DANTULURI NARAYANA RAJU COLLEGE
(Autonomous)
BHIMAVARAM, W.G.DIST, ANDHRA PRADESH, INDIA, PIN- 534202.
(Accredited at 'B++' level by NAAC)
(Affiliated to Adikavi Nannaya University, Rajamahendravaram)

M.Sc. MATHEMATICS

SEMESTER -I

Course: M101 – ALGEBRA – I

Code	COURSE OUTCOME	Level
CO1	Understand the concept of Normal subgroups, Quotient groups and solvable groups	**L2**
CO2	Analyze counting principle and Sylow's theorems and apply them for describing structures of finite groups.	**L4**
CO3	Demonstrate the knowledge of Rings, ideals of Rings and Quotient rings, Field of Quotients of an integral domain	**L3**
CO4	Explain Ideals and Homomorphism, Principal Ideal domain and Euclidean domains.	**L4**
CO5	Discuss basic properties of field extensions.	**L2**
CO6	Explain the concept of Polynomial Rings over UFD	**L4**

Course: M102 – REAL ANALYSIS – I

Code	COURSE OUTCOME	Level
CO1	Understand the basic topological properties of subsets of the real numbers.	**L2**
CO2	Demonstrate the convergence of sequences and series which involves studying different types of convergence (pointwise, uniform, absolute, etc.) and understanding their implications.	**L3**
CO3	Analize the limit of a sequence, series and the Cauchy criterion and Test the convergence of the series using the root and ratio test.	**L4**
CO4	Distinguish between continuity and uniform continuity and prove the theorems on continuous functions.	**L2**
CO5	Discussthe key theorems such as the Intermediate Value Theorem and the Mean Value Theorem.	**L2**
CO6	Explain the concepts of L-Hospital's rule and Taylor's theorem.	**L4**

Course M103 – DIFFERENTIAL EQUATIONS

Code	COURSE OUTCOME	Level
CO1	Classify different types of ordinary differential equations and solve them by various analytical methods	**L4**
CO2	Explain the concepts of existence and uniqueness of solutions of differential equations and analyze the conditions under which solutions exist and unique.	**L4**
CO3	Apply differential equations to model and solve problems from various fields.	**L3**
CO4	Apply various power series methods to obtain series solutions of differential Equations.	**L3**
CO5	Explore the methods of solutions of Boundary value problems.	**L4**
CO6	Use various methods of approximation to get qualitative information about the general behavior of the solutions of various problems	**L3**

Course: M104 – TOPOLOGY

Code	COURSE OUTCOME	Level
CO1	Explain fundamental concepts such as metric spaces as well as topological spaces, continuity, convergence, compactness and connectedness	**L4**
CO2	Demonstrate various types of topological spaces, including metric spaces, Hausdorff spaces, and compact spaces.	**L3**
CO3	Analyze and prove properties of continuous functions between topological spaces	**L4**
CO4	Understand the structures induced by topological spaces, such as open and closed sets, neighborhoods and basis of a topology.	**L2**
CO5	Discuss key topological properties like separability, metrizability, and compactification	**L2**
CO6	Apply topological concepts and techniques to solve problems in various branches of mathematics such as analysis, algebra, and geometry.	**L3**

Course M105 – DISCRETE MATHEMATICS

Code	COURSE OUTCOME	Level
CO1	Understand the notion of a set, types of relations, and their representations by graphs and matrices with the ability of to cote illustrations in algebraic and ordered structures.	**L2**
CO2	Convert algebraic lattices into partially ordered sets and vice – versa, and view lattices differently using Hassi diagrams for foundations to Boolean algebra	**L2**
CO3	Interpret the Boolean expressions in shorter form using implicants by applying different procedures and solve problems.	**L3**
CO4	Illustrate Boolean functions by Gatting Networks which is useful in computer science for minimization process and solve problems	**L3**
CO5	Apply Quine – Mcclusky method and Karnaugh diagram to obtain disjunctive normal form and conjunctive normal form of a Boolean Expression and solve problems	**L3**
CO6	Assess logical and mathematical logic conclusions in day-to-day life situations in this AI driven world	**L5**

SEMESTER II

Course: M201 – ALGEBRA – II

Code	COURSE OUTCOME	Level
CO1	Understand the concept of Rings of fractions, Algebraic Extensions of Fields and Eisenstein Criterion.	**L2**
CO2	Explain splitting fields, multiple roots, Normal and Separable Extensions.	**L4**
CO3	Discuss about Fundamental Theorem of Galois Theory.	**L2**
CO4	Apply of Galois Theory in various problems	**L3**
CO5	Understand the concept of Roots of unity and Cyclotomic polynomials	**L2**
CO6	Discuss about Solvable Polynomials by Radicals, Ruler and Compass Construction.	**L2**

Course: M202 – REAL ANALYSIS – II

Code	COURSE OUTCOME	Level
CO1	Understand the concept of Riemann – Stieltjes Integral, fundamental Theorem of Calculus and rectifiable curves.	**L2**
CO2	Develop a thorough understanding of Riemann integration as a limit of Riemann sums, including the formal definition and properties of Riemann – Stieltje's integrals.	**L6**
CO3	Discuss about Uniform Convergence and Continuity, Uniform Convergence and Integration, Uniform convergence and Differentiation	**L2**
CO4	Explain the concept of Power series, the contraction principle and the inverse function theorem	**L4**
CO5	Express the Implicit function theorem, Rank Theorem, Derivatives of higher order and Differentiation of Integrals.	**L2**
CO6	Develop advanced problem-solving skills in the context of Riemann integration, including solving challenging integrals and applying integration techniques to solve mathematical and physical problems.	**L6**

Course M203 – COMPLEX ANALYSIS – I

Code	COURSE OUTCOME	Level
CO1	Understand the elementary properties with examples of Analytic functions.	**L2**
CO2	Explain the concept of complex functions,including continuity and differentiability	**L4**
CO3	Analize the concept of Power series representation of analytic functions and zeros of analytic functions.	**L4**
CO4	SummarizeCauchy's theorem and it's consequences,such as Cauchy's integral formula and Cauchy's residue theorem	**L5**
CO5	Discuss about the homotopic version of Cauchy's theorem and the open mapping theorem.	**L2**
CO6	Demonstrate the classification of Singularities, the Maximum principle.	**L3**

Course M204 – LINEAR ALGEBRA

Code	COURSE OUTCOME	Level
CO1	Understand the concepts of characteristic values, characteristic vectors, characteristic polynomials and Cauchy – Hamilton theorem to use in the study of Invariance aspect in linear spaces of finite dimension and find them	**L2**
CO2	Explain diagonalization linear operator on finite dimensional linear space and describe the Diagonalisation process to solve problems	**L4**
CO3	Summarize the decomposition of a linear operator on a finite dimensional vector space over the field using minimal polynomials, direct sum and invariant subspaces and decompose linear operators.	**L5**
CO4	Describe the procedure for Jordan form of a matrix and find all possible Jordan forms for a given matrix.	**L2**
CO5	Discuss Bilinear form, Quadratic form, the relationship between them and solve problems	**L2**
CO6	Understand degenerate and non-degenerate bilinear forms and show groups preserving bilinear forms	**L2**

Course M205 – PROBABILITY THEORY AND STATISTICS

Code	COURSE OUTCOME	Level
CO1	Understand some theorems on Probability, Conditional probability, Independent events, Pair-wise Independent Events, Baye's theorem	**L2**
CO2	Discuss about Distribution function, Discrete and continuous Random variables, Properties of Expectation, variance, Covariance, Moment Generating Function, Characteristic function.	**L2**
CO3	Apply Probability distributions like Binomial, Poisson, normal, and Uniform and their properties in daily life situations	**L3**
CO4	Explain quantitative measures for the relationship between two variables(Correlation).	**L4**
CO5	Summarize appropriate mathematical or statistical form of the relationship between two variables (regression).	**L5**
CO6	Estimate using Statistical inference techniques such as hypothesis testing (Large sampling).	**L5**

SEMESTER III

Course M301 – FUNCTIONAL ANALYSIS

Code	COURSE OUTCOME	Level
CO1	Understand fundamental concepts such as normed linear space, Banach space and Hilbert Spaces. Construct new Banach spaces from the given Banach Space namely quotient spaces and convert the requirement of continuity into several more useful equivalent forms	**L2**
CO2	Apply the result "If B and B′ are Banach Spaces, and if T is a continuous linear transformation of B onto B′, then the image of each open sphere centered on the origin in B contains an open sphere centered on the origin in B′ in open mapping theorem	**L3**
CO3	Apply closed graph theorem in many interesting problems in analysis.	**L3**
CO4	Discuss the Gram - Schmidt orthogonalization process and applying it to sequences of certain simple functions, several important orthonormal sets in analysis.	**L2**
CO5	Describe a technique of dissecting a given operator into easily studyable objects called projections.	**L2**
CO6	Analyze and solve problems involving linear operators and spectral theory in finite dimensional Hilbert Space H	**L4**

Course: M302 – LEBESGUE THEORY

Code	COURSE OUTCOME	Level
CO1	Understand aboutmeasurable sets, non-measurable set, Lebesgue measure and Lebesgue integration, including properties and applications	**L2**
CO2	Apply Littlewoods three principles in Egoroff's theorem etc	**L3**
CO3	Analyzing functions in terms of measurability and integrability	**L4**
CO4	Apply theorems such as monotone convergence theorem, dominated convergence theorem, Fatou's lemma	**L3**
CO5	Explore topics like Lebesgue differentiation theorem, absolute continuity, and L^P spaces	**L4**
CO6	Solve problems involving convergence almost everywhere and convergence in measure	**L3**

Course M303 – ANALYTICAL NUMBER THEORY

Code	COURSE OUTCOME	Level
CO1	Understand properties of Mobius functions, Euler totient function and also determine the Dirichlet product of arithmetical functions.	**L2**
CO2	Apply the Euler summation formula in asymptotic equalities and also todetermine the partial sums of dirichlet product.	**L3**
CO3	Explain prime number theorem and Shapiro's Tauberian theorem with their Applications.	**L4**
CO4	Summarize the Euler- Fermat theorem, Lagrange's theorem and Chinese remainder theorem.	**L4**
CO5	Understand the concept of Congruence, Residue classes and Complete Residue classes.	**L2**
CO6	Discuss about the concept of Big O notation, Mangoldt function, divisor function.	**L2**

Course: M304 – PARTIAL DIFFERENTIAL EQUATIONS

Code	COURSE OUTCOME	Level
CO1	Understand definitions of partial differential equations (PDEs) and differentiate them from ordinary differential equations (ODEs).	**L2**
CO2	Understand the classification of Partial Differential Equations (e.g., linear vs. nonlinear, first-order vs. higher-order) and their significance in various fields such as Physics, Engineering, and Mathematics.	**L2**
CO3	Show the basic concepts of partial differential equations.	**L3**
CO4	Explain linear Partial Differential equations with different methods.	**L4**
CO5	Classify partial differential equations and transform into canonical form	**L4**
CO6	Solve boundary value problems of Laplace's equation.	**L3**

Course M305 – LATTICE THEORY

Code	COURSE OUTCOME	Level
CO1	Understand the basic concepts of Posets and the minimum and maximum conditions.	**L2**
CO2	Sketch the diagrams of lattices – sub lattices.	**L3**
CO3	Explain the concept of ideals, semi lattices, and theoretic duality principle.	**L4**
CO4	Analize the concept of the complete lattices, conditionally complete lattices and compactly generated lattices.	**L4**
CO5	Determine the concept of Galois connections, Dedekind cuts and compact elements.	**L5**
CO6	Discriminate distributive lattices, modular lattices and covering conditions.	**L5**

SEMESTER- IV

Course M401 – MEASURE THEORY

Code	COURSE OUTCOME	Level
CO1	Understand definition and properties of measurespaces, including sigma algebras, measurable sets, and measures	**L2**
CO2	Explain the concepts of integration w.r.t a measure, including Lebesgue integration and its properties	**L4**
CO3	Discuss fundamental theorems such as monotone convergence theorem, dominated convergence theorem, Fatou's lemma and the Radon – Nikodym theorem	**L2**
CO4	Understand the notion of measurability and properties of measurable functions, including simple functions and the L^P spaces	**L2**
CO5	Analyzevarious modes of convergence for sequences of functions, like convergence almost everywhere, convergence in measureand convergence in L^P spaces.	**L4**
CO6	Apply measure theory to other areas of mathematics, including probability theory, functional analysis, and harmonic analysis	**L3**

Course M402 – NUMERICAL ANALYSIS

Code	COURSE OUTCOME	Level
CO1	Understand the concept of Transcendental and polynomial equations, Eigen values and Eigen vectors.	**L2**
CO2	AnalyzeBisection method, Regula - falsi method, Newton Raphson method, Muller's method.	**L4**
CO3	Discuss about the concept of Rate of converges of secant method, system of linear algebraic equations.	**L2**
CO4	Explaintriangulization method, cholesky method, partition method, Gauss seidel iteration method.	**L4**
CO5	Demonstrate the concept of Finite difference operators, Sterling and Bessel interpolation, Hermite interpolation, least square approximation.	**L2**
CO6	Illustrateby Euler's method, Taylor's method, Runge Kutta 2^{nd}, 4^{th} order methods.	**L3**

Course: M403 – GRAPH THEORY

Code	COURSE OUTCOME	Level
CO1	Understand the various basic terminology and structuresof graphs, including vertices, edges, adjacency, degree, paths, circuits, and connectivity.	**L2**
CO2	Explain various graph algorithms, like depth – first search, breadth – first search, Prim's algorithm etc and algorithms for finding shortest paths and minimum spanning trees.	**L4**
CO3	Analyze properties of graphs, including planarity, Eulearian graphs, Hamiltonian graphs, colorability, matchings, and graph isomorphisms	**L4**
CO4	Explore advanced topics in graph theory, like graph coloring, graph embedding, graph decomposition, graph connectivity etc.	**L5**
CO5	Apply graph theory in various fields like operations research, network analysis, social sciences and optimization problems.	**L3**
CO6	Develop problem solving skills through solving theoretical and practical problems related to graphtheory	**L6**

Course: M404 – LINEAR PROGRAMMING

Code	COURSE OUTCOME	Level
CO1	Formulate real-world problems into the standard form of linear programming, involving the identification of decision variables, objective function, and constraints.	**L6**
CO2	Apply graphical methods to solve simple LP problems, understanding concepts such as feasible region, objective function, and optimal solution.	**L3**
CO3	Solve the LPP using simplex method, Big – M method, Two Phase simplex Method.	**L3**
CO4	Analyze the comparison of solutions of the Dual and its primal.	**L4**
CO5	Explain travelling salesman problem	**L4**
CO6	Demonstrate optimal solutions of transportation problems and to explain a method to resolve degeneracy, unbalanced transportation problem.	**L2**

Course M405 – DISCRETE DYNAMICAL SYSTEMS

Code	COURSE OUTCOME	Level
CO1	Describe the dynamics of a function using phase portraits, periodic points and estimate the behavior of the functions graphically as well.	**L2**
CO2	Discuss about elegant theorems on continuous functions, differentiability of functions with different point view.	**L2**
CO3	Explain the parametrized family of functions, types of bifurcations, logistic functions and evaluate these functions with different hypothesis.	**L4**
CO4	Understand the notion of topological conjugacy and Newton's method to solve differential equations and solve problems	**L2**
CO5	Explainnumerical solutions of differential equations, the dynamics of complex functions, Quadratic family and Mandelbrot set and solve problems	**L4**
CO6	Summarize the computer programming to solve those problems like Newton's method, Numerical solutions to differential equations using computers which are necessary for a student in this digital world	**L5**