Department of Mathematics

Course Outcomes (U.G) (2022-2023)

B.Sc. - I Semester

Subject: Algebra **Subject Code: BM-111**

Course Outcomes: In this course students will be able to get:

- Find the inverse of a square matrix.
- Solve the matrix equation Ax=b using row operations and matrix operations.
- Find the determinant of a product of square matrices, of the transpose of a square matrix, and of the inverse of an invertible matrix.
- Find the characteristic equation, Eigen values and corresponding Eigen vectors of a given matrix.

Subject: Calculus **Subject Code: BM-112**

Course Outcomes: This course will enable the students to:

- Understand the relationship between the derivative and the definition integral as expressed in both parts of the Fundamental Theorem of Calculus.
- Locate the x and y intercepts, any undefined points, and any asymptotes.
- Determine asymptotes for rational expressions(we will not go into these graphs in much detail)
- Apply the techniques from the previous section to graph a fourth degree polynomial or higher.
- Determine if there is any symmetry to aid in the graphing process.
- Determine the points of intersection of pairs of curves.

Subject: Solid Geometry **Subject Code: BM-113**

Course Outcomes: This course will enable the students to:

- Understand geometrical terminology for angles, triangles, quadrilaterals and circles.
- Measure angles using a protractor.
- Use geometrical results to determine unknown angles.
- Recognize line and rotational symmetries
- Find the areas of triangles, quadrilaterals and circles and shapes based on these.

B.Sc. - II Semester

Subject: Number Theory and Trigonometry **Subject Code: BM-121**

Course Outcomes: This course will enable the students to:

- Demonstrate knowledge and understanding of topics including, but not limited to divisibility, prime numbers, congruence, quadratic reciprocity, Diophantine equations.
- Learn methods and techniques used in number theory.
- Write programs/functions to compute number theoretic functions.
- Use mathematical induction and other types of proof writing techniques.
- Evaluate trigonometric and inverse trigonometric functions.
- Solve trigonometric equations and applications.

Subject: Ordinary Differential Equations **Subject Code: BM-122**

Course Outcomes: This course will enable the students to:

- Student will be able to solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases and find the complete solution of a non homogeneous differential equation as a linear combination of the complementary function and a particular solution.
- Student will be introduced to the complete solution of a non homogeneous differential equation with constant coefficients by the method of undetermined coefficients.
- Student will be able to find the complete solution of a differential equation with constant coefficients by variation of parameters.
- Student will have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.

Subject: Vector Calculus **Subject Code: BM-123**

Course Outcomes: This course will enable the students to:

- Memorize definition of directional derivative and gradient and illustrate geometric meanings with the aid of sketches.
- Memorize theorem relating directional derivative to gradient and reproduce proof.
- Calculate directional derivatives and gradients.
- Apply gradient to solve problems involving normal vectors to level surfaces.
- Explain the concept of vector integration a plane and in space.

B.Sc.- III Semester

Subject: Advanced Calculus **Subject Code: BM-231**

Course Outcomes: This course will enable the students to:

- To understand Different indeterminate forms of limit.
- Calculate functional value in neighborhood of some point using expansions.
- To understand the behavior of curve in space.
- Continuity and Limits - Prove convergence and divergence of limits using the ϵ-δ definition.
- Differentiation - Identify and prove basic facts about derivatives and their properties.
- To understand the maximum and minimum behavior of a function of two variables.

Subject: Partial Differential Equation **Subject Code: BM-232**

Course Outcomes: This course will enable the students to:

- Classify partial differential equations and transform into canonical form
- Solve linear partial differential equations of both first and second order
- Apply partial derivative equation techniques to predict the behavior of certain phenomena.
- Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.
- Extract information from partial derivative models in order to interpret reality.
- Identify real phenomena as models of partial derivative equations.

Subject: Statics **Subject Code: BM-233**

Course Outcomes: This course will enable the students to:

- An ability to construct free-body diagrams and to calculate the reactions necessary to ensure static equilibrium.
- An understanding of the analysis of distributed loads.
- Knowledge of internal forces and moments in members.
- An ability to calculate centroids and moments of inertia.

B.Sc.- IV Semester

Subject: Sequences and Series **Subject Code: BM-241**

Course Outcomes: This course will enable the students to:

- Determine if an infinite sequence is bounded.
- Determine if an infinite sequence is monotonic.
- Determine if an infinite sequence is convergent or divergent
- Find the sequence of partial sums of an infinite series.
- Determine if a geometric series is convergent or divergent.
- Find the sum of a convergent geometric series.
- Determine if an infinite series is convergent or divergent by selecting the appropriate test from the following: (a) test for divergence; (b) integral test; (c) p-series test; (d) the comparison tests; (e) alternating series test; (f) absolute convergence test; (g) ratio test; and (h) root test.
- Determine if an infinite series converges absolutely or conditionally.

Subject: Special Function & Integral Transforms **Subject Code: BM-242**

Course Outcomes: This course will enable the students to:

- Understand integral calculus and special functions of various engineering problem and to known the application of some basic mathematical methods via all these special functions.
- Explain the applications and the usefulness of these special functions.
- Classify and explain the functions of different types of differential equations.
- Understand purpose and functions of the gamma and beta functions, Fourier series and Transformation.
- Use the gamma function, beta function and special functions to: evaluate different types of integral calculus problems and Fourier series to solve differential equations.

Subject: Programming in C & Numerical Methods **Subject Code: BM-243**

Course Outcomes: This course will enable the students to:

- Read, understand and trace the execution of programs written in C language.
- Write the C code for a given algorithm.
- Write programs that perform operations using derived data types.
- Solve an algebraic or transcendental equation using an appropriate numerical method.
- Solve a linear system of equations using an appropriate numerical method.
- Perform an error analysis for a given numerical method.

B.Sc.- V Semester

Subject: Real Analysis **Subject Code: BM-351**

Course Outcomes: This course will enable the students to:

- Describe fundamental properties of the real numbers that lead to the formal development of real analysis.
- Comprehend rigorous arguments developing the theory underpinning real analysis.
- Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.
- Construct rigorous mathematical proofs of basic results in real analysis.
- Appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

Subject: Groups & Rings **Subject Code: BM-352**

Course Outcomes:

- Understand the importance of algebraic properties with regard to working within various number systems.
- Extend group structure to finite permutation groups (Cayley's Theorem).
- Generate groups given specific conditions.
- Investigate symmetry using group theory.
- Understand the three major concrete models of Boolean algebra: the algebra of sets, the algebra of electrical circuits, and the algebra of logic.

Subject: Numerical Analysis **Subject Code: BM-353**

Course Outcomes: At the end of this course, students will be able to:

- Understand the theoretical and practical aspects of the use of numerical analysis.
- Proficient in implementing numerical methods for a variety of multidisciplinary applications.
- Establish the limitations, advantages, and disadvantages of numerical analysis.
- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Understand of common numerical analysis and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.

B.Sc. - VI Semester

Subject: Real & Complex Analysis **Subject Code: BM-361**

Course Outcomes: At the end of this course, students will be able to:

- Students will be able to understand the concept of limit for real functions and be able to calculate limits of standard functions and construct simple proofs involving this concept.
- Student will be introduced to the concept of continuity and be familiar with the statements and proofs of the standard results about continuous real functions.
- Student will understand the concept of the differentiability of a real valued function and be familiar with the statements and proofs of the standard results about differentiable real functions.
- Student will have a working knowledge of differentiability for complex functions and be familiar with the Cauchy-Riemann equations.
- Student will evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem.

Subject: Linear Algebra **Subject Code: BM-362**

Course Outcomes: At the end of this course, students will be able to:

- Identify and construct linear transformations of a matrix.
- Characterize linear transformations as onto, one-to-one.
- Solve linear systems represented as linear transforms.
- Express linear transforms in other forms, such as matrix equations, and vector equations.
- Characterize a set of vectors and linear systems using the concept of linear independence.

Subject: Dynamics **Subject Code: BM-363**

Course Outcomes: This course will enable the students to:

- An ability to construct free-body diagrams.
- An understanding of the analysis of distributed loads.
- Knowledge of internal forces and moments in members.
- Apply Kepler’s laws to solve the problems.

B.Com-I Semester I

Subject: Business Mathematics-I **Subject Code: BC-105**

Course Outcomes: This course will enable the students to:

- The students will be able to learn the logarithms and arithmetic and geometric progressions and applications.
- Familiarize with the concepts of matrices and determinants. Learn to solve system of simultaneous linear equations.
- Have the conceptual knowledge of compound interest, annuity, loan, debenture and sinking funds and attain skills to use these concepts in daily life.

B.Com-I Semester II

Subject: Business Mathematics-II **Subject Code: BC-205**

Course Outcomes: This course will enable the students to:

- The student will be able to apply binomial theorem, learn the concept and applications of permutation and combinations.
- Learn the concept of linear programming problems and formulation of programming problems related to business and commerce.

Department of Mathematics

Course Outcomes (P.G) (2022-2023)

M.Sc. (1st Semester)

Subject: Advance Abstract Algebra-I (MM-401)

Course Outcomes: Through this course students will be able to:

- Understand the concepts of group, ring, field, and will be able to readily give examples of each of these kinds of algebraic structures.
- Have deep knowledge of the concepts of cosets and normal subgroups and to prove elementary propositions involving these concepts.
- Learn about the concept of subgroup and will be able to determine (prove or disprove), in specific examples, whether a given subset of a group is a subgroup of the group.
- Define and work with the concepts of homomorphism and isomorphism.
- Apply the basic concepts of field theory, including field extensions and finite fields.

Subject: Real Analysis -I (MM-402)

Course Outcomes: In this course students will be able to get:

- Fluency in convergence test using standard methods, including the ability to find an appropriate test for a given sequence or series.
- Understanding ideas and concept of Riemann – Stieltjes integral and facility in solving standard examples.
- Fluency in solving standard methods, including the ability to find an appropriate method for a given function of several variables.
- Learn about the concepts of power Series, exponential & logarithmic functions, trigonometric functions, Fourier series and Gamma function; apply the knowledge to prove specified theorems.

Subject: Topology-I(MM-403)

Course Outcomes: Upon successful completion of the program the students will be aware of:

- The definitions of standard terms in topology.
- How to read and write proofs in topology with a variety of examples and counter examples.

- Some important concepts like continuity, compactness, connectedness, projection mapping etc.
- Count ability, separation axioms and convergence in topological spaces.
- Learn about first and second countable spaces, separable and Lindelof spaces, continuous functions, separation axioms and their properties.
- Know about quotient topology; demonstrate understanding of the statements and proofs of Embedding theorem and Urysohn's Lemma
- Using new ideas in mathematics and helping them in communicating the subject with other subjects.

Subject: Complex Analysis –I (MM-404)

Course Outcomes: This course will enable the students to:

- Understand the concepts of limit, continuity, differentiation and integration for functions defined over a complex plane as well as for the elementary functions.
- Solve the complex integrals of various kinds through the applications of relevant theorems, formulae and power series expansions.
- Analyze the complex functions with singularities for zeroes and residues at poles and apply the results to solve the improper integrals.
- Solve complex improper integrals through the indentation, transformation/mapping of integration paths so as to avoid singularities and branch points/cuts.

Subject: Differential Equation-I (MM-405)

Course Outcomes: This course will enable the students to:

- Understand concepts of an initial value problem and its exact and approximate solutions, existence of solutions, uniqueness of solutions and continuation of solutions of an initial value problem of order one. Apply the knowledge to prove specified theorems and to solve relevant exercises.
- Learn about system of linear differential equations of first order and its preliminary concepts, homogeneous and non-homogeneous linear systems, existence and uniqueness theory, fundamental matrix, theory of adjoint systems, linear systems with constant

coefficients and with periodic coefficients. Attain the skill to obtain fundamental matrix of such a given linear system to demonstrate problem solving.

- Have deep understanding of theory of linear differential equations of higher order by getting knowledge of basic theory, Wronskian theory and fundamental sets, adjoint equations and standard theorems related to these topics.
- Understand system of differential equations and its existence theory, dependence of solution of an IVP on initial parameters, extremal solutions, upper and lower solutions so as to be able to develop research aptitude in this area.

Subject: Practical-I(MM-406)

Course Outcomes: At the end of this course, students will be able to:

- Solve practical problems related to theory courses undertaken in Semester-I from application point of view.
- Know syntax of expressions, statements, structures and to write source code for a program in C.
- Edit, compile and execute the source program for desired results.
- Debug, verify/check and obtain output of results.

M.Sc. (2nd Semester)

Subject: Advance Abstract Algebra-II (MM-407)

Course Outcomes: Upon successful completion of the program the students will be able to:

- Understand concepts of irreducible polynomial, Eisenstein criterion, field extension, algebraic and transcendental extension, algebraically closed field.
- Have deep understanding of Splitting fields, normal extension, multiple roots, prime field, finite field and separable extension.
- Learn about automorphism groups, fixed field, Dedekind lemma, fundamental theorem of Galois theory, roots of unity, Cyclotomic polynomial and cyclic extension.
- Have deep understanding of polynomials solvable by radicals, symmetric functions, ruler and compass construction.

Subject: Real Analysis-II (MM-408)

Course Outcomes: This course will develop:

- An appreciation of the basic concepts of measure theory. Able to learn advanced the Lebesgue measure and Lebesgue integral with related problems.
- Demonstrate understanding of the statement and proofs to Study the Stone-Weierstrass theorem and its applications.
- Understanding of the basic concepts underlying the definition of the general Lebesgue integral and apply the theory of the course to solve a variety of problems at an appropriate level of difficulty.
- Describe the Riemann integral and convergence of measure.
- Apply the concept of Mean-value theorem for differentiable functions.

Subject: Computer programming (MM-409)

Course Outcomes: In this course students able to:

- Get familiar with the importance and working of FORTRON as computation platform through the knowledge of characters, variables, operators, functions.
- Learn about the Format specification, strings and array.

- Know about the concepts and features of FORTRON 90 and FORTRON 95.

Subject: Complex Analysis-II (MM-410)

Course Outcomes: After Completion of the course, Students will be able to:

- Solve definite integral easily which is quite difficult by analytical method.
- Understanding fixed points would help students to learn more about those types of functions which possess fixed points.
- Learn more about everywhere differentiable functions and they will learn how it helps them to decide analyticity of function.

Subject: Differential Equations-II (MM-411)

Course Outcomes: On successful completion of the course, the students should be able to:

- Have a deep understanding of elementary concept of Linear and non linear differential equations.
- The student will be able to define and work with the concept of Boundedness of solutions and Strum theory.
- The student will be able to define and work with the concept of Autonomous system.
- The student will be able to apply the Neumann's integral and limit cycles and periodic solutions.
- Learn about the secondary order boundary problem, Sturm-Liouville BVP, use of implicit function theorem.

Subject: Practical-II (MM-412)

Course Outcomes: This course will develop:

- Understanding of the syntax of a language, statements, structures and to write source code for a program in FORTRON.
- Edit, compile and execute the source program for desired results.
- Solve the numeric problems in FORTRON-90 with different array and data types.

M.Sc. (3rd Semester)

Subject: Functional Analysis (MM-501)

Course Outcomes: In this course students will get to:

- Know about the requirements of a norm; completeness with respect to a norm; understand relation between compactness and dimension of a space; check boundedness of a linear operator and relate to continuity; convergence of operators by using a suitable norm; apply the knowledge to compute the dual spaces.
- Extend a linear functional under suitable conditions; apply the knowledge to prove Hahn Banach Theorem for further application to bounded linear functionals on C[a,b]; know about adjoint of operators; understand reflexivity of a space and demonstrateunderstanding of the statement and proof of uniform boundedness theorem.
- Know about strong and weak convergence; understand open mapping theorem, bounded inverse theorem and closed graph theorem; distinguish between Banach spaces and Hilbert spaces; decompose a Hilbert space in terms of orthogonal complements.
- Understand totality of orthonormal sets and sequences; represent a bounded linear functional in terms of inner product; classify operators into self-adjoint, unitary and normal operators.

Subject: Analytical Mechanics and Calculus of Variations (MM-502)

Course Outcomes: This course will enhance the knowledge among the students to:

- Demonstrate an ability to use mathematical techniques and analysis to model physical behavior involving mechanics.
- solve problems about the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.
- Understand concepts calculus of variations and to solve variational problems of different forms of functionals.

Subject: Elasticity (MM-503) (opt. i)

Course Outcomes: This course will enable the students to:

- Understand concepts of extension and torsion and learn to solve different electrostatics problems of extension and torsion of beams.
- Learn techniques to make use of complex analysis (analytic functions, conformal mappings) for solving electrostatics problems. Be familiar with flexure of beams of different cross-sections.
- Understand plane deformation, plain stress and Airy Stress function and attain capability to solve two dimensional problems in elasticity for analytical solutions.
- Learn techniques for solving some scientifically important electrodynamics problems in three dimensions and understand vibrations of elastic solids and wave propagation in such solids.

Subject: Fluid Mechanics (MM-504) (opt. i)

Course Outcomes: Through this course students will be able to know:

- Apply Bernoulli's equation to fluid flow problems and boundary layer theory to determine lift and drag forces on a submerged body.
- Apply appropriate equations and principles to analyze pipe flow problems.
- Use of different fluid flow measuring devices.

Subject: Integral Equations (MM-505) (opt. i)

Course Outcomes: This course will enable the students to:

- Understand the concept of integral equations to identify different constituents to classify them and to apply the eigen-system method for solving the Fredholm type with separable kernel.
- Derive procedures to for iterative methods to solve integral equations of both Fredholm and Volterra types without restricting the kernel to be separable and proving specific theorems of Fredholm's theory.
- Design methods for solving the integral equations with symmetric kernel as linear/bilinear expansions over an orthonormal system of functions and to prove various theorems to analyse these methods. Apply the knowledge to solve problems.

- Learn the use of numerical methods for finding an eigenvalue and the analytical methods to solve the singular integral equations from Cauchy-type to Hilbert-type, which involve Cauchy's principal value, closed/open contours and the Riemann Hilbert problem.

Subject: Practical-III (MM-506)

Course Outcomes: On successful completion of the course, the students should be able to:

- Solve practical problems related to core courses undertaken in the Semester-III from an application point of view.
- Learn advanced features of the language, debugging and test the code of theFORTRON language.
- Know about the serval features of the language such as array operations, modules, dynamic memory allocations and object-oriented programming.
- Solve the numeric problems in FORTRON-95.

M.Sc. (4th Semester)

Subject: General Measure and Integration theory (MM-507)

Course Outcomes: This course will enable the students to:

- Understand the concept of measure defined on a ring of sets, its properties; extension, uniqueness and completeness of measures; measurable spaces, measurable and simple functions.
- Have deep understanding of the concepts of convergence in measure, almost uniform convergence; apply the knowledge to prove Egoroff's theorem, Riesz-Weyl theorem; learn about integrable functions, indefinite integrals; demonstrate understanding of the statement and proof of the monotone convergence theorem.
- Understand the concepts of product measures; apply the knowledge to prove Fubini's theorem; understand signed measures; demonstrate understanding of the statement and proof of the Jordan-Hahn decomposition, Radon-Nikodym theorem.
- Know about the concepts of Baire sets, Baire measures, regularity of measures on locally compact spaces; apply the knowledge to prove Riesz-Markoff representation theorem related to the representation of a bounded linear functional on the space of continuous functions.

Subject: Partial differential equations (MM-508)

Course Outcomes: On successful completion of the course, the students should be able to:

- Classify the PDE of different orders into elliptic/ parabolic/ hyperbolic types and work on the methods to solve homogeneous and non-homogeneous elliptic equations.
- Understand the role of Green's function in solving PDE and work on the methods/principle used to derive formulas for solutions of homogeneous and nonhomogeneous parabolic/heat equations.
- Use various methods to solve the homogeneous and non–homogeneous wave equations, one to three dimensional, in different coordinate systems. Capacityto apply those techniques/methods to numerousproblems that arise in science, engineeringand other disciplines.

- Learn to solve non-linear first order PDEs through complete integrals, envelopes, characteristics and solve Laplace, heat and wave equations using method of separation of variables and using integral transforms.

Subject: Mechanics of Solids (MM-509) (opt. i)

Course Outcomes: This course will develop:

- Understanding of the concept of tensors as a generalized form of directional entities and to explore their properties through the operations of algebra and calculus.
- Demonstrate understanding of strain and stress tensors. Prepare a strong foundationto learn theory of elasticity to solve scientific problems.
- Learn to prove standard theorems related to theory of variational problems and to apply these techniques/methods by minimizing the potential / strain / complementary energies to solve scientific problems in mechanics of solids and get exposed to research problems in the field of elasticity.

Subject: Boundary Value Problem (MM-510) (opt. ii)

Course Outcomes: This course will enable the students to:

- Reduce boundary value problems involving ODEs to the equivalent integral and to solve such problems with Green's function and Modified Green's function approaches. Apply these techniques in problem solving.
- Learn to find solutions of boundary value problems involving Laplace's equation, Poisson's equation and Helmoltz's equation by using theory of integral equations and Green's function. Attain skill to solve such BVP which arise frequently in different branches of engineering and sciences.
- Learn to solve the integral equations by integral transform methods. Apply the knowledge gained in solving mixed boundary problems.
- Understand Perturbation methods and attaincapability to apply perturbation techniques in solving different listed boundary value problems of Electrostatics, Hydrodynamics and Elasticity.

Subject: Mathematics Aspects of Seismology (MM-511) (opt. i)

Course Outcomes: On successful completion of the course, the students should be able to

- Understand introductory concepts of earthquakes, seismology and wave propagation so as to form a strong foundation to learn the subject. Know mathematical representation of progressive waves and wave characteristics. Have knowledge to solve wave equations in different coordinate systems.
- Learn damping, modulation, inhomogeneity and dispersion of waves, representation of spherical waves and their expansion in terms of plane waves. Learn techniques to solve wave equations in order to obtain D'Alembert, Kirchoff, Poisson and Helmholtz formulae which find great importance in energy transport phenomenon in science and engineering.
- Learn about seismic waves and understand reflection and refraction of seismic waves. Apply knowledge of mathematics and knowledge attained in the first two COs to formulate mathematical models having application in seismology and to solve such problems.
- Understand surface waves and seismic sources (area, line and point). Attain skills to formulate and solve Lamb's problems. Attain knowledge and mathematical tools to pursue research in seismology and to contribute to science and society.

Subject: Practical-IV (MM-512)

Course Outcomes: In this course students will be enhancing the knowledge about:

- Solve practical problems related to core courses undertaken in the Semester-IV from an application point of view.
- Implement simple mathematical functions/equations in numerical computing environment such as MATLAB.
- Interpret and visualize simple mathematical functions and operations thereon using plots/display.
- Analyze the program for correctness and determine/estimate/predict the output and verify it under simulation environment using MATLAB tool.