Course Outcomes:

Semester I

S. No.	Course No.	Title	Course Outcomes
1.	PSMATC 101	Abstract Algebra	This course will enable students to 1. write class equation of a group. Students shall learn and do problems related to Cauchy's theorem and Sylow's theorems. 2. learn about normal and subnormal series, composition series and solvability of groups. 3. understand important concepts in module theory like quotient modules and their submodules, homomorphism and isomorphism theorems on modulus and so on. 4. distinguish between prime and irreducible elements of a ring. Students shall learn in detail about Euclidean domains, principle ideal domains and unique factorization domains. Students shall be able to do problems related to reducibility and irreducibility to polynomials.
2.	PSMATC 102	Real Analysis	This course shall enable the students to: 1. understand fundamental concepts of point set topology like openness and closedness of sets in Euclidean spaces, adherent and accumulation points, metric spaces and their properties. 2. solve problems related to Riemann-Steiltjes integral like when a function is R-S integrable, how does a change of variable affects integral. Students shall be able to understand and solve problems related to the first and the second fundamental theorems of integral calculus. 3. understand the difference between pointwise and uniform convergence of sequence and series of functions. Students shall be able to determine the nature of convergence of a sequences of functions. 4. learn about functions of several variables, essence of derivative in higher dimensions and so on. The use of important theorems like inverse function theorem, mean value theorem and implicit function theorem shall be made clear to the students.
3.	PSMATC 103	First Course in Topology	After studying this course, the student shall be able to 1. understand the fundamental concepts in the set theory like Zorn's lemma, Hausdroff maximality principle and so on. 2. determine interior, closure, boundary, limit points of subsets and basis and subbasis of topological spaces. 3. check whether a collection of subsets is a basis for a given topological spaces or not, and determine the topology generated by a given basis. 4. identify the continuous maps between two spaces and maps from a space into product space and determine common topological property of given two spaces. 5. determine the connectedness and path connectedness of the product of an arbitrary family of spaces. 6. find Hausdorff spaces using the concept of net in topological spaces and learn Bolzano Weierstrass property of a space and prove Tychonoff theorem.
4.	PSMATC 104	Differential and Integral Equations	This course shall enable students to 1. find solutions of ordinary differential equations using

			existence and uniqueness theorem, Picard's approximation method, reduction of order, variation of parameter and so on. 2. learn about power series solution of differential equations about ordinary points. Important properties of Legendre polynomials like their orthogonality and eigen values shall be made aware to the students. Moreover, students shall be able to understand and solve problems related to special functions like Bessel's functions and Gauss hypergeometric functions. 3. understand the existence and basic properties of Laplace transform, inverse Laplace transform, the idea of convolution and their applications in solving linear differential equation with constant coefficients. Students shall also be able to construct Green's function for various differential operators. 4. distinguish and solve Fredholom and Volterra integral equations using the method of Picard's approximation and resoovant kernal. Student shall also learn how to convert differential equations into integral equations and vice versa.
5.	PSMATC 105	Computer Applications in Mathematics	After studying this course, students shall be able to 1. write mathematical symbols and notations using LaTeX, create documents such as AMS article, reports, thesis and do customization of these documents as per need. 2. learn computer languages like C-language and do software programming. 3. solve mathematical problems using softwares like MatLab, Wolfram Mathematica and SageMath.

Semester II

S.No.	Course No.	Title	Course Outcomes
1.	PSMATC 201	Rings and Modules	After studying this course, the student shall be able to 1. identify various types and construct examples of rings and modules, and apply homomorphism theorems on them. 2. distinguish between Artinian, Noetherian free, and simple rings and modules. 3. learn about the universal property of tensor product of modules, Hilbert basis theorem, Nakayama and Schur's lemma. 4. differentiate between torsion and torsion free modules. Students shall be able to apply the structure theorem of finitely generated modules over PID.
2.	PSMATC 202	Measure Theory	After studying this course the student shall be able to 1. learn about measurable and measure spaces, types of measure and how to construct an outer measure. Also, students shall be able to check whether a given set or a function is measurable. 2. understand the requirement and the concepts of Lebesgue integral (a generalization of the Riemann

			integration) along its properties. 3. distinguish and understand relationships among uniform convergence, convergence a.e., almost uniform convergence and convergence in mean. 4. demonstrate understanding of the statement and proofs of the fundamental integral convergence theorems like Lebesgue monotone convergence theorem, Lebesgue dominated convergence theorem and their applications. 5. extend the concept of outer measure in an abstract space and integration with respect to a measure.
3.	PSMATC 203	Second Course in Topology	This course shall enable students to 1. know about countability and separation axioms, create examples and solve problems related to them. 2. find one point compactification of spaces like real line and n-sphere. 3. know interesting results on complete regularity and Stone Cech compactification. 4. have studied celebrated results like Urysohn lemma, Tietze extension theorem, Ascoli theorem and Baire category theorem. Also, students shall have better understanding of metrization theorems like Urysohn metrization theorem and Nagata Smirnov metrization theorem. 5. lean about Baire spaces, m-manifolds and define dimension of topological spaces.
4.	PSMATC 204	Complex Analysis	After studying this course the student will be able to 1. understand analytic function as a mapping on the plane, Mobius transformation and branch of logarithm. 2. understand Cauchy's theorems and integral formulas on open subsets of the plane. 3. understand the concept of homotopy and homotopic version of Cauchy's theorem and simply connectivity. 4. understand how to count the number of zeros of analytic function giving rise to open mapping theorem and Goursat theorem as a converse of Cauchy's theorem. 5. know about the kind of singularities of meromorphic functions which helps in residue theory and contour integrations. 6. handle integration of meromorphic function with zeros and poles leading to the argument principle and Rouche's theorem. 7. know different versions of the maximum principle as well as the Schwarz's lemma representing analytic function on a disk as fractional mappings.
5.	PSMATC 205	Differential Geometry	This course shall enable students to 1. understand the concepts of differentiable curves, arc length, curvature graphs, level sets as solutions of smooth real valued functions vector fields and tangent space. 2. familiarize with the notions of coordinate charts, diffeomorphism, tangent plane and Euler's work on surfaces. Students shall be able to compute angle between curves and area of surfaces. 3. learn about linear self-adjoint Weingarten map and curvature of a plane curve with applications in geometry and physics. 4. know line integrals, be able to deal with differential

			forms and calculate arc length and curvature of surfaces. 5. deal with parametrization and be familiar with well-known surfaces as equations in multiple variables. 6. study surfaces with boundary, geodesics, minimizing properties of geodesics and be able to understand Gauss Bonnet theorem and its applications.

Semester III

S.No.	Course No.	Title	Course Outcomes
1.	PSMATC 301	Advanced Complex Analysis	After studying this course the student will be able to 1. understand the basics of logarithmically convex function that helps in extending maximum modulus theorem. 2. be familiar with metric on spaces of analytic, meromorphic and analytic functions, Ascoli and related theorems, equi-continuity and normal families leading to Arzela. 3. know harmonic function theory on a disk and how it helps in solving Dirichlet's problem and the notion of Green's function.
2.	PSMATC 302	Functional Analysis	After studying this course the student will be able to 1. understand Banach contraction Principle and its applications to differential and integral equations, completion theorem, category theorem and its applications. 2. understand Hahn-Banach Theorem in real, Complex and linear spaces and applications, uniform boundedness principle, open mapping theorem, Bounded inverse-theorem, closed graph theorem. 3. understand the existence of orthonormal basis, Riesz representation theorem, the dimension of Hilbert spaces.
3.	PSMATC 303	Linear Algebra	After studying this course the student will be able to 1. understand linear independence, linear transformations, matrix representation of a linear transformation. 2. understand the relation between characteristic polynomial and minimal polynomial, Cayley-Hamilton theorem (statement and illustrations only), diagonalizability, necessary and sufficient condition for diagonalizability. 3. understand Cauchy Schwarz inequality, orthogonality and orthogonal complements, orthonormal basis, Gram-Schmidt process and adjoint of a linear transformation.
4.	PSMATC 304	Advanced Measure Theory	After studying this course the student will be able to 1. understand signed measures and complex measures, ability to use Hahn Nikodym theorem and recognized decomposition, Jordan decomposition, Radon singularity of measures. 2. verify conditions under which a measure defined on a semi-algebra or algebra is extendable to a sigma-algebra and to get the extended measure, and to prove the uniqueness up to multiplication by a scalar of Lebesgue measure as a translation invariant Borel measure. 3. to understand the concepts of Baire sets, Baire measures, regularity of measures on Markov representation theorem related to the locally compact spaces, Riesz representation

			of a bounded linear functional on the space of continuous functions.
5.	PSMATC 305	Complex Dynamics	After studying this course the student will be able to 1. understand Iteration of Mobius transformation, attracting, repelling and indifferent fixed points, critical points, Riemann-Hurwitz relation, topology of rational functions. 2. understand Properties of Julia sets: Exceptional points, backward orbit, minimality property of the Julia set, expanding property of the Julia set. 3. understand Rieman Hurwitz formula for covering maps, maps between components of the Fatou set, the number of components of the Fatou set, components of the Julia set.
6.	PSMATC 306	Partial Differential Equations	After studying this course the student will be able to 1. understand Partial Differential Equation of 2nd and Higher order, classification examples of Partial Differential Equations, Partial Differential Equations relevant to industrial problems, Solutions of elliptic, hyperbolic and parabolic equations. 2. understand Transport Equation: Initial value Problem, Non homogeneous Equation. Laplace equation-Fundamental solution Mean Value Formulas, Properties of Harmonic functions, Green's Function, Energy methods. 3. understand Heat Equation: Fundamental solution, Mean Value Formulas, Properties of solutions, Energy Methods, Wave Equation: Solution by Spherical means, Non-Homogeneous equation.
7.	PSMATC 307	Number Theory	After studying this course the student will be able to 1. understand Farey sequences, Rational Approximations, Euclidean Algorithm, Uniqueness, Infinite Continued Fractions, The Geometry of Numbers. 2. understand Elementary Prime Number Estimates, Dirichlet Series, Estimates of Arithmetic Functions, Primes in Arithmetic Progressions. 3. understand Partitions, Ferrers Graphs, Formal Power Series, Generating Functions, and Euler's Identity, Euler's Formula, Bounds on p(n), Jacobi's Formula, Divisibility Property.
8.	PSMATC 308	Multivariable Calculus	After studying this course the student will be able to 1. understand Limits and Continuity of functions defined on Euclidean Spaces, Real-valued functions of several variables, Vector valued functions of several variables. 2. understand Differentiation, Partial derivatives , Gradient, directional derivatives, Chain Rule. Euler's Theorem, Mean Value Theorem and Taylor's Theorem for functions of several variables. 3. understand First and Second Fundamental Theorems of Calculus for Line Integrals. Green's Theorem and its applications to evaluation of line integrals, Surface Integrals: Parameterized surfaces.
9.	PSMATC 309	Linear Programming and Optimization Techniques	After studying this course the student will be able to 1. understand Convex sets, Basic properties, Differentiable convex functions, Generalization of convex functions. 2. understand Linear Programming: Geometry of linear programming, Graphical method, Linear programming in

			standard form, Solution of LPP by simplex method. 3. understand Transportation and Assignment Problem: Initial basic feasible solutions of balanced and unbalanced transportation/assignment problems, Optimal solutions. Game Theory: Two person zero-sum game, Game with mixed strategies.
10.	PSMATC 310	Numerical Methods	After studying this course the student will be able to 1. understand Transcendental and algebraic equations: Bisection method, Regula-Falsi method, Newton-Raphson method, Secant method, Rate of convergence of these methods. 2. understand System of linear algebraic equations; Direct methods: Gaussian Elimination and Gauss Jordan methods, Iterative methods, Gauss Jacobi method, Gauss Seidel method and their convergence analysis. 3. understand Interpolation: Finite differences, Divided differences, Newton Gregory Forward and Backward formula, Lagrange's formula. Numerical Integration: Trapezoidal rule, Simpson's rules.
11.	PSMATC 311	Graph Theory	After studying this course the student will be able to 1. understand Graphs and their representation, Pseudographs, Subgraphs, Degree sequence, Euler's theorem, Isomorphism of graphs, Paths and circuits, Connected graphs. 2. understand Kruskal's algorithm, Prim's algorithm, Acyclic digraphs and Bellman's algorithm. Planar graphs, Euler's formula, Kuratowski theorem. 3. understand Graph coloring, Applications of graph coloring, Circuit testing and facilities design, Flows and cuts, Max flow-min cut theorem, Matchings, Hall's theorem.

Semester IV

S.No.	Course No.	Title	Course Outcomes
1.	PSMATC 401	Analytic Function Spaces	After studying this course the student will be able to 1. understand Review of Fourier series, Fourier transforms and its properties. 2. understand Poisson Kernel and its properties, Poisson integral of a measure, Boundary behaviour of poisson integral. 3. understand Hardy space Hp(+) over the upper half plane, Poisson integral formula, Cauchy Integral formula, Boundary behaviour of functions in Hp(+), Canonical factorization, Hp(+) as Banach Space.
2.	PSMATC 402	Advanced Functional Analysis	After studying this course the student will be able to 1. understand balanced and absorbing sets, Minkowski functional, normable and metrizable topological vector spaces, complete topological vector spaces and Frechet space. 2. understand Dual spaces, finite dimensional topological vector spaces and Geometric form of Hahn Banach Theorem. 3. understand Duality, Polar, Bipolar theorem, Montel spaces, Schwarz spaces. Quasi completeness inverse limit

			and inductive limit of locally convex spaces.
3.	PSMATC 403	Operator Theory	After studying this course the student will be able to 1. understand Banach Algebra, Multiplicative Functionals Gelfand-Mazur theorem, spectral mapping theorem, Spectral Radius formula. 2. understand Spectrum, point spectrum and approximate points, Spectrum of Unilateral shift. 3. understand Finite rank operators, compact operators and their ideals, Approximation of compact-operators, Fredholm operators and Volterra integral operators.
4.	PSMATC 404	Normal Families in Complex Analysis	After studying this course the student will be able to 1. understand Montel's theorem, Vitali-Porter theorem, zeros of normal families, Riemann mapping theorem, fundamental normality test, Julia theorem. 2. understand Zalcman's lemma, Robinson-Zalcman heuristic principle, Bloch's principle, the converse of Bloch's principle, counterexamples to Bloch's principle and its converse. 3. understand a generalization of Montel's theorem, new composition and its consequences, zero-free families of analytic functions and a new normality criterion.
5.	PSMATC 405	Value Distribution Theory of Meromorphic Functions	After studying this course the student will be able to 1. understand Poison-Jensen formula, Nevanlinna's first fundamental theorem, the Cartan's identity and convexity theorem, growth of meromorphic functions, order and type of meromorphic functions. 2. understand fundamental inequality, the estimation of the error term S(r), conditions for S(r) to be small, Nevanlinna's theory of deficient values, second fundamental theorem of Nevanlinna. 3. understand Milloux theory: Milluox's basic results, exceptional values of meromorphic functions and their derivatives.
6.	PSMATC 406	Geometric Functions Theory	After studying this course the student will be able to 1. understand Harmonic, Subharmonic function, Green function and Univalent functions. 2. understand classes of univalent functions, Bieberbach conjucture, Littlewood's theorem, Lowner's theory and its applications. 3. understand Exponentiation and Reformulation of the Grunsky inequalities, Logarithmic coefficients, Littlewood's subordination theorem and sharpened form of the Schwarz Lemma.
7.	PSMATC 407	Complex Analysis in Several Variables	After studying this course the student will be able to 1. understand holomorphic functions in several complex variables, Partially holomorphic functions, Cauchy-Riemann differential equations and Cauchy Integral Formula. 2. understand Power series, Taylor series, Laurent series and theoretic interpretation of the Laurent series. 3. understand Riemann Mapping Problem and Cartan's Uniqueness Theorem. Elementary properties of Analytic sets, Riemann Removable Singularity Theorem.
8.	PSMATC 408	Algebraic Topology	After studying this course the student will be able to 1. understand Geometric Simplexes, Geometric complexes, Polyhedra, Triangulable Spaces, Simplicial maps and Simplicial Approximation.

			2. understand Computation of Simplicial homology groups of geometric complexes, structure of zero-dimensional homology groups, Induced homomorphisms of simplicial maps, Beti number, Euler-Pioncare Theorem. 3. understand Subdivison chain map, topological invariance of homology groups, Homotopy invariance, Invariance of dimensions, Brower's Fixed point theorem, Degree of a map, Degree of the antipodal map.
9.	PSMATC 409	Fourier Analysis	After studying this course the student will be able to 1. understand Banach space, continuous linear functionals, and the three key theorem, the closed graph, the Hahn-Banach, the uniform boundedness theorems. 2. understand order of magnitude of Fourier coefficents and their applications and estimates. 3. understand Fourier series of square summable sequence in Hilbert spaces, absolutely convergent Fourier series, Fourier coefficients of a functionals, Parseval's formula, Fourier-Stieltjes coefficients and Fourier-Stieltjes series.
10.	PSMATC 410	Dissertation	
11.	PSMATC 411	Numerical Methods and Graph Theory	After studying this course the student will be able to 1. understand Transcendental and algebraic equations: Bisection method, Regula-Falsi method, Newton-Raphson method, Secant method, Rate of convergence of these methods. 2. understand Graphs and their representation, Pseudographs, Subgraphs, Degree sequence, Euler's theorem, Isomorphism of graphs, Paths and circuits, Connected graphs. 3. understand Dijkstra's algorithm, The Chinese postman problem; Digraphs, Bellman-Ford algorithm, Tournaments, Directed network.