ST. XAVIER'S COLLEGE (AUTONOMOUS)

Palayamkottai - 627 002

(Recognized as "College with Potential for Excellence" by UGC)
(Accredited by NAAC at "A^{++}" Grade with a CGPA of 3.66 out of 4 in IV Cycle)
(Star College Programme by DBT, Govt. of India.)

SYLLABUS

M.Sc. MATHEMATICS

(w. e. f. June 2021)

Syllabus -2021
Programme: M. Sc. Mathematics
Programme Code: PMT

Program Specific Outcomes:

Students will

1. develop an appreciation of the basic concepts of Algebra, Analysis, Differential Equations, Combinatorics, Differential Geometry, Optimization techniques, Statistics, Fuzzy logic and Java.
2. develop a quest for knowledge which will pave way for doing Mathematics by students themselves.
3. develop an analytical thinking and taste for research.
4. learn many mathematical structures
5. gain the confidence to work in a team
6. construct and express logical arguments
7. develop generic skills that will pave way for their career

Programme Outline:

Sem.	Status	Course Code	Title of the Paper	Hrs.	Lib.	Cdts.
I	Core-1	21 PMT 11	Linear Algebra	6	-	5
	Core-2	21 PMT 12	Analysis-I	6	-	5
	Core-3	21 PMT 13	Mechanics	5	1	4
	Core-4 T	21 PMT 14	Java	4	-	4
	Core-4 P	21 PMT 15	Java Practical	2	-	1
	Elect-1	21 PMTE 11	Number Theory/Algorithms and Complexity/ MATLAB / Data Analytics	5	1	4
			Sub Total	**28**	**2**	**23**
II	Core-5	21 PMT 21	Algebra - I	6	-	5
	Core-6	21 PMT 22	Analysis-II	6	-	5
	Core-7	21 PMT 23	Ordinary Differential Equations	5	1	4
	Core-8 T	21 PMT 24	Computer Oriented Numerical Methods	4	-	4
	Core-8 P	21 PMT 25	Computer Oriented NumericalMethodsPractical	2	-	1
	Elect-2	21 PMTE 21	Combinatorics / Calculus of Variations and Integral Equations / Advanced Java / Mathematica	5	1	4
			Sub Total	**28**	**2**	**23**
III	Core-9	21 PMT 31	Algebra – II	6	-	5
	Core-10	21 PMT 32	Topology	6	-	5
	Core-11	21 PMT 33	Complex Analysis	6	-	5
	Core-12	21 PMT 34	Partial Differential Equations	5	1	5
	Elect-3	21 PMTE 31	Statistics/ Fuzzy Sets	5	1	4
			Sub Total	**28**	**2**	**24**
IV	Core-13	21 PMT 41	Functional Analysis	5	-	5
	Core-14	21 PMT 42	Differential Geometry	5	-	5
	Core-15	21 PMT 43	Graph Theory	5	-	4
	Core-16	21 PMT 44	Project	10	-	3
	Elect-4	21 PMTE 41	Operations Research / Stochastic Process	5	-	3
			Sub Total	**30**	**-**	**20**
I &II	Ext. Act.		STAND	-	-	1
			Grand Total	**120**		**91**

Extra Credit Courses:

Sem.	Status	Course Code	Title of the Paper	Cdts.
I	ECC	21 PME 11	Analysis I for competitive examinations	3
I	ECC	21 PME 12	Pebbling in Graphs	3
II	ECC	21 PME 21	Analysis II for competitive examinations	3
II	ECC	21 PME 22	Algebraic Graph Theory	3
II	ECC	21 PME 23	History of Mathematics	3
III	ECC	21 PME 31	Algebra for competitive examinations	3
III	ECC	21 PME 32	LaTeX	3
IV	ECC	21 PME 41	Differential equations for competitive examinations	3
IV	ECC	21 PME 42	Queuing and Inventory models	3

LINEAR ALGEBRA

(Course Code : 21 PMT 11)

Semester - I	Core - 1	Hours - 6	Credits – 5

Course Outcomes: By the end of the course the student will be able to

CO 1. recall vector spaces and related concepts(K1)

CO 2. interpret matrix as linear transformation with respect to a basis (K2)

CO 3. solve system of linear equations using elementary row operations(K3)

CO 4. calculate the eigenvalues and eigenvectors of a square matrix (K3)

CO 5. categorize diagonalizable and non-diagonalizable linear operators(K4)

CO 6. conclude Jordan canonical form as generalization of diagonalizability(K5).

Unit - I:

Vector spaces - subspaces - linear combinations and systems of linear equations - linear dependence and linear independence - bases and dimension - maximal linearly independent subsets.

(Chapter 1)

Unit- II:

Linear transformations, null spaces, and ranges - the matrix representation of a linear transformation - combination of linear transformations and matrix multiplication - invertibility and isomorphism - the change of coordinate matrix.

(Chapter 2: Sections 2.1 - 2.5)

Unit- III:

Elementary matrix operations and elementary matrices - the rank of a matrix and matrix inverses - system of linear equations - theoretical aspects and computational aspects

(Chapter 3)

Unit- IV:

Eigen values and eigenvectors - diagonalizability – invariant subspaces and Cayley Hamilton theorem.

(Chapter 5: Sections 5.1-5.2 and 5.4)

Unit- V:

The Jordan canonical form 1 - the Jordan canonical form 2 - the minimal polynomial.

(Chapter 7 Sections 7.1 to 7.3)

Text book:

Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra, Fourth Edition, PHI Learning Private Limited, New Delhi, 2014.

Reference books:

1. Kenneth Hoffman and Ray Kunze, Linear Algebra, Second Edition, Pearson India Pvt. Ltd., 2017
2. S. Kumaresan, Linear Algebra, First edtion, PHI learning, 2004.

ANALYSIS - I

(Course Code: 21 PMT 12)

Semester - I	Core - 2	Hours - 6	Credits – 5

Course Outcomes: By the end of the course the student will be able to

CO 1. recall the concepts of Limits and continuity in metric space (K1)
CO 2. discuss the mean value theorem, L'Hospital's rule and Taylor's theorem (K2)
CO 3. determine the limits of sequence and series of functions (K3)
CO 4. analyze the concepts of Riemann and Riemann-Stieltjes integrals(K4)
CO 5. evaluate the sequence of continuous, differentiable, integrable functions and their limits (K5)
CO 6. develop the various properties of functions of several variables (K6)

Unit - I:

Limits of functions - continuous functions - continuity and compactness – continuity and connectedness - discontinuities - monotonic functions - infinite limits and limits at infinity.

(Chapter 4)

Unit- II:

The derivative of a real function - mean value theorems - the continuity of derivatives - L' Hospital's rule - derivatives of higher order - Taylor's theorem – differentiation of vector valued functions.

(Chapter 5)

Unit- III:

Definition and Existence of the integral – properties of the integral – integration and differentiation – Integration of vector valued functions – rectifiable curves

(Chapter 6)

Unit- IV:

Discussion of main problem - uniform convergence and continuity - uniform convergence and integration - uniform convergence and differentiation - equicontinuous families of functions - The Stone - Weierstrass theorems.

(Chapter 7)

Unit- V:

Functions of several variables: Linear transformations - differentiation - the contraction principle - the inverse function theorem - the implicit function theorem (statement only).

(Chapter 9: Sections 1 - 29)

Text book:

Walter Rudin, Principles of Mathematical Analysis,Third edition, McGraw Hill Book company, New York, 1976.

Reference books:

1. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, Fourth edition, John Wiley and Sons, 2011.
2. S. K. Mapa, Introduction to Real Analysis, 7thedtion, Sarat Book House, 2013.

MECHANICS

(Course Code: 21 PMT 13)

Semester - I	Core - 3	Hours - 5	Credits - 4

Course outcomes: By the end of the course the students will be able to

CO 1. recall the concept of mechanics of a particle (K1)
CO 2. discuss Hamilton's equations using variational principle and Routh's procedure (K2)
CO 3. discuss the concept of Lagrange's equations, D'Alembert's Principle and their applications (K2)
CO 4. discuss the Kepler's problem (K3)
CO 5. classify central orbits (K4)
CO 6. illustrate moment of inertia and Euler's equations (K4).

UNIT - I:

Mechanics of a particle - mechanics of a system of particles – constraints -D'Alembert's principle and Lagrange's equations - simple applications of the Lagrangian formulation.

(Chapter 1: Sections 1.1 - 1.4 and 1.6)

UNIT- II:

Hamilton's principle - some techniques of the calculus of variations - derivation of Lagrange's equations from Hamilton's principle - extension of Hamilton's principle to non holonomic systems - simple applications.

(Chapter 2: Sections 2.1 - 2.4)

UNIT- III:

Reduction to the equivalent one body problem - the equation of motion and first integrals The equivalent one dimentional problem and classification of orbits - The Virial theorem - the differential equation for the orbit and integrable power law potentials - The Kepler's problem - inverse square law of force - the motion in time in the Kepler problem.

(Chapter 3: Sections 3.1 - 3.5, 3.7 and 3.8)

UNIT- IV:

Angular momentum and Kinetic Energy of motion about a point - tensors and dyadics - the inertia tensor and the moment of inertia - the eigen values of the inertia tensor and the principal axis transformation - methods of solving rigid body problems and the Euler's equations of motion - torque free motion of a rigid body - the heavy symmetrical top with one point fixed.

(Chapter 5: Sections 5.1 - 5.7)

UNIT- V:

The Hamilton equations of motion - cyclic co-ordinates and conservation theorems - Routh's procedure - derivation of Hamilton's equations from a variational principle - the principle of least action.

(Chapter 8: Sections 8.1 - 8.3, 8.5 and 8.6)

Text book:

Herbert Goldstein, Classical Mechanics, Second edition, Addison – Wesley Publishing Company Ltd, 2001.

Reference books:

1. Donald T. Greenwood, Principles of Dynamics, Second edition, Pearson College Division, 1988.
2. N C RanaP S Joag, Classical Mechanics, Tata McGraw-Hill Education Pvt. Ltd., 2015.

JAVA

(Course Code: 21 PMT 14)

Semester - I	Core - 4T	Hours - 4	Credits - 4

Course outcomes: By the end of the course the student will be able to

CO 1. recall OOPS, data types and operators in JAVA (K1)
CO 2. discuss control statements, loops, classes, objects, methods and constructors (K2)
CO 3. explain inheritance, packages and interfaces (K2)
CO 4. use exception handling in program execution (K3)
CO 5. analyze Mathematical problems using the above concepts (K4)
CO 6. create own threads in JAVA (K6).

UNIT - I:

Overview of JAVA language - data types - variables - arrays.

(Chapters 2 and 3)

UNIT- II:

Operators - control statements - decision making - branching and looping decision making.

(Chapters 4 and 5)

UNIT- III:

Classes - objects and methods.

(Chapters 6 and 7)

UNIT- IV:

Inheritance - packages and interfaces.

(Chapters 8 and 9)

UNIT- V:

Exception handling - multithreaded programming.

(Chapters 10 and 11)

Text book:

Java 2, The Complete Reference, Partick - Naughton, Herbert Schildt, Third edition, Tata McGraw Hill, 1999.

Reference books:

1. E. Balagurusamy, Programming with Java : A Primer Second edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
2. Herbert Schildt, Java 2, The Complete Reference, Fouth edition, Tata McGraw Hill, 2001.

JAVA PRACTICAL

(Course Code: 21 PMT 15)

Semester - I	Core - 4P	Hours - 2	Credit - 1

Course outcomes: By the end of the course the student will be able to

CO 1. recall control statements, loops, classes, objects, methods and constructors (K1)
CO 2. discuss exception handling in program execution (K2)
CO 3. illustrate inheritance, packages and interfaces using different programs (K3)
CO 4. analyze mathematical problems using the above concepts (K4)
CO 5. compare overloading and overriding methods (K5)
CO 6. create multi-threads in JAVA programs (K6).

List of Practical

1. Simple JAVA Programs
2. Programs using 1-D, 2-D arrays
3. Programs using control statements
4. Programs using classes and objects
5. Programs using overloading
6. Programs using overriding and inheritance
7. Programs using interface
8. Programs using package
9. Programs using threading concept
10. Programs using exception handling

Note: To input values, use assignment statement method or use command - line arguments.

NUMBER THEORY

(Course Code: 21 PMTE 11)

Semester - I	Elect -1	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the students will be able to

CO 1. List out the definitions in Number theory (K1)

CO 2. discuss the concept of congruence and power residues(K2)

CO 3. Determine the quadratic residue and the reciprocity(K3)

CO 4. solve the Diophantine equations(K3)

CO 5. Describe the greatest integer function and the arithmetic functions(K2)

CO 6. evaluate the sum of the fourth powers and the sum of two squares(K5)

UNIT - I:

Divisibility – primes -congruences - solutions of congruences - congruences of degree one

(Chapter 1:Sections 1.2,1.3, Chapter 2: Sections 2.1,2.2,2.3)

UNIT- II:

The function $\varphi(n)$ - congruences of higher degree - prime power moduli- prime modulus - congruences of degree two - prime modulus - power residues

(Chapter 2: Sections 2.4-2.9)

UNIT- III:

Quadratic residues - quadratic reciprocity - the jacobi symbol.

(Chapter 3: Sections 3.1-3.3)

UNIT- IV:

Greatest integer function - arithmetic functions - the moebius inversion formula - multiplication of arithmetic functions.

(Chapter 4: Sections 4.1-4.4)

UNIT- V:

The equation $x^2 + y^2 = z^2$ - The equation $x^4 + y^4 = z^2$ - sum of four and five squares - sum of fourth powers - sum of two squares.

(Chapter 5: Sections 5.5-5.10)

Text book:

Ivan Niven and Herbert S. Zuckerman, An introduction to the theory of numbers, Third edition, Wiley Eastern Ltd., 1976.

Reference books:

1. Thomas Koshy, Elementary Number Theory, Elsevier Publication, Second edition, New Delhi, 2007.
2. S. Kumaravelu and Suseela Kumaravelu, Elements of Number Theory, First edition, Raja Sankar Offset Printers, Sivakasi,2002.

ALGORITHMS AND COMPLEXITY

(Course Code: 21 PMTE 11)

Semester - I	Elective - 1	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the student will be able to

CO 1. describe various counting methods (K1)
CO 2. use various algorithms for the given model (K3)
CO 3. apply the network flow method (K3)
CO 4. apply Primality, factorization and Pseudoprimality tests (K3)
CO 5. solve some contextualized problems (K3)
CO 6. outline an algorithm for the given real time problem (K4)

UNIT- I:

Orders of magnitude - Positional number systems - Manipulation with series- Recurrence relations – Counting - Graphs

(Chapter 1: Sections 1.1 - 1.6)

UNIT - II:

Introduction - Quick sort - Recursive graph algorithms - Fast matrix multiplication

(Chapter 2: Sections 2.1 - 2.4)

UNIT - III:

The discrete fourier transform - Applications of the FFT - Algorithms for the network flow problem - Algorithm of ford and fulkerson - The max-flow min-cut theorem - The complexity of the Ford - Fulkerson algorithm.

(Chapter 2: Sections 2.5 - 2.7, Chapter 3: Sections 3.1 - 3.5)

UNIT - IV:

Layered networks - The MPM algorithm - Applications of network flow - The greatest common divisor – The extended euclidean algorithm - Primality testing - The ring of integers modulo n.

(Chapter 3: Sections 3.6 - 3.8, Chapter 4: Sections 4.1 - 4.5)

UNIT - V:

Pseudoprimality tests - Proof of goodness of the strong pseudoprimality test - Factoring and cryptography - Factoring large integers- Proving primality.

(Chapter 4: Sections 4.6 - 4.10)

Text book:

Herbert S. Wilf, Algorithms and Complexity, Prentice Hall International, 1986.

Reference books:

1. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, The Design and Analysis of Computer Algorithms, Pearson Education Pvt. Ltd, Delhi, 2004.

2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, 3rd edition, MIT Press, Cambridge, 2009.

MATLAB

(Course Code: 21 PMTE 11)

Semester - I	Elective - 1	Hours - 5	Credits - 4

Course Outcomes: By the end of course the student will be able to

CO 1. recall the basics of Linear algebra, Ordinary differential equations (K1)
CO 2. identify the basic concepts in MATLAB (K1)
CO 3. associate the script and function files in MATLAB (K2)
CO 4. solve the Statistical problems using MATLAB (K3)
CO 5. apply MATLAB to solve problems using numerical methods (K3)
CO 6. generate graphics in 2-D, 3-D using MATLAB (K6)

UNIT - I:

Introduction - basics of MATLAB – input/output file types - platform dependence – general commands.

(Chapter 1: Sections 1.1 – 1.6)

UNIT- II:

Interactive computation - matrices and vectors - matrix and array operations - creating and using inline functions - using built-in functions and on-line help - saving and loading data - plotting simple graphs.

(Chapter 3: Sections 3.1-3.2, 3.4-3.7)

UNIT- III:

Programming in MATLAB - scripts and functions - script files - functions files - language specific features - advanced data objects.

(Chapter 4: Sections 4.1-4.4)

UNIT- IV:

Applications: Linear Algebra - curve fitting and interpolation - data analysis and statistics - numerical integration - ordinary differential equations - nonlinear algebraic equations.

(Chapter 5: Sections 5.1 – 5.6)

UNIT- V:

Graphics: Basic 2-D plots - using subplot for multiple graphs - 3-D plots - handle graphics - saving and printing graphs - errors.

(Chapter 6: Sections 6.1 – 6.5, Chapter 7)

Practicals only for internal

1. MatLab I/O statements and general commands
2. Matrix and Array operations using MatLab
3. Plotting simple curves using MatLab
4. Solving problems in Linear Algebra using MatLab
5. Curve fitting and Interpolation using MatLab
6. Numerical Integration using MatLab
7. Solving Differential Equations using MatLab
8. Plotting 2D, 3D graphics using MatLab

Text book:

Rudra Pratab, Getting started with MATLAB, A Quick Introduction for Scientists and Engineers, Oxford University Press, 2006.

Reference books:

1. William John Palm, Introduction to MATLAB 7 for Engineers, McGraw Hill Professional, 2005.
2. Dolores M. Etter, David C. Kuncicky, Introduction to MATLAB 7, Printice Hall,2004.

DATA ANALYTICS

(Course Code: 21 PMTE 11)

Semester - I	Elective - 1	Hours - 5	Credits - 4

Course Outcomes: By the end of course the student will be able to

CO 1. recall the basics of Statistics and Data Analysis (K1)
CO 2. recall the fundamentals of R Programming (K1)
CO 3. explain Supervised Learning with Regression (K2)
CO 4. apply classification techniques in Data Analytics (K3)
CO 5. outline Challenges for Big Data Analytics (K4)
CO 6. Summarize the concepts of OOPs and Data visualization (K5)

UNIT - I

Introduction to core concepts and Technologies:Introduction, Terminology, data analytics process, data analytics toolkit, Types of data, Example applications. ***Data Handling:***Tabular data, Power and the computation of sample size, Advanced data handling, Multiple regression, Linear models, Logistic regression, Rates and Poisson regression, Nonlinear curve fitting.

(Textbook – 1, Chapter-1, Chapter – 3, Chapter – 4, and Chapter – 6)

UNIT - II

Machine Learning:Introduction and Concepts, Differentiating algorithmic and model-based frameworks; Regression: Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification. ***Supervised Learning with Regression and Classification Techniques :***Bias-Variance Dichotomy Model Validation Approaches Logistic Regression Linear Discriminant Analysis Quadratic Discriminant Analysis Regression and Classification Trees Support Vector Machines, *Ensemble Methods:* Random Forest Neural Networks Deep learning.

(Textbook – 2, Chapter-1 to Chapter – 3)

UNIT - III

Unsupervised Learning and Challenges for Big Data Analytics:Clustering, Associative Rule Mining, Challenges for big data analytics. ***Prescriptive Analytics:***Creating data for analytics through designed experiments, Creating data for analytics through Active Learning, Creating data for analytics through Reinforcement learning.

(Textbook – 2, Chapter-4 to Chapter – 5)

UNIT – IV

R for Data Analytics:Introduction to R- Packages, Scientific Calculator, Inspecting Variables, Vectors, Matrices and Arrays, Lists and Data Frames, Functions, Strings and Factors, Flow Control and Loops, Advanced Looping, Date and Times. ***Data Frames:***Creating Data Frames, Matrix-like Operations on a Data Frame, Merging Data Frames, Applying functions to Data Frames, Factors and Tables, Common Functions used with Factors, Working with Tables.

(Textbook – 3, Chapter – 9 to Chapter – 30)

UNIT - V

OOPs:S3 Classes, S4 Classes, Managing the Objects, Input / Output, Accessing Keyboard and Monitor, Reading and Writing Files, accessing the Internet, String Manipulation. ***Data Visualization:***Introduction to GGPlot2, Factors, Aesthetics, Plotting with Layers, Overriding

Aesthetics, Mapping vs Setting, Histograms, Density Charts, Statistical Transformation, Facets, Coordinates, Themes.

(Textbook – 3, Chapter – 1 to Chapter – 8)

Text Books:

1. Tiffany Bergin, "An Introduction to Data analysis – Quantitative , Qualitative and Mixed Models ", SAGA Publisher, 2018.
2. Hefin I. Rhys, "Machine learning with R, the tidyverse, and mlr, e-book, online, MANNING Publisher, 2020.
3. Hadley Wickham, Garrett Grolemund "R for Data Science: Import, Tidy, Transform, Visualize, and Model Data", 1st Edition, O'REILLY, 2017.

References:

1. Hastie, Trevor, et al., "The elements of statistical learning", Vol. 2. No.1, New York: Springer, 2009.
2. Montgomery, Douglas C., and George C. Runger., "Applied statistics and probability for engineers", John Wiley & Sons, 2010.
3. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley, 2013.
4. Robert Knell, " Introductory R: A Beginner's Guide to Data Visualization, Statistical Analysis, and Programming in R", Amazon Digital South Asia Services Inc, 2013.
5. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
6. John Mueller and Luca Massaron, "Machine Learning For Dummies", John Wiley & Sons, 2016.

ALGEBRA - I

(Course Code 21 PMT 21)

Semester - II	Core - 5	Hours - 6	Credits - 5

Course Outcomes: By the end of the course the students will be able to

CO 1. recall the definition of group and discuss some special type of groups (K1)
CO 2. discuss Cayley's theorem using group actions (K2)
CO 3. classify Euclidean domain, principle ideal domain and unique factorization domain (K4)
CO 4. analyze the properties of finite groups using Sylow's theorem (K4)
CO 5. analyze maximal and prime ideals (K4)
CO 6. compose irreducible and reducible polynomials (K6)

Unit- I:

Basic axioms and examples – Dihedral groups – Generators and relations – Symmetric groups –The Quaternion groups – Group actions - Definitions and examples of subgroups – centralizers and normalizers, stabilizers and kernels – Cyclic groups and cyclic subgroups

(**Chapter 1: Sections 1.1-1.3, 1.5, 1.7, Chapter 2: Sections 2.1-2.3)**

Unit-II:

Group actions and permutation representations – Cayley's theorem – The class equations – Automorphisms

(**Chapter 4: Sections 4.1 – 4.4)**

Unit- III:

Sylow's theorem – Applications of Sylow's theorem – Simplicity of A_n – Direct products – The fundamental theorem of finitely generated Abelian groups (Statement only).

(Chapter 4: Sections 4.5, 4.6, Chapter 5: Sections 5.1,5.2)

Unit- IV:

Basic definitions and examples – Polynomial rings, matrix rings, and group rings – Ring homomorphisms and quotient rings – Properties of ideals – Rings of fractions

(Chapter 7: Sections 7.1 – 7.5)

Unit- V:

Euclidean domains – Principal ideal domains – Unique factorization domains- Irreducibility criteria

(Chapter 8: Sections 8.1 – 8.3, Chapter 9: Section 9.4)

Text book:

David S. Dummit and Richard M. Foote, Abstract Algebra, Third Edition, Wiley India Pvt. Ltd., 2014

Reference books:

1. Vijay K. Khanna and S.K. Bhambri, A Course in Abstract Algebra, Third edition, Vikas Publishing House Pvt. Ltd, 2009.
2. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa publication, Eighth edition, 2009.

ANALYSIS - II

(Course Code : 21 PMT 22)

Semester - II	Core - 6	Hours - 6	Credits - 5

Course Outcomes: By the end of the course the student will be able to

CO 1. identify the various inequalities (K1)
CO 2. describe Lebesgue measure (K2)
CO 3. apply the concepts of measure theory in Functional Analysis and Harmonic Analysis (K3)
CO 4. analyze the concept of functions of bounded variations and RS integral(K4)
CO 5. analyze the approximation of L^p functions (K4)
CO 6. compare Riemann integral and Lebesgue integral. (K5)

UNIT - I:

Properties of monotonic functions – Functions of bounded variation – Total variation – Continuous functions of bounded variation – Curves and paths – The definition of Riemann - Stieltjes integral – Reduction to Riemann integral - Euler's summation formula

(Text book 1: Chapter 6 (full) and Chapter 7, Sections 7.1-7.3, 7.7-7.10)

UNIT- II:

Lebesgue measure: Introduction - Outer measure - Measurable sets and Lebesgue measure.

(Text book 2: Chapter 3: Sections 1 - 3)

UNIT- III:

Measurable functions - Littlewood's three principles - The Riemann integral - The Lebesgue integral of a bounded function over a set of finite measure.

(Text book 2: Chapter 3: Sections 5, 6 and Chapter 4: Sections 1, 2)

UNIT- IV:

The integral of a non - negative function - The general Lebesgue integral - Convergence in measure.

(Text book 2: Chapter 4: Section 3, 4 and 5)

UNIT- V:

The classical Banach spaces: The L^p - spaces - The Minkowski and Holder inequalities - convergence and completeness - Approximation in L^p - Bounded linear functionals on the L^p - spaces.

(Text book 2: Chapter 6: Sections 6.1 - 6.5)

Text books:

1. Tom M. Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, (20^{th} reprint) 2002.
2. H. L. Royden, Real Analysis, Second edition, The Macmillan Company, Collier - Macmillan Ltd – London, 2010.

Reference books:

1. G. de Barra, Measure Theory and Integration, First edition, Elsevier, 2003.
2. Inder K Rana, An Introduction to Measure and Integration, Second edition, Narosa publication, 2007

ORDINARY DIFFERENTIAL EQUATIONS

(Course Code: 21 PMT 23)

Semester - II	Core - 7	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the student will be able to

CO 1. discuss Legendre equations and second order differential equations (K2)
CO 2. illustrate system of first order homogenous and non-homogenous equations (K3)
CO 3. solve differential equations using various methods (K3)
CO 4. determine the existence of solutions of ODE's using Picard's theorem (K3)
CO 5. analyze Sturm Liouville problem and Green's function (K4)
CO 6. evaluate initial value problems using successive approximations (K5).

UNIT - I:

Linear independence - Equations with constant coefficients - Equations with variable coefficients - Wronskian - Variation of parameters.

(Chapter 2: Sections 2.4 - 2.8)

UNIT - II:

Introduction - Second order linear equations with ordinary points - Legendre equation and Legendre polynomials – Second order equations with regular singular point.

(Chapter 3: Sections 3.1 - 3.4)

UNIT - III:

System of first order equations - Existence and uniqueness theorem - Fundamental matrix – Non-homogeneous linear systems - Linear system with constant coefficients.

(Chapter 4: Sections 4.2, 4.4 - 4.7)

UNIT - IV:

Introduction - Preliminaries - Successive approximations - Picard's theorem - Some examples - Continuation and dependence on initial condition - Existence of solutions in the large- Existence and uniqueness of solutions of systems

(Chapter 5: Sections 5.1 - 5.8)

UNIT - V:

Introduction – Sturm Liouville problem – Green's function.

(Chapter 7: Sections 7.1 -7.3)

Text book:

S.G. Deo, V. Lakshmikantham, V. Raghavendera, Text book of Ordinary Differential equations, second edition, Tata McGraw - Hill Educational Private Limited, New Delhi, 1997.

Reference books:

1. E. A. Coddington, An Introduction to Ordinary Differential Equations, First edition, Prentice Hall of India Pvt Ltd, New Delhi, 1989.
2. George F. Simmons, Differential Equations, Second edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1991.

COMPUTER ORIENTED NUMERICAL METHODS

(Course Code: 21 PMT 24)

Semester - II	Core - 8 T	Hours - 4	Credits - 4

Course outcomes: By the end of the course the student will be able to

CO 1. discuss the simultaneous algebraic equations (K2)
CO 2. solve the equations by using iterative methods (K3)
CO 3. determine the numerical solutions for differentiation and integration (K3)
CO 4. classify the numerical solutions to differential equations (K4)
CO 5. compare between the various interpolations and regressions (K5)
CO 6. develop algorithms for the above methods (K6)

UNIT - I:

Introduction – beginning an iterative method –the method of successive bisection – the method of false position – Newton-Raphson iterative method – the secant method.

(Chapter 3: Sections 3.1 - 3.6)

UNIT- II:

Introduction – The Gauss elimination method – pivoting – the Gauss-Seidel iterative method – an algorithm to implement the Gauss-Seidel method.

(Chapter 4: Sections 4.1 - 4.3, 4.6, 4.7)

UNIT - III:

Interpolation: Introduction – Lagrange interpolation – Difference Tables (Newton-Gregory Forward Interpolation Formula)

Least Squares Approximation of Functions: Introduction – Linear regression – Algorithm for linear regression – Polynomial regression – Fitting exponential and trigonometric functions.

(Chapter 5: Sections 5.1 - 5.3 and Chapter 6: 6.1- 6.5)

UNIT- IV:

Introduction – formulae for numerical differentiation – Numerical integration – Simpson's rule.

(Chapter 8: Sections 8.1- 8.4)

UNIT- V:

Introduction – Euler's method – Taylor series method – Runge-Kutta methods – Runge-Kutta fourth order formula.

(Chapter 9: Sections 9.1- 9.5)

Text book:

V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India Private Limited, New Delhi, 2013.

Reference books:

1. A. Singaravelu, Numerical Methods, Fourth edition, Meenakshi Publication, 1999.
2. E.V. Krishnamurthy and S. K. Sen, Numerical Algorithms Computations in Science and Engineering, Affiliated East-West, 1996.

COMPUTER ORIENTED NUMERICAL METHODS PRACTICAL

(Course Code: 21 PMT 25)

Semester - II	Core – 8 P	Hours – 2	Credit – 1

Course outcomes: By the end of the course the student will be able to

CO 1. solve the equations by using iterative methods (K2)
CO 2. discuss the simultaneous algebraic equations (K2)
CO 3. determine the numerical solutions for differentiation and integration (K3)
CO 4. classify the numerical solutions to differential equations (K4)
CO 5. compare between the various interpolations and regressions (K5)
CO 6. formulate algorithm for the faster computation (K6).

List of Practical

1. Bisection Method
2. Newton - Raphson Method
3. Gauss Elimination Method
4. Gauss-Seidal Method
5. Lagrange Interpolation
6. Linear Regression
7. Numerical Integration (Trapezoidal and Simpson Rules)
8. Solving D.E. using Euler's Method
9. Solving D.E. using R.K. Methods.

COMBINATORICS

(Course Code: 21 PMTE 21)

Semester - II	Elective - 2	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the student will be able to:

CO 1. recall the concepts of permutation, combination and partition of integers (K1)
CO 2. describe the concept of inclusion and exclusion principle (K2)
CO 3. use the generating function as a tool to solve recurrence relations (K3)
CO 4. analyze the linear homogenous and non-linear recurrence relations (K4)
CO 5. compare the distribution of distinct and non-distinct objects (K5)
CO 6. assess the Polya's fundamental theorem and its generalization (K5).

Unit I:

The rule of sum and product - Permutations and Combinations - distributions of distinct objects – Distributions of non-distinct objects – Stirling's formula.

(Chapter 1)

Unit II:

Generating functions for combinations – Enumerators for permutations – Distributions of distinct objects into non-distinct cells – partitions of integers – Ferrers graph – elementary relations.

(Chapter 2)

Unit III:

Linear recurrence relations with constant co-efficients – solution by the technique of generating functions – a special class of non-linear difference equation - recurrence relations with two indices.

(Chapter 3)

Unit IV:

The principle of inclusion and exclusion – general formula – derangements permutations with restrictions on relative positions – rook polynomials – permutations with forbidden positions.

(Chapter 4)

Unit V:

Sets, relations and groups - equivalence classes under a permutation groups – Equivalence classes of functions – Weights and inventories of functions – Polya's fundamental theorem – Generalization of Polya's theorem.

(Chapter 5)

Text Book:

C.L. Liu, Introduction to Combinatorial Mathematics, McGraw Hill, 1968. Chapters 1 to 5.

Reference books:

1. Richard A. Brualdi, Introductory combinatorics, Fifth edition, Pearson Education, Inc., 2010.
2. V. K. Balakrishnan, Combinatorics, schaum's outlines, First edition, TataMcGraw-Hill Publishing Company Limited, New Delhi, 1994.
3. Martin Aigner, A Course in Enumeration (Graduate text in Mathematics), Springer, 2007.

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

(Course Code: 21 PMTE 21)

Semester - II	Elective - 2	Hours – 5	Credits - 4

Course Outcomes: By the end of the course the students will be able to

CO 1. discuss Hamilton's principle and Lagrange's equations (K2)
CO 2. describe variational problems involving several unknown functions (K2)
CO 3. illustrate general variation of a functional (K3)
CO 4. solve isoperimetric problems of standard types (K3)
CO 5. classify Fredholm equations and Volterra integral equations with separable and symmetric kernels (K4)
CO 6. summarize the relations between Linear differential equations and Volterra integral equations (K5).

UNIT I:

The calculus of variations - functionals – Euler's equations – geodesics – variational problems involving several unknown functions.

(Chapter 9: Sections 1 – 11)

UNIT II:

Functionals dependent on higher order derivatives – variational problems involving several independent variables – constraints and Lagrange multipliers - isoperimetric problems.

(Chapter 9: Sections 12 - 15)

Unit III:

The general variation of a functional – variational problems with moving boundaries – Hamilton's principle and Lagrange's equations – Sturm-Liouville's problems and variational methods – Rayleigh's principle – Ritz method.

(Chapter 9: Sections 16 – 21)

Unit IV:

Integral equations – introduction – relation between differential and integral equations – relationship between linear differential equations and Volterra integral equations - The Green's function and its use in reducing boundary value problems to integral equations.

(Chapter 10: Sections 1 - 5)

Unit V

Fredholm equations with separable kernels – Fredholm equations with symmetric kernels - Hilbert Schmidt theory – iterative methods for the solution of integral equations of the second kind – The Neumann series – orthogonal kernels.

(Chapter 9: Sections 6 - 11)

Textbook:

Dr. M.K. Venkataraman, Higher Mathematics for Engineering and sciences, The National Publishing Company, 2001.

Reference books:

1. M. D. Raisingania, Advanced Differential Equations, Seventeenth Revised Edition, S. Chand and Company Ltd, New Delhi, 1995.
2. M. D. Raisingania, Integral Equations and Boundary Value Problems, S. Chand and Company Ltd, New Delhi, 2016.

ADVANCED JAVA

(Course Code: 21 PMTE 21)

Semester - II	Elective-2	Hours – 5	Credits - 4

Course Outcomes: By the end of the course the student will be able to

CO 1. describe lifecycle of a servlet and its package (K2)
CO 2. use network concepts such as client/server and socket in networking program (K3)
CO 3. analyze applets and event handling mechanisms (K4)
CO 4. compare Key listener and Mouse listener interfaces in application program (K5)
CO 5. develop web-based program using servlet (K6)
CO 6. build client/server application using Remote Method Invocation (K6).

UNIT - I:

I/O Applets and other topics: I/O basics - reading console input - writing console output – the print writer class.

String handling: The string constructors - string length - special string operations - string comparison - searching string - modifying a string - changing the case of character within a string.

(Chapters 12 and 13)

UNIT- II:

Applet fundamentals (recall it form chapter 12) - applet basics - the Applet class - applet initialization and termination - simple applet display methods - the HTML applet tag - passing parameters to applets.

Events - event sources - event listeners - event classes (The key events and mouse event class only). Sources of events - Event listener Interfaces (Key listener and Mouse listener interfaces only)

(Chapters 19 and 20)

UNIT - III:

Awt classes - window fundamentals - working with frame windows - working with graphics and colour.

Control fundamentals - adding and removing controls such as labels, Buttons, check boxes, choice controls, lists, scroll bars and text field - responding to the above listed controls - handling events by extending awt components.

(Chapters 21 and 22)

UNIT - IV:

Inet-address -URL - URL connection TCP / IP client / server sockets- Datagrams - Remote Method Invocation (RMI) only.

(Chapters 18 and 24)

UNIT - V:

Life cycle of a servlet - simple servlet - servlet API - take two packages that contain the classes and interfaces required to build servlets - handling HTTP requests and response - using cookies - session tracking.

(Chapter 27)

Practical (Only for Internal)

1. Simple Program to explain console I/O operations.
2. Programs on string manipulations.
3. Applet program with parameter passing
4. Applet program with mouse events/key events
5. Programs with graphics and colors.
6. Working with awt controls.
7. Simple programs to handle events by extending awt components.
8. Client/Server Network programs using sockets and datagrams.
9. Client/Server program using RMI
10. Simple Servlets to demonstrate how to process HTTP GET and Post requests from a browser.

Text book:

Patrick Naughton, Herbert Schildt, Java 2 - The Complete Reference- 3rd edition, Tata Hill Mcgraw Companies, Inc, 1999.

Reference books:

1. E. Balagurusamy, Programming with Java: A Primer Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2000.
2. Herbert Schildt, Java 2, The Complete Reference, Fourth edition, Tata McGraw Hill, 2001.

MATHEMATICA

(Course Code: 21 PMTE 21)

Semester - II	Elective - 2	Hours - 5	Credits - 4

Course outcomes: By the end of course the student will be able to

CO 1. recall the basic concepts of linear algebra, series and limits (K1)
CO 2. discuss the basic concepts of Mathematica (K2)
CO 3. explain the structure of graphics using Mathematica (K2)
CO 4. solve mathematical problems using Mathematica (K3)
CO 5. analyze various properties of vectors and matrices(K4)
CO 6. generate numerical solutions of algebraic and differential equations (K6)

UNIT - I:

Running Mathematica - numerical calculations - building up calculations - using the Mathematica system - algebraic calculations - symbolic mathematics - numerical mathematics.

(Sections 1.0 – 1.6)

UNIT- II:

Functions and Programs – lists - graphics and sound - input and output in note books.

(Sections 1.7 – 1.10)

UNIT- III:

Mathematical functions - algebraic manipulation - manipulating equations – calculus.

(Sections 3.2 – 3.5)

UNIT- IV:

Series, Limits and Residues - linear algebra - constructing matrices - getting pieces of matrices - scalars, vectors and matrices - operations on scalars, vectors and matrices - multiplying vectors and matrices - matrix inversion - basic matrix operations - solving linear systems – eigen values and Eigenvectors

(Sections 3.6, 3.7.1 - 3.7.9)

UNIT- V:

Numerical operations on data-curve fitting - approximate functions and interpolation - Fourier transforms - numerical operations on functions - numerical integration - numerical evaluation of sums and products - numerical solution of polynomial equations - numerical root finding - numerical solution of differential equations.

(**Sections 3.8, 3.9.3 – 3.9.7)**

Text book:

Stephen Wolfram, The Mathematica, Third Edition, Cambridge University Press, 1996.

Reference book :

Eugene Don, Mathematica, second edition, Schaum's outlines, The McGraw-Hill Companies, United States of America, 2009.

ALGEBRA – II

(Course Code : 21 PMT 31)

Semester - III	Core - 9	Hours – 6	Credits - 5

Course Outcomes: By the end of the course the student will be able to

CO 1. explain the fundamental concepts in field theory and Galois Theory (K2)
CO 2. demonstrate the use of field extensions and Galois Theory (K3)
CO 3. demonstrate the capacity for mathematical reasoning through explaining the concepts from field theory and Galois Theory (K3)
CO 4. determine Galois groups of polynomials, the roots of a polynomial by radicals, splitting fields and algebraic closures (K3)
CO 5. demonstrate the interplay between groups and fields (K3)
CO 6. summarize the extensions of fields and their applications (K5)

Unit - I:

Basic theory of field extensions - Algebraic extensions – Classical straightedge and compass constructions

(Chapter 13: Sections 13.1 - 13.3)

Unit- II:

Splitting fields and algebraic closures – Separable and inseparable extensions – Cyclotomic polynomials and extensions

(Chapter 13: Sections 13.4 - 13.6)

Unit- III:

Basic definitions – The fundamental theorem of Galois theory - Finite fields

(Chapter 14: Sections14.1 – 14.3)

Unit- IV:

Composite extensions and simple extensions – Cyclotomic extensions and abelian extensions over Q – Galois groups of polynomials

(Chapters 14: Sections 14.4 -14.6)

Unit- V:

Solvable and radical extensions – Computation of Galois group over Q – Transcendental extensions, inseparable extensions, infinite Galois groups

(Chapter 14: Sections 14.7 – 14.9)

Text book:

David S. Dummit and Richard M. Foote, Abstract Algebra, Third Edition, Wiley India Pvt. Ltd., 2014

Reference books:

1. Vijay K. Khanna and S. K. Bhambri, A Course in Abstract Algebra, 5th edition, Vikas Publishing House Ltd., 2016.
2. I. N. Herstein,Topics in Algebra, 2nd edition, Wiley India Pvt. Ltd, New Delhi, 2016.

TOPOLOGY

(Course Code: 21 PMT 32)

Semester - III	Core - 10	Hours - 6	Credits - 5

Course Outcomes: By the end of the course the student will be able to

CO 1. define continuous functions on topological spaces (K1)
CO 2. describe various properties and techniques in topological spaces (K2)
CO 3. discuss connectedness and compactness in topological spaces (K2)
CO 4. analyze the sufficient condition for metrizability (K3)
CO 5. classify the topological spaces based on countability and separation axioms (K4)
CO 6. generate continuous functions using extension theorem (K6)

UNIT - I:

Topological spaces – Basis for a topology - Order topology - Product topology on $X \times Y$ - subspace topology - Closed sets and limit points.

(Chapter 2: Sections 12 -17)

UNIT - II:

Continuous functions - The product topology - Metric topology.

(Chapter 2: Sections 18 - 21)

UNIT - III:

Connected spaces - Connected subspaces of real line – Compact spaces

(Chapter 3: Sections 23, 24 & 26)

UNIT - IV:

The Countability axioms - Separation axioms - Normal spaces.

(Chapter 4: Sections 30 - 32)

UNIT - V:

Urysohn Lemma - The Urysohn Metrization Teorem -The Tietze Extension Theorem - The Tychonoff Theorem (Statement only).

(Chapter 4: Sections 33 - 35; Chapter 5: Section 37)

Text book:

James R. Munkres, Topology, Second Edition Prentice Hall of India, New Delhi, 2012.

Reference books:

1. K.D. Joshi, Introduction to General Topology, Second Edition, New Age International Private Limited, 2017.
2. K. Chandrasekhara Rao, Topology, Narosa Publishing House, 2009.

COMPLEX ANALYSIS

(Course Code: 21 PMT 33)

Semester - III	Core - 11	Hours - 6	Credits -5

Course Outcomes: By the end of the course the student will be able to

CO 1. define line integral for complex valued functions of real variable(K1)

CO 2. associate complex integral from real integral perspective (K2)

CO 3. compute complex integrals using Cauchy's integral formula (K3)

CO 4. apply Laurent series to find the residue of a complex function(K3)

CO 5. classify three types of singularities of a complex function(K4)

CO 6. evaluate definite integral of real valued functions by using residue theory(K5).

UNIT - I:

Line integrals – Rectifiable arcs – Line integrals as functions of arcs - Cauchy's theorem for a rectangle - Cauchy's theorem in a disk - Index of a point with respect to a closed curve - Cauchy's integral formula - Higher derivatives.

(Chapter 4: Sections 1.1-1.5, 2.1-2.3)

UNIT - II:

Removable singularities - Taylor's theorem - Zeroes and poles - The local mapping theorem - The maximum principle - Chains and Cycles - Simple connectivity - Homology - The general statement of Cauchy's theorem - Multiply connected regions. **(Chapter 4: Sections 3.1- 3.4, 4.1-4.5, 4.7)**

UNIT - III:

The Residue theorem - The argument principle - Evaluation of Definite integrals - Definition and basic properties of Harmonic functions - The mean value properties - Poisson's formula.

(Chapter 4: Sections 5.1-5.3, 6.1-6.3)

UNIT- IV:

Weierstrass's theorem - The Taylor's series - The Laurent series - Partial fractions - Infinite product - Canonical products - The Gamma function - Jensen's formula.

(Chapter 5: Sections 1.1-1.3, 2.1-2.4, 3.1)

UNIT- V:

Representation by exponentials - The period module - Unimodular transformation - General properties of elliptic functions - The Weierstrass p - function - The functions $\zeta(z)$ and $\sigma(z)$ - The Differential equation.

(Chapter 7: Sections 1.1, 2.1, 2.2, 2.4, 3.1-3.3)

Text book:

Lars V. Ahlfors, Complex analysis, Third edition, McGraw Hill international, 1979.

Reference books:

1. S. Ponnusamy, Foundations of Complex analysis, 2nd edition, Narosa Publishing House, 2005.
2. V. Karunakaran, Complex Analysis, 2nd edition, Narosa Publishing House, New Delhi, 2002.

PARTIAL DIFFERENTIAL EQUATIONS

(Course Code: 21 PMT 34)

Semester - III	Core - 12	Hours - 5	Credits - 5

Course Outcomes: By the end of the course the student will be able to:

CO 1. identify the types of partial differential equations (K1)
CO 2. associate partial differential equations with various real-life problems like heat and wave equation (K2)
CO 3. solve the linear first order partial differential equations using Charpit's and Jacobi's method (K3)
CO 4. determine the solution of non-linear first order partial differential equations (K3)
CO 5. solve the types of boundary value problems (K3)
CO 6. evaluate the heat and the wave equations using PDE.(K5)

UNIT - I:

First order P.D.E – curves and surfaces – genesis of first order P.D.E – classification of integrals – linear equations of the first order – partial differential equations – compatible systems – Charpit's Method - - Jacobi's Method.

(Chapter 1: Sections 1.1 - 1.8)

UNIT - II:

Integral Surfaces through a given curve – quasi linear equations – non-linear first order P.D.E

(Chapter 1: Sections 1.9 - 1.11)

UNIT - III:

Genesis of second order P.D.E – classification of second order P.D.E – one dimensional Wave Equation- vibration of an infinite string- vibration of semi- infinite string- vibration of a string of finite length (method of separation of variables)

(Chapter 2: Sections 2.1 - 2.3 (2.3.1, 2.3.2, 2.3.5 only))

UNIT - IV:

Boundary value problem - maximum and minimum principles – the cauchy problem – the dirichlet problem for the upper half plane – The Neumann problem for the upper half plane – The Dirichlet interior problem for a circle – The Dirichlet exterior problem for a circle- The Neumann problem for a circle – The Dirichlet problem for a rectangle – Harnack's Theorem

(Chapter 2: Sections 2.4.1 – 2.4.10)

UNIT - V:

Heat conduction problem – heat conduction – infinite rod case – heat conduction finite rod case – Duhamel's Principle – Wave Equation – Heat Conduction Equation

(Chapter 2: Sections 2.5.1 – 2.5.2 and 2.6.1-2.6.2)

Text book:

T. Amaranath, An Elementary Course in Partial Differential Equations, Second Edition, Narosa Publishing House, New Delhi, 2010.

Reference books:

1. Clive R. Chester, Techniques in Partial Differential Equations, McGraw-Hill, 1970.
2. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications Inc. 2006

STATISTICS

(Course Code: 21 PMTE 31)

Semester - III	Elect - 3	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the student will be able to

CO 1. recall the difference between the discrete and continuous random variables (K1)

CO 2. explain thegamma, chi-square and beta distribution (K2)

CO 3. use generating functions to determine distribution function and moments (K3)

CO 4. apply the procedure of testing of hypothesis (K3)

CO 5. analyze the convergence in probability and in distribution (K4)

CO 6. compare the Central limit and the Student's theorem(K5)

UNIT -I:

Distributions of two random variables - expectation - transformations: bivariate random variables - conditional distributions and expectations.

(Chapter 2: Sections 2.1, 2.1.1, 2.2 and 2.3)

UNIT - II:

The correlation co-efficient - independent random variables - the binomial and related distributions - the poisson distribution.

(Chapter 2: Sections 2.4 and 2.5; Chapter 3: Sections 3.1 and 3.2)

UNIT - III:

The gamma, chi-square and beta distributions - the normal distributions - the t-distribution - the F-distribution - Student's Theorem.

(Chapter 3: Sections 3.3, 3.4 and 3.6 (Except 3.4.1))

UNIT - IV:

Expectations of functions - convergence in probability- convergence in distributions - moment generating function technique- Central Limit Theorem.

(Chapter 4: Sections 4.1- 4.4 (Except 4.3.1. and 4.3.2))

UNIT - V:

Introduction to hypothesis testing - additional comments about statistical tests - Chi - square tests

(Chapter 5: Sections 5.5 - 5.7)

Text book:

Robert V. Hogg, Joseph N. Mckean and Allen T. Craig, Introduction to Mathematical statistics, Sixth Edition, Pearson Education, Inc 2006.

Reference books:

1. Goon A.M., Gupta M.K., Das Gupta.B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
2. S.M. Ross, Introduction to Probability Models, Academic Press, India, 2000

FUZZY SETS

(Course Code: 21 PMTE 31)

Semester - III	Elect - 3	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the student will be able to

CO 1. recall the basic concepts of crisp and fuzzy sets (K1)
CO 2. describe the fuzzy complement, t-norm and t-co-norm (K2)
CO 3. demonstrate the techniques of fuzzy numbers and fuzzy sets (K3)
CO 4. solve fuzzy equations (K3)
CO 5. illustrate arithmetic operations on fuzzy numbers (K4)
CO 6. compare fuzzy and crisp relations (K5).

Unit - 1:

Basic types - basic concepts - additional properties of α-Cuts - representation of fuzzy sets - extension principle for fuzzy sets.

(Chapter 1: Sections 1.3, 1.4; Chapter 2: Sections 2.1 - 2.3)

Unit - II:

Types of operations - fuzzy complements - fuzzy intersections: t-norms - fuzzy unions: t-co-norms - combinations of operations.

(Chapter 3: Sections 3.1 - 3.5)

Unit - III

Fuzzy numbers - linguistic variables - arithmetic operations on intervals - arithmetic operations on fuzzy numbers.

(Chapter 4: Sections 4.1 - 4.4)

Unit - IV:

Lattice of fuzzy numbers - fuzzy equations - crisp versus fuzzy relations - projections and cylindric extensions.

(Chapter 4: Sections 4.5- 4.6, Chapter 5: Sections 5.1 - 5.2)

Unit - V:

Binary fuzzy relations - binary relations on a single set - fuzzy equivalence relations -fuzzy compatibility relations - fuzzy ordering relations.

(Chapter 5: Sections 5.3 - 5.7)

Text book:

George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic Theory and Applications, PHI Learning Private Limited, New Delhi, 2012.

Reference books:

1. J. Zimmermann, Fuzzy set theory and its applications, Allied Publishers Ltd., New Delhi, 1991.
2. Bhargava A. K., Fuzzy Set Theory Fuzzy Logic and their Applications, S Chand and Company, 2013.

FUNCTIONAL ANALYSIS

(Course Code: 21 PMT 41)

Semester - IV	Core - 13	Hours - 5	Credits - 5

Course Outcomes: By the end of the course the student will be able to:

CO 1. define Banach spaces and continuous linear operators (K1)
CO 2. explain the infinite dimensional spaces (K2)
CO 3. analyze Hahn-Banach theorem and the open mapping theorem(K4)
CO 4. classify finite dimensional spaces using compactness (K4)
CO 5. analyzeRiezrepresentation, uniform boundedness and closed graph theorem.(K4)
CO 6. convince the elegance of Hilbert space through the conjugate space (K5)

Unit-I:

Normed space - Banach space - further properties of normed spaces - finite dimensional normed spaces and subspaces - compactness and finite dimension - linear operators

(Chapter 2 - Sections 2.2 – 2.6)

Unit-II:

Bounded and Continuous linear operators - Linear functional - Linear operators and functionals on finite dimensional spaces - Normed spaces of operators, dual space.

(Chapter 2 - Section 2.7 to 2.10)

Unit III:

Inner product space - Hilbert space - further properties of inner product space - Orthogonal complements and direct sums - orthonormal sets and sequences - series related to orthonormal sequences and sets - total orthonormal sets and sequences.

(Chapter 3 - Sections 3.1 to 3.6)

Unit-IV:

Representation of functionals on Hilbert spaces - Hilbert adjoint operators - Self adjoint, unitary and normal operators - Zorn's lemma - Hahn- Banach theorem.

(Chapter 3 - Sections 3.8 to 3.10, Chapter 4 – Sections 4.1 to 4.2)

Unit-V:

Hahn- Banach theorem for complex vector spaces and normed spaces - adjoint operators, reflexive spaces,category theorem (Statement only) - uniform boundedness theorem - Open mapping theorem - Closed graph theorem.

(Chapter 4 – Sections 4.3, 4.5 to 4.7, 4.12 to 4.13)

Text Book:

Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley and sons, New York.

Reference books:

1. M. Thamban Nair, Functional Analysis - A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill International Editions, 2004.
3. Balmohan.V. Limaye, Functional analysis, Revised 3rd edition, New Age International Pvt. Ltd., 2014.

DIFFERENTIAL GEOMETRY

(Course Code :21 PMT 42)

Semester - IV	Core - 14	Hours - 5	Credits - 5

Course Outcomes: By the end of the course the students will be able to

CO 1. List out the definitions in differential geometry (K1)
CO 2. describe the fundamental theorems for space curves(K2)
CO 3. demonstrate the Serret- Frenet formula and its applications (K3)
CO 4. analyse the properties of geodesics (K4)
CO 5. analyse the curvatures and the developable surfaces(K4)
CO 6. compare the minimal and the ruled surfaces(K5)

UNIT- I:

Space curves – Definitions-arc length-tangents - principal normal – binormal– curvature – torsion –Contact between curves and surfaces- tangent surfaces – involutes - evolutes.

(Chapter I: Sections 1 - 7)

UNIT - II:

Intrinsic equations - fundamental theorem – helices – surfaces - surface of revolution – helicoids – metric - direction coefficients.

(Chapter I: Sections 8 and 9, Chapter II: Sections 1 - 6)

UNIT - III:

Families of curves - isometric correspondence - intrinsic properties – geodesics-Canonical geodesic equation-Normal property of geodesics.

(Chapter II: Sections 7 - 12)

UNIT - IV:

Second fundamental form - principal curvatures - lines of curvatures- developables.

(Chapter III: Sections 1 - 4)

UNIT - V:

Developables associated with space curves - developables associated with curves on surfaces - minimal surfaces and ruled surfaces.

(Chapter III: Sections 5 - 8)

Text book:

T.J. Wilmore, An Introduction to Differential Geometry, Oxford University Press, 2007.

Reference books:

1. D. Somasundaram, Differential Geometry: A first course, Narosa Publishing House, New Delhi, India, 2005.
2. J. N. Sharma and A. R. Vasistha, Differential Geormetry, KedarNath Ram Nath, Meerut, 1998.

GRAPH THEORY

(Course Code: 21 PMT 43)

Semester - IV	Core - 15	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the student will be able to:

CO 1. identify the types of graphs (K1)
CO 2. determine the chromatic number and domination number (K3)
CO 3. generate graph models for real time problems (K6)
CO 4. solve real time problems using various methods in graph theory (K3)
CO 5. illustrate various characteristics of graphs (K4)
CO 6. categorize the graphs using isomorphism (K4)

UNIT- I:

Graphs and graph models- connected graphs – common classes of graphs – the degree of a vertex – regular graphs – degree sequence

(Chapter 1: Sections 1.1-1.3; Chapter 2: Sections 2.1-2.3)

UNIT - II:

The definition of isomorphism – isomorphism as a relation - bridges – trees - Cut vertices – Blocks.

(Chapter 3: Sections 3.1-3.2; Chapter 4: Sections 4.1-4.2; Chapter 5: Sections 5.1-5.2)

UNIT - III:

Connectivity-Eulerian graphs - Hamiltonian graphs – Strong digraphs – Tournaments

(Chapter 5: Section 5.3; Chapter 6: Sections 6.1-6.2; Chapter 7: Sections 7.1-7.2)

UNIT - IV:

Matchings – factorization - planar graphs

(Chapter 8: Sections 8.1-8.2; Chapter 9: Sections 9.1)

UNIT - V:

The fourcolor problem - vertex coloring - edge coloring -The center of a graph-Distant vertices-The domination number of a graph

(Chapter 10: Sections 10.1 - 10.3; Chapter 12: Section 12.1-12.2; Chapter 13: Section 13.1)

Text book:

Gary Chartrand and Ping Zhang, Introduction to Graph Theory, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.

Reference books:

1. J. A. Bondy and U. S. R. Murty, Graph theory with applications, The MacMillan Press Ltd., 1976.
2. Choudum, A First Course in Graph Theory, Laxmi Publications, 2000.

PROJECT

(Course Code: 21 PMT 44)

Semester - IV	Core - 16	Hours - 10	Credits - 3

Objective:

To make the students aware of the recent development in the research in mathematics and prepare the project accordingly.

Guidelines:

Following are the guideline to be adhered to.

1. The project should be prepared by the individual student.
2. The language for the project is English.
3. The minimum number of pages should be 50.
4. Project observations, suggestions and conclusion must from an inevitable part of the project.
5. Marks for the project report will be 200 divided as 100 for internal and 100 for external.

   Average of the two marks will be taken.

OPERATIONS RESEARCH

(Course Code: 21 PMTE 41)

Semester - IV	Elective - 4	Hours - 5	Credits - 3

Course Outcomes: By the end of the course the student will be able to

CO 1. recall the concepts of Linear Programming and Dynamic Programming (K1)
CO 2. discuss the various types of deterministic and probabilistic inventory models (K2)
CO 3. solve a two-person zero-sum game by graphical method and using LPP (K3)
CO 4. outline the concepts of leveling the resources, probability and cost consideration in Project scheduling (K4)
CO 5. decide which model can be applied to a variety of queuing situation (K5)
CO 6. create a network for the given Project (K6)

UNIT - I:

Elements of the DP model - the capital budgeting example - more on the definition of the state - examples of DP models and computations - solution of linear programming by dynamic programming – Game theory: Two -Person Zero-sum Games - Mixed Strategies - Graphical Solutions - solution of Games by Linear Programming.

(Chapter 9: Sections 9.1 - 9.3, 9.5; Chapter 11: Section 11.4)

UNIT - II:

Arrow (Network) diagram representations - critical path calculations - construction of the time chart and resource leveling - probability and cost considerations in project scheduling.

(Chapter 12: Sections 12.1 - 12.4)

UNIT - III:

A Generalized inventory model - Deterministic Models: Single item Static Model - Single item Static Model with Price breaks - Multiple item Static Model with Storage Limitations - Single item N-period Dynamic Model.

(Chapter 13: Sections 13.2, 13.3 (13.3.5 omitted))

UNIT - IV:

ProbabilisticModels:A Continuous Review Model - Single Period Models – Queueing Theory: Basic elements of the Queueing model - Roles of Poisson and Exponential distributions.

(Chapter 13: Sections 13.4.1 and 13.4.2; Chapter 15: Sections 15.1 and 15.2)

UNIT - V:

Queues with combined arrivals and departures - Queueing models of type: (M/M/1):(GD/∞/∞),(M/M/1):(GD/N/∞), (M/G/1):(GD/∞/∞), (M/M/C):(GD/∞/∞), (M/M/∞):(GD/∞/∞) - tandom or series queues : two station series model with zero queue capacity.

(Chapter 15: Sections 15.3 (15.3.5 and 15.3.7 are omitted) &15.5.1)

Text book:

HamdyA.Taha**.,** Operations Research - An Introduction, Fourth Edition Macmillan Publishing Co. Inc., 1989.

Referencebooks:

1. KantiSwarup, P.K. Gupta and Man Mohan, Operations Research, Eighth edition, Sulltan Chand and Sons, New Delhi, 1997.
2. Prem Kumar Gupta and D.S. Hira, Problems in Operations Research, S. Chand and Company Ltd., New Delhi, 2010.

STOCHASTIC PROCESSES

(Course Code: 21 PMTE 41)

Semester - IV	Elective - 4	Hours - 5	Credits - 3

Course Outcomes: By the end of the course the student will be able to

CO 1. recall the concepts of probability distributions and their generating function (K1)
CO 2. discuss the structure of Markov chain and Markov process (K2)
CO 3. examine the stability of Markov chain (K3)
CO 4. outline the simulation of stochastic models (K4)
CO 5. summarize the Poisson process and its related distributions (K5)
CO 6. compose random walk and renewal equation for the real-life problem (K6)

UNIT- I:

Generating functions - Laplace transforms - Laplace (Stieltjes) transform of probability distribution of a random variable - classification of distributions.

(Chapter 1: Sections 1.1 - 1.4)

UNIT - II

Markov chains definitions and examples - higher transition probabilities - generalization of independent bernoulli trials - classification of states and chains – determination of higher transition probabilities - stability of a markov system - graph theoretic approach.

(Chapter 2: Sections 2.1 – 2.7)

UNIT - III:

Poisson process - Poisson process and related distributions - generalizations of Poisson process - birth and death process - Markov processes with discrete state space(continuous time Markov chains).

(Chapter 3: sections 3.1 - 3.5)

UNIT - IV:

Renewal process - renewal processes in continuous time - renewal equation - stopping time - renewal theorems.

(Chapter 6: Sections 6.1 - 6.5)

UNIT - V:

Simulation(Introduction) – evaluation of integrals using random numbers – generation of continuous random variables – simulation of discrete random variates- simulation of stochastic process.

(Chapter 11: Sections 11.1 - 11.5)

Text book:

J. Medhi, Stochastic Processes, 4th edition, New Age International (P) Ltd, 2017.

Reference books:

1. U. Narayan Bhat, Elements of Applied Stochastic Processes, second edition, John Wiley and Sons, New York, 1972.
2. N.V. Prabhu, Stochastic Processes, Macmillan, New York, 1970.

Extra Credit Courses

Analysis I for Competitive Examinations

(Course Code: 21 PME 11)

Semester - I	ECC (Self Study)	Credits - 3

Course Outcomes: By the end of the course the student will be able to

CO 1. recall Archimedean property, supremum and infimum (K1)

CO 2. discuss the convergence of sequences and Bolzano Weierstrass theorem (K2)

CO 3. apply infimum and supremum in various problems related to them (K4)

CO 4. test the uniform convergence of sequence and series of functions (K5)

CO 5. compare continuous, uniform continuous and differentiable functions (K5)

CO 6. build the mental ability to face GATE, CSIR and SET examinations. (K6)

Unit - I:

Elementary set theory, finite -countable and uncountable sets - Real number system as a complete ordered field - Archimedean property – supremum and infimum.

Unit - II:

Real sequences and series – convergence – limsup and liminf - Bolzano Weierstrass theorem.

Unit - III:

Continuity, uniform continuity, differentiability, mean value theorem in Real number system.

Unit - IV:

Sequence and series of real functions, uniform convergence.

Unit - V:

Riemann sums and Riemann integral, Improper Integrals, Monotonic functions, types of discontinuity.

Text Books:

1. Narayan Shanti and Mittal P.K., A Course of Mathematical Analysis, S. Chand Publishers, 2005
2. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, Fourth edition, John Wiley and Sons, 2011.
3. S C Mailk and Savita Arora, Mathematical Analysis, second edition, New Age International(P) Limited Publishers, 2005

PEBBLING IN GRAPHS

(Course Code: 21 PME 12)

Semester - I	ECC (Self Study)	Credits - 3

Course Outcomes: By the end of the course the student will be able to

CO 1. describe various pebbling parameters (K2)
CO 2. determine the pebbling numbers of various types of graphs(K3)
CO 3. analyze Graham's pebbling conjecture (K4)
CO 4. analyzeLourdusamy's pebbling conjecture (K4)
CO 5. design Graham's pebbling conjecture for various graphs(K6)
CO 6. formulate Lourdusamy's pebbling conjecture for various graphs(K6)

Unit I:

Graph Pebbling – Distribution – Solvability – Unsolvability - Pebbling on Some Standard Graphs as Complete Graphs, Path, Cycle, etc. 2-Pebbling Property.

Unit II:

t-Pebbling on Some Standard Graphs as Complete Graphs, Path, Cycle,etc.- 2t- Pebbling Property-Lemke Graphs- Demonic Graphs - Pebbling on $C_5 * C_5$.

Unit III:

Transfer Lemma – Grahams Conjecture on Product of Graphs G*H – Grahams Conjecture on Product of Cycles – Grahams Conjecture on G*H (H Satisfies the 2- Pebbling Property).

Unit IV:

Lourdusamy's Conjecture on Product of Graphs G*H – Loudusamy's Conjecture on Product of Cycles – Lourdusamy's Conjecture on G*H (H Satisfies the 2-Pebbling Property).

Unit V:

Herscovici's Conjecture on Product of Graphs G*H - Herscovici's Conjecture On Product of throne graph and complete graph– Optimal Pebbling on Graphs.

Text & Reference Materials:

1. F.R.K. Chung, *Pebbling in hypercubes*, SIAM J. Disc. Math., 2 (4) (1989), 467-472.
2. J. A. Foster and H. S. Snevily, The 2-pebbling property and a conjecture of Graham's,Graphs and Combin. 16 (2000), 231-244.
3. D.S. Herscovici and A.W. Higgins, The pebbling number of $C5 * C5$, *Discrete Math.*, 187(1998), 123-135.
4. A. Lourdusamyand S.Somasundaram, The t-pebbling number of graphs, South East Asian Bulletin of Mathematics, 30 (2006), 907-914.
5. D. Herscovici, Graham's pebbling conjecture on products of cycles, J. Graph Theory 42 (2003), 141-154.
6. S. Wang, Pebbling and Graham's conjecture, Disc. Math., 226(3) (2001), 6 431-438.
7. A. Lourdusamy, t-pebbling the product of graphs, Acta Ciencia Indica, XXXII (M.No.1) (2006), 171-176.

8. A. Lourdusamy, S.S.Jeyaseelan and A.P. Tharani, *t*-pebbling the product of fan graphs and the product of wheel graphs, *International Mathematical Forum,* 32 (2009), 1573 - 1585.
9. Dong-Lin Hao, Ze-Tu Gao, Jian-Hua Yin, Herscovici's Conjecture on the Product of the Thorn Graphs of the Complete Graphs, J. Oper. Res. Soc. China (2014) 2:263–269
10. Friedman, T.,Wyels, C.: Optimal pebbling of paths and cycles.Mathematics. arXiv:math.CO/0506076.

Analysis II for Competitive Examinations

(Course Code: 21 PME 21)

Semester - II	ECC (Self Study)	Credits - 3

Course Outcomes: By the end of the course the student will be able to

CO 1. describe the concepts of topological properties of metric spaces (K1)

CO 2. associate the concept of continuity and connectedness (K2)

CO 3. apply Cauchy's integral formula and Maximum modulus principle to evaluate integral (K3)

CO 4. outline Liouville's theorem and open mapping theorem (K4)

CO 5. generate Taylor's series for analytic functions (K6)

CO 6. build the mental ability to face GATE, CSIR and SET examinations. (K6)

Unit - I:

Metric spaces – Convergence – Complete.

Unit - II:

Metric space – Connected – Continuity-totally bounded.

Unit - III:

Algebra of complex numbers, the complex plane, polynomials, Power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations.

Unit - IV:

Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem.

Unit - V:

Taylor series, Laurent series, calculus of residues, Conformal mappings, Mobius transformations.

Text Books:

1. Arumugam. S, ThangapandiIssac. A and Somasundaram. A, Modern Analysis, Scitech Publications (I) Pvt. Ltd., 2010.
2. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, Fourth edition, John Wiley and Sons, 2011.
3. S C Mailk and Savita Arora, Mathematical Analysis, second edition, New Age International(P) Limited Publishers, 2005
4. John B. Conway, Functions of one complex variable I, second edition, Springer, 1995.

ALGEBRAIC GRAPH THEORY

(Course Code: 21 PME 22)

Semester - II	ECC (Self Study)	Credits - 3

Course Outcomes: By the end of the course the student will be able to

CO 1. describe graphs from finite groups (K2)
CO 2. determine the zero-divisor graph of commutative rings (K3)
CO 3. analyzezero-divisor graph of commutative rings (K4)
CO 4. analyzezero-divisor graph of semigroup (K4)
CO 5. design total graph of a ring (K6)
CO 6. formulate the domination in graphs from commutative ring (K6)

Unit I : Graphs from Finite Groups: An Overview

Unit II : The zero-divisor graph of commutative rings: A survey

Unit III : The Zero-divisor graph of semigroup: A survey

Unit IV : On the total graph of a ring and its related graphs: A survey

Unit V : On the domination in graphs from commutative ring: A survey

Text Books:

Unit I: **Yusuf F. Zakariya**: Graphs from Finite Groups: An Overview, Proceedings of Annual National Conference-2016, Nigeria, 2017.

Unit II: **Marco Fontana, Salah-EddineKabbaj, Bruce Olberding, Irena Swanson**: Commutative Algebra: Noetherian and Non-Noetherian Perspectives, Springer Londan, (2010). (**Chapter 2**)

Unit III: **M.** Droste**, L.** Fuchs**, B.** Goldsmith**, L.** Strüngmann: Groups, Modules, and Model Theory-Surveys and Recent Developments, Springer, Londan, (2014). (**Chapter 2**)

Unit IV: **Marco Fontana, Sophie Frisch and Sarah Glaz**: Commutative Algebra: Recent Advances in Commutative Rings, Integer-Valued Polynomials and Polynomial functions, Springer, Londan, (2014). (**Chapter 3**)

Unit V: **Syed Tariq Rizvi, Asma Ali, Vincenzo De Filippis**, Algebra and its Applications, Springer, (2014). (**Chapter 23**)

HISTORY OF MATHEMATICS
(Course Code: 21 PME 23)

Semester - II	ECC (Self Study)	Credits – 3

Course Outcomes: By the end of the course the student will be able to

CO 1. recall the aesthetic sense of ancient mathematicians (K1)
CO 2. recall the contribution of modern mathematicians (K1)
CO 3. discuss the development of mathematics (K2)
CO 4. explain the genesis of mathematical ideas (K2)
CO 5. Analyze the ideas which govern the vast tracks of Mathematics(K4)
CO 6. outline mathematical tools (K4).

Unit I

Introduction to Pythagorean Ideas - Introduction to Euclid - The Genius of Archimedes - The Context of the Paradox? - Consideration of the Paradoxes - Decimal Notation and Limits - Infinite Sums and Limits - Finite Geometric Series.

(Sections: 1.1.1, 1.2.1, 1.3.1, 2.1, 2.3 -2.6)

Unit II

Al-Khwarizmi and the Basics of Algebra – The Life of Al-Khwarizmi - Omar Khayyam and the Resolution of the Cubic- The solution of a Quadratic Equation – A Particular Equation – The General Case – The Brief and Tragic Lives of Abel and Galois - The Work of Abel and Galois in Context – Introductory Remarks – The Life of Rene Descartes – The Real Number Line -The Cartesian Plane - Coordinates in Three Dimensional Space.

(Sections: 4.2.1, 4.2.2, 4.2.4, 5.6, 5.7.1, 5.7.2, 5.8.1, 5.9, 6.0-6.3, 6.5)

Unit III

The Life of Fermat - Fermat's Method -Fermat's Lemma and Maximum / Minimum Problems Progenitors of the Complex Number System – Cardano – Euler – Argand – Cauchy-Riemann – Complex Number Basics – The Fundamental Theorem of Algebra - Finding the Roots of a Polynomial - Why Do We Need the Real Numbers?

(Sections: 7.1 - 7.2, 7.4, 8.2 - 8.5, 10.2)

Unit IV

The Sieve of Eratosthenes - The Infinitude of the Primes -The Life of Dirichlet - The Pigeonhole Principle - Riemann and the Geometry of Surfaces - Introduction – George Cantor and the Orders of Infinity – Introductory Remarks – What is a Number – An Uncountable Set – Countable and Uncountable – The Existence of Transcendental Numbers.

(**Sections:11.1 - 11.2, 12.1 - 12.2, 13.0, 14.1 - 14.3)**

Unit V

Henri Poincare, Child Prodigy – Introductory Remarks – Emmy Noether and Algebra – The Life of Emmy Noether – Emmy Noether and Abstract Algebra: Groups – Emmy Noether and Abstract Algebra: Rings-The Idea of an Ideal - Cryptography - What is Cryptography?

(Sections:16.1, 18.1 - 18.3.1, 20.3)

Textbook

1. Steven G. Krantz, An Episodic History of Mathematics, Mathematical Association of America, 2010.

Reference

1. C.B. Boyer and U. Merzbach, History of Mathematics, John Wiley &Sons, New York,1988.
2. E.T.Bell,Men of Mathematics, Penguin Books Ltd., Harmondsworth, Middlesex, UK,1953.

Algebra for Competitive Examinations

(Course Code: 21 PME 31)

Semester - III	ECC (Self Study)	Credits - 3

Course Outcomes: By the end of the course the student will be able to

CO 1. describe central concepts in groups (K2)
CO 2. determine the various applications of groups (K3)
CO 3. analyze rings and fields(K4)
CO 4. analyze vector space concepts (K4)
CO 5. design Jordan and Quadratic forms (K6)
CO 6. formulate matrices for Linear Transformation (K6)

Unit - I:

Groups, subgroups, normal subgroups and Cyclic groups.

Unit - II:

Quotient groups, homomorphisms, permutation groups, Cayley's theorem, class equations, Sylow theorems

Unit - III:

Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain, Polynomial rings and irreducibility criteria, Fields, finite fields, field extensions.

Unit - IV:

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices and Matrix representation of linear transformations.

Unit - V:

Jordan forms, Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms.

Text Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra, eighth edition, Cengage learning, 2013.,
2. Vijay K. Khanna, S. K. Bhambri, A Course in Abstract Algebra, Fifth edition, Vikas publishing house private limited, 2016.
3. S. Arumugam, A.T. Issac, Modern Algebra, Scitech publishers, 2015.
4. David S.Dummit and Richard M. Foote, Abstract Algebra, Third Edition, Wiley India Pvt. Ltd., 2014
5. M.L. Santiago, Modern Algebra, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2001.

LATEX

(Course Code: 21 PME 32)

Semester – III	ECC (Self Study)	Credits - 3

Course Outcomes: By the end of the course the student will be able to:

CO 1. quote different commands for typing math equations (K1)
CO 2. illustrate Multiline, Footnotes and combine different LaTeX files (K3)
CO 3. analyse the error in Latex files (K4)
CO 4. build BibTex file (K6)
CO 5. design LaTeX documents (K6)
CO 6. create new articles, book, thesis (K6)

Unit-I:

Typing Short Article-Typing Math - Typing equations and aligned formula – article templates.

(Chapter I)

Unit-II:

Instructing LaTeX – Commands- Special Characters - Lines Paragraph and pages – Text Spaces – Boxes – Footnotes-combining files-Multiline math displays.

(Chapter II)

Unit III:

LaTeX documents-preamble- document classes - AMS-LaTeX documentssequences.

(Chapter III)

Unit-IV:

Customizing LaTeX- user defined commands- user defined environments- Numbering.

(Chapter IV)

Unit-V:

BibTex- The database – Articles- Books – Theses- Sample files – The four steps of Bibtexing -BibTex rules and messages.

(Chapter V)

Text Book:

George Gratzer, Math into LATEX: an introduction to LaTeX and AMS-LaTeX, Birkhauser, Berlin.

DIFFERENTIAL EQUATIONS FOR COMPETITIVE EXAMINATIONS

(Course Code: 21 PME 41)

Semester - IV	ECC (Self Study)	Credits - 3

Course Code: By the end of the course, the student will be able to

CO 1. describe the basic concepts in solutions for differential equations (K2)
CO 2. describe various properties of homogenous and non-homogeneous linear ODEs(K2)
CO 3. describe Strum-Louville boundary value problem (K2)
CO 4. determine solution for PDEs by various methods (K3)
CO 5. analyze the properties of PDEs (K4)
CO 6. evaluate the solution for Laplace, Heat and Wave equations (K5)

Unit - I:

Existence and Uniqueness of solutions of initial value problems for first order ordinary differential equations – singular solutions of first order ODEs – system of first order ODEs.

Unit - II:

General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

Unit - III:

Lagrange and Charpit's methods for solving first order PDEs – Cauchy problem for first order PDEs.

Unit - IV:

Classification of second order PDEs – General solution of higher order PDEs with constant coefficients.

Unit - V:

Method of separation of variables for Laplace – Heat and Wave equations.

Text Books:

1. E. A.Coddington, An Introduction to Ordinary Differential Equations, First edition, Prentice Hall of India Pvt Ltd, New Delhi, 1989.
2. George F. Simmons, Differential Equations, Second edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1991.
3 S.G. Deo, V. Lakshmikantham, V. Raghavendera, Text book of Ordinary Differential equations, second edition, Tata McGraw - Hill Educational Private Limited, New Delhi, 1997.

QUEUEING AND INVENTORY MODELS

(Course Code: 21 PME 42)

Semester - IV	ECC (Self Study)	Credits - 3

Course Outcomes: By the end of the course, the student will be able to

CO 1. describe the concepts of Probabilistic Queueing Processes (K1)
CO 2. explain the behaviour of Inventory Models (K2)
CO 3. examine the various Exponential Models (K3)
CO 4. outline the components of Inventory Models (K4)
CO 5. compare a Stochastic Continuous Review Model and Stochastic Periodic Review Model(K5)
CO 6. design Stochastic Single Period Model for Perishable Products (K6)

Unit I

Queueing Systems: General Concepts: Introduction - Queueing Processes – Notation – Transient and Steady State Behaviour – Limitations of the Steady State Distribution - Some General Relationships in Queueing Theory – Poisson Arrival Process and Its Characteristics.

(Textbook 1-Chapter: 2)

Unit II

Birth and Death Queueing Systems: Exponential Models: Introduction – The Simple M/M/1 Queue – System with Limited Waiting Space: The M/M/1/K Model – Birth and Death Processes: Exponential Models – The M/M/∞ Model: Exponential Model with an Infinite Number of Servers – The Model M/M/c – The M/M/c System: Erlang Loss Model.

(Textbook 1 - Chapter: 3 (3.1-3.7))

Unit III

Non-Birth and Death Queueing Systems: Markovian Models: Introduction – Bulk Queues – Queueing Models with Bulk (Batch) Service – M/M(a,b)/1: Transient State Distribution – Two Server Model: M/M(a,b)/2 – The M/M(1,b)/c Model. **Network of Queues:** Network of Markovian Queues – Channels in Series or Tandem Queues – Jackson Network – Closed Markovian Network – Cyclic Queue – BCMP Networks.

(Textbook 1- Chapter: 4 and 5)

Unit IV

Inventory Theory: Components of Inventory Models – Deterministic Continuous Review Models – A Deterministic Periodic Review Model.

(Textbook 2 - Chapter: 19 (19.2-19.4))

Unit V

A Stochastic Continuous Review Model – A Stochastic Single Period Model for Perishable Products – Stochastic Periodic Review Models.

(Textbook 2 - Chapter: 19 (19.5-19.7))

Text Book:

1) Medhi J, *Stochastic Models in Queueing Theory*, Academic Press, Second Edition, 2003.
2) Frederick S. Hillier, Gerald J. Lieberman., *Introduction to Operations Research*, McGraw-Hill Higher Education, Seventh Edition, 2001