St. Xavier's College (Autonomous)
Ahmedabad-09
B. Sc. Mathematics

Courses of B.Sc. Mathematics

St. Xavier's College (Autonomous)
Ahmedabad-09
B. Sc. Mathematics

Semester: I
Matrix Algebra and Co-ordinate Geometry (Theory) **Course Code: MT 1501**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to perform matrix operations and employ fundamental concepts of matrix theory.

CO2 Student will be able to use fundamental concepts of matrices in some applicable concepts like system of simultaneous linear equations, eigenvalues and eigenvectors.

CO3 Students will be able to use mathematical concepts studied in coordinate Geometry in three dimensional space like Sphere, Cone & Cylinder.

CO4 Students will be able to establish the connection and transition between previously studied mathematics and more advanced mathematics.

Unit 1: Introduction to matrices, different types of matrices, operations on matrices, theorems on matrices, elementary operations on matrices, symmetric and skew-symmetric matrices, Hermitian and skew-Hermitian matrices, orthogonal matrices, unitary matrices, normal matrices. Linear dependence and independence of row and column of matrix, row rank, column rank and rank of a matrix, row reduced echelon (RRE) form of a matrix and matrix inversion using row reduced echelon (RRE) form.

Unit 2: Application of matrices in solving a system of simultaneous linear equations, Cramer's rule, theorems on consistency of a system of simultaneous linear equations, eigenvalues, eigenvectors and the characteristic equation of a matrix. Cayley-Hamilton theorem and its use to find the inverse of a matrix.

Unit 3: Sphere: Definition of a sphere in $\mathbb{R}^3$, Cartesian equation of a sphere, general equation of a sphere, equation of a sphere with diametrically opposite end points, intersection of a sphere with line/ plane/ sphere (no theory but only problems), equation of a tangent plane to a sphere. The tangency of a plane and normality of a line to a sphere, orthogonal spheres.
Conicoids: Introduction to conicoid, types of central and non central conicoids in $\mathbb{R}^3$, figures of conicoids.

Unit 4: Polar coordinates in $\mathbb{R}^2$ and its relationships with Cartesian coordinates, polar equation of line/ circle/ conic and properties of conics. Spherical, cylindrical, conical coordinates in $\mathbb{R}^3$.
Cone & Cylinder: Introduction to different types of cone and cylinder, equation of enveloping cone and cylinder, right circular cone and cylinder (without proof), problems on cone and cylinder.

Reference books:

1. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley 1995).
2. Linear Algebra Theory and Applications - Ward Cheney, David Kincaid. Jones and Bartlet India Pvt. Ltd.
3. Introduction to Linear Algebra - Serge Lang. Springer (India).

4. Gilbert Strang, Linear Algebra and its Applications (English) 4th edition, Academic press, Indian edition.
5. Matrix and Linear Algebra - K. B. Dutta, Prentice Hall.
6. A Textbook of Matrices - Shanti Narayan, P. K. Mittal, S. Chand Group.
7. Analytical Solid Geometry- Shanti Narayan
8. Co-ordinate Geometry By : R.J.T. Bell.
9. Solid Geometry(three dimension) - H. K. Das, S. C. Saxena and Raisinghania, S. Chand.
10. Coordinate Geometry, Polar Coordinate approach, M. M. Tripathi, Alpha Science International.

Semester: I

Matrix Algebra and Co-ordinate Geometry (Practical)	**Course Code: MT 1502L**
No. of Credits: 03	**Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to perform matrix operations to determine invertible matrices and its RRE forms.

CO2 Student will be able to apply matrix operations to solve system of simultaneous linear equations, eigenvalues and eigenvectors.

CO3 Students will be able to use mathematical concepts in coordinate Geometry in three dimensional space like Sphere, Cone & Cylinder.

CO4 Students will be able to establish the connection and transition between previously studied mathematics and more advanced mathematics.

List of practicals (problems on):

(1) Matrix algebra.

(2) Different methods of finding Inverse of a matrix.

(3) RRE form and rank of a matrix.

(4) Solution of system of linear equations using row operations and Cramer's rule.

(5) Linearly independent and dependent vectors.

(6) The Cayley-Hamilton theorem and its applications.

(7) Eigen values and eigen vectors of matrices.

(8) Various coordinate systems in $\mathbb{R}^2$ and polar equation of line.

(9) Various coordinate systems in $\mathbb{R}^3$. Transformation equations from one system to another system.

(10) Polar equations of Circle.

(11) Polar equations of Conic.

(12) Sphere-I.

(13) Sphere-II.

(14) Cone.

(15) Cylinder.

(16) Project on identification of curves/surfaces.

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Semester: I
Matrix Algebra through SCILAB (Elective) **Course Code: EG 1308**
No. of Credits: 02 **Learning Hours: 30 Hours**

Course Outcomes:

CO1 Student will be able to perform matrix operations in Sci-Lab.

CO2 Student will be able to write programme in Sci-Note to perform various matrix operations.

CO3 Student will be able to write programme in Sci-Note to apply various matrix operations in different scientific problems.

CO4 Students will use mathematical computing software in studying and analysing mathematical concepts.

Unit 1: Introduction to SCILAB, SCILAB environment, Workspace and working directory, some elementary programming.

Unit 2: Creating matrices, some simple matrix operations.

Unit 3: Some advanced matrix algebra through SCILAB.

Unit 4: Practical based on the Unit-I, Unit-II, Unit-III

1. To input row vectors, column vectors, square and rectangular matrices.
2. To obtain addition, subtraction and multiplication, division of matrices and multiplication of matrix with scalar.
3. To obtain sub matrices of given matrix and to delete rows and columns.
4. To find minors, cofactors and adjoint of a matrix.
5. To find inverse of the matrix using adjoint of a matrix.
6. To learn commands zeros, ones, eye, rand, det(), inv(), command for transpose.
7. To find the inverse of a matrix using GAUSS-ELIMINATION method.
8. To find inverse of given matrix using GAUSS-JORDAN method
9. To find Eigen values and Eigen vectors of given matrix
10. To find inverse of given matrix using CAYLEY-HAMILTON theorem

Reference books:

1. An Introduction to Scilab-Satish Annigeri, December 2009
2. Scilab for very beginners-Scilab enterprises.

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Semester: I
Elementary Mathematics with SageMath **Course Code: EG 1313**
No. of Credits: 02 **Learning Hours: 30 Hours**

Course Outcomes:

CO1 Student will be able to perform matrix operations in SageMath.

CO2 Student will be able to solve mathematical problems using SageMath.

CO3 Student will be able to plot curves and surfaces using SageMath.

CO4 Students will use mathematical computing software in studying and analysing mathematical concepts.

Unit 1: Introduction to SageMath program, Symbolic Expressions, Python Variables, Symbolic Variables, Transforming Expressions, Elementary Functions and Usual Constants.

Unit 2: Usual Mathematical Functions, Solving equations, plotting of curves and surfaces.

Unit 3: Creating matrices, some simple matrix operations. Some advanced matrix algebra through SageMath.

Unit 4: Practical based on the Unit-I, Unit-II, Unit-III

1. To input functions, mathematical expressions and solving equations.
2. To plot curves Cartesian, parametric, polar curves.
3. To plot surfaces.
4. To input row vectors, column vectors, square and rectangular matrices.
5. To obtain addition, subtraction and multiplication and multiplication of matrix with scalar.
6. To obtain row echelon form, reduced obtain row echelon form, determinant and rank of matrix.
7. To solve matrix equation.
8. To find inverse of given matrix using GAUSS-JORDAN method.
9. To find Eigen values and Eigen vectors of given matrix.
10. To find inverse of given matrix using CAYLEY-HAMILTON theorem.

Text book:

'Computational Mathematics with SageMath' – Paul Zimmermann et. al., SIAM, 2018.

Unit I Sections : 1.2.1, 1.2.2, 1.2.4, 1.2.5, 2.1.1, 2.1.2.

Unit II Sections : 2.1.3, 2.2.1, 2.2.2, 4.1.1 to 4.1.4, 4.2.

Unit III Sections : 2.4.3, 2.4.4, 8.1.2, 8.1.3, 8.1.4, 8.2.

Reference books:

1. 'AN INTRODUCTION TO SAGE PROGRAMMING', Razvan A. Mezei, John Wiley & amp; Sons, Inc., Hoboken, New Jersey.
2. 'SAGE - BEGINNER'S GUIDE', Craig Finch, Packt Publishing (2011).

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Semester: II
Calculus and Differential Equations (Theory) **Course Code: MT 2501**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to employ concepts of differential calculus like higher order derivative of several real valued functions.

CO2 Student will be able to test the convergence of infinite series.

CO3 Student will be able to obtain series expansion of several real valued functions of one variable.

CO4 Students will be able to formulate real-life problems in form of ordinary differential equations.

CO5 Students will be able to solve ordinary differential equations.

Prerequisites: Introduction of differential equations, its order and degree. Family of curves leading to differential equation and its solution in family of curves, different types of solutions (viz. General, particular and singular solutions). Constant of integration, boundary/initial conditions, differential equations of first order and first degree.

Unit 1: Successive Differentiation: Introduction to successive derivatives, nth derivatives of some standard functions, Leibnitz theorem.
Mean Value theorems: Rolle's mean value theorem, Lagrange's mean value theorem.
Different forms of Lagrange's mean value theorem, Cauchy's mean value theorem, Applications of mean value theorems.

Unit 2: Convergence and divergence of infinite series: Definition of series, Convergent and divergent series of real numbers, sum of series, different test of convergence of infinite series-convergence of geometric series, comparison test, practical comparison test, D'Alembert's ratio test, Cauchy's root test, alternating series, power series.
Taylor's and Maclaurin's Theorems (without proof), expansions of some standard functions as infinite power series without validity of the expansions.

Unit 3: Methods of solving differential equations of first order and degree one: Variable separable, Homogeneous and non- homogeneous differential equations, exact differential equations (without proof), Integrating factors, linear differential equation, Bernoulli's differential equation and Differential Equations reducible to them.
Method of solving differential equations of first order and higher degree solvable for y, solvable for x, solvable for p $\left(\text{where} p = \frac{\mathrm{d}y}{\mathrm{d}x}\right)$, Clairaut's differential equation, Lagrange's differential equation.

Unit 4: Linear differential equations of higher order and degree one: Differential operators. Linear differential equations of higher order and degree one with constant coefficients, Complementary and particular integrals. Inverse operator, operational methods for its solutions, Euler form of homogeneous linear differential equations with variable coefficients.

Reference books:

1. Differential Caculus, Shanti Narayan, S. K. Mittal, S. Chand and Co. Publication.
2. Anton, Biven and Davis, Calculus, 10th edition, Willey Publication.
3. Thomas, Calculus early transcendental, Addison-Wesley person publication.
4. Integral calculus, Shanti Narayan, S. Chand Limited, 2005.
5. Elementary Differential Equations, Rainville and Bedient, Macmillan Publication.
6. Ordinary and Partial Differential Equations, M. D. Raisingania, S. Chand, 2009.
7. Differential Equations- D.A. Murray, Tata McGraw Hills.
8. Ordinary Differential Equations and Partial Differential Equations, Nita shah, PHI Ltd.
9. Theory and problems on Differential Equations- Frank Ayres, McGraw Hill Book Co., New York.

Semester: II
Calculus and Differential Equations (Practical) **Course Code: MT 2502L**
No. of Credits: 03 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to plot the curves give in different forms.

CO2 Student will be able to identify the behaviour of curve in given interval and at infinity.

CO3 Student will be able to obtain series expansion of several real valued functions of one variable.

CO4 Students will be able to solve ordinary differential equations.

List of practicals (problems on):

(1) Graphs of some Cartesian curves $\mathbb{R}^2$. (Trigonometric function, conic, polynomial)

(2) Graphs of some parametric and polar curves in $\mathbb{R}^2$. (Cycloid, conic, asteroid, cardioids)

(3) Discuss concavity and point of inflexion of the curve in $\mathbb{R}^2$.

(4) To find asymptotes of curves including Cauchy's method.

(5) Method of Integration: Partial fraction, Limit of sum using definite integral, Substitution method, Integration by parts.

(6) Reduction formula only for definite integrals.

(7) Application of Integration-I (Arc length and Area)

(8) Application of Integration-II (Volume and surface Area)

(9) Application of Leibniz theorem.

(10) Discuss convergence of the infinite series.

(11) Problems on Mean value theorem.

(12) Expansion of function in infinite power series using Taylor's and Maclaurin's formula.

(13) Evaluate limits using L'Höspital's Rule.

(14) The differential equations of order 1 and degree 1.

(15) The differential equations of order 1 and higher degree.

(16) The differential equations of higher order and degree 1.

Semester: III
Advanced Calculus-I (Theory) **Course Code: MT 3501**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to employ concepts of multivariate calculus.

CO2 Student will be able to obtain series expansion of several real valued functions of more than one variable and use it in real-life estimation problems.

CO3 Students will be able to employ multivariate differential calculus to extreme value problems.

CO4 Students will be able to employ multivariate differential calculus to solve geometrical problems.

Unit 1: Limit-Continuity of function of several variables and partial derivatives
Introduction to function of several variables, rectangular and spherical neighborhood of a point in $\mathbb{R}^n$, Limit of function of several variables, concept of iterated limits, limit and path, continuity of function of several variables.

Unit 2: Differentiability of function of several variables-I
Directional derivatives, Introduction to partial derivatives and their geometric interpretation, higher order partial derivatives and problems. Differentiability of function of two variables, theorems on differentiability conditions and their converses, Schwartz's theorem and Young's theorem on mixed partial derivatives.

Unit 3: Differentiability of function of several variables-II
Differential of function of two variables, Chain rules for differentiability, derivatives of implicit functions. Homogeneous functions, Euler's theorem for homogeneous functions of n-variables, Extreme values of functions of two variables and its converse, Lagrange's method of undetermined multipliers (only problems to be asked).

Unit 4: Applications of partial derivatives
Taylor's Theorem for function of two variables (proof of two variables only), Maclaurin's theorem, problems on Taylor's and Maclaurin's theorems, multiple points, different types of double points and examples, radius of curvature for Cartesian-parametric-polar equations of a curve in Application to geometry.

Reference books:

1. Mathematical Analysis - S. C. Malik and Savita Arrora, Second Edition, New Age Int. (P) Ltd.
2. Differential Calculus - Shanti Narayan.
3. Calculus - David V. Widder- PHI-second edition.
4. Calculus & Analytic Geometry - G. B. Thomas & R. L. Finney Addison- Wesley pub. India.
5. Calculus with Early Transcendental functions - James Stewart, Indian Edition, Engage Learning India Pvt Ltd.

6. Advanced Calculus Volume I & II - T. M. Apostol.
7. Howard Anton, Stephen Davis and Irl Bivens. Calculus: a new horizon. New York: Wiley, 1999.
8. The calculus with analytic geometry, Louis Leithold, Harper & Row, 5th edition, 1986.

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Semester: III
Linear Algebra - I (Theory) **Course Code: MT 3502**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to identify vector space and subspace.

CO2 Student will be able to obtain basis and determine dimension of vector spaces and subspaces.

CO3 Students will be able to employ linear algebra to solve some scientific problems.

CO4 Student will be able to solve different mathematical problems using the transition between vector spaces by some mathematical tools such as linear transformations.

Prerequisites: Relation, Equivalence Relation, Binary Operation.

Unit 1: Vector space: definition, examples, properties, subspaces, span of a set, operations of subspaces, sum and direct sum of subspaces, linear variety.

Unit 2: Finite linear combination, linear dependence/independence, basis and dimension of a vector space, dimension theorem.

Unit 3: Linear transformations, range and kernel of a linear map, rank and nullity of a linear map, rank - nullity theorem, inverse of a linear map, consequences of rank - nullity theorem, isomorphism, operation equation.

Unit 4: Matrix associated with a linear map, linear map associated with a matrix, linear operations in $\mu_{(m,n)}$, dimension theorems for $\mu_{(m,n)}$ and $L(U, V)$. Rank - Nullity of matrices and verification of the rank-nullity theorem for matrices.

Text book:

An Introduction to Linear Algebra - V. Krishnamurthy & others. (Affiliated East-West press, New Delhi)

Reference books:

1. Linear Algebra: a Geometric Approach - S. Kumaresan, PHI.
2. Linear Algebra with Applications - Otto Bretscher, 3rd edition, Pearson Education.
3. An Introduction to Linear Algebra - I. K. Rana, Ane Books Pvt. Ltd., New Delhi.
4. Matrix and Linear Algebra - K. B. Datta, Prentice Hall, New Delhi.
5. Linear Algebra: Theory & Appl. - Ward Cheney & David Kincaid Viva Books, Jones & Bartlett.
6. Vector Calculus, Linear Algebra & Differential Forms: A unified approach - Hubbard J. & Hubbard B. Prentice Hall 1999.
7. Introduction to Linear Algebra - Serge Lang, Springer, India.

8. Finite Dimension Vector Spaces - P. R. Halmos.

9. Linear Algebra Problem Book - P. R. Halmos.

10. Linear Algebra with Applications - Jeanne, L. Agnew & Robert C. Knapp Brooks / Col publishing Co, California.

11. A First Course in Linear Algebra - Dr. Aloknath Chakrabarti, Tata McGraw-Hill Edu. Pvt. Ltd

Semester: III
Practical Based on MT 3501, MT 3502 and Numerical Methods **Course Code: MT 3503L**
No. of Credits: 2.5 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to trace curves given in different forms.

CO2 Student will be able to obtain series expansion of several real valued functions of more than one variable and use it in real-life estimation problems.

CO3 Students will be able to employ multivariate differential calculus to extreme value problems.

CO4 Students will be able to approximate function at certain point with limited information of function using various interpolation.

List of practicals (problems on):

(1) Different types of errors and to find missing terms from the given table and to express a polynomial in terms of factorial notations.

(2) Newton's forward interpolation and Newton's backward interpolation.

(3) Gauss's forward interpolation and Gauss's backward interpolation.

(4) Stirling's, Bessel's and Everette's interpolation.

(5) Lagrange's interpolation and Newton's divided interpolation.

(6) Inverse interpolation for equispaced arguments (Only Newton's forward interpolation and Newton's backward interpolation and Gauss's forward interpolation)

(7) Inverse interpolation for unequispaced arguments (Newton's divided and Lagrange's inverse interpolation)

(8) LU Factorization Method.

(9) Gauss Jacobi iterative method and Gauss Seidel iterative method.

(10) Curve Tracing- 1 (Cartesian curves in $\mathbb{R}^2$), some simple graphs.

(11) Curve Tracing-2 (Parametric curves in $\mathbb{R}^2$), some simple graphs.

(12) Curve Tracing-3 (Polar curves in $\mathbb{R}^2$), some simple graphs.

(13) Limit, Continuity and Differentiation of functions of several variables using definition.

(14) Euler's theorem and Examples on Extreme values.

(15) Subspace, base and dimension theorem.

(16) Matrix Associated with Linear map and linear map associated with matrix.

Reference books:

1. Numerical Analysis and Computational Procedures -S. A. Mollah.
2. Elementary Numerical Analysis - Shastry.
3. Numerical Mathematical Analysis - James Scarborough.
4. Numerical Analysis - S. Kunz.
5. Numerical Methods for Scientific and Engineering Computation, 6th Edition, M. K. Jain, S. Iyengar, R. K. Jain, New Age International Publishers.
6. Numerical Analysis with C++ programming, Nita H. Shah, PHI Learning Ltd.

Semester: IV
Logical and Analytical Reasoning (Elective) **Course Code: EG 3308**
No. of Credits: 02 **Learning Hours: 30 Hours**

Course Outcomes:

CO1 Student will be able to engage logic and reasoning to solve logical problems.

CO2 Student will be able to solve the problems of sequence of letters, numerals or combined.

CO3 Student will be able to solve seating arrangement problems, clock problems.

CO4 Students will be able to solve data interpretation problems

Unit 1: Number System, LCM and HCF, Divisibility Rules, Factors, Remainders and Factors, Progressions.

Unit 2: Number and Letter Series, Calendars, Clocks, Venn Diagrams, Binary Logic.

Unit 3: Seating Arrangement, Logical Matching, Logical Connectives, Syllogism, Odd one out.

Reference books:

1. A Morden Approach to Logical Reasoning , R.S. Aggarwal, S. Chand, First Edition, 2007.
2. 501 CHALLENGING LOGIC AND REASONING PROBLEMS, Gnanadeep, Learning Express, LLC, 2005.
3. Analytical Reasoning, N K Pandye, Third Edition, BSC publishing, 2012.

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Semester: IV
Advanced Calculus-II (Theory) **Course Code: MT 4501**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Students will be able to solve some real life problems using multiple integral.

CO2 Students will be able to evaluate definite integral using Beta and Gamma functions.

CO3 Students will be able to apply vector calculus to solve some scientific problems.

CO4 Student will be able to formulate and solve partial differential equations.

Unit 1: Multiple integrals

Introduction to double integral, repeated or iterated integral, double integral over a closed region, evaluation of double integral, changing the order of double integral, triple integrals, Iterated triple integrals, Geometrical interpretation of double and triple integrals and problems based on it, Introduction to Jacobian (only definition), transformation of double and triple integrals.

Unit 2: Beta and Gamma functions and Vector Calculus

Definition of beta and gamma functions, properties of beta and gamma functions, relation between beta and gamma functions, duplication formula, evaluation of definite integrals using beta-gamma functions.
Definition of gradient, divergence and curl, properties of theses operators.

Unit 3: Line surface and volume integrals

Definition of line integral, Green's theorem, surface and volume integral, Gauss's divergence theorem, Stoke's theorem, verification of the three theorems and problems based on the theorems.

Unit 4: Partial Differential Equations

Formation of' Partial differential equations by the elimination of arbitrary constants and arbitrary functions, Partial differential equations of the first order, the complete and particular integrals, Lagrange's solution of' the linear equation, Some special types of equations which can be solved easily by the methods other than Charpit's method.

Reference books:

1. Mathematical Analysis - S. C. Malik and Savita Arrora, Second Edition, New Age Int.(P) Ltd.
2. Integral calculus - Shanti Narayan.
3. Calculus - David V. Widder, Second Edition, PHI.
4. Calculus: Early Transcendentals, James Stewart, Indian Edition, Cengage Learning India Pvt Ltd.
5. Partial Differential Equations - T. Amarnath.
6. Ordinary and Partial Differential Equations - Nita H Shah, PHI Learning.

7. Calculus & Analytic Geometry - G. B. Thomas & R. L. Finney, Addison - Wesley pub. India.

8. Elements of' Partial Differential Equations- Ian N. Sneddon, McGraw Hill co.

9. Advanced Calculus Volume I & II - T. M. Apostol.

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Semester: IV
Abstract Algebra-I (Theory) **Course Code: MT 4502**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Students will have a working knowledge of important basic mathematical concepts useful in abstract algebra such as relation, equivalence relation, partition of set, binary operations, division algorithm for integers, congruence modulo relation, group and types of group.

CO2 Students will be to recognize different types of concepts of group theory like subgroup, normalizer, centralizer, order of an element, order of a group, cyclic subgroup and use them in other fields of mathematics.

CO3 Students will be apply many mathematical concepts studied in abstract mathematics such as permutation groups, Symmetric groups and Alternating groups, Normal subgroup and Quotient group in allied fields of mathematics.

CO4 Student will be able to solve different mathematical problems using the transition between groups by some mathematical tools such as homomorphism & isomorphism.

Unit 1: Relation, Equivalence Relation, Partition of set, Binary operations, Division Algorithm for Integers, Congruence modulo Relation in Z, Groups, elementary properties, Finite Groups and Group tables, Commutative and non-commutative groups.

Unit 2: Subgroups, normalizer and centralizers, order of an element, order of a group, cyclic subgroup generated by an element, Lattice diagrams of finite groups, cosets and their properties, Lagrange's theorem and their applications, Euler's theorem, Fermat's theorem.

Unit 3: Permutations, cycle, transposition, even and odd permutations, order of a permutation, inverse of a permutation, Symmetric groups and Alternating groups, normal subgroups, quotient group.

Unit 4: Isomorphism of groups: Definitions and Examples, Cyclic Groups: Properties of Cyclic groups, Isomorphism of Cyclic Groups.
Homomorphism of groups: Definitions and Examples, Kernel of a Homomorphism, Fundamental Theorem of Homomorphism, Cayley's Theorem.

Text book:

Abstract Algebra - I. H. Sheth, PHI, New Delhi, 2nd edition-2009.

Reference books:

1. Topics in Algebra - I. N. Herstein, Vikas Publishing, New Delhi.
2. A First Course in Abstract Algebra - J. B. Fraleigh, Narosa Publishing, New Delhi.
3. Basic Abstract Algebra - P.B. Bhattacharya, S.K. Jain and S. R. Nagpal, Foundation Books, New Delhi.

4. Abstract Algebra - Dipak Chatterajee, PHI Learing Pvt. Ltd, New Delhi.

5. Algebra - Michael Artin, PHI.

6. A survey of Modern - G. Birkhoff & S. Maclane, Algebra Univ. Press.

7. A first course in Abstract Algebra (Rings, Groups & fields) - Marlow Anderson & Todd Fel, Chrpman & Halilereivy.

8. Contemporary Abstract Algebra, Joseph A. Gallian, 7th EDITION, Cengage learning.

Semester: IV
Practicals based on MT 4501, MT 4502 and Numerical Methods **Course Code: MT 4503L**
No. of Credits: 2.5 **Learning Hours: 30 Hours**

Course Outcomes:

CO1 Students will be able to solve some real life problems using multiple integral.

CO2 Students will be able to evaluate definite integral using Beta and Gamma functions.

CO3 Students will be able to find the zeros of given functions with several methods .

CO4 Student will be able to formulate and solve differential equations.

List of practicals (problems on):

(1) Relation between roots and coefficients of polynomial equations and problems of finding equations from given conditions.

(2) Cardon's method to solve a cubic polynomial equation

(3) Ferrari's method to solve a bi-quadratic polynomial equation

(4) Graphical method to find a real root of an equation.

(5) Bisection method and method of false position.

(6) Fixed point iteration method and Newton-Raphson's method.

(7) Euler's method and Modified Euler's method to solve an IVP.

(8) Taylor's series method and Picard's method to solve an IVP.

(9) Runge-Kutta method of order two and order four to solve an IVP.

(10) Numerical differentiation for equispaced arguments: Newton's forward and backward differentiation formula, Gauss's forward differentiation formula.

(11) Numerical differentiation for unequispaced arguments: Newton's divided difference interpolation and Lagrange's interpolation formula.

(12) Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Weddle's rule.

(13) Problems on change of the order of integration.

(14) Problems on line integrals and volume integrals.

(15) Group of Symmetries

(16) Examples of cyclic group and its subgroups and lattice diagrams.

Reference books:

1. Numerical Analysis and Computational Procedures -S. A. Mollah.
2. Elementary Numerical Analysis - Shastry.
3. Numerical Mathematical Analysis - James Scarborough.
4. Numerical Analysis - S. Kunz.
5. Numerical Methods for Scientific and Engineering Computation, 6th Edition, M. K. Jain, S. Iyengar, R. K. Jain, New Age International Publishers.
6. Numerical Analysis with C++ programming, Nita H. Shah, PHI Learning Ltd.

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Semester: IV
Latex for Mathematics & Science (Elective) **Course Code: EG 4308**
No. of Credits: 02 **Learning Hours: 30 Hours**

Course Outcomes:

CO1 Student will be able to perform basic typesetting and formatting in LaTeX.

CO2 Student will be able to insert mathematical symbols and equations in LaTeX.

CO3 Student will be able to make presentation using LaTeX.

CO4 Students will be able to create own command, environment, package and class in LaTeX.

Unit 1:
(a) Software installation
(b) LATEX typesetting basics
(c) LATEX math typesetting
(d) Tables and matrices

Unit 2:
(a) Graphics
(b) Packages
(c) User-definable
(d) Document classes

Unit 3:
(a) Introductory notions. Handling errors.
(b) Bibliographies and indices
(c) beamer
(d) Creating your own packages

Reference books:

1. http://www.dickimaw-books.com/latex/novices/novices-report.pdf
2. http://www.stats.ox.ac.uk/pub/susan/oucs latex/Further LaTeXHandbook:pdf

General information

1. The TEXUsers Group Web Site
2. Getting started with TEX, LATEX, and Friends
3. TEXResources on the Web
4. LATEX- A document preparation system
5. The TEXShowcase

6. What the heck is LATEX?
7. What is TEX?
8. LATEXentry from Wikipedia
9. TEXblog - Typography with TEX and LATEX
10. TeXample.net

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Semester: V
Linear Algebra-II (Theory) **Course Code: MT 5501**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to transform regions in a vector space by some mathematical tools such as linear operators, linear functional and bilinear forms.

CO2 Student will be able to solve different mathematical problems using the transition between vector spaces and transform by some mathematical tools such as linear functional.

CO3 Student will be able to identify quadratic curves as well as quadratic surfaces using diagonalization of a square matrix.

CO4 Students will be able to employ linear algebra to solve some scientific problems.

CO5 Student will be able to identify real life problems which can be solved by some advanced concepts in linear algebra.

Unit 1: Composition of Linear Maps, The Space $L(U, V)$, Operator Equation, Linear Functional, Dual Spaces, Dual of Dual, Dual Basis Existence Theorem, Annihilators, Bilinear Forms.

Unit 2: Inner Product Space, Norm, Cauchy-Schwarz Inequality, Orthogonalization and Orthonormalization of Basis, Gram-Schmidt Orthogonalization Process. Orthogonal Complement and its properties. Orthogonal Transformations.

Unit 3: Determinants and their properties. Value of determinant, Basic results, Laplace expansion, Cramer's rule.

Unit 4: Eigenvalues and Eigenvectors of linear operators and square matrices, Caley-Hamilton's Theorem and its verification. Application to reduction of Quadrics, Classification of Quadrics, Diagonalization of real and symmetric Matrices, Spectral Theorem.

Text books:

1. An Introduction to Linear Algebra - V. Krishnamurthy and others, Affiliated East- West press, New Delhi.
2. Linear Algebra a Geometric Approach - S. Kumaresan, PHI.
3. Linear Algebra -I H Sheth, Nirav Prakashan.

Reference books:

1. Linear Algebra with Applications - Otto Bretscher, 3rd edition, Pearson Education.
2. An Introduction to Linear Algebra - I. K. Rana, Ane Books Pvt. Ltd., New Delhi.
3. Matrix and Linear Algebra by - K. B. Datta, Prentice Hall, New Delhi.

4. Linear Algebra: Theory & Applications - Ward Cheney & David Kincaid Viva Books, Jones & Bartlett.
5. Vector Calculus, Linear Algebra & Differential Forms: A unified approach - Hubbard J & Hubbard B., Prentice Hall 1999.
6. Linear Algebra with Applications -Jeanne, L. Agnew & Robert C. Knapp Brooks / Col publishing Co, California.
7. A First Course in Linear Algebra - Dr. Aloknath Chakrabarti, Tata McGraw-Hill Edu. Pvt. Ltd.
8. Elementary linear algebra with applications- H. Anton, 9th edition, Wiley-India.(2008)
9. Linear Algebra and its applications- G. Strang,4th eEdition, Thomson.(2006)
10. Linear algebra- Kenneth M Hoffman and Ray Kunze, 2nd edition, Prentice Hall Inc.

St. Xavier's College (Autonomous)
Ahmedabad-09
B. Sc. Mathematics

Semester: V
Analysis-I (Theory) **Course Code: MT 5502**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to exhibit the analytic properties of the ordered field of real numbers.

CO2 Student will be able to demonstrate fundamentals of convergence of sequences and related results.

CO3 Student will be able to exhibit different types of continuity of function in real life in mathematical form.

CO4 Students will be able to express the most applicable concept of rate of change, the derivative, in different aspects.

CO5 Student will be able demonstrate some direct applications of the derivative of function and related results in real life problems.

Unit 1: The Real Numbers
Sets and functions, finite and infinite sets, algebraic and order properties of R, absolute value and real line, the completeness property of R, the applications of supremum property, intervals.
Articles 1.1, 1.3, 2.1 to 2.5 of Text Book (2)

Unit 2: Sequences
Sequences and limits, theorems on limits, Monotonic sequences, Sequences defined inductively, Subsequence (includes lim sup and lim inf), Cauchy Sequences, Infinite limits.
Articles 2.1-2.7 of Text Book (1)

Unit 3: Functions and continuity
Limit of a function, theorems on limits and Other Limits, continuity. Intermediate values, extreme values, Uniform continuity, Monotone and Inverse functions.
Articles 3.1-3.6 of Text Book (1), Article 5.6 of Text Book (2)

Unit 4: The derivative
Definition and Rules for differentiation, Mean value theorems, Inverse functions, Intermediate value Property of Derivatives, L'Höspital's Rules.
Articles 4.1 to 4.4 of Text Book (2), Sections 6.2.11 and 6.2.12, Article 6.3 of Text Book (2)

Text books:

1. An Introduction to Analysis - Gerald G. Bilodeau, Paul R. Thie and G. E. Keough. Jones and Bartlett Student edition.
2. Introduction to Real Analysis - Robert G. Bartle and Donald R. Sherbert, Wiley Student Edition, 2010.

Reference books:

1. A Course in Calculus & Real Analysis - S. R. Ghorpade & B. V. Limaye.

2. Elementary Analysis: The theory of calculus - K. Ross, Springer, India.
3. Numbers to Analysis - I. K. Rana, World scientific.
4. Calculus - Michael Spivak.
5. Principles of Mathematical Analysis- W. Rudin, McGraw-Hill
6. Fundamentals of mathematical analysis- G. Das & S Pattanayak, Tata Mcgraw Hill
7. A First course in Analysis- D. Somasundaram & B. Choudhary

St. Xavier's College (Autonomous)
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B. Sc. Mathematics

Semester: V
Complex Variables and Fourier series (Theory) **Course Code: MT 5503**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to perform operations on complex numbers and use it in further concepts of complex analysis.

CO2 Student will be able to identify differentiable and analytic functions and use it in further concepts of complex analysis.

CO3 Students will be able to transform complex domain using conformal mapping.

CO4 Students will be able to identify functions of complex variable having Fourier series and obtain their Fourier series.

Unit 1: Sum and product of complex numbers with properties, moduli and conjugate, triangle inequality, polar coordinates, product and quotients in exponential form, roots of complex numbers, de Moivre's theorem and application, the exponential function, trigonometric functions, hyperbolic functions, convergence of sequence and series.

Unit 2: Functions of complex variables, theorems on limits, continuity, derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient condition for differentiability, polar coordinates, analytic functions and harmonic functions.

Unit 3: Linear transformations, linear fractional transformations, Elementary transformation, an implicit form, preservation of angles, further properties.

Unit 4: Fourier series, Bessel's inequality, Riemann-Lebesgue theorem.

Text books:

1. Complex variables and applications - James W. Brown & Ruel V. Churchill, Mcgraw-hill international. 6th edition, Articles 1 to 7, 23 to 25 and 43. Chapter 2 (omit art. 13). Articles. 68, 69, 70, 71,79, 80.
2. A first course in Mathematical analysis - D. Somasundaram, Chapter-10.1 and 10.2 (only first two theorems).

Reference books:

1. Fundamentals of Mathematical Analysis- G. Das & S Pattanayak, Tata Mcgraw Hill Pub. Co. Ltd.
2. Analytical Geometry & Real and Complex analysis - T. Veerarajan, Mcgraw Hill.
3. Complex Analysis - V. Karunakaran, Narosa publishers.
4. Higher Engineering Mathematics - B. S. Grewal, Khanna Publishers.
5. Advance engineering Mathematics - H. K. Dass, S. Chand.

6. A First Course in Complex Analysis with Applications - Dennis G. Zill & Patrick S. Shanahan Jones & Bartlett India Pvt Ltd.
7. Complex Analysis - T. W. Gamelin, Springer (India) Ltd.
8. Theory of Complex functions - Marden & Hoffman W. H. Freeman, N.Y.
9. Functions of One Complex Variable - Conway.
10. An Introduction to Complex Analysis - A. R. Shastri, Macmilan India.
11. Fourier Analysis: An Introduction - E. M. Stein & R. Shakarchi, Princeton Uni. Press.
12. Fourier Series - R. Bhatia, Hindustan Book Agency-2010 corrected edition.

St. Xavier's College (Autonomous)
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Semester: V
Mathematical Programming (Theory) **Course Code: MT 5504**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to formulate and model linear programming problems.

CO2 Student will be able to solve linear programming problems and interpret solution of linear programming problems.

CO3 Student will be able to formulate and model assignment and transportation problems.

CO4 Student will be able to solve assignment and transportation problems and interpret solution of assignment and transportation problems.

Unit 1: Convex Set and Linear Programming Problem:
Convex set, extreme points of a convex set, convex combination, examples of convex sets and theorems on convexity.Formulation techniques of LP problems (only examples), graphical method, simplex method for solving LPP.

Unit 2: Problem solving techniques for LP problems:
Big-M (penalty) method, two-phase method, integer programming problem (only Gomory's cutting plane method).

Unit 3: Duality and Dual simplex method:
Introduction, definition of the dual problem, general rules for converting any primal problem into its dual, how to interpret the solution of the dual from its primal and vice versa, comparison of the solution of the primal and its dual. Find initial solution for dual simplex table, mathematical procedure to find solution by dual simplex method.

Unit 4: Transportation and Assignment Problems:
Introduction, mathematical formulation, tabular representation, definitions, methods for finding initial basic feasible solution (North West corner rule, least cost method, Vogel's approximation method), optimality test (MODI method), degeneracy in transportation problem, unbalanced transportation problem. Introduction of assignment problem, mathematical formulation of assignment problem, method for solving assignment problem (Hungarian method), unbalanced assignment problem, examples.

Text book:

Optimization method in O.R. & System Analysis - K. V. Mittal, New Age inter. Publishers.

Reference books:

1. Mathematical models in Operations Research - J. K. Sharma, Tata-MacGraw Hills book-company.
2. Operations Research - Nita H Shah, Ravi Gor and Hardik Soni. PHI - Learning.

3. Operation Research - S. D. Sharma, Kedarnath Ramnath & Co.
4. Operation Research - Kanti Swaroop & Man Mohan, Sultan Chand & Co.
5. Linear Programming - L. I. Gass, Tata MacGraw Hills book-company.
6. Linear Programming - G. Hadley, Narosa Publishing house.
7. Operation Research- A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.
8. Operations Research: An Introduction (9th Edition):,Hamdy A Taha, Pearson Education

St. Xavier's College (Autonomous)
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Semester: V
Discrete Mathematics (Theory-Elective) **Course Code: MT 5401**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to use the techniques of discrete mathematics in the problems of logic.

CO2 Student will be able to convert from SOP to POS and vise-versa.

CO3 Student will be able to create Hasse diagram to study lattice structure.

CO4 Student will be able to use Boolean algebra in some scientific applications.

Unit 1: Binary relation, reflexive, irreflexive, symmetric, antisymmetric, transitive, partial ordering (omit lexicographic ordering), Hasse diagram, upper bound, lower bound, lub, glb, lattice as a poset, properties of lattices.

Unit 2: Lattice as an algebraic system (only definition), sublattice, homomorphism, some special lattices, Boolean algebra, subalgebra, direct product, homomorphism, join irreducible, atoms.

Unit 3: Boolean expression, equivalent Boolean expression, minterm, maxterm, values of Boolean expressions, stone's representation theorem for finite Boolean algebra, sum of products canonical forms, product of sums canonical forms.

Text book:

Discrete Mathematical Structures with Applications to Computer Science - J. R. Tremblay and R. Manohar, Macgraw-Hill International Editions. Definitions: 2-3.3 to 2-3.7, Definition 2-3.16, 2-3.17 (omit Lexicographic ordering), Article 2-3.9, Chapter 4 up to 4-3.

Reference books:

1. Boolean Algebra and its Application - J. E. Whitesitt, Addison-Wesley Publishing Co. Inc.
2. Foundation of Discrete Mathematics - K. D. Joshi, New Age International Limited Publishers.
3. Logic and Boolean Algebra - B. H. Arnold, P H Inc LCCN 62-19100.
4. Introduction to Lattice Theory - D. E. Rutherford, University Mathematical Oliver and Boyed Ltd.
5. Modern Applied Algebra - Garret Birkhoff and Thomas C Bartee, CBS Publishers and Distributors.
6. Sets Lattices and Boolean Algebras - James C Abbott.
7. Lattice Theory: First Concepts and Distributive Lattices - George A. Gratzer, Dover Books.

St. Xavier's College (Autonomous)
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Semester: V
Number Theory (Theory-Elective) **Course Code: MT 5402**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will gain working knowledge of fundamentals of theory of numbers.

CO2 Student will be able to solve different mathematical problems using the nature of numbers.

CO3 Student will be able to apply number theory in different area of mathematics.

CO4 Student will be able to use some number theoretic functions in solving some mathematical problems.

Unit 1: Some Preliminary Consideration: Well-Ordering Principle, Mathematical Induction, the Binomial Theorem & binomial coefficients.
Divisibility Theory: the division algorithm, divisor, remainder, prime, relatively prime, the greatest common divisor, the Euclidean algorithm (Without proof), the least common multiple, the linear Diophantine equation & its solution.

Unit 2: Prime Numbers: Prime and composite number, the Fundamental Theorem of Arithmetic (without proof), canonical form of a number, the Sieve of Eratosthenes.
Theory of Congruence: Definition and basic properties of congruence, Residue class & complete system of residues, special divisibility test, linear congruence, Chinese Remainder Theorem. (without proof)

Unit 3: Fermat's Theorem: Fermat's Factorization method, Fermat's little theorem, Wilson's theorem.
Euler's theorem: Euler's Phi-function and formula for $\phi(n)$, Euler's theorem (without proof) and only problems on Euler's theorem.

Text book:

Elementary Number Theory - David M. Burton, Sixth Edition, Universal Book stall, New Delhi.
Sections: 1) 1.1 & 1.2 2) 2.1 to 2.4 3) 3.1 & 3.2 4) 4.1 to 4.3 5) 5.2 & 5.3 7) 7.2 & 7.3.

Reference books:

1. An introduction to the Theory of numbers - Niven, Zuckerman and Montgomery, Wiley Eastern Ltd.
2. Number Theory - S. G. Telang, Tata McGraw-Hill Publishing Co. Ltd, New Delhi.
3. Elementary Theory of Numbers - C. Y. Hsiung, Allied Publishers Ltd.-India.
4. Number Theory - George E. Andrews, Hindustan Publishing Corporation- Delhi.
5. Elementary Number Theory - Gareth A. Jones & J. Mary Jones, Springer Verlag.
6. Number Theory - J. Hunter, Oliver and Boyd-London.
7. Beginning Number Theory - Neville Robbins, Narosa Pub. House -New Delhi.

8. Introduction to the theory of Numbers - G. H. Hardy & E. M. Wright, Oxford Uni. Press.
9. Higher Algebra - S. Barnard & J. M. Child, Macmillan India Ltd.
10. Elements of Number Theory - I. M. Vinogradov , Dover Pub INC.
11. Elementary Number Theory in Nine chapters - James J. Tattersall, Cambridge Uni Press.
12. A first course in Theory of Numbers - K. C. Chowdhary, Asian Books Pvt Ltd New Delhi.
13. 1001 problems in Classical Number Theory - Jean Marie De Konick Armed Mercier, AMS.
14. An Excursion in Mathematics, M. R. Modak, S. A. Katre, V. V. Acharya and V. M. Sholapurkar, Bhaskaracharya Pratishthana, Pune.

St. Xavier's College (Autonomous)
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Semester: V
Combinatorics (Theory-Elective) **Course Code: MT 5404**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to apply various elementary counting techniques for counting problems.

CO2 Student will be able to apply binomial theorem and Pascal's triangle.

CO3 Student will be able to pigeon hole principle and Ramsey theory for various problems.

CO4 Student will be able to Principle of Inclusion and Exclusion in various counting problems.

Unit 1: Permutations and Combinations:
Basic Counting Principles, Permutations, Circular Permutations, Combinations, The injection and Bijection Principles, Arrangements and selection with Repetitions, Distribution Problems.

Unit 2: Binomial Coefficients and Multinomial Coefficients:
The Binomial Theorem, Combinatorial Identities, The Pascal's Triangles, Chu Shin-Chie's Identity, Shortest Routes in a Rectangular Grid, Some properties of Binomial Coefficients, Multinomial Coefficients and the Multinomial Theorem.

Unit 3: The Pigeonhole Principle, Ramsey Numbers, Principles of Inclusion and Exclusion:
The Pigeonhole Principle and examples, Ramsey Type Problems and Ramsey Numbers, Bounds for Ramsey Numbers, The Principle of Inclusion and Exclusion, A Generalization, Integer Solutions and Shortest Problems, Surjection Mapping and Stirling Number of the second Kind, Derangements and A Generalization, The Sieve of Eratosthenes and Euler's ϕ function.

Text book:

Principles and Techniques in Combinatorics - Chen Chuan Chong and Koh Khee Meng, World Scientific Chapters 1 to 4 (omit 4.8).

Reference books:

1. Combinatorial Techniques, Sharad Sane, Hindustan Book Agency
2. Combinatorics including concepts of Graph Theory - V. K. Balakrishnan, Schaum's Outline Series, McGraw-Hill, INC.
3. A Path to Combinatorics for Undergraduates Counting Strategies - Titu Andreescu and Zuming Feng, Birkhauser.
4. Introduction to Combinatorial Mathematics - C. L. Liu, McGraw Hill Book Company.
5. Introduction to Combinatorics - 4th edition, Richard A. Brualdi, Pearson Education.
6. An Excursion in Mathematics, M. R. Modak, S. A. Katre, V. V. Acharya and V. M.
7. lapurkar, BhaskaracharyaPratishthana, Pune.
8. A First Course in Graph Theory and Combinatorics, Sebastian M. Cioaba and M. Ram Murty, Hindustan Book Agency.

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Semester: V
Financial Mathematics (Theory-Elective) **Course Code: MT 5405**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to demonstrate arbitrage, return and interest, time value of money, bonds, shares and indices, models and assumptions.

CO2 Student will be able to exhibit Net Present Value (NPV) and Internal Rate of Return (IRR).

CO3 Student will be able to exhibit clean and dirty price, price - yield curves, duration, term structure of interest rates, immunization and convexity.

CO4 Student will be able to exemplify random returns, portfolio diagrams and efficiency, feasible set.

Unit 1: Basic Concepts: Arbitrage, Return and Interest, Time Value of Money, Bonds, Shares and Indices, Models and Assumptions.

Unit 2: Deterministic Cash Flows: Net Present Value (NPV), Internal Rate of Return (IRR), Comparison of IRR and NPV, Bonds price and yield, Clean and Dirty Price, Price - Yield Curves, Duration, Term structure of Interest rates, Immunization, Convexity.

Unit 3: Random Cash Flows: Random Returns, Portfolio Diagrams and Efficiency, Feasible Set, Markowitz Model.

Text book:

The Calculus of Finance - Amber Habib, University Press, Chapters 1, 2, 3 (upto 3.4).

Reference books:

1. Financial Calculus: An Introduction to Derivative Pricing Hardcover - Martin Baxter & Andrew Rennie.
2. Introduction to Mathematics of Finance - R.J. Williams, American Mathematical Society.

Semester: V
Mathematical Statistics (Theory-Elective) **Course Code: MT 5406**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to exemplify probability.

CO2 Student will be able to formulate a problem in statistical terms.

CO3 Student will be able to exemplify properties of variance and covariance

CO4 Student will be able to analyze statistical data graphically using frequency distributions and cumulative frequency distributions.

Unit 1: Theory of probability

Introduction, basic terminology, mathematical and statistical probability, subjective probability, mathematical tools (sets and elements of sets, operation on sets, algebra on sets, limit of sequence of sets, classes of sets), random experiment, sample space, elementary events, event, addition theorem of probability, Boole's inequality, conditional probability, multiplication theorem of probability, independent events, multiplication theorem of probability for independent events, mutually independent events, Bayes' theorem.

Unit 2: Random variable and some basic idea of distribution

Introduction, distribution function, discrete random variable (probability mass function, discrete distribution function), continuous random variable (probability mass function, continuous distribution function), mathematical expectation, expected value of function of random variable, properties of expectation, properties of variance, covariance, moment generating function (M.G.F), cumulate generating function (C.G.F).

Unit 3: Discrete and Continuous Probabilities distributions

Introduction, Bernoulli distribution, binomial distribution (moments, recurrence relation for the moments, recurrence relation for the probabilities, moment generating function (M.G.F), cumulate generating function (C.G.F), characteristic), Poisson distribution (moments, recurrence relation for the moments, recurrence relation for the probabilities, moment generating function (M.G.F), cumulate generating function (C.G.F), characteristic), negative binomial distribution, normal distribution (mode, median, moments, moment generating function (M.G.F), cumulate generating function (C.G.F), characteristic), exponential distribution (moment generating function (M.G.F)), beta distribution of first kind, beta distribution of second kind.

Text book:

Fundamentals of Mathematical Statistics - S. C. Gupta and V. K. Kapoor, Sultan Chand and Sons, Educational Publishers, New Delhi.

Reference books:

1. An introduction to Probability Theory and Mathematical Statistics - V. K. Rohatgi, Wiley Eastern limited, New Delhi.

2. Elementary Mathematical Statistics - S. C. Gupta and V. K. Kappor, Sultan Chand and Sons, Educational Publishers, New Delhi.

3. Mathematical Statistics - Parimal Mukhopadhyay.

4. Modern Probability Theory - B. R. Bhatt.

Semester: V
Practical based on MT 5501, MT 5502, MT 5503 and MT 5504 **Course Code: MT 5505L**
No. of Credits: 5 **Learning Hours: 180 Hours**

Practical based on MT 5501 and MT 5502 (Practical 1)

Course Outcomes:

CO1 Student will be able to transform regions in a vector space by some mathematical tools such as linear operators, linear functional and bilinear forms.

CO2 Students will be able to employ linear algebra to solve some scientific problems.

CO3 Student will be able to demonstrate fundamentals of convergence of sequences and related results.

CO4 Student will be able to exhibit different types of continuity of function in real life in mathematical form.

List of practicals (problems on):

(1) Solving an operator equation.

(2) Finding dual bases for $\mathbb{R}^2$ and $\mathbb{R}^3$ from their given bases through the dual-basis-existence-theorem.

(3) Orthogonalization and orthonormalization of basis through Gram-Schmidt orthogonalization process.

(4) Determinants using their properties.

(5) Some geometrical linear transformations (Reflection, Rotation, Shear etc.

(6) Applications of Cayley-Hamilton Theorem.

(7) Diagonalization of square matrices.

(8) Identifications of conic and Quadrics.

(9) Countable and uncountable sets.

(10) Completeness property of R, problems related to infimum, supremum of sets.

(11) Limits of sequence including inductively defined sequence, limit inferior and superior.

(12) Cauchy sequence.

(13) Types of discontinuities-discussion and examples.

(14) Uniform continuity.

(15) Problems based on Mean Value Theorems and L'Höspital's Rule.

(16) Application of Intermediate Value Theorem and modelling using differentiation.

Practical based on MT 5503 and MT 5504 (Practical 2)

Course Outcomes:

CO1 Students will be able to identify functions of complex variable having Fourier series and obtain their Fourier series.

CO2 Student will be able to solve linear programming problems and interpret solution of linear programming problems.

CO3 Student will be able to formulate and model assignment and transportation problems.

CO4 Student will be able to solve assignment and transportation problems.

List of practicals (problems on):

(1) Application of De-Moivere's theorem

(2) Verification of Cauchy-Riemann equations (Cartesian & polar form).

(3) Find the harmonic conjugate of a function and hence find corresponding analytic function.

(4) Solving equation involving elementary complex valued functions

(5) Problems on transformation under elementary complex valued functions

(6) Problems on verification of conformal mappings.

(7) Find the Fourier series of functions -I.

(8) Find the Fourier of functions-II.

(9) Solve linear programming problem by simplex method-I. (3 problems)

(10) Solve linear programming problem by big-M method and two-phase method. (4 problems)

(11) Solve linear programming problem by graphical method. (3 problems)

(12) Solve integer programming problem (only Gomory's cutting plane method). (3 problems)

(13) Using duality solve linear programming problem. (3 problems)

(14) Using MODI method to solve transportation problem (balanced). (3 problems)

(15) Using MODI method to solve transportation problem (unbalanced). (3 problems)

(16) Using 'Hungarian method' to solve assignment problem (balanced and unbalanced). (3 problems)

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Semester: VI
Abstract Algebra-II (Theory) **Course Code: MT 6501**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to recognize rings and demonstrate the concepts related to ring.

CO2 Student will be able to demonstrate the transition between rings using homomorphism and exhibit related properties.

CO3 Student will be able to demonstrate division algorithm theorem and obtain factors of a polynomial, and roots of a polynomial in the ring $R[x]$.

CO4 Student will be able to determine ideals, ideals of special types in a ring and identify quotient ring.

Unit 1: Ring: Definition and examples, commutative ring, division ring, unity and unit elements of a ring, field, properties of a ring, Boolean ring, finite rings. Integral domain: Zero divisor, definition and examples of integral domain (finite and of infinite order), characteristic of a ring.

Unit 2: Subring: Definition and examples, necessary and sufficient criterion for subring. Ideals: Definition and examples, necessary and sufficient criterion for ideal, principal ideal ring, quotient ring and its operation tables.
Homomorphism: Definition and some examples, Kernel of homomorphism, isomorphism of rings, fundamental theorem on homomorphism, homomorphism and characteristic.

Unit 3: Polynomial ring: Introduction and definition of polynomial, degree of polynomial, operation between polynomials, integral domain $D[x]$, different types of polynomials, factorization of polynomials, division algorithm for polynomials, irreducibility of polynomial over field, remainder and factor theorem, solution of polynomial equation, zero of polynomial, Eisenstein's criterion for irreducibility, rational zero of polynomial.

Unit 4: Field: fields, subfields, extension field, the field of quotients and integral domain, prime fields, finite fields, maximal ideals, prime ideals and their characterization through quotient ring.

Text book:

Abstract Algebra - I. H. Sheth, Prentice-Hall of India Pvt. Ltd. New Delhi, Second edition - 2003.

Reference books:

1. Abstract Algebra Theory and Applications -Thomas W. Judson, Stephen F. Austin State University, 2009.
2. Basic Abstract Algebra - Bhattacharya P.B., Jain S. K. and Nagpal S. R., Foundation Books, New Delhi.
3. A First Course in Abstract Algebra - Fraleigh J.B., Narosa Publishing, New Delhi.
4. Topics in Algebra - I. N. Herstein, Vikas Publishing, New Delhi.
5. Algebra - Michael Artin, PHI.
6. A survey of Modern Algebra - G.Birkhoff & S. Maclane, Uni. Press.
7. Proofs from the Book -M Aigner, G M Ziegler and Hofmann, Springer.

Semester: VI
Analysis-II (Theory) **Course Code: MT 6502**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to recognize use of real analysis in different real-life problems.

CO2 Student will be able to solve mathematical problems using integrability of functions.

CO3 Student will be able to obtain series expansion of several real valued functions of one variable.

CO4 Student will be able to solve differential equations using power series method.

Unit 1: Riemann Integration:

1.1. Definition of the integral.
1.2. Properties of the integral.
1.3. Existence theory (monotone, continuous functions etc. (includes Riemann sums).
1.4. Fundamental theorem.
1.5. Integration by parts and change of variable.
1.6. Mean value theorems (Weierstrass's Form and Bonnet's Form).
Articles 5.1 to 5.5 of (I); 1.5 and 1.6 to be supplemented from reference books

Unit 2: Infinite series - I:

2.1. Basic Theory (covers upto comparison test).
2.2. Series with positive terms (Condensation Test, Pringsheim's Test).
2.3. Absolute convergence (includes alternating series), ratio and root tests with lim sup and lim inf.
Articles 6.1, and 6.2 of (I); 2.2 to be supplemented from reference books.

Unit 3: Infinite Series -II:

3.1. Rearrangement of series, Cauchy Product of Series, Merten's theorem.
3.2. Power Series.
3.3. Improper integrals of the first and second kind.
3.1 to be supplemented from reference books; others from Articles 6.3 and 5.5 of (I).

Unit 4: Taylor Series:

4.1. Taylor's Theorem with Lagrange and Cauchy form of remainders.
4.2. Expansions of exponential,logarithmic and trigonometric functions.
4.3. Binomial series theorem.
4.4. Power series solutions of differential equations.

Articles 6.4 and 8.3 of (I); 4.2 and 4.3 to be supplemented from reference books.

Text book:

An Introduction to Analysis, Gerald G. Bilodeau, Paul R. Thie and G.E. Keough. Jones and Bartlett Student edition.

Reference books:

1. Fundamentals of Mathematical Analysis, Das and Pattanayak, TMH.
2. Calculus Vol 1, Tom M. Apostol.
3. Principles of Mathematical Analysis, W. Rudin, McGraw-Hill.
4. Mathematical Analysis by Tom M. Apostol, Narosa Publ. House India.
5. Calculus, Michael Spivak.
6. Understanding Analysis - Stephen D. Abbott.
7. A Course in Calculus & Real Analysis - S. R. Ghorpade & B. V. Limaye.
8. Elementary Analysis: The theory of calculus - K. Ross, Springer, India.
9. Numbers to Analysis - I. K. Rana, World Scientific.
10. Mathematical Analysis- Andrew Browder, Springer.
11. A First course in Analysis- D. Somasundaram & B. Choudhary, Narosa Publication.
12. Introduction to Real Analysis - Robert G. Bartle and Donald R. Sherbert, Wiley Student Edition, 2010.

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Semester: VI
Analysis-III (Theory) **Course Code: MT 6503**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to identify open sets and closed sets in metric space.

CO2 Student will be able to identify continuous mappings on metric spaces.

CO3 Students will be able to identify connected and compact metric spaces.

CO4 Students will be able to test and use convergence in different form in metric space.

Unit 1: Metric Spaces:

1.1 Definition and Examples.
1.2 Open Sets.
1.3 Closed Sets.
1.4 Convergence, Completeness and Baire's Theorem.
Articles 9, 10, 11 and 12 of Text Book (1)

Unit 2: Continuity, Compactness and Connectedness:

2.1 Continuous mappings.
2.2 Compactness.
2.3 Continuous function on compact set.
2.4 Connected set.
2.5 Continuous function on connected set.
To be covered from Text Book (4)

Unit 3: Uniform Convergence:

3.1 Pointwise Convergence.
3.2 Uniform Convergence.
3.3 Uniform Convergence and Continuity.
3.4 Uniform Convergence and Differentiation.
3.5 Term by Term Integration of Series.
3.6 Term by Term Differentiation of Series.
Articles 9.1-9.5 of Text Book (2)

Unit 4: Applications of Uniform Convergence:

4.1 Abel's Limit Theorem, Multiplication of Power Series.

4.2 Taylor's Series.

4.3 Weierstrass' Approximation Theorem.

4.4 Exponential, Logarithmic and Trigonometric Functions.

Articles 9.6-9.8 of Text Book (2), 4.5 from section 8.3 and 8.4 of Text Book (3)

Text books:

1. Topology and Modern Analysis - G. F. Simmons.
2. Fundamentals of Mathematical Analysis - Das and Pattanayak, TMH.
3. Introduction to Real Analysis - Robert G. Bartle and Donald R. Sherbert, Wiley Student Edition, 2010.
4. A First course in Analysis- D. Somasundaram & B. Choudhary, Narosa Publication.

Reference books:

1. A Course in Calculus & Real Analysis - S. R. Ghorpade & B. V. Limaye.
2. Elementary Analysis: The theory of calculus - K. Ross, Springer.India.
3. Numbers to Analysis - I. K. Rana, World Scientific.
4. Metric Spaces - Shirali, Springer, India.
5. Topology of Metric Spaces - S. Kumaresan, Narosa.
6. An Introduction to Analysis - Arlen Brown & Carl Pearcy, Springer, India.
7. Analysis I by Herbert Amann & Joa Chim Escher, Birkhauser Verlag, Berlin.
8. Mathematical Analysis: Linear & Metric Structure & Continuity - Mariano Giaquinta & Giuseppe Modica Birkhauser, Boston.
9. Mathematical Analysis - Andrew Browder, Springer.
10. Introduction to Real Analysis, William F. Trench, free online.

St. Xavier's College (Autonomous)
Ahmedabad-09
B. Sc. Mathematics

Semester: VI
Graph Theory (Theory) **Course Code: MT 6504**
No. of Credits: 04 **Learning Hours: 60 Hours**

Course Outcomes:

CO1 Student will be able to demonstrate properties of different graphs.

CO2 Student will be able to use to solve mathematical problems using isomorphism of graphs.

CO3 Student will be able to use to solve mathematical problems using isomorphism invariant properties of graphs.

CO4 Student will be able to apply the relationship between the matrix representation of a graph and the structure of the underlying graph.

CO5 Student will be able to apply various graph theoretical algorithms to solve some real life problems.

Unit 1: Graph, Graphs as Models, More Definitions, Vertex Degrees, Subgraphs, Path and Cycles.

Unit 2: Matrix Representation of Graphs, Fusion, Tree: Definition and simple properties, Bridges.

Unit 3: Spanning Trees, Connector problems (Omit the proofs of theorems 2.14-2.18), Shortest path Problems, Cut vertices and Connectivity.

Unit 4: Euler Tours, (Omit the proof of Theorem 3.5), Hamiltonian Graphs.

Text book:

A First Look at Graph Theory - John Clark and Derek Allan Holton, Allied Publishers Limited, Chapters 1 to 3 (Omit 3.2 and 3.4).

Reference books:

1. Introduction to Graph Theory - R. J. Wilson, Longman.
2. Introduction to Graph Theory - Douglas B. West, Prentice-Hall of India, Second Edition, 2006.
3. Invitation to Graph Theory - S. Arumugam, S. Ramchandran, Scitech Publication (India) Pvt. Ltd, Chennai.
4. A First Course in Graph Theory - S. A. Choudum, Macmillan India Limited.
5. Graph Theory - G. Suresh Singh, Prentice Hall of India,
6. A First Course in Graph Theory and Combinatorics, Sebastian M Cioaba and M Ram Murty, Hindustan Book Agency.
7. Graph Theory Frank Harrary,
8. Graph Theory with Application- John Bondy and U.S.R Murty, Palgrave.
9. Graph Theory- Reinhard Diestal, 4th edition 2010, Springer- Verlag.

St. Xavier's College (Autonomous)
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B. Sc. Mathematics

Semester: VI
Operations Research (Theory-Elective) **Course Code: MT 6401**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to develop the inventory models with different characteristics like model with finite replenishment rate, with shortages, Order-level Lot-size model, Order-level Lot-size model with finite replenishment rate.

CO2 Student will be able to exhibit the notion of PERT & CPM and its applications.

CO3 Student will be able to set up framework of PERT & CPM and construct project network.

CO4 Student will be able to set up different game strategies and solve some real life problems.

Unit 1: Inventory Problems:
Introduction, types of inventory, cost involved in inventory problems, notations, EOQ model, limitations of EOQ formula, EOQ model with finite replenishment rate, EOQ model with shortages, Order - level Lot - size model, Order - level Lot - size model with finite replenishment rate.

Unit 2: PERT and CPM:
Introduction, origin of PERT & CPM, applications of PERT & CPM, framework of PERT & CPM, construction of project network, dummy activities and events, rules for network construction, finding the critical path, concepts of float, total float and free float and its interpretations.

Unit 3: Game Theory:
Introduction, Two person zero-sum games, Maximin and Minimax Principles, Mixed strategies, expected pay-off, solution of mixed strategy game, solution of mixed strategy game by the method of oddments, Dominance Principle, solution of mixed game by matrix method, solution of a two person zero-sum game, Algebraic method for solving a game, solution of games with mixed strategy by the method of oddments, Iterative method for approximate solution.

Text book:

Operations Research - Nita H. Shah, Ravi M. Gor and Hardik Soni, PHI learning. Chapter 11 (11.1 - 11.10), Chapter 15 (15.1 - 15.9) and Chapter 18 (18.1 - 18.14).

Reference books:

1. Operations Research: An Introduction (9th Edition): Hamdy A Taha, Pearson Education
2. Mathematical models in O.R. - J. K. Sharma,Tata-MacGraw Hills book-company.
3. Operation Research - S. D. Sharma, Kedarnath Ramnath & Co.
4. Operation Research - Kanti Swaroop & Man Mohan, Sultan Chand & Co.

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Semester: VI
C Programming for Mathematical Problems (Practical-Elective) **Course Code: MT 6402**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to insert/use variables and data types, operators and expressions.

CO2 Student will be able to develop algorithms and understand mathematical concepts in order to create algorithms

CO3 Student will be able to create 'C' program.

CO4 Student will be able to analyze some of the mathematical concepts using 'C' programs.

Instructions:

1. The programming language 'C' should be used only for syntax and semantics. Detailed non-mathematical examples, which divert the attention, should be discarded from the discussion.
2. Each student should have to perform one practical for each week.
3. Each practical is of three lecture hours.

Syllabus:
Importance of C, Basic Structure of C programs, Programming style, Executing a C program, Constants, Variables and Data types, Operators and Expressions, Managing Input Output Operations, Decision making and Branching, Decision making and Looping, Arrays.

Programs for Practical:
Design an algorithm and write a program for each of the following:

Unit 1:
1. To generate the first terms of the Fibonacci sequence.
2. To find the greatest common divisor and the least common multiple factorial of given two non-zero integer.
3. To find all the prime numbers in the first positive integers.
4. To find (i) all the prime divisors (ii) all the divisors (iii) the prime power factorization of a given positive integer.

Unit 2:
5. To evaluate for a given positive integer and a given real number.
6. To find the n-th Fibonacci number without finding all the preceding Fibonacci numbers.
7. To remove all duplicates from an ordered array and contract the array accordingly.
8. To partition the elements of a given randomly ordered array of elements and a given an element into two subsets such that the elements x are in one subset and the elements are in the other subset.

Unit 3:
9. To merge two monotonically increasing arrays into a single monotonically increasing array.

10. To sort a given randomly ordered array of elements into non-descending order using (i) the selection sort method (ii) the exchange method (iii) Shell's diminishing increment insertion method.

Text books:

1. For "C programming language "Programming in ANSI C covers the course -second edition E. BALAGURUSAMY, Tata McGraw-Hill Publishing Company Limited. Chapter 1-7, 9,11,13 (omit case studies, 7.8, 9.20, 11.16, 13.14)
2. Algorithms and practicals are covered by "How to Solve It by Computer-R. G. Dromey (second edition) Prentice Hall of India.

Reference books:

1. Algorithms + Data Structures = Programs Niklaus Wirth-Prentice-Hall of India ISBN-81- 203-05698.
2. Numerical Methods with C++ programming - Nita H Shah. PHI Learning.

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Semester: VI
Cryptography (Theory-Elective) **Course Code: MT 6403**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to set up privacy or secrecy of information.

CO2 Student will be able to maintain information and keep it safe from unauthorized people.

CO3 Student will be able to describe and implement some of the techniques for encryption, public-key cryptosystems, hashing, and digital signature schemes.

CO4 Student will be able to apply some of the mathematical concepts like number theory and group theory in implementing different encryption techniques.

Unit 1: Rings, Modular Arithmetic, Prime Numbers, Primitive Elements, Discrete Logarithm.

Unit 2: Conventions in Representation, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, A Case for Modern Cryptography.

Unit 3: Trapdoor Function, Diffie-Hellman(DH) Algorithms for Key Exchange, Algorithms for discrete logarithms, ElGamal Public-Key Cryptosystem, RSA Cryptosystem, Digital Signature.

Text book:

Cryptography and Security - C K Shyamala, N Harini and Dr T R Padmanabhan Wiley-India.
Ch-1(omit1.5.6), ch-2(omit 2.9), ch-5(up to 5.5), ch-7.5(up to 7.5.2).

Reference books:

1. Cryptography & Network Security - Behrouz A Forouzan and Debdeep Mukhopadhyay, McGraw Hill.
2. Cryptography - Atul Kahate.
3. Cryptography and information Security - V K Pachgrare, PHI, EEE.
4. Public-Key Cryptography Theory and Practice - Abhijit Das, Madhvan and C E Veni Pearson.
5. Cryptograph, An Introduction- V.V. Yaschenko, Americal Mathematical Soc.

Semester: VI
Computational Mathematics with SageMath **Course Code: MT 6404**
No. of Credits: 02 **Learning Hours: 30 Hours**

Course Outcomes:

CO1 Student will be able to solve mathematical problems of mathematical analysis using SageMath.

CO2 Student will be able to solve mathematical problems of linear algebra using SageMath.

CO3 Student will be able to solve mathematical problems of algebra of polynomials using SageMath.

CO4 Students will be able to use mathematical computing software in studying and analysing mathematical concepts.

Unit 1: Analysis : Limit, sequence, series, evaluation of sum, power series, derivative, partial derivative, integral, solution of ordinary differential equations, displaying solution of ordinary differential equations.

Unit 2: Solving linear systems, vector computations, reduction of a square matrix, spaces of vectors and matrices, basis for range and null space, Eigen values and Eigen vectors, diagonalization and similarity transformation..

Unit 3: Creating polynomials on different rings, basic operations on polynomials, Euclidean division and computation of the greatest common divisor of polynomials, factorization and roots of polynomials.

Unit 4: Practical based on the Unit-I, Unit-II, Unit-III

1. To input sequence and obtain limit of convergent sequence.
2. To input finite sum and series and obtain sum of finite terms and sum of convergent series.
3. To obtain derivative, partial derivative and integral of function.
4. To obtain solution of ordinary differential equation and displaying solution of ordinary differential equation.
5. To solve the system of linear equations.
6. To obtain basis for range and null space of a matrix.
7. To obtain Eigen values and Eigen vectors and diagonalization of a matrix.
8. To create polynomials on different rings and basic operations on polynomials.
9. To perform Euclidean division and computation of the greatest common divisor of polynomials.
10. To obtain factors and roots of polynomials.

Text book:

'Computational Mathematics with SageMath' – Paul Zimmermann et. al., SIAM, 2018.

Unit I Sections : 2.3, 10.1.1, 10.1.2, 10.1.3, 4.1.6.

Unit II Sections : 2.4, 8.1.1, 8.1.2, 8.2.2, 8.2.3.

Unit III Sections : 7.1, 7.2.1, 7.3.1, 7.3.2.

Reference books:

1. 'AN INTRODUCTION TO SAGE PROGRAMMING', Razvan A. Mezei, John Wiley & amp; Sons, Inc., Hoboken, New Jersey.
2. 'SAGE - BEGINNER'S GUIDE', Craig Finch, Packt Publishing (2011).

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Semester: VI
Convex Analysis and Probability Theory (Theory-Elective) **Course Code: MT 6406**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to apply convexity of set and function in different concept of Mathematics.

CO2 Student will be able to apply some inequalities and different means to solve convexity problems.

CO3 Student will be able to solve some real life problems using probabilistic concepts.

CO4 Student will be able to solve some real life problems using probabilistic distributions.

Unit 1: Convex Analysis:
Convex and concave sets, Affine sets & Hyper planes, Convex combination, Convex cones, Algebra of convex sets: Convex functions and discussion of its continuity, graphs, sequences, limits, maxima & minima, monotonicity, linearity on an interval & convex sets, Convexity & connectedness and discussion of differentiability of convex functions. Examples, counter examples and theorems based on them.

Unit 2: Jensen inequality and its consequences & related results. A.M., G.M., Quadratic Mean (Q.M) inequality, logarithmic mean and convexity. Problems, Lagrange Mean Value Theorem (LMVT) & Convexity. Probability as a stochastic (uncertainty) mathematical model. Axiomatic & classical definition of probability, Sample space, events, probabilistic 2-set, 3-set, n-set. Inclusion & Exclusion and examples: Box office queue, Birthday problems, Bertrand's paradox. Independent, Conditional & geometric probability. Law of total probability.

Unit 3: Random walk & Random variable, Baye's Rule. Classical problems: Shakespeare's monkey Eccentric Warden, 3-prisoner's Dilemma, D'Alembert's Confusion Gambler's Ruin etc. Expected values & variance Binomial poison & normal Distributions Banach match-box problem & some classical problems.

Text books:

1. Convex Analysis by R.Tyrrell, Rockafellor, Princeton Uni. Press.
2. A course in Calculus & Real Analysis By Sudhir R. Ghorpade & Balmohan V. Limaye, Springer India. Pages: 23, 24, 25, 34, 36 (ex.27 to 35), 42, (ex.71, 72), 74 to 77, 100, 102, 125 to 130 (ex.15), 174 (ex.12)
3. Probability: An Introduction By David A. Santos, Viva Books Ch. 3 & 4

Reference books:

1. All the mathematics you missed but Need to Know - Thomas A. Garrity, Camb. Univ. Press.
2. An Introduction to Probability Theory & its Applications - Feller Vol. I John Wiley & sons, NY.

3. Introduction to Probability Models -Sheldom M. Ross, Academic Press, 9th edition.
4. Probability & Probability Distributions (MS-8, Block:3), IGNOU, New Delhi.
5. Elementary Probability Theory - Chung, Springer, India.
6. What is Mathematics? - Courant & Robbins, Revised by Ian Stewart Pg. 108 to 116.
7. Calculus, once again (for convex function & monotonicity) - David A. Santos.
8. Convex functions - A. W. Roberts and D. E. Varberg. Academic press.
9. Lecture slides on Convex Analysis & Optimization - Dimitri P. Bertsekas, MIT Cambridge MASS.
10. Convex Analysis by Jose' De Dona; The Uni. of New Castle.
11. A course in Multivariable Calculus & Analysis - S. R. Ghorpade & B. V. Limaye Springer (India) pg: 8, 9, 25, 26, 35(ex 5, 6, 7, 8), 37 (ex 23, 24, 25, 58 to 60 (for continuity & Convexity) Pg:125 & 126, 129 to 137.
12. Convex Analysis: An Introductory Text - J. Van Tid, John Wiley, New York.

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Semester: VI
Bio-Mathematics (Theory-Elective) **Course Code: MT 6407**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to analyze epidemic situations.

CO2 Student will be able to study epidemic situations using different Mathematical models.

CO3 Student will be able to analyze and study some population models.

CO4 Student will be able to provide solutions to the problems related to some population models.

Unit 1: Mathematical Models in epidemiology : Basic concepts, SI model, SIS model with constant coefficient, SIS model with coefficient as a function of time t, SIS model with constant number of carriers, SIS model when the carriers is a function of time t, SIR model, Epidemics with vaccination.

Unit 2: Single-species population models - Age structured : Continuous-time continuous-Age-Scale population models, Lotka's model for population growth, Discrete-Time Discrete-Age-Scale population model, Bernardelli, Lewis and Leslie (BLL) model, Density dependence model, Two-sec models, Continuous-time Discrete-Age population model.

Unit 3: Single-species population models - non-age structured: Exponential Growth model, its formulation, solution and interpretation, Effects of immigration and Emigration on population, Logistic Growth model, its formulation, solution and interpretation.

Text book:

Bio-Mathematics - S. K. Aggarwal, ALP Books.

Reference books:

1. Mathematical Modeling- J N Kapoor, New Age Publishers.
2. Mathematical Biology I : J.D. Murray, Springer.

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Semester: VI
Mechanics (Theory-Elective) **Course Code: MT 6408**
No. of Credits: 02 **Learning Hours: 45 Hours**

Course Outcomes:

CO1 Student will be able to establish equilibrium of system of particles.

CO2 Student will be able to set up concept of gravity to mathematical modeling.

CO3 Student will be able to demonstrate concept of suspension bridge.

CO4 Student will be able to apply concept of Mechanics.

Unit 1: Foundation of Mechanics- The ingredients of mechanics (particles, mass, rigid bodies, events, frame of reference, time, units, rest of motion, force), Introduction of vectors, velocity and acceleration. Fundamental laws of Newtonian mechanics. The theory of dimensions.

Unit 2: Methods of Plane Statics- Equilibrium of a particle, Equilibrium of a system of particles, the moment of a vector about a line, the theorem of verignon, necessary condition for equilibrium equipollent system of forces, couples, reduction of a general plane force system, work, the principle of virtual work, sufficient condition for the equilibrium of a rigid body movable parallel to a fixed plane. Potential energy

Unit 3: Mass centers and centre of gravity, Theorem of Pappus, gravitation, centre of gravity. Friction, laws of Static and kinetic friction, thin beams, flexible cables, differential equation of flexible cables, the suspension bridge, the common catenary, cables in contact with smooth curves, cables in contact with rough curves.

Text book:

Principles of Mechanics - John L. Synge and Byron A. Grifith . McGraw Hill Book Comp.-New Delhi.

Reference books:

1. Introduction to classical Mechanics - R. G. Takwale & P. S. Puranik. McGraw Hill Book Comp.-New Delhi.
2. A Text Book on Mechanics - P. N. Sinhal & S. Sareen, Anmol Publications Pvt. Ltd., New Delhi.
3. Classical Mechanics - Herbert Goldstein, Addison Wesley Publishing Company, INC.
4. Classical Mechanics T.W. B. Kibble, Longman scientific & Technical Co-published in US with John,Wiley & Sons Inc., New-York.
5. Mechanics - S. L. Kalani, C. Hemrajani, Shubhara Kalani, Viva Books Pvt. Ltd., New Delhi

Semester: VI
Practical based on MT 6501, MT 6502, MT 6503 and MT 6502 **Course Code: MT 6505L**
No. of Credits: 5 **Learning Hours: 180 Hours**

Practical based on MT 6501 and MT 6502 (Practical 1)

Course Outcomes:

CO1 Student will be able to demonstrate the transition between rings using homomorphism and exhibit related properties.

CO2 Student will be able to recognize use of real analysis in different real-life problems.

CO3 Student will be able to obtain series expansion of several real valued functions of one variable.

CO4 Student will be able to solve differential equations using power series method.

List of practicals (problems on):

(1) Verification of Rings, Commutative ring and ring with unity. Finite rings and their operation tables.

(2) Examples of Ideals and Integral Domain.

(3) Examples of finite fields and extension fields.

(4) Construction of quotient ring and their operation tables.

(5) Find the g.c.d. of two given polynomials and express it as a linear combination of these two polynomials.

(6) Check the irreducibility of polynomial over the given field (By different methods)

(7) Factorization of polynomial and the rational zeros of given polynomial.

(8) Example of Maximal and prime ideal.

(9) Definition and evaluation of Riemann integrals by various methods.

(10) Verifying MVTs and problems based on Fundamental Theorem of Integration.

(11) Convergence of infinite series of positive terms.

(12) Absolute convergence, root and ratio tests using limit inferior and superior.

(13) Power Series, radius of convergence.

(14) Improper integrals.

(15) Power series expansion of functions.

(16) Power series solutions of differential equations.

Practical based on MT 6503 and MT 6504 (Practical 2)

Course Outcomes:

CO1 Students will be able to test and use convergence in different form in metric space.

CO2 Student will be able to use to solve mathematical problems using isomorphism of graphs.

CO3 Student will be able to apply the relationship between the matrix representation of a graph and the structure of the underlying graph.

CO4 Student will be able to apply various graph theoretical algorithms to solve some real life problems.

List of practicals (problems on):

(1) Metric spaces, examples

(2) Uniform convergence of sequences

(3) Uniform convergence of series, tem by term differentiation and integration

(4) Multiplication of power series

(5) Properties of exponential, logarithmic and trigonometric functions

(6) Problems on compact and connected spaces.

(7) One article to be chosen from journals/books and presented in own words with proofs.

(8) Oral presented of project which is done in practical 7.

(9) Using the adjacency matrix, determine whether the given graph is connected or not.

(10) Determine whether the given graph is connected or not using fusion algorithm.

(11) Find a minimal spanning tree of a given connected weighted graph using Kruskal's algorithm.

(12) Find a minimal spanning tree of a given connected weighted graph using Prim's algorithm.

(13) Find a shortest path between two vertices of a given connected graph using the Breadth First.

(14) Find a shortest path between two vertices of a given connected graph using the Back-tracking.

(15) Find a shortest path between two vertices of a given connected weighted graph using the Dijk.

(16) Construct an Euler tour in a Euler graph using Fleury's algorithm.

Reference books:

1. www.mathworld.com.
2. Selected Papers On Precalculus: Vol I - Edited by Tom M Apostol: The Mathematical Association of America: (MAA):ISBN 0-88385-200-4.
3. Selected Papers On calculus: Vol II - Edited by Tom M Apostol: The Mathematical Association of America: (MAA).
4. Resonance: The Indian Academy of Sciences.