St. Xavier's College (Autonomous), Palayamkottai
Department of Mathematics
Syllabus 2023

Programme : M.Sc. Mathematics

Programme Code : PMT

Programme Outcomes (POs) for PG Programmes

Students of all Postgraduate Degree Programmes at the time of graduation will be able to attain the following at the institution level:

PO 1. Critical Thinking: Acquire the knowledge in the respective field and take informed actions.

PO 2. Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO 3. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 4. Problem analysis: Identify, formulate, review research literature, and analyze complex problems reaching substantiated conclusions using the principles of all branches of sciences, commerce, economics, management studies, language and literature.

PO 5. Design/development of solutions: Design solutions for problems and design system components or processes that meet the specified needs with appropriate consideration for the public, health and safety, and the cultural, societal, and environmental considerations.

PO 6. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 7. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modeling to complex activities with an understanding of the limitations.

PO 8. Self-directed and Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes (PSOs):

Students of all Postgraduate Degree Programmes at the time of graduation will be able to attain the following at the department level:

PSO 1. Domain Knowledge: Apply the knowledge of all courses for the solution of problems.

PSO 2. Grasp the theories: Ability to grasp the meaning of all definitions, theories and processes learned in all courses.

PSO 3. Create Methods and Algorithms: Formulate solution for complex problems and design system components or procedures that can build the theories of different courses that may pave the way for the evaluation of the theories learned in different courses.

PSO 4. Analysis and Evaluation of Procedures: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO 5. Concept Development: Evaluate and create procedures that may pave the way for the development of analytical thinking so that new theories can be invented.

M.Sc. Mathematics Programme Outline

Sem	Part	Status	Sub. Code	Title of the Paper	Hours	Credit
I	A	Core -1	23PMTC11	Algebraic Structures	6	5
		Core -2	23PMTC12	Real Analysis - I	6	5
		Core -3	23PMTC13	Ordinary Differential Equations	6	4
	B	EC -1	23PMTE11	Number Theory and Cryptography / Formal Languages and Automata Theory	6	3
		EC -2	23PMTE12	Theory of Vector spaces and Linear Transformations / Mathematical Programming / Introduction of Fuzzy Sets and Their Applications	6	3
Sub Total					**30**	**20**

Sem	Part	Status	Sub. Code	Title of the Paper	Hours	Credit
II	A	Core -4	23PMTC21	Advanced Algebra	6	5
		Core -5	23PMTC22	Real Analysis - II	6	5
		Core -6	23PMTC23	Partial Differential Equations	6	4
	B	EC -3	23PMTE21	Calculus of Variations and Integral Equations / Tensor Analysis and Relativity	5	3
		EC -4	23PMTE22	Neural Networks / Modelling and Simulation with Excel	5	3
		SEC1	23PMTS21	Computational Mathematics using Sage Math (Practical)	2	2
Sub Total					**30**	**22**

Sem	Part	Status	Sub. Code	Title of the Paper	Hours	Credit
III	A	Core - 7	23PMTC31	Topology	6	5
		Core - 8	23PMTC32	Complex Analysis	6	5
		Core - 9	23PMTC33	Graph Theory and Applications	5	4
		Core -10	23PMTC34	Object Oriented Programming with Java	4	2
	B	Core -11	23PMTC35	Object Oriented Programming with Java Practical	2	2
		EC - 5	23PMTE31	Mechanics / Combinatorics	5	4
		SEC2	23PMTS31	Training for CSIR/NET/GATE Examinations - I	2	2
		Internship	23PMTI35	Carried out in Summer Vacation at the end of Semester II		2
Sub Total					**30**	**26**

Sem	Part	Status	Sub. Code	Title of the Paper	Hours	Credit
IV	A	Core - 12	23PMTC41	Functional Analysis	5	5
		Core - 13	23PMTC42	Differential Geometry	5	5
		Project	23PMTE43	Project with viva voce	8	6
	B	EC - 6	23PMTE41	Operations Research/ Stochastic Processes	5	4
		EC - 7	23PMTE42	Statistics/Algorithms and Complexity	5	4
		SEC 3	23PMTS41	Training for CSIR/NET/GATE Examinations - II	2	2
Extension Activities				**STAND**		**1**
Sub Total					**30**	**27**
				Grand Total	**120**	**91**
			Additional Compulsory Courses			
I PG		**Value Added (Any one)**	23PMTCC1	Problem Solving in Algebra and Linear Algebra		**3**
			23PMTCC2	Integral Transforms		
			23PMTCC3	Problem solving in advanced algebra and analysis		
II PG		**Extra Credit Courses (Any one)**	23PMTEC1	Analysis I for Competitive Examinations		**3**
			23PMTEC2	Pebbling in Graphs		
			23PMTEC3	Analysis II for Competitive Examinations		
			23PMTEC4	Algebraic Graph Theory		
			23PMTEC5	History of Mathematics		
			23PMTEC6	Algebra for Competitive Examinations		
			23PMTEC7	Mathematical Documentation Using LaTeX		
			23PMTEC8	Differential Equations for Competitive Examinations		
			23PMTEC9	Queuing and Inventory Models		
				Grand Total	**120**	**97**

ALGEBRAIC STRUCTURES
Course Code: 23PMTC11

Semester - I	Core -T1	Hours - 6	Credits - 5

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

CO 1. Recall basic counting principle, class equations and the concepts of Linear Algebra (K1)
CO 2. Apply Sylow's theorem to find number of Sylow subgroups (K3)
CO 3. Discuss Solvable groups, direct products and the properties of finite abelian groups and modules (K2)
CO 4. Apply characteristic polynomial of linear transformation to find canonical forms (K3)
CO 5. Compare Jordan and rational canonical forms (K5)
CO 6. Conclude Jordan canonical form as a generalization of diagonalizability (K5)

UNIT - I: **(18 hours)**

Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, any one of the Proof).

(Chapter 2: 2.11 - 2.12 (Omit Lemma 2.12.5))

UNIT - II: **(18 hours)**

Direct products – Finite abelian groups - Modules - Solvable groups

(Chapter 2: 2.13 - 2.14 (Theorem 2.14.1 only) Chapter 4: 4.5) (Chapter 5: 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1 only)

UNIT - III: **(18 hours)**

Linear Transformations: Canonical forms – Triangular form – Nilpotent transformations.

(Chapter 6: 6.4 - 6.5)

UNIT - IV: **(18 hours)**

Jordan form (Definition and Statements only) - Rational Canonical form - Trace and Transpose

(Chapter 6: 6.6 - 6.8)

UNIT - V: **(18 hours)**

Inner Product Space – Hermitian - Unitary - Normal Transformations - Real Quadratic Form.

(Chapter 4: 4.4, Chapter 6: 6.10 and 6.11)

Text book:

I. N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Reference books:

1. M.Artin, Algebra, Prentice Hall of India, 1991.
2. P.B. Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition).
3. I.S.Luther and I.B.S.Passi, Algebra, Vol. I – Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999.
4. D.S.Malik, J.N. Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill (International Edition), New York. 1997.

REAL ANALYSIS - I

Course Code: 23PMTC12

Semester – I	Core – T2	Hours – 6	Credits – 5

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

CO 1. Recall the concepts of limits, sequence and series (K1)

CO 2. Analyze functions of bounded variation and Rectifiable Curves (K4)

CO 3. Determine the limits of sequence and series of functions (K3)

CO 4. Analyze the concepts of Riemann -Stieltjes integrals and its properties (K4)

CO 5. Evaluate the sequence of continuous, differentiable, integrable functions and their limits (K5)

CO 6. Develop the various properties of double sequence and series (K6)

UNIT - I: **(18 hours)**

Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation - Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.

(Chapter – 6 : 6.1 to 6.8 and Chapter 8 : 8.8, 8.15, 8.17, 8.18)

UNIT - II: **(18 hours)**

Introduction - Notation - The definition of the Riemann-Stieltjes integral - Linear Properties - Integration by parts - Change of variable in a Riemann-Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.

(Chapter - 7 : 7.1 to 7.14)

UNIT - III: **(18 hours)**

The Riemann-Stieltjes Integral - Integrators of bounded variation - Sufficient conditions for the existence of Riemann–Stieltjes integrals - Necessary conditions for the existence of Riemann-Stieltjes integrals - Mean value theorems - integrals as a function of the interval – Second fundamental theorem of integral calculus - Change of variable - Second Mean Value Theorem for Riemann integral - Riemann-Stieltjes integrals depending on a parameter- Differentiation under integral sign – Lebesgue criterion for existence of Riemann integrals.

(Chapter - 7 : 7.15 - 7.26)

UNIT - IV: **(18 hours)**

Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products - Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem.

(Chapter – 8: 8.20, 8.21 to 8.26 and Chapter 9 : 9.14 9.15, 9.19, 9.20, 9.22, 9.23)

UNIT - V: **(18 hours)**

Point wise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann-Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. **(Chapter - 9:9.1 to 9.6,9.8,9.9,9.10,9.11, 9.13)**

Text Book:

Tom M. Apostol, Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.

Reference Books:

1. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, Fourth edition, John Wiley and Sons, 2011.

2. S. K. Mappa, Introduction to Real Analysis, 7 thedtion, Sarat Book House, 2013.

3. Kenneth A. Ross, Elementary Analysis: The theory of Calculus, Springer, New York, 2004.

4. Richard R. Goldberg, Methods of Real Analysis, Oxford & IBH Publishing co. Pvt. Ltd., New Delhi 1970.

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

6. S. Kumaresan, Topology of Metric Spaces, 2 nd Edition, Narosa Publishing House, 2011.

7. S. Ponnusamy, Foundations of Mathematical Analysis, Springer Birkhauser, 2012.

8. S. C. Malik and Savita Arora, Mathematical Analysis, Wiley Eastern Ltd., New Delhi, 1991.

ORDINARY DIFFERENTIAL EQUATIONS

Course Code: 23PMTC13

Semester – I	Core - T3	Hours - 6	Credits - 4

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

CO 1. Construct successive approximations to an ordinary differential equations (K2)

CO 2. Evaluate linear differential equations (K3)

CO 3. Recognize the Legendre, Euler and Bessel equations and evaluate their solutions (K3)

CO 4. Evaluate the Ordinary differential equations with regular singular points (K3)

CO 5. Apply the Wronskian for verifying linear independence of functions (K5)

CO 6. Recall the fundamental properties of homogeneous and Non-homogeneous equations (K1)

UNIT - I: Linear Equations With Constant Coefficients (18 hours)

Introduction – The Second order homogeneous equations - Initial value problems for second order equations - Linear dependence and independence - A formula for the Wronskian.

(Chapter 2: Sections 1 to 5)

UNIT - II: Linear Equations With Constant Coefficients (Cont'd.) (18 hours)

The Non- homogenous equations of order two - The Homogeneous equations of order n – Initial value problems for n-th order equations - Equations with real constants – The non-homogeneous equations of order n – A special method for solving the non-homogeneous equation.

(Chapter 2 : Sections 6 to 11)

UNIT - III: Linear Equations With Variable Coefficients (18 hours)

Introduction – Initial value problem for the homogenous equation - solutions of the homogeneous equation - The Wronskian and linear independence - Reduction of the order of a homogenous equation - The non-homogenous equation - Homogenous equations with analytic coefficients - The Legendre equation.

(Chapter 3: Sections 1 - 8)

UNIT – IV: Linear Equations With Regular Singular Points (18 hours)

Introduction - The Euler equation - Second order equations with regular singular points – an example - Second order equations with regular singular points – the general case- The Bessel equation – The Bessel equation (continued).

(Chapter 4: Sections 1 – 4,7 and 8)

UNIT – V: Existence And Uniqueness Of Solutions To First Order Equations

(18 hours)

Introduction - The method of successive approximations - The Lipschitz Condition - Convergence of the successive approximations - Approximations to, and uniqueness of, solutions.

(Chapter 5: Sections 1, 4 to 6 and 8)

Text book:

A introduction to ordinary differential equations E.A. Coddington, (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.

Reference Books:

1. Williams E. Boyce and Richard C. Diprima Elementary Differential Equations and Boundary Value Problems, 10th edition John Wiley and Sons, New York 2012.

2. M.D. Raisinghania, Advanced Differential Equations, S. Chand & Company Ltd., New Delhi 2012.

3. George F. Simmons, Differential Equations with Application And Historical Notes, Tata McGraw Hill, New Delhi 1974.

4. B. Rai, D.P. Choudhury and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House Pvt. Ltd, New Delhi 2012.

5. Ravi P. Agarwal and Ramesh C. Gupta, Essentials of Ordinary Differential Equations, McGraw Hill, New York, 1991.

NUMBER THEORY AND CRYPTOGRAPHY

Course Code: 23PMTE11

Semester - I	EC-1	Hours - 6	Credits – 3

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

CO 5. Evaluate the sum of the fourth powers and the sum of two squares (K5)

CO 6. Apply number theory in Cryptography (K5)

UNIT - I: **(18 hours)**

Divisibility and Euclidean algorithm - Congruence's - Euler's theorem - Wilson's Theorem.

(Text Book 1-Sections: 1.2, 2.1)

UNIT - II: **(18 hours)**

Chinese Remainder Theorem- Quadratic residues - Quadratic reciprocity – The Jacobi symbol.

(Text Book 1-Sections: 2.3, 3.1-3.3)

UNIT - III: **(18 hours)**

Arithmetic functions – The Mobius Inversion formula - Multiplication of arithmetic functions.

(Text Book 1-Sections: 4.2-4.3)

UNIT - IV: **(18 hours)**

Linear Diophantine equations – Sum of Four and Five Squares – Sum of Fourth Powers - Sum of Two Squares.

(Text Book 2- Sections: 2.4. 12.2-12.3-5.4)

UNIT - V: **(18 hours)**

Public key Cryptography – Concepts of public key Cryptography – RSA – Discrete logarithm – Elliptic curve Cryptography.

(Text Book 2- Sections: 7.5)

Text Books:

1. An Introduction to Theory of Numbers by Ivan Nivan and Herberts Zucherman, Third Edition, 1972, Wiley Eastern Limited, New Delhi.

2. David M. Burton, Elementary Number Theory, Wm. C. Brown Publishers, Dubuque, Iowa,1989.

Reference Books:

1. Tom Apostol, Introduction to Analytic Number theory, Narosa Publications, New Delhi.

2. Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, NewYork,1987.

3. Cryptograpy and Network Security Principles and Practice by William Stallings, Prentice Hall, Fifth Edition, New Delhi, 2011.

FORMAL LANGUAGES AND AUTOMATA THEORY

Course Code: 23PMTE11

Semester - I	EC - 1	Hours - 6	Credit - 3

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

CO 1. Enhance their knowledge in mathematical notions of computation, such as computability, decidability and reducibility of the theory of formal languages and automata (K1)

CO 2. Perceive the techniques of computations including finite state automata, grammars and regular expressions and their relations (K2)

CO 3. Design and explain finite automata without ε-moves, derivation trees and pushdown automata (K3)

CO 4. Analyze and recognize the patterns of automata and grammars using regular expressions (K4)

CO 5. State and explain Chomsky Normal Form, Greibach Normal form and Properties of Context-Free Languages (K5)

CO 6. Analyze the properties of regular sets (K4)

UNIT - I: **(18 hours)**

Finite Automata and Regular Expressions: Finite state systems - Deterministic Finite state Automata - Non deterministic Finite Automata - Finite Automata with Epsilon - Transitions – Regular Expressions - Finite Automata and Regular Expressions.

(Chapter 2: Sec 2.1- 2.5)

UNIT - II: **(18 hours)**

Properties of Regular Sets: The Pumping Lemma for Regular Sets – Application of the Pumping Lemma – Converting NFA's to DFA'S – Minimization of DFA's.

(Chapter 3: Sec 3.1,3.4.)

UNIT - III: **(18 hours)**

Context Free Grammars and Languages: Context Free Grammars – Derivation Trees – Normal forms for Context Free Grammars – Chomsky Normal Form – Greibach Normal Form.

(Chapter 4: Sec 4.2- 4.6.)

UNIT - IV: **(18 hours)**

Pushdown Automata: Definition – The languages of a PDA – Equivalence of PDA's and CFG's – Deterministic Pushdown Automata.

(Chapter 5: Sec 5.2- 5.3.)

UNIT - V: **(18 hours)**

Properties of Context - Free Languages: The Pumping Lemma for Context - free Languages – Closure Properties of Context - Free Languages – Decision properties of CFL's.

(Chapter 6: Sec 6.1- 6.3.)

Text Book:

John E. Hopcroft and Jeffery D. Ullman, Introduction to Automata theory, Languages and Computations, Narosa Publishing House, Chennai, 2002.

Reference Books:

1. Harry R. Lewis and Christos H.Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall, 1997.
2. A.V. Aho, Monica S. Lam, R. Sethi, J.D. Ullman, Compilers: Principles, Techniques, and Tools, Second Edition, Addison-Wesley,2007.
3. John C. Martin, Introduction to Languages and theory of Computations (2ndEdn), Tata – McGraw Hill company Ltd., New Delhi, 1997.
4. Dr. Rani Siromoney, Formal Languages and Automata, The Christian Literature Society, 1979.

THEORY OF VECTOR SPACES AND LINEAR TRANSFORMATIONS

Course Code : 23PMTE12

Semester - I	EC – 2	Hours - 6	Credits – 3

Course Outcomes: By the end of the course the students 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: **(18 hours)**

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: **(18 hours)**

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: **(18 hours)**

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: **(18 hours)**

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

(Chapter 5: Sections 5.1-5.2 and 5.4)

Unit - V: **(18 hours)**

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.

MATHEMATICAL PROGRAMMING
Course Code: 23PMTE12

Semester - I	EC - 2	Hours - 6	Credit - 3

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

CO 1. Understand a basic thoughtfulness for linear programming problem (K2)

CO 2. Apply the techniques of LPP to solve real world problems (K3)

CO 3. Determine the decision maker's goals and constraints (K3)

CO 4. Analyze restricted non-linear programming problems (K4)

CO 5. Compare non-linear programming and linear programming problems (K5)

CO 6. Evaluate optimal solution of an optimization problem using simplex method (K5)

UNIT - I: **(18 hours)**

Integer Linear Programming: Introduction - Types of Integer Linear Programming Problems – Enumeration and Cutting Plane concept - Gomory's All Integer Cutting Plane Method - Gomory's mixed Integer Cutting Plane method - Branch and Bound Method. – Application of Zero-One Integer Programming.

(Chapter 7: 7.1 - 7.7)

UNIT - II: Goal Programming **(18 hours)**

Introduction - Difference between LP and GP approach - Concept of Goal Programming - Goal Programming Model formulation - Graphical Solution Method for Goal Programming - Modified Simplex method of Goal Programming.

(Chapter 8: 8.1 - 8.4, 8.6 and 8.7)

UNIT - III: Classical Optimization Methods **(18 hours)**

Introduction - Unconstrained Optimization - Constrained Multi-variable Optimization with Equality Constraints - Constrained Multi-variable Optimization with inequality Constraints.

(Chapter 23: 23.1 – 23.4)

UNIT - IV: Non-linear Programming Methods **(18 hours)**

Introduction – General NLPP – Graphical solution method – Quadratic Programming – application of Quadratic Programming.

(Chapter 24: 24.1 – 24.5)

UNIT - V: Theory of Simplex Method (18 hours)

Introduction - Canonical and Standard form of LPP - Slack and Surplus Variables - Reduction of Feasible solution to a Basic Feasible solution - Alternative Optimal solution - Unbounded solution - Optimality conditions - Some complications and their resolutions.

(Chapter 25: 25.1 - 25.4, 25.6-25.9)

Text Book:

J.K. Sharma, Operations Research, Theory and Applications, Third Edition (2007) Macmillan India Ltd.

Reference Books:

1. Hamdy A. Taha, Operations Research, (seventh edition) Prentice - Hall of India Private Limited, New Delhi, 1997.
2. F.S. Hillier &J.Lieberman Introduction to Operation Research (7th Edition) Tata- McGraw Hill ompany, New Delhi, 2001.
3. Beightler. C, D.Phillips, B. Wilde, Foundations of Optimization (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979.
4. S.S. Rao - Optimization Theory and Applications, Wiley Eastern Ltd. New Delhi. 1990.

INTRODUCTION OF FUZZY SETS AND THEIR APPLICATIONS
Course Code: 23PMTE12

Semester - I	EC - 2	Hours - 6	Credit - 3

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

CO 1. Recall in basic concepts of fuzzy theory and to develop their intuitive mind further (K1)

CO 2. Understand the concept of uncertainty and fuzziness in logic (K2)

CO 3. Evaluate fuzzy operations, fuzzy relations like projections, composition, etc (K3)

CO 4. Analyze about Fuzzy Arithmetic (K4)

CO 5. Make decisions on real life problems through Individual, Multi Person Decision Making (K5)

CO 6. Develop fuzzy relations (K6)

UNIT - I: **(18 hours)**

Crisp sets and Fuzzy sets: Overview of Classical Sets, Membership Function, Height of a fuzzy set – Normal and sub normal a fuzzy set – Support – Level sets - fuzzy points - α–cuts – Decomposition Theorems - Extension Principle.

(Chapter1: 1.2 -1.4 &Chapter2: 2.1-2.3.)

UNIT - II: **(18 hours)**

Operation on fuzzy sets: Standard fuzzy operations – Union, intersection and complement – properties .

(Chapter 3: 3.1& 3.2.)

UNIT - III: **(18 hours)**

Fuzzy Arithmetic: Fuzzy numbers - Linguistic variables - Arithmetic operations on intervals - Arithmetic operations on fuzzy numbers - Fuzzy equations.

(Chapter 4: Sec 4.1 - 4.4, 4.6.)

UNIT - IV: **(18 hours)**

Fuzzy relations: Crisp and fuzzy relations – Projections and Cylindrical Extensions – Binary Fuzzy relations – Binary Relations on a Single Sets– Fuzzy Equivalence Relations .

(Chapter 5: 5.1 - 5.5.)

UNIT - V: **(18 hours)**

Decision Making in Fuzzy environments: General discussion – Individual Decision making – multi person decision making – multi criteria decision making – multi stage decision making.

(Chapter 15: Sec 15.1-15.5.)

Text Book:

George J.Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, Prentice Hall of India Private Limited, New Delhi (2007).

Reference Books:

1. K. Pundir and R.Pundir, Fuzzy sets and their application, Published by A Pragatiedition(2012).
2. H.J.Zimmermann, Fuzzy set theory and its applications, Second Edition, Springer New Delhi, 2012.
3. TimothyJ. Ross, Fuzzy logic with Engineering Applications, McGraw-Hill,Inc.NewDelhi,2000.
4. George J.Klir, Tina. AFolger, Fuzzy sets, uncertainty and information, Prentice Hall of India Pvt Ltd, New Delhi, 2008.

ADVANCED ALGEBRA

Course Code : 23PMTC21

Semester - II	Core - T4	Hours - 6	Credits - 5

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

CO 1. Explain the fundamental concepts in field theory and Galois Theory (K2)
CO 2. Illustrate the properties of normal extension (K3)
CO 3. Demonstrate e is transcendental (K3)
CO 4. Determine the roots of a polynomial by radicals and splitting fields (K3)
CO 5. Summarize the properties of Finite fields (K5)
CO 6. Develop polynomials of certain degree whose Galois group over Q is S_p (K6)

UNIT - I: **(18 hours)**

Extension Fields – The Transcendence of e. **(Chapter 5: 5.1, 5.2)**

UNIT - II: **(18 hours)**

Roots of Polynomials - More about Roots. **(Chapter 5: 5.3, 5.5)**

UNIT - III: **(18 hours)**

The Elements of Galois Theory. **(Chapter 5: 5.6)**

UNIT - IV: **(18 hours)**

Finite Fields – Wedderburn's Theorem on Finite Division Rings(Theorem 7.2.1 only).

(Chapter 7: 7.1, 7.2)

UNIT - V: **(18 hours)**

Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.

(Chapter 5: 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1, Chapter 7 : 7.3, 7.4)

Text book:

I. N. Herstein ,Topics in Algebra, 2nd edition, Wiley India Pvt. Ltd, New Delhi, 2016.

Reference books:

1. David S. Dummit and Richard M. Foote, Abstract Algebra, Third Edition, Wiley India Pvt. Ltd., 2014.
2. Vijay K. Khanna and S. K. Bhambri, A Course in Abstract Algebra, 5th edition, Vikas Publishing House Ltd., 2016.
3. M.Artin, Algebra, Prentice Hall of India, 1991.

4. P. B. Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition).
5. I.S.Luther and I.B.S.Passi, Algebra, Vol. I –Groups(1996); Vol. II Rings,Narosa Publishing House , New Delhi, 1999.
6. D.S.Malik, J.N. Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill (International Edition), New York. 1997.
7. N.Jacobson, Basic Algebra, Vol. I & II Hindustan Publishing Company, New Delhi.

Website and e-Learning Source:

1) http://mathforum.org
2) http://ocw.mit.edu/ocwweb/Mathematics
3) http://www.opensource.org
4) www.algebra.com

REAL ANALYSIS II

Course Code : 23PMTC22

Semester - II	Core - T5	Hours - 6	Credits – 5

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

CO 1. Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system (K2)

CO 2. Analyze the representation and convergence problems of Fourier series (K4)

CO 3. Analyze and evaluate the difference between transforms of various functions (K4)

CO 4. Formulate and evaluate complex contour integrals directly and by the fundamental theorem (K5)

CO 5. Apply the Cauchy integral theorem in its various versions to compute contour integration (K3)

CO 6. Evaluate Implicit Functions and Extremum Problems (K5)

UNIT - I: **(18 hours)**

Measure on the Real line: Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability.

(Text book 1: Chapter – 2: 2.1 to 2.5)

UNIT - II: **(18 hours)**

Integration of Functions of a Real variable: Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals.

(Text book 1: Chapter – 3: 3.1,3.2 and 3.4)

UNIT - III: **(18 hours)**

Fourier Series and Fourier Integrals: Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point – Cesaro summability of Fourier series- Consequences of Fejer's theorem - The Weierstrass approximation theorem.

(Text book 2: Chapter 11 : 11.1 to 11.15)

UNIT - IV: **(18 hours)**

Multivariable Differential Calculus: Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1.

(Text book 2: Chapter 12 : 12.1 to 12.14)

UNIT - V: **(18 hours)**

Implicit Functions and Extremum Problems: Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions.

(Text book 2: Chapter 13 : 13.1 to 13.7)

Text books:

1. G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1981.

2. Tom M.Apostol: Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.

Reference books:

1. Burkill, J.C. The Lebesgue Integral, Cambridge University Press, 1951.
2. Munroe, M.E. Measure and Integration. Addison-Wesley, Mass.1971.
3. Roydon, H.L. Real Analysis, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York,1979.
5. Malik, S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
6. Sanjay Arora and BansiLal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.

Website and e-Learning Source:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics
2. http://www.opensource.org

PARTIAL DIFFERENTIAL EQUATIONS

Course Code: 23 PMTC23

Semester - II	Core - T6	Hours - 6	Credits - 4

Course Outcomes: By the end of the course the students 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: **(18 hours)**

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: **(18 hours)**

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: **(18 hours)**

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: **(18 hours)**

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: **(18 hours)**

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.

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Course Code: 23PMTE21

Semester - II	EC -3	Hours - 5	Credits - 3

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 kernels and symmetric kernels (K4)
CO 6. Summarize the relations between Linear differential equations and Volterra integral equations (K5)

UNIT - I: **(15 hours)**

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

(Chapter 9: Sections 1 – 11)

UNIT - II: **(15 hours)**

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: **(15 hours)**

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: **(15 hours)**

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: **(15 hours)**

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.

TENSOR ANALYSIS AND RELATIVITY

Course Code: 23PMTE21

Semester - II	EC- 3	Hours - 5	Credits – 3

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

CO 1. Explain the concepts of tensors and algebra of tensor (K3)
CO 2. Analyze Quotient Law of Tensors, Reciprocal Tensor and Relative Tensor (K4)
CO 3. Describe about the Riemann Christoffel theorem (K2)
CO 4. Analyze Covariant Differentiation of Tensors (K4)
CO 5. Evaluate the Relativistic Kinematics: Lorentz Transformation equation and its related problems (K5)
CO 6. Compute Lagrangian and Hamiltonian formulations (K5)

UNIT - I: **(15 hours)**

Tensor Algebra: Systems of Different orders – Summation Convention – Kronecker Symbols - Transformation of coordinates in Sn - Invariants – Covariant and Contravariant vectors - Tensors of Second Order – Mixed Tensors – Zero Tensor – Tensor Field – Algebra of Tensors – Equality of Tensors – Symmetric and Skew-symmetric tensors - Outer multiplication, Contraction and Inner Multiplication – Quotient Law of Tensors – Reciprocal Tensor – Relative Tensor – Cross Product of Vectors.

(Text Book: 1, Chapter I : I.1 – I.3, I.7 and I.8 and Chapter II : II.1 – II.19)

UNIT - II: **(15 hours)**

Tensor Calculus: Riemannian Space – Christoffel Symbols and their properties.

(Text Book: 1, Chapter III: III.1 and III.2)

UNIT - III: **(15 hours)**

Tensor Calculus (contd): Covariant Differentiation of Tensors – Riemann–Christoffel Curvature Tensor.

(Text Book: 1, Chapter III: III.3 – III.4)

UNIT - IV: **(15 hours)**

Special Theory of Relativity: Galilean Transformations – Maxwell's equations – The ether Theory – The Principle of Relativity. Relativistic Kinematics: Lorentz Transformation equations – Events and simultaneity – Example – Einstein Train – Time dilation – Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example – twin paradox – addition of velocities – Relativistic Doppler effect.

(Text Book: 2, Chapter 7 : Sections 7.1 and 7.2)

UNIT - V: **(15 hours)**

Relativistic Dynamics: Momentum – Energy – Momentum – energy four vector – Force - Conservation of Energy – Mass and energy – Example – inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations.

(Text Book: 2, Chapter 7 : Section 7.3)

Text books:

1. U.C. De, Absos Ali Shaikh and JoydeepSengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004.
2. D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

Reference books:

1. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949.
2. A.S.Eddington. The Mathematical Theory of Relativitity, Cambridge University Press, 1930.
3. P.G.Bergman, An Introduction to Theory of Relativity, Newyor, 1942.
4. C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge, 1938.

NEURAL NETWORKS

Course Code: 23PMTE22

Semester - II	EC- 4	Hours - 5	Credits – 3

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

CO 1. Discuss the important concepts and theories of artificial neural networks (K2)
CO 2. Apply simpler models as a component to build up feed forward neural network architectures (K3)
CO 3. Analyse how ANNs can be designed and trained (K4)
CO 4. Evaluate simple examples of ANNs (K5)
CO 5. Compare real-valued states and continuous dynamics (K5)
CO 6. Develop Synchronous and asynchronous networks (K6)

UNIT - I: **(15 hours)**

Neural Computation –Artificial Neural Networks - Networks of Functions.

(Chapter 1: 1.1, 1.3, Chapter 2: 2.1)

UNIT - II: **(15 hours)**

Synthesis of Boolean functions – Equivalent Networks - Recurrent Networks – Harmonic Analysis of Logical Functions. **(Chapter 2: 2.2 - 2.5)**

UNIT - III: **(15 hours)**

Perceptron and Parallel Processing – Implementationof Logical Functions - Learning Algorithms for Neural Networks. **(Chapter 3: 3.1- 3.2, Chapter 4: 4.1)**

UNIT - IV: **(15 hours)**

Synchronous and Asynchronous networks - Definition of Hopfield networks - Converge to stable states - Equivalence of Hopfield and Preceptron learning - Parallel Combinatorics. **(Chapter 13: 13.1-13.5)**

UNIT - V: **(15 hours)**

Variations of the Hopfield model - Stochastic systems - Learning algorithms and applications. **(Chapter 14: 14.1-14.3)**

Text Book:

R. Rojas, Neural Networks, A Systematic Introduction, Springer-Verlag Berlin Heidelberg New York, 1996.

MODELLING AND SIMULATION WITH EXCEL
Course Code : 23PMTE22

Semester – II	EC – 4	Hours - 5	Credits – 3

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

CO 1. Recall the basics of Excel functions (K1)
CO 2. Explain the different type of functions in diagrams (K2)
CO 3. Apply functions to solve simple problems (K3)
CO 4. Analyze lists and databases using database functions (K4)
CO 5. Evaluate the data analysis skill in Excel (K5)
CO 6. Create model using excel (K6)

UNIT - I: **(15 hours)**

Mathematical Functions: SUM, SUMIF, COUNT, COUNTIF, ROUND, PRODUCT, LCM, GCD; **Basic Statistical Functions:** MAX, MIN, AVERAGE, COUNT, MEDIAN, QUARTILE, STDEV, CORREL; **Logical Functions:** AND, OR, XOR, IF.

(**Text Book 1)**

UNIT - II: **(15 hours)**

Presentation of Quantitative Data: Data Visualization: Introduction - Data Classification -Data Context and Data Orientation - Types of Charts and Graphs - An Example of Graphical Data Analysis and Presentation.

Analysis of Quantitative Data: Introduction - What Is Data Analysis? - Data Analysis Tools - Data Analysis for Two Data Sets - Analysis of Time Series Data: Forecasting/Data Relationship Tools. **(Text Book 2: Ch: 2.1 to 2.5, Ch: 3.1 to 3.5)**

UNIT - III: **(15 hours)**

Presentation of Qualitative Data - Data Visualization: Introduction–What Is Qualitative Data? - Essentials of Effective Qualitative Data Presentation - Data Entry and Manipulation - Data Queries with Sort, Filter, and Advanced Filter.

Analysis of Qualitative Data: Introduction - Essentials of Qualitative Data Analysis - Dealing with Data Errors - PivotChart or PivotTable Reports.

(Text Book 2: Ch 4.1 to 4.4 Ch 5.1 to 5.3)

UNIT - IV: **(15 hours)**

Modeling and Simulation- Part 1: Introduction - What Is a Model? - How Do We Classify Models? - An Example of Deterministic Modeling - Understanding the Important Elements of a Model - Model Building with Excel.

(Text Book 2: Ch 7.1 to 7.5)

UNIT - V: **(15 hours)**

Modeling and Simulation- Part 2: Introduction - Types of Simulation and Uncertainty - The Monte Carlo Sampling Methodology - A Financial Example–Income Statement.

(Text Book 2: Ch 8.1 to 8.4)

Text books:

1. B. Held, B. Moriarty and T. Richardson, Microsoft Excel Functions and Formulas, Fifth Edition, Mercury Learning and Information, 2019.
2. Hector Guerrero, Excel Data Analysis Modeling and Simulation, Second Edition, Springer, 2019.

Reference book:

1. Wayne Winston, MS Excel 2013: Data Analysis & Business Modelling, PHI, 2014.

COMPUTATIONAL MATHEMATICS USING SAGEMATH

(PRACTICAL)

Course Code: 23PMTS21

Semester - II	SEC-1	Hours - 2	Credits – 2

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

CO 1. Compute the properties of equations without solving them explicitly (K1)

CO 2. Describe the elementary computational domains (K2)

CO 3. Perform computations on series, derivatives and partial derivatives (K3)

CO 4. Deal with basic useful functions in linear algebra (K4)

CO 5. Evaluate matrices and their vector spaces together with basic operations (K5)

CO 6. Describe the use of Sage for working with objects related to finite fields and integer factorization (K6)

1. Programs using loops.
2. Programs using conditionals.
3. Programs using Lists and Other Data Structures.
4. Programs using computational domains.
5. Programs to solve equations.
6. Programs to compute limits.
7. Programs to compute power series expansion.
8. Programs to compute Partial Derivatives.
9. Programs to compute indefinite or definite integral.
10. Programs for matrix computation.
11. Programs for vectors computation.

TOPOLOGY

Course Code : 23PMTC31

Semester - III	Core - T7	Hours - 6	Credits - 5

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

CO 1. Define and illustrate the concept of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space. (K1)

CO 2. Understand continuity, compactness, connectedness, homeomorphism and topological Properties (K2)

CO 3. Analyze and apply the topological concepts in Functional Analysis. (K4)

CO 4. Ability to determine that a given point in a topological space is either a limit point or not for a given subset of a topological space (K3)

CO 5. Develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff (K6)

CO 6. Develop tools to identify when two are equivalent (homeomorphic) (K6)

UNIT - I: **(18 hours)**

Topological spaces : Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology – Closed sets and limit points.

(Chapter 2 : Sections 12 to 17)

UNIT - II: **(18 hours)**

Continuous functions: Continuous functions – the product topology – The metric topology.

(Chapter 2 : Sections 18 to 21 (Omit Section 22))

UNIT - III: **(18 hours)**

Connectedness: Connected spaces- connected subspaces of the Real line – Components and local connectedness.

(Chapter 3 : Sections 23 to 25)

UNIT - IV: **(18 hours)**

Compactness : Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness.

(Chapter 3 : Sections 26 to 29)

UNIT - V: **(18 hours)**

Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn metrization Theorem – The Tietz extension theorem.

(Chapter 4 : Sections 30 to 35)

Text book:

James R. Munkres, *Topology* (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)

Reference books:

1. J. Dugundji ,*Topology* , Prentice Hall of India, New Delhi, 1975.
2. George F.Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963 .
3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York .
4. L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
5. S.Willard, *General Topology*, Addison - Wesley, Mass., 1970.

Website and e-Learning Source:

1.http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,

2. http://www.opensource.org , http://en.wikipedia.org.

COMPLEX ANALYSIS

Course Code : 23PMTC32

Semester - III	Core - T8	Hours - 6	Credits - 5

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

CO 1. Understand the concepts of Complex integration-Series and Product Developments-Conformal Mappings- Elliptic Functions-Global Analytic Functions (K2)
CO 2. Define line integral for complex valued functions of real variable (K1)
CO 3. Associate complex integral from real integral perspective (K3)
CO 4. Compute complex integrals using Cauchy's integral formula and apply Laurent series to find the residue of a complex function (K5)
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: **(18 hours)**

Line integrals - 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 : Section 1.1-1.4, 1.5, 2.1-2.3)

UNIT - II: **(18 hours)**

Removable singularities - Taylor's theorem - Zeroes and poles - The local mapping theorem – The maximum principle - Definition of 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: **(18 hours)**

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: **(18 hours)**

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: **(18 hours)**

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, (3 rd Edition) McGraw Hill Book Company, New York, 1979.

Reference books:

1. H.A. Presfly, Introduction to complex Analysis, Clarendon Press, oxford, 1990.
2. J.B. Corway, Functions of one complex variables, Springer - Verlag, International students Edition, Narosa Publishing Co.
3. E. Hille, Analytic function Thorey (2 vols.), Gonm& Co, 1959.
4. M.Heins, Complex function Theory, Academic Press, New York,1968.

GRAPH THEORY AND APPLICATIONS

Course Code: 23PMTC33

Semester - III	Core -T 9	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the students 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: **(12 hours)**

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: **(12 hours)**

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: **(12 hours)**

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: **(12 hours)**

Matchings – factorization - planar graphs

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

UNIT - V: **(12 hours)**

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.

OBJECT ORIENTED PROGRAMMING WITH JAVA

Course Code: 23PMTC34

Semester - III	Core – T10	Hours - 4	Credits - 2

Course outcomes: By the end of the course the students 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: **(12 hours)**

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

(Chapters 2 and 3)

UNIT - II: **(12 hours)**

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

(Chapters 4 and 5)

UNIT - III: **(12 hours)** Classes - objects and methods.

(Chapters 6 and 7)

UNIT - IV: **(12 hours)**

Inheritance - packages and interfaces.

(Chapters 8 and 9)

UNIT - V: **(12 hours)**

Exception handling - multi threaded 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, Fourth edition, Tata McGraw Hill, 2001.

OBJECT ORIENTED PROGRAMMING WITH JAVA PRACTICAL

Course Code: 23PMTC35

Semester - III	Core – 11	Hours - 2	Credit – 2

Course outcomes: By the end of the course the students 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)

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.

MECHANICS

Course Code: 23PMTE31

Semester - III	EC - 5	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: **(15 hours)**

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: **(15 hours)**

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: **(15 hours)**

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: **(15 hours)**

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: **(15 hours)**

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, Narosa Publishing House,2018.

Reference books:

1. Donald T. Greenwood, Principles of Dynamics, Second edition, Pearson College Division, 1988.

2. N. C. Rana P. S. Joag, Classical Mechanics, Tata McGraw-Hill Education Pvt. Ltd., 2015.

COMBINATORICS

Course Code: 23PMTE31

Semester - III	EC - 5	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the students 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 permutation and combination (K5)
CO 6. Assess the Polya's counting formula (K5)

Unit - I: **(15 Hours)**

The pigeon hole principle: Simple form, Strong form - Theorem of Ramsey - Four basic counting principles- Permutations of sets -Combinations of sets.

(Chapter 2: Sections 2.1- 2.3 and Chapter 3 : Sections 3.1-3.3)

Unit - II: **(15 Hours)**

Permutations of multisets- Combinations of multisets-Generarting permutations- Inversion in permutations- Generating combinations -Generating r-combinations

(Chapter 3: Sections 3.4- 3.5 and Chapter 4 : Sections 4.1-4.4)

Unit - III: **(15 Hours)**

Pascal's formula- The binomial theorem- Identities - Unimodality of binomial coefficients-The multinomial theorem- Newton's binomial theorem - The inclusion exclusion principle - Combinations with repetition- Derangements.

(Chapter 5: Sections 5.1-5.6 and Chapter 6 : Sections 6.1-6.3)

Unit - IV: **(15 Hours)**

Some number sequences - Linear homogeneous recurrence relations - Non-homogeneous recurrence relations -Generating functions - Recurrences and generating functions - Exponential generating function.

(Chapter 7: Sections 7.1-7.7)

Unit - V: **(15 Hours)**

Permutation and symmetry groups - Burnside theorem - Polya's counting formula.

(Chapter 14: Sections 14.1- 14.3)

Text Book:

Richard A. Brualdi, Introductory Combinatorics, Fifth edition, Pearson Education, Inc., 2010.

Reference books:

1. C.L. Liu, Introduction to Combinatorial Mathematics, McGraw Hill, 1968.
2. V. K. Balakrishnan, Combinatorics, schaum's outlines, First edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1994.
3. Martin Aigner, A Course in Enumeration (Graduate text in Mathematics), Springer, 2007.

Training for CSIR/ NET/ GATE Examinations – I

Course Code: 23PMTS31

Semester - III	SEC- 2	Hours - 2	Credits - 2

Course Outcomes: By the end of the course the students 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: **(6 Hours)**

Problems in elementary set theory, finite -countable and uncountable sets - Real number system as a complete ordered field - Archimedean property – Supremum and Infimum.

Unit - II: **(6 Hours)**

Problems in real sequences and Series – Convergence – limsup and liminf - Bolzano Weierstrass theorem.

Unit - III: **(6 Hours)**

Problems in continuity - Uniform Continuity – Differentiability - Mean Value Theorem in Real Number System.

Unit - IV: **(6 Hours)**

Problems in sequence and Series of Real Functions - Uniform Convergence.

Unit - V: **(6 Hours)**

Problems in Riemann sums and Riemann Integral - Improper Integrals - Monotonic Functions - Types of Discontinuity.

Reference:

1. Previous year CSIR – NET Mathematical Sciences Question papers.
   Ref: https://csirhrdg.res.in/Home/Index/1/Default/2769/81

FUNCTIONAL ANALYSIS

Course Code: 23 PMTC 41

Semester - IV	Core - 12	Hours - 5	Credits - 5

Course Outcomes: By the end of the course the students 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.** Analyze Riez representation, uniform boundedness and closed graph theorem.(K4)
- **CO 6.** Convince the elegance of Hilbert space through the conjugate space (K5)

Unit - I: **(15 hours)**

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: **(15 hours)**

Bounded and Continuous Linear Operators - Linear Functional - Linear Operators and Functional on Finite Dimensional Spaces - Normed Spaces of Operators - Dual Space.

(Chapter 2 - Section 2.7 to 2.10)

Unit - III: **(15 hours)**

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: **(15 hours)**

Representation of Functional 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: **(15 hours)**

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 :23PMTC42

Semester - IV	Core - T13	Hours - 5	Credits - 5

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

CO 1. Calculate curvature and torsion of space curves (K3)
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 intrinsic properties and 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: **(15 hours)**

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: **(15 hours)**

Intrinsic equations - fundamental theorem – helices – curves on a surface - surface of revolution – helicoids – metric - direction coefficients.

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

UNIT - III: **(15 hours)**

Families of curves - isometric correspondence - intrinsic properties – geodesics - canonical geodesic equation - normal property of geodesics.

(Chapter II: Sections 7 - 12)

UNIT - IV: **(15 hours)**

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

(Chapter III: Sections 1 - 4)

UNIT - V: **(15 hours)**

Developables associated with space curves - developable associated with curves on surfaces - minimal surface - 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.
3. D.T. Struik, “Lectures on Classical Differential Geometry”, Addition –Wesley, Mass, 1950.
4. S. Kobayashi and K. Nomizu, “Foundations of Differential Geometry”, Interscience Publishers, 1963.
5. W. Klingenberg, “A Course in Differential Geometry”, Graduate Texts in Mathematics, Springer – Verlag 1979.
6. C.E.Weatherburn, “Differential Geometry of Three Dimensions”, University Press, Cambridge, 1930.

OPERATIONS RESEARCH

Course Code: 23 PMTE41

Semester - IV	EC- 6	Hours - 5	Credits - 4

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

CO 1. Recall the concepts of Dynamic Programming (K1)
CO 2. Discuss the various types of deterministic 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: **(15 hours)**

Network models - Scope and definition of network models – Minimal spanning tree algorithm – Shortes-Route algorithms - CPM and PERT - Network Represeentation – Critical Path Method (CPM) Computations - Construction of the Time Schedule – Linear Programming Formulation of CPM – PERT networks.

(Chapter 6: Sections 6.1, 6.2, 6.3.2, 6.5)

UNIT - II: **(15 hours)**

Deterministic Dynamic Programming – Recursive nature of Dynamic programming (D.P.) computations – Forward and Backward recursion – Selected DP applications – Knapsack/Fly-Away Kit/ Cargo – Loading model – work force size model – Equipment Replacement Model – Investment model – Problem of Dimensionality -

(Chapter 12 (Exclude 12.3.5))

UNIT - III: **(15 hours)**

Deterministic Inventory Models – Role of demand in the development of inventory models - Static Economic-Order-Quntity (EOQ) models – Dynamic EOQ models.

(Chapter 13)

UNIT - IV: **(15 hours)**

Decision under uncertainity – Game theory **(Chapter 15: Sections 15.3 and 15.4.)**

UNIT - V: **(15 hours)**

General Poisson queuing model – Specialized poisson queues – (M/G/1):(GD/∞/∞) - Pollaczek- Khintchine (P-K) formula.

(Chapter 18: Sections 18.5, 18.6 and 18.7)

Text book:

Hamdy A.Taha**.,** Operations Research - An Introduction, Ninth Edition, Pearson Publication, 2012.

Reference books:

1. Kanti Swarup, 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: **23PMTE41**

Semester - IV	EC - 6	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the students 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: **(15 Hours)**

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: **(15 Hours)**

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: **(15 Hours)**

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: **(15 Hours)**

Renewal Process - Renewal Processes in Continuous Time - Renewal Equation - Stopping Time - Renewal Theorems.

(Chapter 6: Sections 6.1 - 6.5)

Unit - V: **(15 Hours)**

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.

STATISTICS
Course Code: 23 PMTE42

Semester - IV	EC - 7	Hours - 5	Credits - 4

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

CO 1. Recall the difference between the discrete and continuous random variables (K1)
CO 2. Explain the gamma, 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: **(15 hours)**

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

(Text book 1: Chapter 2: Sections 2.1, 2.1.1, 2.2 and 2.3)

UNIT - II: **(15 hours)**

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

(Text book 1: Chapter 2: Sections 2.4 and 2.5; Chapter 3: Sections 3.1 and 3.2)

UNIT - III: **(15 hours)**

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

(Text book 1: Chapter 3: Sections 3.3, 3.4 and 3.6 (Except 3.4.1))

UNIT - IV: **(15 hours)**

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

(Text book 1: Chapter 4: Sections 4.1- 4.4 (Except 4.3.1. and 4.3.2)

UNIT - V: **(15 hours)**

Tests about proportions - Tests about one mean and one variance - Tests of equality of two normal distributions - Chi- square goodness of fit tests.

(Text book 2: Chapter 7: Sections 7.1 -7.3 and 7.5)

Text book:

1. Robert V. Hogg, Joseph N. Mckean and Allen T. Craig, Introduction to Mathematical statistics, Sixth Edition, Pearson Education, Inc 2006.
2. Hogg, Tanis,Rao, Probability and Statistical Inference, Seventh Edition, Pearson Edition.

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.
3. Understanding Statistics, Graham Upton and Ian Cook, Oxford University Press.

ALGORITHMS AND COMPLEXITY

Course Code: 23PMTE42

Semester - IV	EC - 7	Hours - 5	Credits - 4

Course Outcomes: By the end of the course the students 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: **(15 hours)**

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

(Chapter 1: Sections 1.1 - 1.6)

UNIT - II: **(15 hours)**

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

(Chapter 2: Sections 2.1 - 2.4)

UNIT - III: **(15 hours)**

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: **(15 hours)**

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: **(15 hours)**

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 Pte. 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.

Training for CSIR/ NET/ GATE Examinations -II

Course Code: 23PMTS41

Semester - IV	SEC-3	Hours - 2	Credits - 2

Course Outcomes: By the end of the course the students 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: **(6 Hours)**

Problems in metric spaces – Convergence – Complete.

Unit - II: **(6 Hours)**

Problems in metric space – Connected – Continuity - totally bounded.

Unit - III: **(6 Hours)**

Problems in 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: **(6 Hours)**

Problems in contour integral, Cauchy's theorem - Cauchy's integral formula - Liouville's theorem, Maximum modulus principle - Schwarz lemma - Open mapping theorem.

Unit - V: **(6 Hours)**

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

Reference:

Previous year CSIR – NET Mathematical Sciences Question papers.
Ref: https://csirhrdg.res.in/Home/Index/1/Default/2769/81.

VALUE ADDED COURSES
PROBLEM SOLVING IN ALGEBRA AND LINEAR ALGEBRA
Course Code: 23PMTCC1

Hours-2 Credits – 2

Course Outcomes: By the end of the course the students will be able to:
CO 1. Identify the problems in algebra and linear algebra (K1)
CO 2. Discuss the concepts in algebra and linear algebra (K2)
CO 3. Determine the techniques for solving problems (K3)
CO 4. Classify methods for solving problems (K4)
CO 5. Compare the UFD, PID and ED (K5)
CO 6. Build the mental ability to face the competitive examination. (K6)

UNIT - I:

Problems in Groups – Subgroups – Homomorphism - Cyclic Groups - Permutation Groups - Cayley's Theorem.

UNIT - II:

Problems in Rings – Ideals - Prime and Maximal Ideals - Polynomial Rings and Irreducibility Criteria.

UNIT - III:

Problems in Unique Factorization Domain (UFD) - Principal Ideal Domain (PID) - Euclidean Domain (ED) - Fields.

UNIT - IV:

Problems in Vector Spaces – Subspaces - Linear Dependence – Basis – Dimension - Algebra of Linear Transformations - Eigenvalues and Eigenvectors - Cayley-Hamilton Theorem.

UNIT - V:

Problems in Matrix Representation of Linear Transformation - Change of Basis - Canonical Forms - Diagonal Forms - Triangular Forms and Jordan Forms.

Reference:

1. Previous year CSIR – NET Mathematical Sciences Question papers.
   Ref: https://csirhrdg.res.in/Home/Index/1/Default/2769/81

INTEGRAL TRANSFORMS
Course Code: 23PMTCC2

Credits – 2

Course Outcomes: By the end of the course the students will be able to:
CO 1. Identify the types of transforms (K1)
CO 2. Determine the solution of integral equations using Fourier Transform (K3)
CO 3. Solve the BVP using Mellin transform (K3)
CO 4. Solve boundary value problems using Laplace transform (K3)
CO 5. Analyze Hilbert transform (K4)
CO 6. Compare all transforms (K5)

Unit - I: Fourier Transform

The Fourier Integral Formulas- Definition of the Fourier Transform and Examples-Applications of Fourier Transforms to Ordinary Differential Equations - Solutions of Integral Equations. **(Chapter 2: 2.2-2.3, 2.10-2.12)**

Unit - II: Laplace Transform

Definition of the Laplace Transform and Examples-Solutions of Integral Equations - Solutions of Boundary Value Problems. **(Chapter 3: 3.2, Chapter 4:4.4-4.5**)

Unit - III: Mellin Transform

Definition of the Mellin Transform and Examples-Applications of Mellin Transforms.
(Chapter 8: 8.2, 8.4)

Unit - IV: Hilbert Transform

Definition of the Hilbert Transform and Examples-Applications of Hilbert Transforms.
(Chapter 9: 9.2, 9.5)

Unit - V: Z Transform

Definition of the Z Transform and Examples- Basic Operational Properties of Z Transforms -The Inverse Z Transform and Examples - Applications of Z Transforms to Finite Difference Equations. **(Chapter 12: 12.3-12.6)**

Text Book:

Lokenath Debnath, Dambaru Bhatta, Integral Transforms and their Applications, 3rd Edition, CRC Press.

PROBLEM SOLVING IN ADVANCED ALGEBRA AND ANALYSIS
Course Code:23PMTCC3

Credits-2

Course Outcomes: By the end of the course the students will be able to
CO 1. Identify the problems in algebra and analysis (K1)
CO 2. Discuss the concepts in algebra and linear algebra (K2)
CO 3. Determine the techniques for solving problems (K3)
CO 4. Classify methods for solving problems (K4)
CO 5. Evaluate the integral equations (K5)
CO 6. Build the mental ability to face the competitive examination. (K6)

UNIT - I:

Problems in algebra.

UNIT - II:

Problems in linear algebra.

UNIT - III:

Problems in real analysis and complex analysis.

UNIT - IV:

Problems in Calculus of variations and integral equations.

UNIT - V:

Problems in quantitative aptitude and reasoning.

Text Books:

1. Previous year CSIR – NET Mathematical Analysis Question papers.
   Ref: https://csirhrdg.res.in/Home/Index/1/Default/2769/81
2. Dr. R. S. Aggarwal, Quantitative Aptitude, Revised Edition 2022.

Extra Credit Courses

Analysis I for Competitive Examinations

Course Code: 23PMTEC1

Semester - I	ECC (Self Study)	Credits - 2

Course Outcomes: By the end of the course the students 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: 23 PMTEC2

Semester - I	ECC (Self Study)	Credits - 2

Course Outcomes: By the end of the course the students 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. Analyze Lourdusamy'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 C5*C5.

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 *C*5 * *C*5, *Discrete Math.,* 187(1998), 123-135.
4. A. LourdusamyandS.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, ActaCienciaIndica, 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-TuGao, 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: 23PMTEC3

Semester - II	ECC (Self Study)	Credits - 2

Course Outcomes: By the end of the course the students 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: 23PMTEC4

Semester - II	ECC (Self Study)	Credits - 2

Course Outcomes: By the end of the course the students 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. Analyze zero-divisor graph of commutative rings (K4)
CO 4. Analyze zero-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 London, (2010). (Chapter 2)

Unit III: M**.** Droste**,** L. Fuchs**,** B. Goldsmith**,** L. Strüngmann**:** Groups, Modules, and Model Theory-Surveys and Recent Developments, Springer, London, (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, London, (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: 23PMTEC5

Semester - III	ECC (Self Study)	Credits - 2

(Compulsory for III Semester M.Sc. Mathematics students)

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

CO1. Recall the aesthetic sense of ancient mathematicians (K1)

CO2. Recall the contribution of modern mathematicians (K1)

CO3. Discuss the development of mathematics (K2)

CO4. Explain the genesis of mathematical ideas (K2)

CO5. Analyze the ideas which govern the vast tracks of Mathematics (K4)

CO6. 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– TheLife 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

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,NewYork,1988.
2. E.T.Bell, Men of Mathematics, Penguin Books Ltd., Harmondsworth, Middlesex, UK,1953.

ALGEBRA FOR COMPETITIVE EXAMINATIONS
Course Code: 23PMTEC6

Semester - III	ECC (Self Study)	Credits - 2

Course Outcomes: By the end of the course the students 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.

MATHEMATICAL DOCUMENTATION USING LATEX

Course Code: 23PMTEC7

Semester - III	ECC (Self Study)	Credits - 2

Course Outcomes: By the end of the course the students 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 documents sequences.

(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: 23PMEC8

Semester - IV	ECC (Self Study)	Credits - 2

Course Code: By the end of the course, the students 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: 23PMTEC9

Semester - IV	ECC (Self Study)	Credits - 2

Course Outcomes: By the end of the course, the students 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 Behavior – 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 Queuing Theory, Academic Press, Second Edition, 2003.
2) Frederick S. Hillier, Gerald J. Lieberman., Introduction to Operations Research, McGraw-Hill Higher Education, Seventh Edition, 2001.