SIDDHINATH MAHAVIDYALAYA
DEPARTMENT OF MATHEMATICS
TEACHING PLAN 2021-22
MATHEMATICS(H)
ODD & EVEN SEMESTER

Sem	Paper	Unit	Topic	Teacher	No of lecture	To be completed by
1ST SEM	CC-1 Calculus, Geometry & Differential Equation	Unit-1	Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, envelopes, asymptotes, curve tracing in cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences.		12	
		Unit-2	Reduction formulae, derivations and illustrations of reduction formulae of the type $\int\sin nx\,dx$, $\int\cos nx\,dx$, $\int\tan nx\,dx$, $\int\sec nx\,dx$, $\int(\log x)^n\,dx$, $\int\sin^n x\sin^m x\,dx$, parametric equations, parameterizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution, techniques of sketching conics.		12	
		Unit-3	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 conicoids, paraboloids, plane sections ofconicoids, generating lines, classification of quadrics, illustrations of graphingstandard quadric surfaces like cone, ellipsoid.	J.M	12	1st ,2nd ,3rd ,4th Month
		Unit-4	Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations		12	
		Unit-4	**Graphical Demonstration (Teaching Aid)** 1. Plotting of graphs of function e^{ax+b}, $\log(ax+b)$, $1/(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $\lvert ax+b\rvert$ and to illustrate the effect of a and b on the graph. 2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them. 3. Sketching parametric curves (Eg. trochoid, cycloid, epicycloids, hypocycloid). 4. Obtaining surface of revolution of curves. 5. Tracing of conics in cartesian coordinates/ polar coordinates. 6. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using cartesian coordinates		15	
			Class Test			

						5th Month
			Revision and preparation for University exam			

CC-2 Algebra		Unit-1	Polar representation of 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 ofequation, Descartes rule of signs, cubic and biquadratic equation. Inequality: The inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality.	AKS	15	1st & 2nd Month
		Unit-2	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.		15	
		Unit-3	Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.		15	3rd & 4th Month
		Unit-4	Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n, rank of a matrix, Eigen values, eigen vectors and characteristic equation of a matrix.Cayley-Hamilton theorem and its use in finding the inverseof a matrix.		15	
			Class Test			5th Month
			Revision and preparation for University exam			

Sem	Paper	UNIT	Topic	Teacher	No of lecture	To be completed by
3RD SEM	**CC-5** **Theory of Real Functions & Introduction to Metric Space**	UNIT-1	Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n, rank of a matrix, Eigen values, eigen vectors and characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.	JM	15	1st & 2nd Month
		UNIT-2	Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.		15	
		UNIT-3	Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $\ln(1+x)$, $1/(ax+b)$ and $(x+1)^n$. Application of Taylor's theorem to inequalities.		15	3rd & 4th Month
		UNIT-4	Metric spaces: Definition and examples. open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, subspaces, dense sets, separable spaces		15	
			Class Test			5th Month
			Revision and preparation for University exam			
	CC-6 **Group Theory**	UNIT-1	Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.	AKS	12	1st & 2nd Month
		UNIT-2	Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups		12	
		UNIT-3	Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.		12	3rd & 4th Month
		UNIT-4	External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.		12	
		UNIT-5	Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems.		12	
			Class Test			5th Month
			Revision and preparation for University exam			

	CC-7 **Numerical Method s**	UNIT-1	Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.		12	1st & 2nd Month
		UNIT-2	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.	J.M	12	
		UNIT-3	System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition		12	
		UNIT-4	Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Numerical differentiation: Methods based on interpolations, methods based on finite differences.		12	3rd & 4th Month
		UNIT-5	Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Simpsons 3/8th rule, Weddle's rule, Boole's Rule. midpoint rule, Composite trapezoidal rule, composite Simpson's $1/3^{rd}$ rule, Gauss quadrature formula. The algebraic eigen value problem: Power method. Approximation: Least square polynomial approximation.		12	
			Class Test			5th Month
			Revision and preparation for University exam			
	SEC-1 **Logic & Set**	UNIT-1	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.		15	1st Month
		UNIT-2	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	J.M	18	2nd Month
		UNIT-3	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.		20	3rd & 4th Month
			Class Test			5th Month
			Revision and preparation for University exam			

Sem	Paper	UNIT	Topic	Teacher	No of lecture	To be completed by

	Partial Differential Equations & Applications CC-11	UNIT-1	Partial differential equations – Basic concepts and definitions. Mathematical problems. First- order equations: classification, construction and geometrical interpretation. Method of characteristics for obtaining general solution of quasi linear equations. Canonical forms of first-order linear equations. Method of separation of variables for solving first order partial differential equations.		12	1st Month
		UNIT-2	Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms.		12	2nd Month
		UNIT-3	The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string. Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Equations with non-homogeneous boundary conditions. Non-homogeneous wave equation. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem	AKS	12	3rd Month
		UNIT-4	Central force. Constrained motion, varying mass, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law.		12	4th Month
		UNIT-5	Graphical Demonstration(Teaching aid) 1. Solution of Cauchy problem for first order PDE. 2. Finding the characteristics for the first order PDE. 3. Plot the integral surfaces of a given first order PDE with initial data.		12	
			Class Test			5th Month
			Revision and preparation for University exam			
	Group Theory II CC-12	UNIT-1	Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.		15	1st Month
		UNIT-2	Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental theorem of finite abelian groups.		15	2nd Month
		UNIT-3	Group actions, stabilizers and kernels, permutation representation associated with a given group action. Applications of group actions. Generalized Cayley's theorem. Index theorem.	JM	15	3rd Month
		UNIT-4	Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn, p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for n ≥ 5, non-simplicity tests.		15	4th Month
			Class Test			5th month
			Revision and preparation for University exam			

DSE-1 Linear Programming	UNIT-1	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 method and their comparison.		20	1st Month
	UNIT-2	Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.	AKS	20	2nd Month
	UNIT-3	Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure,linearprogramming solutionof games.		20	3rd & 4th Month
		Class Test			5th month
		Revision and preparation for University exam			
DSE-2 Probability and Statistics	UNIT-1	Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.		20	1st Month
	UNIT-2	Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.	J.M	20	2nd Month
	UNIT-3	Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. Central limit theorem for independent and identically distributed random variables with finite variance, Markov chains, Chapman-Kolmogorov equations, classification of states.		20	3rd Month
	UNIT-4	Random Samples, Sampling Diatributions, Estimation of parameters, Testing of hypothesis.		20	4th Month
		Class Test			5th Month
		Revision and preparation for University exam			

SIDDHINATH MAHAVIDYALAYA
DEPARTMENT OF MATHEMATICS
TEACHING PLAN 2021-22
MATHEMATICS(H)
2nd ,4th ,6th Semester

Sem	Paper	UNIT	Topic	Teacher	No of lecture	To be completed by
2nd SEM	CC-3 Real Analysis	Unit-1	Review of algebraic and order properties of R, ε-neighbourhood of a point in R. Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima. Completeness property of R and its equivalent properties. The Archimedean property, density of rational (and Irrational) numbers in R, intervals. Limit points of a set, isolated points, open set, closed set, derived set, illustrations of Bolzano-Weierstrass theorem for sets, compact sets in R, Heine-Borel Theorem.	JM	15	1st Month
		Unit-2	Sequences, bounded sequence, convergent sequence, limit of a sequence, lim inf, lim sup. Limit theorems. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only), Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion.		15	2nd Month
		Unit-3	Infinite series, convergence and divergence of infinite series, Cauchy criterion, tests for convergence: comparison test, limit comparison test, ratio test, Cauchy's nth root test, integral test. Alternating series, Leibniz test. Absolute and conditional convergence.		15	3rd Month
		Unit-4	Graphical Demonstration (Teaching aid) 1. Plotting of recursive sequences. 2. Study the convergence of sequences through plotting. 3. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot. 4. Study the convergence/divergence of in 5. finite series by plotting their sequences of partial sum. 6. Cauchy's root test by plotting nth roots. 7. Ratio test by plotting the ratio of nth and (n+1)th term		15	4th Month
			Class Test			5th Month
			Revision and preparation for University exam			
	CC-4 Differential Equations & Vector Calculus	Unit-1	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, Linear homogeneous and nonhomogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters	J.M		1st Month
		Unit-2	Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.			2nd Month
		Unit-3	Equilibrium points, Interpretation of the phase plane Power series solution of a differential equation about an ordinary point, solution about a regular singular point			3rd Month

		Unit-4	Triple product, introduction to vector functions, operations with vector-valuedfunctions, limits and continuity of vector functions, differentiation and integration of vector functions.			4th Month
		Unit-5	Graphical demonstration (Teaching aid) 1. Plotting of family of curves which are solutions of second order differential equation 2. Plotting of family of curves which are solutions of third order differential equation			
			Class Test			5th Month
			Revision and preparation for University exam			

Sem	Paper	UNIT	Topic	Teacher	No of lecture	To be completed by
4TH SEM	CC-8: Riemann Integration and Series of Functions	UNIT-1	Riemann integration: inequalities of upper and lower sums, Darbaux integration, Darbaux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions. Riemann integrability of monotone and continuous functions, properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorem of Integral Calculus	JM	15	1st Month
		UNIT-2	Improper integrals. Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test		15	2nd Month
		UNIT-3	Fourier series: Definition of Fourier coefficients and series, Reimann Lebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition. Examples of Fourier expansions and summation results for series		15	3rd Month
		UNIT-4	Power series, radius of convergence, Cauchy Hadamard theorem. Differentiation and integration of power series; Abel's theorem; Weierstrass approximation theorem		15	4th Month
			Class Test			5th Month
			Revision and preparation for University exam			
	CC-9 Multivariate Calculus	UNIT-1	Functions of several variables, limit and continuity of functions of two or more variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems	JM	15	1st Month
		UNIT-2	Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical coordinates.Change of variables in double integ		15	2nd Month

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		UNIT-3	Definition of vector field, divergence and curl. Line integrals, applications of line integrals: mass and work. Fundamental theorem for line integrals, conservative vector fields, independence of path		15	3rd Month
		UNIT-4	Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem		15	4th Month
			Class Test			5th Month
			Revision and preparation for University exam			
	CC-10 Ring Theory and Linear Algebra I	UNIT-1	Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.	J.M	15	1st Month
		UNIT-2	Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients		15	2nd Month
		UNIT-3	Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.		15	3rd Month
		UNIT-4	Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.		15	4th Month
			Class Test			5th Month
			Revision and preparation for University exam			
	SEC-2 Graph Theory	UNIT-1	Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs isomorphism of graphs.	J.M	10	1st Month
		UNIT-2	Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles,theorems Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,		10	2nd Month
		UNIT-3	Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm		10	3rd Month & 4th Month
			Class Test			5th Month
			Revision and preparation for University exam			

Sem	Paper	UNIT	Topic	Teacher	No of lecture	To be completed by
6TH	CC-13 Metric Spaces and Complex Analysis	UNIT-1	Metric spaces: sequences in metric spaces, Cauchy sequences. Complete metric spaces, Cantor's theorem.	J.M	10	1st Month
		UNIT-2	Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Connectedness, connected subsets of R. Compactness: Sequential compactness, Heine-Borel property, totally bounded spaces, finite intersection property, and continuous functions on compact sets. Homeomorphism. Contraction mappings. Banach fixed point theorem and its application to ordinary differential equation.		15	2nd Month
		UNIT-3	Limits, limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability		15	3rd Month
		UNIT-4	Analytic functions, examples of analytic functions, exponential function, logarithmic function, trigonometric function, derivatives of functions, and definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula		15	4th Month
		UNIT-5	Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series		18	
			Class Test			5th Month
			Revision and preparation for University exam			
	CC-14 Ring Theory and Linear Algebra II	UNIT-1	Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, and unique factorization in Z [x]. Divisibility in integral domains, irreducible, primes, unique factorization domains, Euclidean domains.	JM	15	1st Month
		UNIT-2	Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators. Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms		20	2nd Month
		UNIT-3	Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator. Least squares approximation, minimal solutions to systems of linear equations. Normal and self-adjoint operators. Orthogonal projections and Spectral theorem		25	3rd Month & 4th Month
			Class Test			5th Month
			Revision and preparation for University exam			
	DSE-3 Mechanics	UNIT-1	Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work.. Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium	JM		1st Month

		UNIT-2	Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law.Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution.			2nd Month
		UNIT-3	Degrees of freedom. Moments and products of inertia. Momental Ellipsoid. Principal axes. D'Alembert's Principle. Motion about a fixed axis. Compound pendulum. Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum and energy.			3rd Month & 4th Month
			Class Test			5th Month
			Revision and preparation for University exam			
DSE-4 Mathematics Modeling		UNIT-1	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	J.M	30	1st,2nd,3rd Month
		UNIT-2	Monte Carlo simulation modelling: simulating deterministic behaviour (area under a curve, volume under a surface), generating random numbers: middle square method, linear congruence, queuing models: harb or system, morning rush hour, Overview of optimization modelling. Linear programming model: geometric solution algebraic solution, simplex method, sensitivity analysis	JM	30	1st,2nd,3rd Month
			Class Test			5th Month
			Revision and preparation for University exam			