOs):

CSO1: Differentiate between fluids and solids their properties.
CSO2: Properties of various fluid flows and their classifications.
CSO3: The properties of strain and stress components will be familiar.

Learning Outcomes(LOs):

LO1: Able to understand the equation of continuity and general analysis of fluid motion.
LO2: Able to understand the equation of motion of a fluid , Bernoulli's equation and circulation theorem.
LO3: Able to understand the two dimensional fluid flows and their properties.
LO4: Able to understand the various deformations and equation of compatibility.
LO5: Able to understand the properties of the stress , Mohr's Diagram and certain examples of stress.

Mapping of course outcomes with the program outcomes:

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

Unit-I

Kinematics of fluids, real and ideal fluids, velocity of fluid at a point, streamlines and path lines, velocity potential, velocity vector, local and particle rates of change, equation of continuity, Acceleration of fluid, conditions at a rigid boundary, General analysis of fluid motion (Chapter 2 of Text book 1).

Unit-II

Equation of motion of a fluid, pressure at a point in a fluid at rest and in a moving fluid, conditions at a boundary of two in viscid immiscible fluids, Euler's equations of motion, Bernoulli's equation. Discussion of the case of steady motion under conservative body forces, Vortex motion, Kelvin's circulation theorem. Some further aspects of vortex motion (Chapter 3(excluding sections 3.8 to 3.11) of Text book 1).

Unit-III

Some two - dimensional flows: Meaning of two - dimensional flow, use of cylindrical polar coordinates, the stream function, the complex potential for two – dimensional, irrotational, incompressible flow, complex potential for standard two – dimensional flows, some worked examples, two - dimensional image systems. The Milne- Thomson circle theorem, the theorem of Blasius (Chapter 5(excluding sections 5.10 to 5.12) of Text book 1).

Unit-IV

Analysis of strain: Deformation, affine deformation, infinitesimal affine deformation, geometrical interpretation of the components of strain, strain quadric of Cauchy, principal directions, invariants, general infinitesimal deformation, Examples of strain, equations of compatibility, finite deformations. (Chapter 1 of Text book 2)

Unit-V

Analysis of stress, body and surface forces, stress tensor, equations of equilibrium, transformation of coordinates, stress quadric of Cauchy, Mohr's diagram, examples of stress (Chapter 2 of Text book2)

Text books:

1. Text book of Fluid Dynamics by F.Chorlton, CBS publishers and distributors, New Delhi.
2. Mathematical theory of Elasticity, by I.S.SOKOLNIKOFF 2nd edition; Tata Mc Graw Hill-New Delhi

M.Sc. APPLIED MATHEMATICS (SECOND SEMESTER)

21AM 205: NUMERICAL ANALYSIS
(With effect from 2021-2022 Admitted Batch)
Course Code:21AM205

(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: Identity and analyze different types of errors encountered in numerical computing

CO2:Apply the knowledge of Numerical Mathematics to solve problems efficiently arising in science, engineering.

CO3: Utilize the tools of the Numerical Mathematics in order to formulate the real-world problems from the view point of numerical mathematics.

CO4: Design, analyze and implement of numerical methods for solving different types of problems, viz. initial and boundary value problems of ordinary differential equations etc.

CO5: Create, select and apply appropriate numerical techniques with the understanding of their limitations so that any possible modification in these techniques could be carried out in further research.

CO6: Identify the challenging problems in continuous mathematics (which are difficult to deal with analytically) and find their appropriate solutions accurately and efficiently.

Course Specific outcomes (CSOs):

CSO1: Students will learn numerical techniques to solve differential equations.

CSO2: students will gain understanding in the theoretical and practical aspects of the use of numerical methods.

CSO3 : They will be able to handle challenging problems in and find their appropriate solutions efficiently.

Learning outcomes (LOs):

LO1: In this course, students will learn well-known numerical techniques to solve differential equations, root finding problems.

LO2: The objective will be to train students to understand why the numerical methods work, what type of errors to expect, and when an application might lead to difficulties.

LO3: In particular, the students will become proficient in: Understanding the theoretical and practical aspects of the use of numerical methods.

LO4: Implementing numerical methods for a variety of multidisciplinary applications.

LO5: Establishing the limitations, advantages, and disadvantages of numerical methods.

Mapping of course outcomes with the program outcomes:

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

Unit-I

Numerical techniques of solving transcendental and polynomial equations: Bisection methods, secant method, Newton-Raphson method, Chebyshev method, Rate of convergence. (Sec 2.1-2.5 of Textbook 1)

Unit-II

Numerical techniques of solving system of Linear Algebraic equations: Triangularization method, Gauss elimination method, Gauss-Jordan method, Iterative methods: Jacobi method, Gauss-Seidel method. Numerical techniques of determining the eigen values and eigen vectors of a matrix: Jacobi method, Power method. (Sec 3.1-3.7, 3.11 of Text book 1).

Unit-III

Approximation: Lagrange interpolation, Hermite interpolation, Spline interpolation, Least squares approximation. Methods based on undetermined coefficients – Gauss Legendre, Gauss-Chebyshev integration methods, Lobatto integration, Composite integration methods – Trapezoidal rule, Simpson's rule and Romberg integration. (Sec 4.1-4.6, 4.9, 5.6-5.10 of Text book.1).

Unit-IV

Numerical techniques for solving ordinary differential equations: Euler method, backward Euler method, Midpoint method. Single step methods: Taylor series method, Runge-Kutta methods, Multistep methods: Predictor-corrector method, Adams Bashforth method, Adams –Moulton method, Convergence and stability analysis of single – step methods. (Sec 6.1-6.7 of Text book 1)

Unit-V

Numerical methods for solving elliptic partial differential equations: Difference methods, Dirichlet problem, Laplace and Poisson equations. (Sec 1.1, 1.2, 4.1, 4.2 of Text book 2).

Text books:

1. Numerical method for Scientific and Engineering Computation, M.K. Jain, S.R.K. Iyengar and R.K. Jain, 6rd edition, 2012, New Age International Pvt. Ltd.
2. Computational methods for partial differential equations by M.K. Jain, S.R.K. Iyengar and R.K. Jain, New Age International Pvt. Ltd. (1993).