Programme outcome/Course outcome (Department of Mathematics)

<table>
<tr><td colspan="3">Programme Specific Outcome (PSO) – After successful completion of three-year honours degree course in Mathematics-
1. Students will acquire thorough knowledge on different branches of Mathematics and can evaluate hypothesis, theories, methods and evidence within their proper contexts.
2. Students will develop proficiency in solving complex mathematical problems by critical thinking and analysis.
3. Students will be prepared with mathematical skills and techniques which can be applied in both academic and non-Academic areas.
4. Students will have engagement in future life in academic areas including jobs as teaching faculties at Government and Non-Government schools, colleges, space research, Oceanography, Banking corporate and I.T sectors etc.
5. Students will be acquainted with different computer languages and mathematical software.
6. Learn advanced topics in mathematics that will help students in further studies of applied sciences.
7. Students will be able to work individually or as a team member or leader in uniform and multidisciplinary settings.
8. Develop the ability of analytical and logical thinking which will help them in all aspects of life.</td></tr>
<tr><td>CC-1T: Calculus, Geometry & Differential Equation</td><td>Course Content:
Hyperbolic functions, Higher order derivatives, Leibnitz rule, concavity, Envelopes, Asymptotes, Curve tracing, L’Hospital’s rule, Reduction formulae, Length of a curve, Area under a curve, Area and Volume of surface of revolution, Second degree equation & Classification of conics, Polar equation, Spheres, Central conicoids, Singular solutions of a differential equation, Exact differential equation and integrating factors, Linear & Bernoulli equation.</td><td>After completion of this course students will be able to:
1. Achieve clear concepts of Higher order derivative, Leibnitz rule and its applications.
2. Gain knowledge of L’Hospital rule and evaluate the limits of indeterminate forms.
3. Acquire the concepts of concavity, convexity and point of inflection, Envelope & rectilinear asymptotes.
4. Understand the concepts of reduction formulae and also evaluate arc length
of a curve, area and volume of surface of revolution.
5. Explain the idea of sphere, cone, conicoids(hyperboloid, paraboloid, ellipsoid) and generating lines.
6. Understand the basic idea of differential equation and apply its knowledge to solve real life problems.
7. Solve the first order differential equation using different types of method With an emphasis on Linear equations and Bernoulli equations.</td></tr>
<tr><td>SEC01P</td><td>Course Content:
MATLAB interface, data types, variables, Flow control statements, arrays: creating, indexing, operations, Matrix creating, indexing, operations, Input and output function, Mathematical library functions, user-defined function: anonymous function. Plotting of</td><td>After completion of this course students will be able to:
1. To understand the importance of operators, and functions in MATLAB.
2. To understand the purpose of variables and how to create variables in MATLAB.
3. To learn how to create 1 and 2-D arrays and their uses in MATLAB.</td></tr>
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	two-dimensional functions: Graph plotting, Graph formatting (title, axis, line styles, colors, etc.), multiple plots, matrix plots, polar plots, 3D plotting (line, surface, mesh, and contour) of three-dimensional functions.	4. To Understand the different aspect of Plotting and graphing in MATLAB. 5. To write simple programs involving loops using commands like for, while, if-else, return, etc using MATLAB. 6. To solve a first order ODE by Euler's method and Runge Kutta method using MATLAB. 7.Have an in-depth understanding and use of MATLAB fundamental data structure.
SEC02P	**Course Content:** Introduction to M-file: scripts and function, flow control statements, standard arrays library functions, standard matrix library functions, User-defined function: primary function, sub-function, private function, eval function, function handles, function of functions, library functions. Importing and Exporting data, read spread sheet data, write spread sheet data, MAT-file	After the completion of the course, Students will be able to 1. To learn how to create 1 and 2-D arrays and their uses in MATLAB. 2. To understand different types of functions in MATLAB like user defined function and in-build-function. 3. Understand solving a system of linear equations, perform numerical integration, ODE and so on 4. To evaluate Eigen values and eigen vectors of a given matrix in MATLAB 5. Study the convergence of sequences through plotting, Ratio test by plotting the ratio of nth and $(n+1)^{th}$ term. 6. understand the convergence/divergence of in finite series by plotting their sequences of partial sum and Cauchy's root test by plotting nth roots.
SEC-1(CBCS): Logic and Sets	Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations, Sets, subsets, set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, generalized union and intersections. Relation: Product set. Composition of relations, types of relations, partitions, equivalence Relations with example of congruence modulo relation. Partial ordering relations, n- ary relations.	After completion of this course students will be able to: 1.Understand basic of proposition and truth table with different classification. 2. To acquire the knowledge of Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations 3.. Gain the concept of set theory with different operations and theory. 4.Understand the Cartesian product of sets and relations between sets 5. Make clear concept about equivalence Relations with example of congruence modulo relation. Partial ordering relations, n- ary relations
CC-5T: Theory of	**Course Content:** Limits of functions, Sequential criterion, Infinite limits,	After the completion of the course, Students will be able to 1. Understand limit of functions, sandwich theorem, Cauchy criterion for the

Real Functions & Introduction To Metric Space	Continuity, Intermediate value theorem, Uniform continuity, Differentiability, Rolle's theorem, Mean value theorem, Darboux's theorem. Taylor's theorem and its application, relative extrema, Metric spaces, open and closed balls, neighbourhood, open set, dense sets.	existence of limit. 2. Explain continuity of functions, Bolzano's theorem, Intermediate value theorem, Uniform continuity and their properties. 3. Make a clear concept differentiability of a function at a point and in an interval. 4. Acquire knowledge of mean value theorem, Darboux's theorem. 5. Gain a clear concept of maxima and minima of functions, sufficient condition For the existence and their applications. 6. Expand functions using Taylor's series. 7. Gain clear concepts about Metric spaces, open and closed balls, limit point, Interior point, closure, open set, dense subset, separable space.
C7T: Numerical Methods	**Course Content:** Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation. Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods. System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition. Interpolation: Lagrange and Newton's methods, Numerical differentiation: Methods based on interpolations, methods based on finite differences.Numerical Integration, Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Composite trapezoidal rule, composite Simpson's $1/3^{rd}$ rule, Gauss quadrature formula, Ordinary differential equations,	After completion of this course students will be able to: 1. Understand different types of numerical error and their practical uses in solving problems. 2. To acquire the knowledge of solving transcendental and polynomial equation using different iteration process, like bisection, newton, regula-falsi. 3. Acquire knowledge about solution of system of linear algebraic equations. 4. Gain the concept of Cayley-Hamilton theorem and its applications. 5. Make clear concept about interpolation technique using different numerical methos. 6. Understand the numerical integration process through trapezoidal rule, Simpson's rules etc
C8T: Riemann Integration and Series of Functions	**Course Content:** Riemann integration, Darbaux integration, Darbaux theorem, Riemann conditions of integrability, Riemann integrability of monotone and continuous functions, properties of the Riemann integral, Improper integrals. Convergence of Beta and Gamma functions, Pointwise and uniform convergence of sequence of functions, Fourier series: Reimann Lebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition	After completion of this course students will be able to: 1. To understand the basic concept of Integrability as the approximation for the area under the curve. 2. To understand the basic difference in integration and Reimann integration. 3. Acquire knowledge about Darbaux theorem and Integration along with its application. 4. Understand the concepts of Improper Integral and convergence of Beta and Gamma function. 5. Gain a clear idea about Pointwise and uniform convergence of sequence of functions.

		6. Understand about Fourier series: Reimann Lebesgue lemma and Bessel's inequality. 7. Gain a clear idea about Parseval's identity and Dirichlet's condition.
SEC-2(H): Graph Theory	**Course Content:** Definition, examples and basic properties, pseudo graphs, complete graphs, bipartite graphs, Eulerian graph, Hamiltonian cycles, representation of a graph by matrix, adjacency matrix, weighted graph, travelling salesman's problem, tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm,	After completion of this course students will be able to: 1. Define basic concepts of graph, directed graph and weighted graph. 2. Gain idea about bipartite graphs, its properties, particularly in trees. 3. understand Eulerian and Hamiltonian graphs and explain the basic results With them. 4. Acquire knowledge on Travelling salesman's problem, spanning tree and Dijkstra's algorithm.
DSE-1 T: Linear Programming Real Analysis	**Course Content:** Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M, Duality, formulation of the dual problem, Transportation problem and its mathematical formulation, northwest-corner method, least cost method. Game theory: formulation of two-person zero sum games	After completion of this course students will be able to: 1. Gain basic idea of linear programming problem. 2. Know the simplex method and graphical solution linear programming problem. 3. Understand the concept of convex set with optimality and unboundedness of LPP. 4. Gain the concept of artificial variables, two-phase method and Big-M. 5. Know about duality and transformation problem with its different properties. 6. gain knowledge about Game theory.
CC-14T: Ring Theory and Linear Algebra II	**Course Content:** Polynomial rings, Principal ideal domains, Factorization of Polynomials, irreducibility tests, Eisenstein criterion, unique factorization domains, Euclidean domains, Dual space, Dual basis, annihilators, Cayley-Hamilton theorem, Minimal polynomial, Inner product spaces, Gram-Schmidt process, adjoint of a linear operator, Normal and Self-adjoint operators, Spectral theorem.	After completion of this course students will be able to: 1. Understand polynomial rings, Principal ideal domain clearly. 2. Gain the concept of irreducibility test using Eisenstein criterion. 3. Acquire knowledge about dual space, dual basis, invariant subspaces. 4. Gain the concept of Cayley-Hamilton theorem and its applications. 5. Make clear concept of Inner product spaces, Bessel's inequality, Gram-Schmidt orthogonalization method. 6. Understand normal and self-adjoint operator and spectral theorem.
DSE-2: Probability and Statistics	**Course Content:** Probability axioms, Probability mass functions, Mathematical Expectation, Moments, Characteristic function, uniform, binomial, poisson, geometric, normal…etc distribution, joint distribution, marginal distribution, bivariate normal distribution, joint moment generating function, covariance, linear regression,	After completion of this course students will be able to: 1. Know the basic concept of probability, its axioms, Bayes' theorem. 2. Understand about Bernoulli trials and Binomial law, Poisson trials, Probability distribution function, continuous and discrete distribution: binomial, poisson, gamma, uniform and normal distributions. 3. Acquire knowledge about transformation of random variables, two

	Chebyshev's inequality, law of large numbers,, central limit theorem, Markov chains, sampling distribution, estimation of parameters, Testing of hypothesis.	dimensional probability distributions, discrete and continuous distributions conditional distribution. 4. Understand the concepts of expectation, mean, variance, moments, dispersion, skewness and kurtosis, median, mode quartiles, characteristic Equation, regression curves, least regression lines. 5. Know the idea of Chebyshev's inequality, law of large number and central limit theorem. 6. Understand about sampling distribution, estimation of parameter. 7. Gain a clear idea about statistical hypothesis.
DSE-4: Mathematics Modeling	**Course Content:** Power series solution of Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order. Monte Carlo simulation modelling: simulating deterministic behavior (area under a curve, volume under a surface), generating random numbers: middle square method, linear congruence, queuing models: harbor system, morning rush hour, Overview of optimization modelling. Linear programming model: geometric solution algebraic solution, simplex method, sensitivity analysis.	After completion of this course students will be able to: 1. Make clear concepts on Power series solution of Bessel's equation and Legendre's equation. 2. Understand Laplace transform and inverse transform, application to initial value problem up to second order. 3. Know about Monte Carlo simulation modelling: simulating deterministic behavior along with its different properties 4. Acquire knowledge on generating random numbers with middle square method, linear congruence method. 5. know about different type of Linear programming model like geometric solution algebraic solution, simplex method and sensitivity analysis.
GE-1: Calculus, Geometry & Differential Equation	**Course Content:** higher order derivatives, Leibnitz rule. concavity and inflection points, envelopes, asymptotes, curve tracing in cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, Reduction formulae, derivations and illustrations of reduction formulae of the type. Reflection properties of conics, rotation of axes and second-degree equations, classification of conics using the discriminant, polar equations of conics. Spheres. Cylindrical surfaces. Central conicoid, paraboloids	After completion of this course students will be able to: 1. Gain knowledge about higher order derivatives with Leibnitz rule. concavity and inflection points. 2. Understand the envelopes, asymptotes, curve tracing in cartesian coordinates, tracing in polar coordinates of standard curves. 3. Acquire knowledge about L'Hospital's rule, 4. Acquire knowledge about Reduction formulae, derivations and illustrations of reduction formulae of the type 4. Understand Reflection properties of conics, rotation of axes and second-degree equations, classification of conics using the discriminant, polar equations of conics. Spheres. Cylindrical surfaces. Central conicoid, paraboloids.
GE-2: Algebra	**Course Content:** complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. Theory of equations: Relation between roots and coefficients, transformation of equation, Descartes rule of	After completion of this course students will be able to: 1. Make a clear concept of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications 2. Theory of equations: Relation between roots and coefficients, transformation of

	signs, cubic and biquadratic equation. Inequality: The inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality. Equivalence relations. Functions, composition of functions, Invertible functions, one to one correspondence and cardinality of a set. Well-ordering property of positive integers, division algorithm, divisibility and Euclidean algorithm. Congruence relation between integers. Principles of Mathematical induction, statement of Fundamental Theorem of Arithmetic. Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b,	equation, Descartes rule of signs, cubic and biquadratic equation. 3. Gain the concept of the inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality. 4. Know the Well-ordering property of positive integers, division algorithm, divisibility and Euclidean algorithm. Congruence relation between integers. Principles of Mathematical induction, statement of Fundamental Theorem of Arithmetic. 5. Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b.
GE3T**:** Differential Equations &Vector Calculus	Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications. Euler's equation, method of undetermined coefficients, method of variation of parameters. Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Equilibrium points, Interpretation of the phase plane Power series solution of a differential equation about an ordinary point, solution about a regular singular point. Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions	After completion of this course students will be able to: 1.Gain basic concept on Lipschitz and Picard's theorem and general solution of homogeneous equation of second order and principle of super position for homogeneous equation. 2.make clear concept about Wronskian: its properties and applications. Euler's equation, method of undetermined coefficients and method of variation of parameters. 3. Understand the Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. 4. know about the Power series solution of a differential equation about an ordinary point, solution about a regular singular point. 5.gain idea about triple product, vector function and operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions
DSC-1A(G): Differential Calculus	**Course Content:,** Limit and Continuity, Differentiability, successive differentiation, Leibnitz rule, Partial differentiation, Euler's theorem, Tangents and normals, curvature, asymptotes, curve tracing, mean value theorem, Taylor's theorem, maxima and minima, Indeterminate forms.	After completion of this course students will be able to: 1. Gain idea of limit and continuity of a function and its types. 2. Know higher order derivatives, Leibnitz rule and its application. 3. Understand concept of envelope, asymptotes and curve tracing. 4. Gain the concept of maxima-minima, evaluate limits using L'Hospital rule. 5. Know about Taylor's theorem and its application, Partial differentiation,

		Euler's theorem and its application.
DSC-1B(G): Differential Equation	**Course Content:** First order exact differential equation, Integrating factors, method for solving higher order differential equation, Wronskian, Linear homogeneous equation with constant coefficients, Method of variation of parameters, Cauchy-euler equation, simultaneous differential equation, partial differential equation, Lagrange's method, Charpit's method, Classification of partial differential equation.	After completion of this course students will be able to: 1. Make clear concepts on exact differential equation, integrating factors and its application. 2. Understand wronskian and its application to solve equation. 3. Know about method of variation of parameters, solve Cauchy-euler equation. 4. Acquire knowledge on partial differential equation and learn different Method to solve them. 5. know about different type of partial differential equation.
DSE-1(G) Linear Algebra	**Course Content:** Vector spaces, subspaces, quotient spaces, linear span, linear independence, basis and dimension, Linear transformations, null space, range, rank and nullity of linear transformation, matrix representation of linear transformation, isomorphism theorems, invertiility.	After completion of this course students will be able to: 1. Gain knowledge about Vector space, subspaces and dimension of subspaces. 2. Understand basis and dimension of Vector space. 3. Acquire knowledge about linear transformation, rank, nullity and the matrix representation of linear transformation. 4. Understand isomorphism theorem.
DSE-2(G) Numerical Methods	**Course Content:** Bisection method, False position method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Seidel method, Lagrange and Newton interpolation, finite difference operator, Numerical differentiation, forward difference, backward difference, integration: trapezoidal rule, Simpson's rule, solving ordinary differential equations: Euler's method, Runge-Kutta method.	After completion of this course students will be able to: 1. Make a clear concept of polynomial interpolations like Lagrange's and Newton's interpolation formula. 2. Gain a clear concept of finding solution of numerical equations by Bisection method, Newton's method. 3. Gain the concept of numerical differentiation, numerical integration, their formulae and application in solving problems. 4. Know the method to solve the system of linear equations by Gauss-Jacobi And Gauss-Seidel method. 5. Solve the ordinary differential equations by Euler method and Runge-Kutta Method.