Syllabus
Second Semester Courses in Mathematics
2023-2024

Contents:

APPROVED SYLLABUS

PRINCIPAL
ST. XAVIER'S COLLEGE
AUTONOMOUS
MUMBAI - 400 001.

ST. XAVIER'S COLLEGE-AUTONOMOUS * MUMBAI-400 001 *

F.Y.B.Sc.
Title: Calculus and Linear Algebra

Course Code: USMAT4502CR1

Prerequisite: Revise the following topics learnt at Junior College or School level:-
Derivative of a function, to find extreme values of a differentiable function, Review of vectors in R^2 and R^3 as points, Addition and scalar multiplication of vectors in terms of co-ordinates, Dot product, Scalar triple product, Length (norm) of a vector, matrix row operations.

Course Objectives:

1. To study differentiable functions and higher order derivatives using Leibnitz rule.
2. To apply Mean value theorems and Taylor's theorem.
3. To draw graph of given functions.
4. To solve System of linear equations.
5. To study Vector Spaces, subspaces, linearly dependent/ independent sets, spanning set, basis.

Credits: 4

Course Outcomes (COs):
On completing the course, the student will be able to:

1. Find higher order derivatives and evaluate limts with indeterminate forms. Apply Leibnitz test.
2. Analyse applications of differentiable functions like mean value theorems, Taylor's theorem and sketch graph of a given function.
3. Solve a system of linear equations using Gauss elimination method; understand the geometric interpretation of the system and its solution.
4. Check whether a given set forms a vector space and verify its properties, its subspaces andunderstand 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.
5. Acquire the habit of independent problem-solving, skill development and creativity.

Unit 1: Differentiation of a real valued function in one variable **(15 Lectures)**

Definition of differentiation of a real valued function in one variable at a point, examples of differentiable and non-differentiable functions, differentiable functions are continuous but not conversely, Algebra of differentiable functions, chain rule, Derivative of inverse function,

Implicit differentiation (only examples), Characterization of a differentiable function, Successive differentiation/Higher order derivatives, Leibnitz rule for n^{th} derivative,L`hospital`s rule (without proof), examples of indeterminate forms.

Unit 2: Applications to derivatives **(15 Lectures)**

Monotone increasing and decreasing functions with examples, Rolle's theorem, Lagrange's and Cauchy's mean value theorems with applications and examples, concave up and Concave down, Point of inflection, Taylor's theorem with Lagrange's form of remainder with proof, Taylor's polynomial and applications, Taylor series and Maclaurin series. Definition of local maximum and local minimum, necessary condition, stationary points, first and second derivative test, examples, Graphs of some standard functions, Graph of a bijective function and its inverse, Graphing of functions using first and second derivatives.

Unit 3: System of Linear equations and Vector Spaces **(15 Lectures)**

System of homogeneous and non-homogeneous linear equations, the solution of system of m homogeneous linear equations in n unknowns by elimination, Definition of n tuples of real numbers, sum of n tuples and scalar multiple of n tuple. System of linear equations in matrix form, elementary row operations, row echelon matrix, Gaussian elimination method, to deduce that the system of m homogeneous linear equations in n unknowns has a non-trivial solution if $m < n$.

Vector Spaces: Definition of a real vector space, examples. Definition and examples of subspaces. Properties of subspaces such as necessary and sufficient condition for a non-empty subset to be a subspace of a vector space, arbitrary intersection of subspaces of a vector space is a subspace, union of two subspaces is a subspace if and only if one is a subset of the other.

Unit 4: Linear Independence and basis **(15 Lectures)**

Linear combinations of vectors in a vector space, Linear span L[S] of a non-empty subset S of a vector space, S is the generating set of L[S], linear span of a non-empty subset of a vector space is a subspace of the vector space. Linearly independent/Linearly dependent sets in a vector space, Its properties such as a set of vectors in a vector space is linearly dependent if and only if one of the vectors v_i is a linear combination of the other vectors v_j's. Basis of a vector space, Dimension of a vector space, maximal linearly independent subset of a vector space is a basis of a vector space, minimal generating set of a vector space is a basis of a vector space, any set ofn+1 vectors in a vector space with n elements in its basis is linearly dependent, any two basis of a vector space have the same number of elements, any n linearly independent vectors in an n dimensional vector space is a basis of a vector space. If U and W are subspaces of a vector space then U+W is a subspace of the vector space, dim [U+W]=dim U + dimW – dim [U ∩ W]. Extending the basis of a subspace to a basis of a vector space.

List of Recommended Reference Books:

1. Ajit Kumar and Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
2. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Calculus and Real Analysis,Springer International Ltd, 2000.
3. S. Kumaresan, Linear Algebra, A Geometric Approach, Prentice Hall of India, Pvt. Ltd, 2000.
4. James Stewart, Calculus, Third Edition, Brooks, Cole Publishing Company,1994.
5. Serge Lang, Introduction to Linear Algebra, Second Edition, Springer, 1985.
6. K. Hoffman and R. Kunze, Linear Algebra, Tata McGraw-Hill, New Delhi, 1971.
7. J.P. Singh , Calculus , Ane's Student Edition, Ane Books Pvt.Ltd. 2014.

Evaluation (Core Theory): Total marks of thecourse – 100

I. Formative Assessment 'for' Learning (continuous internal assessment – CIA to improve learning).
CIA– 40 marks
CIA – 1: Written test – 20 marks(Objectives/Short questions, not more than 5 marks each)
CIA – 2: Written test – 20 marks(Objectives/Short questions, not more than 5 marks each)

II. Summative Assessment 'of' Learning (Focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 60 marks
One question from each unit for 15 marks, with internal choice. Total marks per question with choice – 20 to 22.

Template for the End Semester examination in Semester – 2 for the Core course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS Per unit
1	3	7	5	15
2	3	6	6	15
3	3	7	5	15
4	3	5	7	15
-TOTAL- Per objective	12	25	23	60
% WEIGHT-AGE	20%	41.67%	38.33%	100%

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F.Y.B.Sc.
Title: Combinatorics

Course Code: USMAT4501VS1

Prerequisite: Set, Relation, function, binomial theorem

Course Objectives: To learn about

1. Advanced counting
2. Euler phi function $(\phi(n))$
3. Pigeonhole Principle
4. No. of Partitions
5. Derangements
6. Permutation group and Recurrence Relation

Credits:2

Course Outcomes (COs):
On completing the course, the student will be able :

1. To understand countable, uncountable sets and their meaning.
2. To learn addition and multiplication rule to calculate sample space for probability.
3. To learn to calculate multinomial expansions
4. To understand meaning of permutation as arrangement and apply it in day-to-day life.
5. To study various of types of recurrence relations such as linear, nonlinear and to apply them to solve various counting problems

Unit 1: Counting Principle – 1 **(15 lectures)**

Finite and infinite sets, Countable and uncountable sets, examples such as $\mathbb{N}, \mathbb{Z}, \mathbb{N} \times \mathbb{N}, \mathbb{Q}, (0,1), \mathbb{R}$. Addition and multiplication principle, counting sets of pairs, two ways counting. Pigeon hole principle and its strong form, its applications. Binomial and Multinomial Theorem, Pascal identity, examples of standard identities. Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems. Non-negative and positive integral solutions of equation $x_1 + x_2 + \cdots + x_k = n$.

Unit 2: Counting Principle – 2 **(15 lectures)**

Principle of Inclusion and Exclusion, its applications, derangements, explicit formula for D_n, various identities involving D_n, deriving formula for Euler's phi function $\varphi(n)$. Permutation of objects, $S_n$composition of permutations, results such as every permutation is product of disjoint cycles; every cycle is product of transpositions, even and odd permutations, rank and signature of permutation, cardinality of S_n, A_n . Recurrence relation, definition of homogeneous, non-homogeneous, linear and non-linear recurrence relation, obtaining recurrence relation in counting problems, solving (homogeneous as well as non-homogeneous) recurrence relation by using iterative method, solving a homogeneous recurrence relation of second degree using algebraic method proving the necessary result.

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List of Recommended Reference Books:

1. Discrete Mathematics; Norman Biggs; Oxford University Press, Second edition, 2002.
2. Introductory Combinatorics; Richard Brualdi; Pearsons, Fifth edition, 2019.
3. Discrete Mathematics with Graph Theory; Edgar Goodaire and Michael Parmenter; Pearson, Third edition, 2017.
4. Discrete Mathematics and Its Applications; Kenneth H. Rosen; McGraw Hill Edition, Second edition, 1999.
5. Combinatorics–Theory and Applications; V. Krishnamurthy; Affiliated East West Press, 2008.
6. Discrete Mathematics; Schaum's outline series, Third edition, 2017.
7. Applied Combinatorics; Alan Tucker; John Wiley and Sons, third edition, 1994.
8. Discrete and Combinatorial Mathematics; Ralph P Grimaldi; Pearson international edition, Fifth edition, 2019.
9. Discrete Mathematics; Kenneth Ross and Charles Wright; Pearson, Fifth edition, 2002.
10. Discrete Mathematical Structures; Bernard Kolman, Robert Busby, Sharon Ross; Pearsons, Sixth edition, 2017.

Evaluation (VSC): Total marks per course – 50

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA- 20 marks

II. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 30 marks

Template for End Semester examination in Semester-2 for the VSC course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	3	6	6	15
2	3	6	6	15
-TOTAL- Per objective	6	12	12	30
% WEIGHTAGE	20%	40%	40%	100%

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APPROVED SYLLABUS

Syllabus
First Semester Courses in Mathematics
2023-2024

Contents:

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PRINCIPAL
ST. XAVIER'S COLLEGE
AUTONOMOUS
MUMBAI - 400 001.

ST. XAVIER'S COLLEGE - AUTONOMOUS * MUMBAI-400 001 *

F.Y.B.Sc. **Course Code:** USMAT4501CR1

Title: Calculus and Discrete Mathematics

Prerequisite: Revise the following topics learnt at Junior College or School level:-
Limit of a sequence, limit and continuity of a function, intervals, g.c.d and l.c.m. of numbers, division of polynomials, mathematical induction, basics of complex numbers.

Course Objectives:

1. To learn lub axiom of $\mathbb{R}$ and its consequences.
2. To understand Convergence of sequences in $\mathbb{R}$.
3. To learn $\in -\delta$ definition of limit and continuity of a function, sequential Continuity
4. To study Properties of continuous functions and Intermediate value theorem
5. To apply Divisibility of integers
6. To learn how to find roots of polynomials

Credits: 4

Course Outcomes (COs):

On completing the course, the student will be able to:

1. Apply 'lub' axiom to obtain interesting results such as Archimedean property, density theorem etc.
2. Analyze convergent sequences and Cauchy sequences in $\mathbb{R}$
3. Obtain properties of continuous functionsandapply intermediate value theorem
4. Can prove important results and properties of integers using Euclidean algorithm,division algorithm and mathematical induction and congruenes.
5. Check the reducibility and irreducibility of polynomials over real numbers.
6. Acquire the habit of independent problem-solving, skill development and creativity

Unit 1: Real Number System and Sequence of Real Numbers **(15 Lectures)**

Real Number System: Algebric and order properties of $\mathbb{R}$, properties of Absolute value, Intervals and neighbourhood, Hausdorff property, Bounded sets, Supremum and infimum, Continuum property (l.u.b. axiom) and its consequences, Archimedean property and its applications, Density theorem.

Sequences: Definition of a sequence and examples, Convergence of a sequence, every convergent sequence is bounded, Limit of a sequence, uniqueness of limit of sequence if it exists, Divergent sequences, Monotone sequences, Monotone Convergence theorem, Subsequence, Subsequence of a convergent sequence is convergent and converges to the same limit, Cauchy sequence, every convergent sequence is a Cauchy sequence and its converse.

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Unit 2: Limit and Continuity of real valued function in one variable **(15 Lectures)**

Limit of functions: Limit of a function, evaluation of limit of simple functions using $\in -\delta$ definition, uniqueness of limit if it exists, Algebra of limits , Limit of a composite function, Sandwich theorem, Left hand and Right hand limits, non–existence of limits, Limit as $x \to \pm\infty$.

Continuous functions and its properties: Continuity of a real valued function on a set in terms of limits, examples, Continuity of a real valued function at end points of domain, $\in -\delta$ definition of continuity, Sequential continuity, Algebra of continuous functions, Continuity of composite functions. Discontinuous functions, Intermediate value theorem and its applications, Bolzano-Weierstrass theorem (statement only). A continuous function on a closed and bounded interval is bounded and attains its bounds.

Unit 3: Integers and divisibility **(15 Lectures)**

Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of well-ordering property, Binomial theorem for nonnegative exponents, Pascal Triangle. Divisibility in integers, division algorithm, greatest common divisor (G.C.D.) and least common multiple (L.C.M.) of two integers, basic properties of g.c.d. such as existence and uniqueness of g.c.d. of integers a and b and that the g.c.d. can be expressed as $ma + nb$ where $m, n \in \mathbb{Z}$, Euclidean algorithm, Primes, Euclid's lemma, Fundamental theorem of arithmetic, the set of primes is infinite. Congruences, definition and elementary properties, Euler's ϕ function, Statements of Euler's theorem, Fermat's theorem and Wilson theorem, its applications.

Unit 4: Polynomials **(15 Lectures)**

Definition of polynomial, polynomials over F where F = Q , R ,C. Algebra of polynomials, degree of polynomial, basic properties, Division algorithm in F[X](without proof) and g.c.d. of two polynomials and its basic properties (without proof), Euclidean algorithm (without proof), applications, Roots of a polynomial, relation between roots and coefficients, multiplicity of a root, Remainder theorem, Factor theorem, A polynomial of degree n over F has atmost n roots. Complex roots of a polynomial in R[X] occur in conjugate pairs, Statement of Fundamental Theorem of Algebra, A polynomial of degree n in R[X] has exactly n complex roots counted with multiplicity. A non-constant polynomial in R[X] can be expressed as a product of linear and quadratic factors in C[X]. Necessary condition for a rational number to be a root ofapolynomial with integer coefficients, simple consequences such as p is an irrational number where p is a prime number, n^{th} roots of unity, sum of n^{th} roots of unity.

List of Recommended Reference Books:

1. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Calculus and Real Analysis,Springer International Ltd, 2000.

2. Ajit and Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
3. James Stewart, Calculus, Third Edition, Brooks/cole Publishing Company,1994.
4. David M. Burton, Elementary Number Theory, Seventh Edition, McGraw Hill Education (India) Private Ltd, 2009.
5. Norman L. Biggs, Discrete Mathematics, Revised Edition, Clarendon Press, Oxford 1989.
6. Kenneth Rosen, Discrete Mathematics and its applications, McGraw Hill International Edition, Mathematics Series, 2017
7. Robert G. and Sherbert, Donald R: Introduction to real analysis(Third edition) New Delhi Wiley India (P) Ltd, 2009.

Evaluation (Core Theory): Total marks of thecourse– 100

I. FormativeAssessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA– 40 marks(Objectives/Short questions, not more than 5 marks each)

II. SummativeAssessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 60 marks
One question from each unit for 15 marks, with internal choice. Total marks per question with choice – 20 to 22.

Template for the End Semester examination in Semester – 1 for the Core course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	3	7	5	15
2	3	6	6	15
3	3	7	5	15
4	3	5	7	15
-TOTAL- Per objective	12	25	23	60
% WEIGHTAGE	20%	41.67%	38.33%	100%

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F.Y.B.Sc.
Title: Combinatorics

Course Code: USMAT4501VS1

Prerequisite: Set, Relation, function, binomial theorem

Course Objectives: To learn about

1. Advanced counting
2. Euler phi function $(\phi(n))$
3. Pigeonhole Principle
4. No. of Partitions
5. Derangements
6. Permutation group and Recurrence Relation

Credits:2

Course Outcomes (COs):
On completing the course, the student will be able :

1. To understand countable, uncountable sets and their meaning.
2. To learn addition and multiplication rule to calculate sample space for probability.
3. To learn to calculate multinomial expansions
4. To understand meaning of permutation as arrangement and apply it in day-to-day life.
5. To study various of types of recurrence relations such as linear, nonlinear and to apply them to solve various counting problems.

Unit 1: Counting Principle – 1 **(15 lectures)**

Finite and infinite sets, Countable and uncountable sets, examples such as $\mathbb{N}, \mathbb{Z}, \mathbb{N} \times \mathbb{N}, \mathbb{Q}$, (0,1), $\mathbb{R}$. Addition and multiplication principle, counting sets of pairs, two ways counting. Pigeon hole principle and its strong form, its applications. Binomial and Multinomial Theorem, Pascal identity, examples of standard identities. Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems. Non-negative and positive integral solutions of equation $x_1 + x_2 + \cdots + x_k = n$.

Unit 2:Counting Principle – 2 **(15 lectures)**

Principle of Inclusion and Exclusion, its applications, derangements, explicit formula for D_n, various identities involving D_n, deriving formula for Euler's phi function $\varphi(n)$. Permutation of objects, $S_n$composition of permutations, results such as every permutation is product of disjoint cycles; every cycle is product of transpositions, even and odd permutations, rank and signature of permutation, cardinality of S_n, A_n . Recurrence relation, definition of homogeneous, non-homogeneous, linear and non-linear recurrence relation, obtaining recurrence relation in counting problems, solving (homogeneous as well as non-homogeneous) recurrence relation by using

iterative method, solving a homogeneous recurrence relation of second degree using algebraic method proving the necessary result.

Recommended Reference Books:

1. Discrete Mathematics; Norman Biggs; Oxford University Press, Second edition, 2002.
2. Introductory Combinatorics; Richard Brualdi; Pearsons, Fifth edition, 2019.
3. Discrete Mathematics with Graph Theory; Edgar Goodaire and Michael Parmenter; Pearson, Third edition, 2017.
4. Discrete Mathematics and Its Applications; Kenneth H. Rosen; McGraw Hill Edition, Second edition, 1999.
5. Combinatorics–Theory and Applications; V. Krishnamurthy; Affiliated East West Press, 2008.
6. Discrete Mathematics; Schaum's outline series, Third edition, 2017.
7. Applied Combinatorics; Alan Tucker; John Wiley and Sons, third edition, 1994.
8. Discrete and Combinatorial Mathematics; Ralph P Grimaldi; Pearson international edition, Fifth edition, 2019.
9. Discrete Mathematics; Kenneth Ross and Charles Wright; Pearson, Fifth edition, 2002.
10. Discrete Mathematical Structures; Bernard Kolman, Robert Busby, Sharon Ross; Pearsons, Sixth edition, 2017.

Evaluation (VSC): Total marks per course – 50

I. FormativeAssessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA- 20 marks

II. SummativeAssessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 30 marks

Template for End Semester examination in Semester-1 for the VSC course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	3	6	6	15
2	3	6	6	15
-TOTAL- Per objective	6	12	12	30
% WEIGHTAGE	20%	40%	40%	100%

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First Semester Courses in Mathematics
2023-2024

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MUMBAI-400 001

APPROVED SYLLABUS

F.Y.B.Sc.
Title: Mathematical computations using SageMath

Course Code: USMAT4501SE1

Prerequisite: Basic knowledge of Calculus such as maxima, minima, Mean Value Theorems, vectors, matrices, graphing various types of functions, divisibility, HCF(GCD), LCM and ODE.

Course Objectives:

1. To learn about software for using approximate calculations
2. To study various types of functions and their plotting in 2-D and 3-D space
3. To calculate various types of vectors products
4. To use sage for estimating solutions of ODE, maxima and minima of function.
5. To understand basic number theoretical concepts.

Credits: 2

Course Outcomes (COs): On completing the course, the student will be able to:

1. Solve problems using Sagemath such as solving arithmetic problems, equations and polynomials.
2. Learn to plot various functions in 2-D and 3-D place.
3. Obtain properties of continuous functions and apply intermediate value theorem.
4. Prove important results and properties of integers using Euclidean algorithm, division algorithm, congruences
5. Acquire the habit of independent problem-solving, skill development and creativity

UNIT 1: Introduction to SageMath **(15 lectures)**

What is SageMath, Installation of SAGE, exploring integers in SageMath. Basic Arithmetic functions, factorial, trigonometric, logarithmic, exponential functions. Solving Equations in SageMath, 2d Plotting with SageMath, 3d Plotting with SageMath, complex numbers and operation related to complex numbers. Defining vectors, operations on vectors, products of vectors (dot, cross, scalar triple).

UNIT 2: Problem solving using SageMath **(15 Lectures)**

Addition and multiplication of matrices, Inverse and transpose of matrices, Determinant of matrix, Calculus of one variable, Applications of derivatives, Integrals in SageMath, Applications of Integrals, Local maximum-minimum, Application of local maximum and minimum, first order differential equations, some number theoretical concepts such as congruence modulo, divisibility, Euclidean algorithm, GCD and LCM.

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List of Recommended References Books:

1. www.sagemath.org.
2. Mathematical Computation with Sage by Paul Zimmermann, Society for Industrial & Applied Mathematics, U.S, 2019.
3. A First Course in Linear Algebra by Robert Beezer, Third edition, 2012.
4. An Introduction to SAGE Programming: With Applications to SAGE Interacts for Numerical Methods by Razvan A. Mezei, Wiley, First edition, 2015.
5. Elementary Number Theory: Primes, Congruences, and Secrets: A Computational Approach by William Stein, Springer 2009 edition

Evaluation (SEC): Total marks per course – 50

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA- 20 marks

II. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 30 marks

Template for End Semester examination in Semester-I for the SEC course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	3	6	6	15
2	3	6	6	15
-TOTAL - Per objective	6	12	12	30
% WEIGHTAGE	20%	40%	40%	100%

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APPROVED SYLLABUS

Syllabus
Second Semester Courses in Mathematics
2023-2024

Contents:

APPROVED SYLLABUS

F.Y.B.Sc.
Title: Quantitative Mathematical techniques I

Course Code: USMAT4502SE1

Course Objectives:

1. This course aims to provide students with a comprehensive understanding of mathematical concepts and their applications.
2. This course also aims to enhance problem-solving and analytical skills by applying mathematical concepts in different contexts.
3. This course also aims to develop the ability to think critically and creatively while solving mathematical problems.

Credits: 2

Course Outcomes (CO):
After completing the course, the student will be able to:

1. Develop effective strategies, techniques, and time management skills for solving similar problems in competitive exams like GRE, Banking exams, etc.
2. Develop speed and accuracy in solving mathematical problems.
3. Apply mathematical concepts to real-life situations.

Unit I: (15 Lectures)

Module I: Arithmetic and Algebra
Numbers and number systems, Integers and their properties, prime factorization, l.c.m., g.c.d., Rational numbers and Irrational numbers, Real numbers, Absolute value of a real number, the division algorithm, Logarithms, Linear Equations in 1 and 2 variables, Arithmetic Progressions and Geometric Progressions. Quadratic Equations, Linear Inequalities.

Module II: Geometry
Lines And Angles, Polygons, Triangles, Area of a Triangle, the Pythagorean theorem Trigonometric Ratios, Heights and Distances, Similar and Congruent Triangles, Quadrilaterals and Types of Quadrilaterals, Circles, Area of a circle, Arc and Sector of a Circle, Three-Dimensional Figures and their Areas, Mensuration, Pattern completion.

List Of Practicals:

1. Real numbers, absolute value of a real number, Number Systems.
2. Prime Factorization, l.c.m, g.c.d., divisibility tests, division algorithm, modular arithmetic.
3. Fractions and arithmetic operations between them, rational numbers, irrational numbers.
4. Percentages, percent increase, percent decrease, ratio and proportion, simple interest, compound interest.
5. Profit and loss, distance and time, Mixture, rate, Work and time, averages.

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6. Algebraic Expressions, Exponents and laws of exponents, Logarithms, Algebraic Identities.
7. Linear Equations in 1 and 2 variables. Quadratic Equations, Linear Inequalities.
8. Sequences And Series, Arithmetic Progressions and Geometric Progressions.
9. Lines And Angles.
10. Polygons, Triangles, Area of a Triangle, the Pythagorean theorem.
11. Trigonometric Ratios.
12. Heights and Distances, Similar and Congruent Triangles, Quadrilaterals and Types of Quadrilaterals.
13. Circles, Area of a circle, Arc and Sector of a Circle.
14. Three-Dimensional Figures and their Areas, Mensuration.
15. Pattern Completion.

List of Recommended Reference Books:

1. Quantitative Aptitude by R.S. Aggarwal, 2022.
2. The Official Guide to the GRE General Test, Third Edition by ETS, 2017.
3. Arithmetic (Quant) Book for SSC CGL, CHSL, CPO and Other Govt. Exams (English Printed Edition), 2021.
4. Pearson Guide to Quantitative Aptitude for Competitive Examinations, Dinesh Khattar, Fourth edition, 2019.

Evaluation (SEC): Total marks per course – 50

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA- 20 marks

II. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 30 marks

Template for End Semester examination in Semester-1 for the SEC course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	3	6	6	15
2	3	6	6	15
-TOTAL - Per objective	6	12	12	30
% WEIGHTAGE	20%	40%	40%	100%

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APPROVED SYLLABUS

ST. XAVIER'S COLLEGE – MUMBAI
(Est. 1869)
(An Autonomous College affiliated with the University of Mumbai)

Syllabus for Undergraduate Programme as per National Education Policy(NEP-2020)

Programme: BSc in Mathematics

The academic year 2023–2024

APPROVED SYLLABUS

PRINCIPAL
ST. XAVIER'S COLLEGE
AUTONOMOUS
MUMBAI - 400 001.

ST. XAVIER'S COLLEGE-AUTONOMOUS * MUMBAI-400 001 *

Preamble:
The foundational principles of the National Education Policy 2020 (NEP 2020) released by MHRD are:

- Multidisciplinary and holistic education (student-centred), encompassing courses from multiple disciplines across the sciences, social sciences, arts, humanities, and commerce for a multidisciplinary world, with emphasis on outcome-based learning.
- 50-50 formulation, where 50% of the credits must be from the core discipline and the rest 50% from other disciplines. Also, 50% of the course must be conceptual and theory based and the rest 50% must be the application of the concepts into practice through student engagement in activities/apprenticeship and internship. Pedagogic methods must be problem-centred/ based and project-based learning and activities.
- Integration of technology into teaching-learning-evaluation resources, blended teaching-learning (face-to-face, online collaborative learning, hands-on and practicum and flipped learning), strengthening research pedagogy of the discipline.
- Integrating skilling and employability with curriculum and teaching-learning across disciplinary, inter-disciplinary, and multi-disciplinary studies.
- Multiple entry and exit options for students within an academic programme of study with credit transfer and accumulation of credits in the Academic Bank of Credits (ABC).
- Equality is the Goal, and Equity is a process to achieve equality and inclusion to promote students' sense of belonging.

The framework of the choice-based credit system
Major Subject: A single subject course of study pursued by a student as a mandatory requirement of the programme of study. Indian knowledge system (IKS) to be included in the core courses.

Elective Course: An elective course could be a project designed to acquire skills to supplement the major study.

Minor Subject: A second subject of study pursued by a student as an additional requirement of the programme of study.

OE: Open Elective - An elective course chosen generally from an unrelated discipline/subject, to seek multidisciplinary exposure.

AEC: Ability Enhancement Course - Mandatory Courses on content related to Language, and Literature (i) Compulsory – English communication (ii) Elective – any Indian language other than English.

IKS: Indian Knowledge System (Generic) – Mandatory course - an overview of the contribution of India towards multidisciplinary research and development.

VSC: Vocational Skill Course – Courses aimed at imparting practical skills, hands-on training, and soft skills to increase the employability of students. Specific or supporting the major subject is to be chosen from a basket/pool offered by the college.

SEC: Skill Enhancement Course – Courses aimed at imparting practical skills, hands-on training, and soft skills to increase students' employability. It could be chosen from a basket/pool offered by the college or a MOOC on Swayam or NPTEL platforms.

On-Job Training (OJT)/Internship/Field Project (FP)/Community Engagement Programme (CEP) Research Project (RP): Application of knowledge/concepts in solving or analyzing a real-life problem. All these are related to the major subject.

CC: Co-curricular Course – For the holistic development of students through Cultural activities such as performing art, visual art, NCC, NSS, Yoga, etc.

VEC: Value Education Course – Compulsory courses on (i) The Constitution of India and (ii) Environmental Education.

FYUGP Credit Structure with number of courses 2023-24													
Level	Sem	Sub-1/Major	Elective	Sub-2/Minor	OE	VSC	SEC	IKS generic	AEC	VEC	OJT, FP, RP, CEP, CC	Total	Degree/Cum Cr
4.5/100-199 (2023-24) First Year	Sem 1	1	0	1	2	1	1	1	1	1	0	9	44 credits UG certificate
	Sem 2	1	0	1	2	1	1	0	1	1	CC 1	9	
Introductory	Courses	2	0	2	4	2	2	1	2	2	1	18	
Exit option with a UG Certificate in Major &/or Minor with an additional 4 credits NSQF course/internship OR continue with Major & Minor													
5/200-299 (2024-25) Second Year	Sem 3	2	0	1	1	1	0	0	1	0	FP/CEP 1 (Sci) & CC 1	8	88 credits UG Diploma
	Sem 4	2	0	1	1	0	1	0	1	0	FP/CEP 1 (Art Com) & CC 1	8	
Intermediate	Courses	6	0	4	6	3	3	1	4	2	5	34	
Exit option with a UG Diploma in Major & Minor with an additional 4 credits NSQF course/internship OR continue with Major & Minor													
5.5/300-399 (2025-26) Third Year	Sem 5	3	1	1	0	1	0	0	0	0	FP 1	7	132 credits UG Degree
	Sem 6	3	1	1	0	0	0	0	0	0	OJT 1 Internship	6	
Higher	Courses	12	2	6	6	4	3	1	4	2	7	47	
Exit option with a Three-Year Bachelor Degree with Major and Minor OR continue with Major & Minor (Fourth year by Papers)													
6/400-499 (2026-27) Fourth Year	Sem 7	3	1	RM 1	0	0	0	0	0	0	FP 1	6	176 credits UG Honours
	Sem 8	3	1	0	0	0	0	0	0	0	OJT 1 Internship	5	
Advanced	Courses	18	4	7	6	4	3	1	4	2	9	58	
Exit option with a Three-Year Bachelor Degree with Major and Minor OR continue with Major & Minor (Fourth year by Research)													
6/400-499 (2026-27) Fourth Year	Sem 7	3	1	RM 1	0	0	0	0	0	0	RP 1	6	176 credits UG Honours with Research
	Sem 8	3	1	0	0	0	0	0	0	0	RP 1	5	
Advanced	Courses	18	4	7	6	4	3	1	4	2	9	58	
Four-Year UG Honours with Research Degree with Major and Minor													

FYUGP Credit Structure from 2023-24 (Sci-Arts)										
Level	Sem	Major (Sub-1)	Elective	Minor (Sub-2)	OE	VSC / SEC	IKS Generic / AEC, VEC	OJT, FP, RP, CEP / CC	Cum Cr/Sem	Degree/Cum Cr
4.5 (2023-24)	Sem 1	4	0	4	4	4	6	0	22	44 UG certificate
	Sem 2	4	0	4	4	4	4	2	22	
	Cum Cr	8	0	8	8	8	10	2	44	
A student will decide which of the 2 subjects (Sub-1 or Sub-2) will be major and minor at the end of the second semester (ie the first year) Major subject-specific IKS of 2 credits must be done on 2 units (could be 1 unit + 1 unit) from Sem 3 to Sem 6										
Exit option with a UG Certificate in Major with an additional 4 credits core NSQF course/internship OR continue with Major & Minor										
5 (2024-25)	Sem 3	8	0	4	2	2	2	4	22	88 UG Diploma
	Sem 4	8	0	4	2	2	2	4	22	
	Cum Cr	24	0	16	12	12	14	10	88	
Exit option with a UG Diploma in Major & Minor with an additional 4 credits core NSQF course/internship OR continue with Major & Minor										
5.5 (2025-26)	Sem 5	12	4	2	0	2	0	2	22	132 UG Degree
	Sem 6	12	4	2	0	0	0	4	22	
	Cum Cr	48	8	20	12	14	14	16	132	
6 (2026-27)	Sem 7	12	4	4	0	0	0	2	22	176 UG Honours
	Sem 8	12	4	0	0	0	0	6	22	
	Cum Cr	72	16	20	12	14	14	24	176	
Exit option with a Three-Year Bachelor Degree with Major and Minor OR continue with Major & Minor										
6 (2026-27)	Sem 7	10	4	4	0	0	0	4	22	176 UG Honours with Research
	Sem 8	10	4	0	0	0	0	8	22	
	Cum Cr	68	16	20	12	14	14	28	176	
Four-Year UG Honours with Research Degree with Major and Minor										

APPROVED SYLLABUS

Programme Outcomes aligned to the Vision and Mission of St. Xavier's College (Autonomous), Mumbai (Bachelor's degree programme)

The students who complete three years of an undergraduate programme will be able to manifest skills and competencies in the following areas:

1. **Disciplinary knowledge and Core competencies/skills:**
   Demonstrate (i) a lucid understanding of the fundamentals of the subject-related curriculum and (ii) basic and global skills in the academic field of study.
2. **Critical and Creative thinking:**
   (i) Critically reflect on acquired knowledge and skills in areas of core competencies (ii) Explore new possibilities and be resourceful by generating relevant and practical ideas
3. **Problem-solving and Analytical reasoning:**
   Demonstrate skills in identifying and investigating a problem. Collect relevant qualitative and quantitative data and analyze the results meaningfully.
4. **Research-related skills:**
   (i) Apply comprehensive research-based knowledge and skills required for identifying issues, interpreting results, and synthesis of valid information. (ii) Communicate results of studies undertaken in an academic field effectively and accurately.
5. **Social Application of research and development:**
   Employ core competencies and skills to develop solutions for the improvement of social and environmental conditions.
6. **Industry-related skills:**
   Employ skills that are relevant to the industry and commit to strong work ethics and professionalism.
7. **Ethical and Moral Integrity:**
   Practice values such as honesty, transparency, and accountability and commit to interpersonal and social ethics.
8. **Empathy and Social Intelligence:**
   Cultivate and demonstrate affective, interpersonal, social, and spiritual intelligence.
9. **Collaboration, Teamwork, and Multidisciplinary competence:**
   Apply knowledge and skills as an individual, team member or leader to manage ventures in monodisciplinary and interdisciplinary settings.
10. **Leadership and Management:**
    Demonstrate effective strategic planning, and efficient organizational and transformational leadership skills to manage a mission embarked upon.
11. **Social Concern:**
    Demonstrate (i) empathy and care for the marginalized and disadvantaged, (ii) respect, compassion, and concern for others.
12. **Social responsibility and inclusion:**
    (i) Strive for social justice, harmony, and solidarity (ii) Value cultural pluralism and diversity.
13. **Environmental Wellbeing**
    Investigate and design strategies to care for and enhance the well-being of the environment.
14. **Self-motivation and Lifelong learning:**
    Develop a passion for ongoing personal and professional growth.

APPROVED SYLLABUS

Abbreviations:

- OE: Open Electives
- AEC: Ability Enhancement Course
- VSC: Vocational Skill Course
- SEC: Skill Enhancement Course

List of Courses offered from Semesters 1-6 in Mathematics

Level	Semester	Major (Sub-1) Course titles	Minor (Sub-2) Course titles	OE Course title/s	VSC Course title/s	SEC
4.5 100-199	Sem 1	Calculus and Discrete Mathematics	---	---	Combina-torics	Mathematica l computations using SageMath
	Sem 2	Calculus and Linear Algebra	---	---	Combina-torics	Quantitative Mathemtical techniques I
5 200-299	Sem 3	1. Analysis 2. Linear Algebra -I	---	---	Numerical methods	Game theory
	Sem 4	1. Multivariable Calculus 2. Linear Algebra II	---	---	Graph theory	Quantitative Mathemtical techniques II
5.5 300-399	Sem 5	1. Topology of metric spaces I 2. Integal Calculus 3. Group theory 4. Differential Equations 5. Mathematical Computations using Python programming	---	---	---	---
	Sem 6	1. Topology of metric spaces II 2. Complex Analysis 3. Ring theory 4. Integral transforms	---	---	---	---
6	Sem 7					

400-499	Sem 8					
	Total					

Composition of the Board of Studies in Mathematics 2022 – 2023

Board of Studies, Department of Mathematics

2022-23

The Department of Mathematics has the following BOS composition:

Sr. No.	Composition	Name
1	Head of the Department concerned (Chairman)	Mrs. Meenal Kolkar
2	Entire faculty of each specialisation	Dr. Ashok Bingi, Mrs. Simi Cyriac, Mr. Aditya Garg
3	Two subject experts (other University)	Dr. Amiya Bhowmik, Mr. Pritesh Kalan
4	VC nominee	Mrs. Leena Upadhye
5	Representative from industry/corporate sector/allied	Mr. Rohit Gupta
6	PG meritorious alumnus	------
7	(a) Experts from outside the college (co-opted)	Mr. Subhash Krishnan, Mr. Amit Gawde
	(b) Other members of staff of the same faculty	-------

Three-Year Undergraduate Programme in Mathematics

Year of Implementation	Semester	Course Code	BOS Date	Academic Council Date
2023-2024	1	USMAT4501CR1, USMAT4502CR1	09/03/2023	20/04/2023
2023-2024	2	USMAT4501SE1, USMAT4502SE1, USMAT4501VS1,	30/08/2023	06/10/2023

Programme Specific Outcomes

After successful completion of this program in Mathematics, students will be able to

1. To think in a critical manner
2. Acquire good knowledge and understanding in different areas of mathematics.
3. Formulate and develop mathematical arguments logically.
4. Communicate mathematical ideas with clarity and coherence, both written and verbally.
5. Pursue research in challenging areas of pure/applied mathematics.
6. Apply the knowledge of mathematical concepts in interdisciplinary fields.

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