St. Xavier's College (Autonomous), Mumbai
Department of Mathematics

Programme: B.Sc. Mathematics

Programme Specific Outcomes (PSOs) for B.Sc. Mathematics

Sr. No.	A student completing B.Sc. Mathematics will be able to:
PSO 1	Understand the fundamental concepts in mathematics and develop ideas based on them.
PSO 2	Internalise mathematical reasoning.
PSO 3	Be motivated towards research in mathematics and related fields.
PSO 4	Possess advanced knowledge on topics in pure mathematics, empowering her/him to pursue higher degrees at reputed academic institutions.
PSO 5	Have a strong foundation in algebra, analysis and calculus leading to pursuing postgraduate studies in mathematics, theoretical physics, statistics etc.
PSO 6	Demonstrate problem-solving skills, innovative thinking, creativity and programming capability in Java and Python.

Course Outcomes (COs): B.Sc. Mathematics

Semester I

Course Title: Calculus – I
Course Code: SMAT0101

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Apply 'lub' axiom to obtain interesting results such as Archimedean property, density theorem, etc.	1	Ap
CO 2	Analyze convergent sequences and Cauchy sequences in R to obtain relation between them.	1, 2	An
CO 3	Solve exact, non-exact, linear differential equations of first order and first degree.	1	E
CO 4	Acquire the habit of independent problem-solving, skill development and creativity.	2, 6	Ap, C

Course Title: Algebra – I
Course Code: SMAT0102

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Find the gcd and lcm of any 2 or 3 numbers using Euclidean algorithm and understand division algorithm; know the properties of gcd, check whether a number is prime or composite and understand their properties; and prove a theorem or proposition based on natural numbers using mathematical induction.	1	U, Ap
CO 2	Define a function, check whether a given function is injective, surjective, bijective and invertible and find composition of functions; check whether a binary relation is closed, commutative, associative, has identity and inverse.	1	U, Ap
CO 3	Find gcd and lcm of any two polynomials using Euclidean algorithm and understand Division Algorithm; understand the rational root theorem and use it to find real roots of a polynomial degree up to 3; understand fundamental theorem of arithmetic, DeMoivre's theorem; and find all real and complex roots of a polynomial of finite degree and understand the relationship between them.	1, 2	U, Ap
CO 4	Solve problems independently.	2, 6	Ap, C

Semester II

Course Title: Calculus – II
Course Code: SMAT0201

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Apply various tests such as comparison test and its limit form, condensation test, Leibnitz test, ratio test, root test to check convergence of a given infinite series.	1, 2	U, Ap
CO 2	Obtain properties of continuous functions, prove intermediate value theorem and obtain higher order derivatives.	1	U
CO 3	Analyse applications of differentiable functions like mean value theorems, Taylor`s theorem and sketch graph of a given function.	2	An

Course Title: Algebra – II
Course Code: SMAT0202

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Solve a system of linear equations using Gauss elimination method; understand the geometric interpretation of the system and its solution; and find parametric equations of a line and plane.	1	U, Ap
CO 2	Check whether a given set forms a vector space and verify its properties, its subspaces and understand their properties and theorems; check whether a subset of a vector space is linearly dependent or independent and understand its properties and find its basis and dimension.	1, 2	U, Ap
CO 3	Check whether a map is a linear transformation between two vector spaces and understand its properties; find the kernel, image and their respective dimensions for a linear transformation; understand rank nullity theorem and use it to solve problems.	1, 2, 6	U, Ap
CO 4	Possess independent problem-solving skills.	2, 6	Ap, C

Semester III

Course Title: Calculus – III
Course Code: SMAT0301

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand concept of Riemann integration and properties of Riemann integrable functions.	1, 2	U
CO 2	Compute improper integrals and possess expertise in very important functions such as beta and gamma functions.	1, 5	U, Ap
CO 3	Be conversant with integration of bounded function in two variables through double integration, and appreciate its applications in real-life problems such as computing area, volume and centre of a mass etc.	1, 5	U, Ap

Course Title: Algebra – III
Course Code: SMAT0302

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Represent linear maps on vector spaces by matrices; generate isomorphic vector spaces, and obtain its related results.	1	U
CO 2	Prove properties of determinant via permutations, evaluate determinant by Laplace/cofactor expansion, solve system of equations by Cramer`s rule and obtain results of adjoint of a matrix.	1, 2	U, E
CO 3	Check whether a given product is an inner product and obtain its properties; prove theorems related to norms such as Cauchy-Schwarz inequality, triangle inequality, Pythagoras's theorem and Gram-Schmidt orthogonalization process.	1, 5	U
CO 4	Develop skills and creativity to solve problems independently.	6	C, Ap

Course Title: Discrete Mathematics
Course Code: SMAT0303

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the concept of advanced counting and observe their applications to various real-life problems.	1	U
CO 2	Understand and apply the concepts of algorithms, including sorting and searching algorithms which is important to development of logic.	1, 2	U, Ap
CO 3	Use PASCAL language to see the implementation of algorithms and writing programs.	2	U
CO 4	Understand the concepts of graphs and trees, their types and applications in study of shortest path algorithms and spanning trees.	1, 4	U, Ap
CO 5	Inculcate the habit of problem solving, especially in logic.	2, 6	Ap, E

Course Title: Mathematics Practicals – III
Course Code: SMAT03PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Use algorithms to write a program in any programming language.	1, 2, 6
CO 2	Understand the importance of graphs to computer programming.	1, 3, 6

Semester IV

Course Title: Calculus – IV
Course Code: SMAT0401

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Analyse convergent sequences and Cauchy sequences in Rn; to study concepts of limit, continuity, differentiability, partial/ directional derivatives, gradients of scalar fields.	1, 2, 5	An, U
CO 2	Analyse concept of differentiability of scalar fields and relate with gradient of a scalar field; study higher order partial derivatives of f(x, y).	1, 2, 5	An
CO 3	Find extreme values of f(x, y) by second derivative test and by Lagrange`s method of undetermined multipliers; analyse differentiability of vector fields.	1, 4, 5	U, E
CO 4	Develop independent problem-solving skills.	2, 6	Ap, C

Course Title: Algebra – IV
Course Code: SMAT0402

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Possess knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element, and mathematical concepts in abstract mathematics such as permutation groups, dihedral groups, Abelian groups, centre of a group etc.	4, 5	U, Ap
CO 2	Be knowledgeable of subgroups, cyclic subgroups and understand the structure and characteristics of these subgroups.	4, 5	U, An
CO 3	Understand concepts such as cosets, Lagrange's theorem, homomorphisms and isomorphisms of groups.	4, 5	U, An

Course Title: Differential Equations
Course Code: SMAT0403

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Formulate differential equations for various mathematical models.	4, 5, 6	Ap
CO 2	Solve first, second and higher order ordinary differential equation using various techniques.	6	U, Ap
CO 3	Apply these techniques to solve and analyse various mathematical models.	6	Ap
CO 4	Formulate, classify and transform partial differential equations into canonical form.	6	Ap
CO 5	Solve some of the physical problems, for example, heat and wave equations.	5, 6	Ap

Course Title: Mathematics Practicals – IV
Course Code: SMAT04PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Solve problems on ordinary and partial differential equations.	1, 4, 6
CO 2	Formulate differential equations for mathematical models.	1, 2, 6

Semester V

Course Title: Calculus – V
Course Code: SMAT0501

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the extension of the studies of single variable integral calculus to functions of two or more independent variables.	4, 5	U
CO 2	Formulate inter-relationships amongst the line, surface, double and triple integrals.	4	An
CO 3	Study applications of multi-variable calculus tools in physics, economics; optimization, and understand the architecture of curves and surfaces in plane and space etc.	3, 4, 5	Ap
CO 4	Evaluate double, triple, line and surface integrals.	1	E
CO 5	Understand the interpetation and application of Green's, Gauss' and Stokes' theorems.	2, 4	U, Ap
CO 6	Possess an in-depth knowledge calculus, and the habit of solving problems independently.	3, 5, 6	Ap

Course Title: Algebra – V
Course Code: SMAT0502

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand concepts such as quotient spaces, eigenvalues, eigenvectors, characteristic polynomial and minimal polynomial and their properties.	3, 4, 5	U
CO 2	Compute geometric multiplicities and algebraic multiplicities of eigenvalues; check whether the given matrix is diagonalizable or not; and understand application of diagonalization in studying quadratic forms.	4, 5, 6	Ap, E
CO 3	Analyse orthogonal linear transformations and isometries.	5	U

Course Title: Topology of Metric Spaces – I
Course Code: SMAT0503

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Determine whether a given function is a metric or not; whether a given set is open or not in the given metric space; whether a given set is closed or not in the given metric space.	4, 5	U, Ap
CO 2	Determine if a sequence is Cauchy or not; if a sequence is convergent or not.	2, 5	Ap, An
CO 3	Determine if a given point is a closure point of a given set; and if a given point is a limit point of a given set; determine whether a given metric space is compact or not.	5, 6	Ap, An

Course Title: Numerical Methods – I
Course Code: SMAT0504

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Solve algebraic and transcendental equations by iteration methods (based on first degree equation) such as regula falsi method, secant method, Newton-Raphson method, general iteration method.	4, 5, 6	U, E
CO 2	Solve algebraic and transcendental equations by iteration methods (based on second degree equation) such as Muller method, Chebyshev method, multipoint iteration method; solve polynomial equations by iteration methods such as Birge-Vieta method, Bairstow method, Graeffe's root squaring method.	4, 6	U, E
CO 3	Solve a system of linear algebraic equations by direct methods such as Cholesky's method, LU decomposition, partition method and iterative methods such as Jacobi iteration method, Gauss-Siedel iterative method, SOR method.	4, 6	U, Ap
CO 4	Obtain eigenvalues and eigenvectors of a matrix by Jacobi method, Givens method, Householder method, Rutishauser method, power method.	4, 5, 6	Ap, E
CO 5	Show creativity and skill development to solve problems independently.	3, 6	Ap, C

Course Title: Mathematics Practicals – V
Course Code: SMAT05PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Understand basic concepts and solve problems in different areas of mathematics such as differential and integral calculus, diagonalization of matrices and metric spaces.	1, 2, 3, 5, 6
CO 2	Find roots of transcendental equations and find eigenvalues/ eigenvectors of those symmetric matrices for which traditional methods fail.	1, 2, 6

Course Title: Computer Programming – I
Course Code: SMAT05AC

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Write a computer program using Java.	6	U, C
CO 2	Solve problems instantly with accuracy by implementing them using Java programs.	2, 6	Ap, E
CO 3	Create applets with geometrical shapes and pictures and run them on local and remote computers via html code.	6	U
CO 4	Create very basic CUI-based apps and games.	5, 6	U, Ap
CO 5	Store and/or retrieve data in/from a table of a database by writing queries using sql.	6	U
CO 6	Carry out independent problem-solving activities.	6	Ap, C

Course Title: Applied Component Practicals – I
Course Code: SMAT05ACPR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Solve number theory and combinatorics problems using Java.	6
CO 2	Learn about SQL and use it to create tables and execute various queries.	6

Semester VI

Course Title: Calculus – VI
Course Code: SMAT0601

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Recognize the difference between point-wise and uniform convergence of a sequence of functions.	2, 4, 5	U
CO 2	Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.	5	U, An
CO 3	Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.	5	U
CO 4	Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.	6	E
CO 5	Expand some simple functions as the Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy residue theorem to evaluate integrals.	2, 5	U, Ap
CO 6	Apply the theory of the power series expansion of analytic functions.	3, 5, 6	Ap

Course Title: Algebra – VI
Course Code: SMAT0602

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the importance of a ring as a fundamental object in algebra.	4, 5	U
CO 2	Possess knowledge of concepts such as ED, PID and UFD.	5	U, An
CO 3	Understand the irreducibility of elements in a ring, and ring homomorphisms and isomorphisms.	2, 5	U, An
CO 4	Comprehend concepts such as normal subgroups, quotient groups, external direct product of groups; and applications of these concepts in classification of groups till order 7.	3, 5	U, An, Ap

Course Title: Topology of Metric Spaces – II
Course Code: SMAT0603

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Determine if a metric space is complete or not; show that the set of real numbers is uncountable; and show denseness of rational numbers.	5	U, An
CO 2	Determine if a function defined between two metric spaces is continuous or not.	5, 6	U, An
CO 3	Determine whether a given metric space is connected/disconnected; determine if two sets are separated or not.	3, 5	U, An

Course Title: Numerical Methods – II
Course Code: SMAT0604

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Find a polynomial that fits given data by Lagrange's interpolation, Newton's divided interpolation, Gregory-Newton forward/ backward difference interpolation methods; prove fundamental theorem of difference calculus.	5, 6	U, Ap
CO 2	Obtain best fit of given data by the least square approximation; find a polynomial that fits given data by piece-wise interpolation, Hermite interpolation; and obtain formulae for numerical (partial) differentiation.	4, 5	An, Ap
CO 3	Evaluate definite (double) integral by numerical integration methods, trapezoidal rule, Simpson's (1/3) rule, Simpson's (3/8) rule.	6	E
CO 4	Solve ordinary differential equations with initial condition (IVP) by Taylor's series, Picard's, Euler's, Modified Euler's and Runge-Kutta methods.	5, 6	Ap
CO 5	Practice independent problem solving.	3, 6	Ap, C

Course Title: Mathematics Practicals – VI
Course Code: SMAT06PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Understand areas of mathematics such as complex analysis; strengthen concepts in topics from abstract algebra such as group theory and ring theory.	1, 2 ,3, 5, 6
CO 2	Obtain interpolating polynomial from given data for further analysis; solve those ordinary differential equations with initial conditions (initial value problems) which are not solvable by the traditional methods.	1, 2, 6

Course Title: Computer Programming – II
Course Code: SMAT06AC

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Write a computer program using Python.	6	U
CO 2	Use NumPy and SymPy python libraries in data science.	5, 6	Ap
CO 3	Solve problems instantly with accuracy by implementing them using Python programs.	6	Ap
CO 4	Create very basic CUI-based apps and games.	5, 6	C
CO 5	Possess the habit of independent problem solving.	6	Ap, C

Course Title: Applied Component Practicals – II
Course Code: SMAT06ACPR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Solve number theory and combinatorics problems using Python.	6
CO 2	Develop simple CUI-based applications and games.	6