Programme Outcome, Programme Specific Outcome and Course Outcome

Name of the Department: Mathematics

2014-2018 Admission (BSc Mathematics)

Programme Outcomes

(i) Critical Thinking

(ii) Effective Citizenship

(iii) Effective Communication

(iv) Interdisciplinarity

Programme Specific Outcomes

(i) Understand the basic concepts and tools of Mathematical logic, Set theory, Number theory, Geometry, Calculus, Algebra, Abstract structures, Linear Algebra, Analysis, Laplace transforms, Fourier series, Graph theory, and Optimization and methods of proofs.

(ii) Model real-world problems into Mathematical problems and find solutions and understand the application of Mathematics in other Sciences and Engineering.

Course Outcome

Sl. No.	Name of Course (paper)
1	**1B01 MAT:** Differential Calculus
2	**2B02 MAT :**Integral Calculus
3.	**3B03 MAT:** Elements ofMathematics I

4.	**4B04 MAT :**Elements ofMathematics II
5	**5B05 MAT:** Real Analysis
6.	**5B06 MAT:** Abstract Algebra
7.	**5B07 MAT**Differential Equations,Laplace transform and Fourier Series
8	**5B08 MAT :**Vector Calculus
9	**5B09 MAT :**Graph Theory
10	**6B10 MAT:** Linear Algebra
11	**6B11 MAT:**Numerical Methods and Partial Differential Equations
12	**6B12 MAT:** Complex Analysis
13	**6B13 MAT:**Mathematical Analysis and Topology
14	**6B14A MAT:** Operations Research
Open Courses- Mathematics	
	5D04 MAT Linear Programming
Complementary Courses	

1	**1C01 MAT-PH:** Mathematics for Physics and Electronics I
2	**2C02 MAT-PH:** Mathematics for Physics and Electronics II
3.	**3C03 MAT-PH:** Mathematics for Physics and Electronics III
4.	**4C04 MAT-PH:** Mathematics for Physics and Electronics IV
5	**1C01 MAT-CH:** Mathematics for Chemistry I
6.	**2C02 MAT-CH:** Mathematics for Chemistry II
7.	**3C03 MAT-CH:** Mathematics for Chemistry III
8	**4C04 MAT-CH:** Mathematics for Chemistry IV

2019 Admission Onwards (BSc Mathematics)

Programme Outcomes

(i) Critical Thinking

(ii) Effective Citizenship

(iii) Effective Communication

(iv) Interdisciplinarity

ProgrammeSpecific Outcomes

(i) Understand the basic concepts and tools of Mathematical logic, Set theory,

Number theory, Geometry, Calculus, Algebra, Abstract structures,

Linear Algebra, Analysis, Laplace transforms, Fourier series, Graph theory, and Optimization and methods of proofs.

(ii) Model real-world problems into Mathematical problems and find solutions

and understand the application of Mathematics in other Sciences and Engineering.

Course Outcome

Sl. No.	Name of Course (paper)	Outcomes	
1	**CORE COURSE 1:** **SET THEORY, DIFFERENTIAL CALCULUS AND NUMERICAL METHODS**	1	Understand Relations and Functions
		2	Understand the limit of a function, limit laws, continuity, Inverse functions and their derivatives
		3	Understand successive differentiation and Leibnitz theorem

			Understand functions of several variables, limit and continuity, partial derivatives, chain rule, homogenous functions and Euler's theorem on homogenous functions
		4	Understand bisection method, Regula-false method and Newton-Raphson method to solve algebraic and transcendental equations
2	**CORE COURSE 2:** **INTEGRAL CALCULUS AND LOGIC**	**1**	Understand Hyperbolic functions
		2	Understand Reduction formulae for trigonometric functions and evaluation of definite integrals.
		3	Understand Polar coordinates
		4	Understand Double integrals in Cartesian and polar form.
		5	Understand triple integrals in rectangular, cylindrical and spherical coordinates
		6	Understand Substitution in multiple integrals
		7	Understand Numerical integration: Trapezoidal rule, Simpson's 1/3rd rule
		8	Understand Logic and methods of proofs
		9	Understand Propositional functions, truth set and Negation of quantified statements

3	**CORE COURSE 3:** **ANALYTIC GEOMETRY AND APPLICATIONS OF DERIVATIVES**	**1**	Understand cartesian equation of conics, eccentricity, polar equations for a conic, lines, circles
		2	Understand Tangents, Normals and Asymptotes
		3	Understand Curvature, Radius of curvature, Centre of Curvature, Circle of curvature and Evolutes of Cartesian and polar curves,
		4	Understand Rolle's Theorem, Lagrange's Mean Value Theorem, Cauchy's Mean Value Theorem and Taylors Theorem.
		5	Understand extreme values of functions, monotonic functions, first derivative test, concavity and curve sketching.
		6	Understand Indeterminate forms.
4	**CORE COURSE 4:** **NUMBER THEORY AND APPLICATIONS OF INTEGRALS**	**1**	Understand Division algorithm, Greatest common Divisor, Euclidean Algorithm, Diophantine equation $ax+by=c$.
		2	Understand Primes and their distribution, fundamental theorem of arithmetic, the sieve of Eratosthenes
		3	Understand Basic properties of congruence.

		4	Understand Picard's little theorem, Wilson's theorem and Euler's theorem.
		5	Understand Substitution and the area between curves, Arc length, Areas and length in polar coordinates.
		6	Understand Volumes using cross-sections, volumes using cylindrical shells and areas of surfaces of revolution.

5	**CORE COURSE 5:** **SET THEORY, THEORY OF EQUATIONS AND COMPLEX NUMBERS**	**1**	Understand finite and infinite sets, Countable and Uncountable sets, Cantor's theorem.
		2	Understand Roots of equations, Relations connecting the roots and coefficients of an equation, Transformation of equations, The cubic equation, Character and position of roots of an equation.
		3	Understand Descarte's rule of signs, De Gua's Rule, Limits to the roots of an equation, Rational roots of equations, Newton's method of divisors, Symmetric functions of roots of an equation, Symmetric functions involving only the difference of the roots of f(x)=0, Equations whose roots are symmetric functions.
		4	Understand Reciprocal equations.
		5	Understand Cubic equation, Equation whose roots are the squares of the difference of the roots, Character of the Roots, Cardan's Solution.
		6	Understand Roots of complex numbers, Gthe eneral form of De Moivre's theorem, the n_{th} roots of unity, the n_{th} roots of -1, Factors of x_n-1 and x_n+1, the imaginary cube roots of unity.

		7	Understand polar form of complex numbers, powers and roots
6	**CORE COURSE 6:** **REAL ANALYSIS I**	**1**	Understand Algebraic Properties, Order Properties and Absolute values of $\mathbb{R}$. Understand the Completeness Property of $\mathbb{R}$ and its applications to derive Archimedean Property and Density theorem.
		2	Understand intervals in the real line.
		3	Understand Sequences and their Limits, Limit Theorems, Monotone Sequences.
		4	Understand Subsequences and the Bolzano-Weierstrass Theorem, The Cauchy Criterion.
		5	Understand Infinite Series, Absolute Convergence.
		6	Understand Comparison test, Root test, Ratio test, Integral test and Raabe's test for Absolute convergence.
		7	Understand Alternating series test, Dirichlet's test and Abel's test for Non-Absolute convergence.
		8	Understand Continuous Functions, the composition of continuous functions and continuous functions on intervals.

7	**CORE COURSE 7:** **ABSTRACT ALGEBRA**	**1**	Understand the definition and elementary .properties of Groups, Subgroups and Cyclic groups.

		2	Understand Groups of Permutations, orbits, Alternating groups and theorem of Lagrange.
		3	Understand group homomorphisms, factor Groups
		4	Understand Fundamental Homomorphism Theorems.
		5	Understand the definition and properties of rings and fields
		6	Understand Ring homomorphisms and isomorphisms
		7	Understand zero divisors, integral domains, characteristic of a ring and their properties.
8	**CORE COURSE 8:** **DIFFERENTIAL EQUATIONS AND LAPLACE TRANSFORMS**	**1**	Understand Separable ODEs, Exact ODEs, Linear ODEs, Bernoulliequation and methods to solve these ODEs.
		2	Understand the theorem of Existence and Uniqueness of solutions of first and second-order ODEs.
		3	Understand Homogeneous Linear ODEs of Second Order and solve homogeneous linear ODEs of second order with constant coefficients and Euler-Cauchy equation**.**
		4	Understand Nonhomogeneous ODEs and solve by variation of parameters**.**
		5	Understand Laplace Transform and inverse Laplace Transformation**.**

		6	Understand The first and The second shifting theorems and their applications.
		7	Understand the methods to find Laplace transforms of derivatives and integrals of functions.
		8	Understand the method of differentiating and integrating Laplace transform.
		9	Solve ordinary differential equations and integral equations using Laplace transform.

9	**CORE COURSE 9:** **VECTOR CALCULUS**	**1**	Understand lines and planes in space
		2	Understand curves in space, their tangents, normal, curvature, the tangential and normal curvature of acceleration.
		3	Understand Directional derivatives and gradient vectors, tangent planes and differentials. Solve extreme value problems using Lagrange multipliers.
		4	Understand Partial derivatives with constrained variables and Taylor's formula for two variables.
		5	Understand Line integrals. Solve for work, circulation and flux using line integrals.

		6	Understand path independence conservative fields and potential functions.
		7	Understand Green's theorem and solve problems using Green's theorem.
		8	Understand Surface area and surface integrals.
		9	Understand Stoke's theorem and solve problems using Stoke's theorem.
		10	Understand the Divergence theorem and solve problems using the Divergence theorem.
10	**CORE COURSE 10:** **REAL ANALYSIS II**	**1**	Understand Uniform Continuity, Monotone and Inverse Functions and Interchange of Limits
		2	Understand Riemann Integral and Riemann-integrable Functions
		3	Understand Fundamental Theorem of Calculus.
		4	Understand Improper Integrals.
		5	Understand Beta and Gamma Functions and their properties.
		6	Understand Transformations of Gamma Function and Duplication formula**.**

		7	Understand Pointwise and Uniform Convergence of a sequence of functions.
		8	Understand Series of Functions.
			Understand the concept of Metric Spaces

11	**CORE COURSE 11:** **COMPLEX ANALYSIS**	**1**	Understand Analytic Function, Cauchy–Riemann Equations. Laplace's Equation.
		2	Understand Exponential Function, Trigonometric Functions, Hyperbolic Functions, Logarithmic functions and General Power of complex numbers.
		3	Understand line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula and derivatives of analytic functions
		4	Understand convergence of Sequences and Series of complex functions.
		5	Understand power series, functions given by power series, Taylor series, Maclaurin's Series and Laurent Series.
		6	Understand singularities and zeros of complex functions
		7	Understand residue integration method and integrate real integrals.

12	**CORE COURSE 12:** **NUMERICAL METHODS, FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS**	**1**	Understand Interpolation techniques: Interpolation with unevenly spaced points, Lagrange interpolation, Newton's divided differences interpolation, Finite-difference operators and finite differences, Newton's interpolation formulae and Central difference interpolation.
		2	Understand Numerical differentiation using different formulae**.**
		3	Understand Picard's method, Solution by Taylor series method, Euler method and Runge- Kutta methods.
		4	Understand Fourier Series: Arbitrary period, Even and Odd Functions, Half-Range Expansions and Fourier Integrals.
		5	Understand Partial Differential equations Solution by Separating Variables.
		6	Understand the use of Fourier Series in solving PDE: D'Alembert's Solution of the Wave Equation. Characteristics and solving Heat Equation by Fourier Series.
		7	Understand Laplacian in Polar Coordinates

13	**CORE COURSE 13:** **LINEAR ALGEBRA**	**1**	Understand the concept of Vector spaces, subspaces, linear combinations ad system of equations.

		2	Understand the concept of Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets and solves problems.
		3	Understand the concept of Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation.
		4	Understand Rank of a matrix, Elementary transformations of a matrix, Invariance of rank through elementary transformations, Normal form, Elementary matrices.
		5	Understand the concept System of linear homogeneous equations Nullspace and nullity of the matrix, Range of a matrix, Systems of linear non-homogeneous equations.
		6	Understand Eigenvalues, Eigenvectors, Properties of Eigenvalues, Cayley-Hamilton theorem.
14	**DISCIPLINE SPECIFIC ELECTIVE COURSE: 6B14B MAT: OPERATIONS RESEARCH**	**1**	Understand convex sets, convex functions, their properties, local and global extrema and quadratic forms without saddle point, Graphic solution of 2xn and mx2 games and Arithmetic method for nxn Games.
		2	Understand LPP, formulate and solve using graphical method
		3	Understand General LPP, canonical and standard forms of LPP

		4	Understand simplex method and solve LPP
		5	Understand basic solution, degenerate solution, basic feasible solution, optimum basic feasible solution, fundamental properties of the solution and simplex method
		6	Understand primal-dual pair, formulation of dual and duality theorems
		7	Understand LP formulation of a transportation problem and its solution
		8	Understand Mathematical formulation of an Assignment problem and the Hungarian Assignment method
		9	Understand the problem of sequencing, Processing ‘n’ jobs through ‘2’ machines, Processing ‘n’ jobs through ‘k’s machines
		10	Understand basic terms in Game theory, The Maximin-Minimax Principle, the Solution of the game with saddle point, Solution of the 2x2 game.

COMPLEMENTARY ELECTIVE COURSES

1	**MATHEMATICS FOR PHYSICS I**	**1.** Understand the concept of Differentiation and successive differentiation. **2.** Understand Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem, Cauchy's mean-value theorem. **3.** Understand Taylor's theorem, expansions of functions Maclaurin's series, expansion by use of known series **4.** Understand the Matrices and System of Equations, Linear Transformations. **5.** Understand the Rank of a matrix, elementary transformations, the normal form of a matrix, the inverse of a matrix, solution of a linear system of equations. **6.** Understand Linear transformations, orthogonal transformation, vectors – linear dependence. **7.** Understand Derivative of arc, curvature, Polar coordinates, Cylindrical and Spherical coordinates.
2.	**MATHEMATICS FOR PHYSICS II**	**1.** Understand partial derivatives, homogeneous functions, Euler's theorem, total derivative, differentiation of implicit functions, change of variables. **2.** Understand Integration and Integration by Successive Reduction, Integration of Trigonometric Functions **3.** Comprehend Applications of Integration **4.** Comprehend Eigenvalues, Eigenvectors, properties of Eigenvalues, **5.** Understand Cayley- Hamilton theorem, Diagonal form, the similarity of matrices, powers of a matrix, canonical form, nature of a quadratic form.

3.	**MATHEMATICS FOR PHYSICS III**	**1**.Understand the concept of Multiple Integrals and solves Problems. **2.** Understand Vector Differentiation. **3.**Understand Laplace Transforms and its Applications **4**.Understand Fourier Series and Half range expansions
4.	**MATHEMATICS FOR PHYSICS IV**	**1.**Understand Wave Equation, Solution by Separating Variables, D-Alembert's solution of the wave equation. **2.**Understand Heat Equation and Solution by Fourier Series **3.**Understand Line integrals, path independence, conservative fields and potential functions, Green's theorem in the plane. **4.**Understand Surface area, surface integrals, Stoke's theorem, Divergence theorem **5.**Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule **6.** Understand Numerical Solutions of Ordinary Differential Equations by Taylor's series, Euler's Method, Modified Euler's method, Runge-Kutta methods.

5.	**MATHEMATICS FOR CHEMISTRY I**	**1.** Understand Successive differentiation and Leibnitz's theorem for the nth derivative of the product of two functions. **2.** Understand Fundamental theorem – Rolle's theorem, Lagrange's mean-value theorem and Cauchy's mean value theorem. **3.** Understand Taylor's theorem, expansions of functions – Maclaurin's series, expansion by use of known series and Taylor's series. **4.** Understand the method of finding limits of indeterminate forms. **5.** Understand Polar, Cylindrical and Spherical Coordinates. **6.** Understand the Rank of a matrix, elementary transformation of a matrix, equivalent matrices, elementary matrices, Gauss-Jordan method of finding the inverse, normal form of a matrix and partition method of finding the inverse. **7.** Understand solution of a linear system of equations – method of determinants – Cramer's rule, matrix inversion method, consistency of the linear system of equations, Rouche's theorem, a procedure to test the consistency of a system of equations in n unknowns, a system of linear homogeneous equations. **8.** Understand Linear transformations, orthogonal transformation and linear dependence of vectors. **9.** Understand methods of curve fitting, graphical method, laws reducible to the linear law, principles of least squares, method of least squares and apply the principle of least squares to fit the straight

		line $y=a+bx$, to fit the parabola $y=a+bx+cx^2$, to fit $y=ax^b$, $y=ae^{bx}$ and $xy^n=b$.
	MATHEMATICS FOR CHEMISTRY II	**1.** Understand Functions of two or more variables, limits and continuity. **2.** Understand partial derivatives, homogeneous functions, Euler's theorem on homogeneous functions, total derivative, differentiation of implicit functions and change of variables. **3.** Understand Reduction formulae for trigonometric functions and evaluation of definite integrals. **4.** Understand Substitutions and the area between curves, arc length, areas and length in polar coordinates. **5.** Understand Double and Iterated Integrals over rectangles, double integrals over general regions, area by double integration, double integrals in polar form and triple integrals in rectangular coordinates. **6.** Understand Eigenvalues, Eigenvectors, properties of Eigenvalues, Cayley- Hamilton theorem, reduction to diagonal form, the similarity of matrices, powers of a matrix, reduction of quadratic form to canonical form and nature of a quadratic form.

7	**MATHEMATICS FOR CHEMISTRY III**	**1.** Understand Ordinary differential equations, Geometrical meaning of $y'=f(x, y)$ and Direction Fields. **2.** Understand Methods of solving Differential Equations: Separable ODEs, Exact ODEs, Integrating Factors, Linear ODEs and Bernoulli Equation. **3.** Understand Orthogonal Trajectories, Existence and Uniqueness of Solutions. **4.** Understand Second-order ODEs, Homogeneous Linear ODEs of second-order, Homogeneous Linear ODEs with constant coefficients, Differential Operators, Euler-Cauchy Equation, Existence and Uniqueness of Solutions – Wronskian, Nonhomogeneous ODEs and Solution by variation of Parameters **5.** Understand Laplace Transform, Linearity, first shifting theorem, Transforms of Derivatives and Integrals, ODEs, Unit step Function, second shifting theorem, Convolution, Integral Equations, Differentiation and integration of Transforms and to solve special linear ODE's with variable coefficients and Systems of ODEs. **6.** Understand Fourier series, arbitrary period, Even and Odd functions, Half-range Expansions.

8.	**MATHEMATICS FOR CHEMISTRY IV**	**1.** Understand Partial Differential Equations, Modeling, Vibrating String, Wave Equation. **2.** Solve PDE by Separating Variables, by use of Fourier Series, D-Alembert's solution of the wave equation and Heat Equation. **3.**Understand Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule **4.** Understand Numerical methods to find Solutions of Ordinary Differential Equations: Solution by Taylor's series, Euler's Method, Modified Euler's method, Runge-Kutta methods. **5.** Understand volumes of solid using cross-sections and areas of surfaces of revolution

GENERIC ELECTIVE COURSE

1	**LINEAR PROGRAMMING**	**1.** Understand General linear programming problem – canonical and standard forms of L.P.P, Solutions and fundamental properties of solutions of LPP. **2.** Understand Graphical solution method, Simplex method, Duality in linear programming, Formulating a dual problem. **3.** Understand General transportation problem, the transportation tables, Loops in transportation table and solves the transportation problem **4.** Understand Degeneracy in transportation problem, Transportation algorithm (MODI method) and solves problems

Details

- **Programme outcome: It is attained in the period of UG / PG Programme -common to all UG courses (common for all PG courses).**

- **Programme specific outcome: For each UG programme, it is different. Programme specific outcomes of B.Sc Mathematics and B.Sc Physics are different.**

- **Course outcome: Paper (course) wise outcome. In the case of Mathematics their are14 core courses, 8 complementary courses and one open course.**

- **Use the 2014 syllabus to prepare PO, PSO and CO for the academic year2018-19.**

- **Use the 2019 syllabus to prepare PO, PSO and CO for the academic year 2019-20.**

- **Programme Outcome, Programme Specific Outcome and Course Outcome are included in the 2019 syllabus. Collect course outcomes of each paper (course) and consolidate the same.**

- **It will be uploaded on the college website.**