CURRICULUM AND SYLLABUS

of

M. Sc. MATHEMATICS (2 YEAR) PROGRAMME

After revision 2024-2025

DEPARTMENT OF MATHEMATICS
SCHOOL OF MATHEMATICAL SCIENCES
BHARATHIDASAN UNIVERSITY
TIRUCHIRAPPALLI - 620024

Bos 25 April 2024

DEPARTMENT OF MATHEMATICS
SCHOOL OF MATHEMATICAL SCIENCES
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M.Sc. MATHEMATICS (2 Year) Programme (CBCS)
(For the candidates to be admitted from the year 2024-2025 onwards)

Semester	Courses
I	4 Core Courses 1 Elective Course
II	3 Core Courses 1 Elective Course 1 Non-Major Elective Course 1 Value Added Course[1]
III	3 Core Courses 1 Elective Course 1 Non-Major Elective Course 1 Value Added Course [1]
IV	2 Core Courses 1 Entrepreneurship/Industry Based Course 1 Elective Course 1 Project

COURSE STRUCTURE

Sem	Course	Code	Title of the Course	Lec Hrs	Tut Hrs	Prac Hrs	Cr	Prerequisite (Exposure)
I	Core Corse I (CC)	24S1M01CC	Linear Algebra	4	2	0	5	Nil
	Core Corse II (CC)	24S1M02CC	Real Analysis I	4	2	0	5	Nil
	Core Corse III (CC)	24S1M03CC	Ordinary Differential Equations	4	2	0	5	Nil
	Core Course IV (CC)	24S1M04CC	Theory of Numbers	4	2	0	5	Nil
	Elective Course I(EC)	24S1M01ECA	(1) Graph Theory	3	2	0	4	Nil
	(any one)	24S1M01ECB	(2) Computational Mathematics	3	0	2	4	Nil
		24S1M01ECC	(3) Discrete Mathematics	3	2	0	4	Nil
II	Core Corse V (CC)	24S2M05CC	Algebra I	4	2	0	5	24S1M01CC 24S1M04CC
	Core Corse VI (CC)	24S2M06CC	Real Analysis II	4	2	0	5	24S1M02CC
	Core Corse VII (CC)	24S2M07CC	Topology	4	2	0	5	24S1M02CC
	Elective Course II(EC)	24S2M02ECA	(1) Partial Differential Equations	3	2	0	4	24S1M03CC
	(any one)	24S2M02ECB	(2) Integral Transforms	3	2	0	4	24S1M03CC
		24S2M02ECC	(3) Classical Dynamics	3	2	0	4	24S1M03CC
	Non-major Elective I(NME)	24S2M01NMEA	(1) Programming in C	2	0	1	2	Nil
	(any one)	24S2M01NMEB	(2) Resource Management Techniques	2	1	0	2	Nil
		24S2M01NMEC	(3) Mathematical Modeling	2	1	0	2	Nil
	Value Added Course I(VAC)	24S2M01VACA	(1) Introduction to Latex	1	0	1	2	Nil
	(any one)	24S2M01VACB	(2) General Intelligence	1	1	0	2	Nil
		24S2M01VACC	(3) Introduction to Sagemath	1	0	1	2	Nil
III	Core Corse VIII (CC)	24S3M08CC	Algebra II	4	2	0	5	24S1M01CC 24S2M05CC
	Core Corse IX (CC)	24S3M09CC	Complex Analysis	4	2	0	5	24S1M02CC 24S2M06CC
	Core Course X (CC)	24S3M10CC	Measure Theory and Integration	4	2	0	5	24S1M02CC 24S2M06CC
	Elective Course III(EC)	24S3M03ECA	(1) Integral Equations and Calculus of Variations	3	2	0	4	24S1M03CC
	(any one)	24S3M03ECB	(2) Numerical Analysis	3	2	0	4	24S1M03CC
		24S3M03ECC	(3) Stochastic Processes	3	2	0	4	Nil
	Non-major Elective II(NME)	24S3M02NMEA	(1) Statistics	2	1	0	2	Nil
	(any one)	24S3M02NMEB	(2) Quantitative Aptitude	2	1	0	2	Nil
		24S3M02NMEC	(3) Object Oriented Programming using C++	2	0	1	2	+2 level mathematics
	Value Added Course II(VAC)	24S3M02VACA	(1) Introduction to Python programming	1	0	1	2	Nil
	(any one)	24S3M02VACB	(2) Introduction to R Programming	1	0	1	2	Nil
		24S3M02VACC	(3) Sagemath for Abstract Algebra	1	0	1	2	Nil
IV	Core Corse XI (CC)	24S4M11CC	Functional Analysis	4	2	0	5	24S2M06CC 24S2M07CC 24S3M10CC
	Core Corse XII (CC)	24S4M12CC	Differential Geometry	4	2	0	5	24S2M07CC
	Entrepreneurship/ Industry Based Course	24S4M01IBC	Optimization Techniques	4	2	0	5	Nil
	Elective Course IV (EC)	24S4M04ECA	(1) Probability and Statistics	3	2	0	4	Nil
	(any one)	24S4M04ECB	(2) Operator Theory	3	2	0	4	24S2M06CC
		24S4M04ECC	(3) Fluid Dynamics	3	2	0	4	24S1M03CC
	Project Work	24S4MPW	Project Work	0	0	0	5	Nil

S.No	Types of Course	No. of Courses	N0. of Credits
1	Core Courses	12	60
2	Entrepreneurship/Industry Based Course	1	5
3	Elective Courses	4	16
4	Project	1	5
5	Non-major Elective Courses	2	4
	Total	20	90
6	Value Added Courses [1]	2 [1]	4[1]

For each Course other than the Project.

Continuous Internal Assessment (CIA)	-	25	Marks
End Semester Examination (ESE)	-	75	Marks
Total	-	100	Marks

ESE Duration - 3 Hours

Question paper pattern and CIA components.

10 questions compulsory	10×02	=	20 Marks	(2 from each unit)
5 questions	05×05	=	25 Marks	(either or, one from each unit)
3 questions from 5	03×10	=	30 Marks	(one question from each unit)
Total			75 Marks	

CIA components.

Tests	-	15 Marks	(2 tests from 3)
Seminar	-	5 Marks	
Assignment	-	5 Marks	

For Project Dissertation.

Evaluation (Internal examiner (40) and external examiner (40))	-	80	Marks
Viva Voce	-	20	Marks
Total	-	100	Marks

Total credits should not be less than 90

Programme Educational Outcomes:

PEO1	PG Graduands are Professionally Competent with characteristic Knowledge-bank, Skill-set, Mind-set and Pragmatic Wisdom in their chosen fields.
PEO2	PG Graduands demonstrate the desired sense of being Seasoned and exhibit unequivocal Spiritedness with excellent qualities of productive contribution to society and nation in the arena Science and Technology.
PEO3	PG Graduands are mentored such that they exert Leadership Latitude in their chosen fields with commitment to novelty and distinction.
PEO4	PG Graduands are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining Cultural and Civilized personality.
PEO5	PG Graduands are able to Collate information from different kinds of sources and gain a coherent understanding of the subject.

[1]The marks of VAC are included in the fourth semester marks statement and not added in the CGPA

Programme Outcomes:

On the successful completion of the Master of Science Programme in Mathematics students will be able to

PO1	gain proficiency in mathematics and scientific computational techniques and solve problems using efficient methods.
PO2	formulate and develop mathematical concepts with logical reasoning and critical thinking.
PO3	use mathematical ideas to model real-world problems, analyze them and solve them using the techniques learnt.
PO4	acquire analytic reasoning and problem solving skills for their professional development.
PO5	gain impetus by learning the techniques of mathematics from the interdisciplinary areas such as Computer science, Physics, Acturial Sciences, Social science, etc.
PO6	inculcate the habit of group discussion with their peers and thereby learning to communicate hard core mathematical ideas elegantly and effectively.
PO7	develop intellectual curiosity and adapt to grow with changing technology and learn how to apply them in mathematics and statistics.
PO8	able to pursue higher studies and conduct research independently and demonstrate highest standards of ethical principles in his career.

Programme Specific Outcomes:

Students will be able to

PSO1	gain mastery of fundamental mathematical concepts with a variety of demonstrating examples.
PSO2	acquire the ability to understand and deal with the abstract concepts effectively with logical reasoning.
PSO3	communicate mathematical concepts effectively with their peers and learn to think critically and writing them in a professional way.
PSO4	gain exposure to a variety of areas of mathematics and related fields such as computer science, the natural sciences, business and economics.
PSO5	develop problem solving skills and gain mastery in computational techniques.
PSO6	compete nationally by passing competitive examinations including CSIR-NET, SET, IAS, etc and also be globally competitive. Ability to pursue higher studies and do multi-disciplinary research independently.
PSO7	gain the ability to pursue higher studies and multi-disciplinary research.
PSO8	will have a commitment to continue professional development and learning as a life long activity.

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CORE COURSES

LINEAR ALGEBRA

Course Code: 24S1M01CC
Prerequisite: Nil

L	T	P	C
4	2	0	5

Objectives.

- Linear Algebra is ubiquitous in Mathematics and therefore a strong foundation has to be laid in studying the abstract algebraic concepts intertwining geometric ideas.
- The fundamental notions of vector spaces viz linear dependence, basis and dimension and linear transformations on these spaces have to be studied thoroughly.
- The students have to learn how the subject encompasses the isomorphic theory of matrices and comprehend the key ideas involved in the study of the structure theory of linear maps.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Gain mastery in the basic concepts of linear algebra; vector spaces, span of a set, linear dependence, basis and dimension of a vector space.	K2& K3
CO2	Understand the theory of linear transformations and master the rank and nullity theorem which is often exploited.	K2 & K3
CO3	Having got trained in numerous examples the student realizes the isomorphic -theory of linear transformations and matrices.	K1, K5 & K7
CO4	Understand the central theme of structure theory of linear maps	K5, K6 & K7
CO5	learn Jordan canonical forms of various linear transformation and thereby able to solve various problems.	K5, K6 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Vector spaces - Subspaces - Linear Combinations and Systems of Linear Equations - Linear Dependence and Linear Independence - Bases and Dimension - Maximal Linearly Independent Subsets.

Unit-II. Linear Transformations, Null Spaces, and Ranges - The Matrix Representation of a Linear Transformation - Combination of Linear Transformations and Matrix Multiplication - Invertibility and Isomorphisms - The Change of Coordinate Matrix.

Unit-III. Elementary Matrix Operations and Elementary Matrices - The Rank of a Matrix and Matrix Inverses - System of Linear Equations - Theoretical Aspects and Computational Aspects - Determinants of Order 2 - Determinants of Order n - Properties of Determinants - Summary - Important Facts about Determinants.

Unit-IV. Eigenvalues and Eigenvectors - Diagonalizability - Cayley Hamilton Theorem.

Unit-V. The Jordan Canonical Form 1 - The Jordan Canonical Form 2 - The Minimal polynomial.

Unit-VI (Advanced topics only for discussion). **Current Contours:** Introduction to Module theory

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	3	2	3	3	3
CO2	2	3	2	3	2	3	3	3
CO3	2	3	2	3	2	3	3	3
CO4	2	3	3	3	2	3	3	3
CO5	2	3	3	3	2	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	3	2	1
CO2	3	3	3	2	2	3	2	1
CO3	3	3	3	2	3	3	3	3
CO4	3	3	3	2	3	3	3	3
CO5	3	3	3	2	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Text book(s): Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra, Fourth Edition, PHI Learning Private Limited, New Delhi, 2014.

Unit-I: Chapters 1

Unit-II: Chapter 2: Sections 2.1 to 2.5

Unit-III: Chapter 3 and Chapter 4: Sections 4.1 to 4.4

Unit-IV: Chapter 5: Sections 5.1 to 5.3 and 5.5

Unit-V: Chapter 7 Sections 7.1 to 7.3

References.

(1) S. Kumaresan, Linear Algebra, Prentice-Hall of India Ltd, 2000.

(2) K. Hoffman and R. Kunze, Linear Algebra, Second Edition, Pearson, 2015.

(3) M.Artin, Algebra, Pearson, 2015.

(4) Jin Ho Kwak, Linear Algebra, Second Edition, Birkhäuser, 2004.

(5) I.N. Herstein, Topics in Algebra, Wiley India Pvt Limited, New Delhi, 2012.

(6) Gilbert Strang, Linear Algebra and its applications, Cengage Learning 8th Indian edt, 2011.
(7) A.R. Rao, P. Bhimashankaram, Linear Algebra, 2nd Edition, Hindustan Book Agency, 2000.
(8) V. Krishnamurthy et al, Introduction to Linear Algebra, East West Press Ltd, 1985.

REAL ANALYSIS I

Course Code: 24S1M02CC
Prerequisite: Nil

L	T	P	C
4	2	0	5

Objectives.

- To learn the basic quantitative concepts of real analysis such as least upper bound property, convergence of sequences and continuity of functions.
- To comprehend the qualitative aspects of real analysis in the setting of Metric spaces. The intrinsic geometric ideas in the basic notions of metric spaces viz., open sets, closed sets, limit points, cluster points and compactness have to be brought out.
- Very important concept of uniform convergence is contrasted with pointwise convergence and its utility in analysis is emphasized.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Inculcate interest in analysis and understand how pictures and asking leading questions get into the strategy of proofs. Gain mastery in the fundamental concepts and appreciate the role of LUB property	K2, K4 & K6
CO2	Realize the key idea convergence of sequences and the quantitative inequality estimates with the help of numerous examples.	K2, K4 & K5
CO3	Understand the basic concepts in metric spaces geometrically and with rigour	K2 & K4
CO4	Be Familiar with the crucial concept of continuity of functions and uniform continuity. Also, will be able to work on problems emphasizing these ideas of real analysis.	K3, K5 & K7
CO5	Attain the mastery in the very useful concept of uniform convergence of sequences and series of functions in analysis	K1, K3 & K4
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline.

Unit-I. Sets and Functions, Mathematical Induction, Finite and Infinite sets. Real Number system: Algebraic and Order properties: Infimum, Supremum, LUB Axiom. Countable and uncountable sets.

Unit-II. Sequences and their limits - limit theorems - monotone sequences - subsequences - Cauchy criterion - continuous functions - uniform continuity

Unit-III. Metric spaces - Definition and examples - open balls and open sets - Convergent sequences in metric spaces - limit and cluster points - Cauchy sequences - Bounded sets - Dense sets.

Unit-IV. Continuous functions - Equivalent Definitions of Continuity - Uniform Continuity -Limit of a function - Discontinuities of a Real Valued function - Compact spaces and their properties - Continuous functions on Compact spaces

Unit-V. Sequences and Series of functions - Pointwise and Uniform convergence - Interchange of limits - Series of functions - Weierstrass M-test

Unit-VI (Advanced topics only for discussion). **Current Contours:** Generalizations to topological spaces.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	2	3	2	3	3	2
CO2	2	3	2	3	2	3	3	3
CO3	2	3	2	3	2	3	3	3
CO4	2	3	2	3	2	3	3	3
CO5	2	3	2	3	2	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	3	3	2	3
CO2	3	3	3	2	3	3	2	3
CO3	3	3	3	2	3	3	2	3
CO4	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s):

(1) R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis 4th Edn, Wiley India Edition, 2014.

(2) S. Kumaresan, Topology of Metric Spaces, 2nd Edition, Narosa Publishing House, New Delhi, 2011.

Unit-I: Chapters 1 and 2 from [1]
Unit-II: Chapter 3 and Chapter 5 from [1]
Unit-III: Chapter 1 and Chapter 2, sections 2.1 to 2.5 from [2]
Unit-IV: Chapter 3 and Chapter 4 from [2] (sections 3.3, 3.6, 4.3 and 4.4 omitted)
Unit-V: Chapter 8, sections 8.1 and 8.2 and Chapter 9, section 9.4 from [1].

References.

(1) Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, Third Indian Reprint, 2015.
(2) Edward D. Gaughan, Introduction to Analysis, AMS, Indian edition, 2010.
(3) Kenneth A. Ross, Elementary Analysis: The Theory of Calculus, Springer Verlag, 2004.
(4) M.H. Protter, C.B. Morrey, A First Course in Real Analysis, 2nd Edition, Springer Verlag, 2004.
(5) S.K. Berberian, A First course in Real Analysis, Springer Verlag, Reprint, 2019.
(6) Charles Chapman Pugh, Real Mathematical Analysis, Springer Verlag, 2017.
(7) R.P. Boas, A primer of real functions, Mathematical Association of America, 1966.
(8) Tom M. Apostol, Mathematical Analysis 2 edn, Narosa, New Delhi, Reprint, 2002.
(9) Walter Rudin, Principles of Mathematical Analysis,Third Edition, Mcgraw Hill, 2017.
(10) N.L. Carothers, Real Analysis, Cambridge University Press, South Asian Edition, 2006.

ORDINARY DIFFERENTIAL EQUATIONS

Course Code: 24S1M03CC
Prerequisite: Nil

L	T	P	C
4	2	0	5

Objectives.

- Ordinary differential equations arise as a natural mathematical model of many physical situations and hence the concepts involved in solving them are rudiments and vital for the course. The main objective is to give elementary, thorough, systematic approach for the subject.
- The existence and uniqueness of solutions for first order differential equations are studied in detail. Qualitative properties of solutions are carried out elaborately.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Will be able to solve first order linear homogeneous equations and understand the utility of the theory of power series through solving . various second order differential equations	K2, K3 & K4
CO2	Understand basics of Hypergeometric functions which arises in connection with solutions of the second order ODE's with regular singular points.	K2, K4 & K5
CO3	Appreciate and understand the importance of studying well-posedness of the problem namely existence, uniqueness and . continuous dependence of first order ODE through Picard's theorem	K2 & K4
CO4	Will be able to work on numerous problems using comparison theorem in Sturm Liouville problems	K1 & K7
CO5	Learn the nature of solutions which involves critical points and phase portrait of non-linear equations.	K1, K6 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline.

Unit-I. The general solution of the homogeneous equation - The use of one known solution to find another - The method of variation of parameters - Power Series solutions. A review of power series - Series solutions of first order equations - Second order linear equations; Ordinary points.

Unit-II. Regular Singular Points - Gauss's hypergeometric equation - The Point at infinity - Legendre Polynomials - Bessel functions - Properties of Legendre Polynomials and Bessel functions.

Unit-III. Linear Systems of First Order Equations - Homogeneous Equations with Constant Coefficients - The Existence and Uniqueness of Solutions of Initial Value Problem for First Order Ordinary Differential Equations - The Method of Solutions of Successive Approximations and Picard's Theorem.

Unit-IV. Oscillation Theory and Boundary value problems - Qualitative Properties of Solutions - Sturm Comparison Theorems - Eigenvalues, Eigenfunctions and the Vibrating String.

Unit-V. Nonlinear equations: Autonomous Systems; the phase plane and its phenomena - Types of critical points; Stability - critical points and stability for linear systems - Stability by Liapunov's direct method - Simple critical points of nonlinear systems.

Unit-VI (Advanced topics only for discussion). **Current Contours:** System of ODE and use of canonical forms to solve.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	3	3	2	2
CO2	3	2	3	3	3	3	2	2
CO3	2	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	2	2
CO5	3	3	3	3	3	3	2	2

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	2	2
CO2	3	2	3	3	3	3	2	2
CO3	3	3	3	3	2	3	2	2
CO4	3	2	2	3	3	3	2	2
CO5	3	2	2	3	3	3	2	2

3-Strong; 2-Medium; 1-Low

Text book(s):

G.F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Edition, McGraw Hill, 2017.

Unit-I: Chapter 3: Sections 15, 16, 19 and Chapter 5: Sections 25 to 27

Unit-II: Chapter 5 : Sections 28 to 31 and Chapter 6: Sections 32 to 35

Unit-III: Chapter 7: Sections 37, 38 and Chapter 11: Sections 55, 56

Unit-IV: Chapter 4: Sections 22 to 24

Unit-V: Chapter 8: Sections 40 to 44

References.

(1) E.A. Coddington, Ordinary Differential Equaitons, McGraw Hill, 1989.

(2) M.E. Taylor, Introduction to Differential Equations, AMS Indian Edition, 2011.

(3) M. Braun, Differential Equations and Their Applications, 4th Edition, Springer, 1993.

(4) Boyce and DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn, John Wiley, 2009.
(5) S. Deo et al, A textbook of Differential Equations, McGraw Hill, 2002.
(6) Lawrence Perko, Differential Equations and Dynamical Systems, Springer, 2006.
(7) Tyn Myint-U, Ordinary Differential Equations, North-Holland, New York, 1978.

THEORY OF NUMBERS

Course Code: 24S1M04CC
Prerequisite: Nil

L	T	P	C
4	2	0	5

Objectives.

- Number theory is one of the classical branches of Mathematics. In this course, the basic concepts such as divisibility, primes, congruences and solutions in congruences are introduced in detail. Emphasize is made on the concepts which turn out to be concrete examples which motivate the abstract ideas in the algebra course.
- Quadratic Residues, Mobius inversion Formula and the Diophantine equations and their solutions are studied in detail.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Comprehend and work numerous problems on concepts of divisibility and primes. Gain expertise in Euler's totient, Fermat's, Euler's and Wilson's Theorems and work on applications illustrating them	K2 & K4
CO2	Understand number theory from algebraic point of view there by improving their sense of abstraction.	K4 & K5
CO3	Work on sum of two squares problems using Quadratic residue and Jacobi symbol.	K1, K3 & K7
CO4	Attain mastery in the fundamentals of greatest integer function and recurrence functions and attack combinatorial problems using them.	K6 & K7
CO5	Solve simple simultaneous linear Diophantine equations.	K1, K5 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course outline.

Unit-I. Introduction - Divisibility - Primes - The Binomial Theorem - Congruences Euler's totient - Fermat's, Euler's and Wilson's Theorems - Solutions of congruences - The Chinese Remainder theorem.

Unit-II. Prime power Moduli - Primitive roots and Power Residues - Number theory from an Algebraic Viewpoint - Groups, rings and fields.

Unit-III. Quadratic Residues - Quadratic Reciprocity - The Jacobi Symbol - Binary Quadratic Forms - Equivalence and Reduction of Binary Quadratic Forms - sum of two squares.

Unit-IV. Greatest integer Function - Arithmetic Functions - The Mobius Inversion Formula Recurrence Functions - Combinatorial number theory.

Unit-V. Diophantine Equations - The equation ax+by = c - Simultaneous Linear Diophantine Equations - Pythagorean Triangles - Assorted examples

Unit-VI (Advanced topics only for discussion). **Current Contours:** A discussion on Prime number theorem

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	1	3	2	3	3	3
CO2	3	3	1	3	2	3	3	3
CO3	3	3	1	3	2	3	3	3
CO4	3	3	1	3	2	3	3	3
CO5	3	3	3	3	1	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	3	3	3	3
CO2	3	3	3	2	3	3	3	3
CO3	3	3	3	2	3	3	3	3
CO4	3	3	3	2	3	3	3	3
CO5	3	3	3	2	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): Ivan Niven, Herbert S, Zuckerman and Hugh L, Montgomery, An Introduction to the Theory of Numbers, Fifth edn., John Wiley & Sons Inc, 2008.

Unit-I: Chapter 1 and Chapter 2 : Sections 2.1 to 2.3

Unit-II: Chapter 2 : Sections 2.6 to 2.11

Unit-III: Chapter 3: Sections 3.1 to 3.6

Unit-IV: Chapter 4

Unit-V: Chapter 5: Sections 5.1 to 5.4

References.

(1) Gareth A. Jones and J. Mary Jones, Elementary Number Theory, Springer Verlag, Indian Reprint, 2005.

(2) David M. Burton, Elementary Number Theory, 6th edition, McGraw Hill, 2007.

(3) George Andrews, Theory of Numbers, Saunders, 1971.

(4) William, Fundamentals of Number Theory, Leveque, Addison-Wesley Publishing Company, Phillipines, 1977.

ALGEBRA - I

Course Code: 24S2M05CC
Prerequisite: 24S1M01CC, 24S1M04CC

L	T	P	C
4	2	0	5

Objectives.

- To learn the fundamental abstract algebraic structures namely groups and rings with rigor. The need for the abstract concepts are illustrated with numerous examples.
- To comprehend how group action is effectively used in Sylow's theorems.
- To study in detail the basic concepts of Rings such as Ring homomorphisms and Euclidean domains.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Gain expertise in the basic concepts of group theory with the help of numerous examples.	K2 & K4
CO2	Acquire deep knowledge in permutation groups, normal subgroups, homomorphism and isomorphism of groups	K2, K3 & K6
CO3	Apply Sylow's theorems to classify groups of finite order upto 120 achieved via counting tricks in algebra.	K1 & K7
CO4	Understand Ring structure in algebra and gain mastery in quotient rings.	K2, K4 & K5
CO5	Master the dvisibity concepts genralized to Rings of Polynomials.	K2 & K4
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Binary Operations - Groups - Subgroups - Permutations I - Permutations II - Cyclic Groups.

Unit-II. Isomorphisms - Direct Products - Finitely Generated Abelian groups - Groups of Cosets - Normal subgroups and factor groups- Homomorphisms.

Unit-III. Series of Groups - Isomorphism theorems- Proof of the Jordan Holder theorem—Group action on a set- Applications of G-sets to counting - Sylow's theorems - Applications of Sylow theorems.

Unit-IV. Rings - Integral Domains - Some non-commutative examples - The Field of quotients - Quotient rings and Ideal.

Unit-V. Homomorphism of Rings - Rings of polynomials - Factorization of Polynomials over a field - Euclidean domains- Gaussian integers and norms.

Unit-VI (Advanced topics only for discussion). Current Contours: Classification of finite Groups - Commutative rings.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	3	2	3	2	3
CO2	2	3	2	3	2	3	2	3
CO3	2	3	1	3	2	3	2	3
CO4	3	3	2	3	2	3	2	3
CO5	3	3	3	3	3	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	3	3	3	3
CO2	3	3	3	2	3	3	3	3
CO3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): John B. Fraleigh, A First course in Abstract Algebra, Pearson, 7th Edition, 2013.

Unit-I: Chapter 1, 2, 3,4,5,6

Unit-II: Chapter 7,8,9,11,12,13

Unit-III: Chapter 14,15,16,17,18,19

Unit-IV: Chapter 23,24,25,26,27,28

Unit-V: Chapter 29,30,31,33,34

References.

(1) Gallian, Contemporary Abstract Algebra, Cenpage Learning India Pvt Ltd., Ninth Edition, 2019.

(2) Mark R. Sepanski, Algebra, AMS Indian Edition, 2012.

(3) David S. Dummit and Richard M. Foote, Abstract Algebra, Wiley , Third Edition, 2011.

(4) P.B. Bhattacharya et al., Basic Abstract Algebra, 2nd edition, Cambridge University Press, 2003.

(5) C. Lanski, Concepts in Abstract Algebra, AMS Indian edition, 2010

(6) M.Artin, Algebra, Pearson Education India, New Delhi, 2015.

(7) I.N.Herstein, Topics in Algebra, John Wiley, 2nd Edition, 2006.

(8) R. Solomon, Abstract Algebra, AMS Indian edition, 2010.

REAL ANALYSIS II

Course Code: 24S2M06CC
Prerequisite: 24S1M02CC

L	T	P	C
4	2	0	5

Objectives.

- To perceive and retain that the basic idea of differential calculus is to approximate the given function by a first degree polynomial. To study the powerful tool of maxima-minima in calculus using mean value theorems.
- To introduce the theory of multivariable calculus and emphasize is on important concepts on chain rule, mean value theorem. Inverse function theorem and implicit function theorem are explained in a lucid manner. Applications to Lagrange multiplier method are done through simple examples.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Gain mastery on single variable differentiable calculus, functions of bounded variations and rectifiable paths	K2 & K4
CO2	Compute the total variation of a function over an interval and learn techniques for changing the parameter of a curve.	K3, K6 & K7
CO3	Comprehend the basic integration theory and demonstrate how the results the results are obtained and gain the confidence in Analysis.	K1 & K2
CO4	Have a solid understanding in the foundation on the fundamentals of multivariable calculus.	K2 & K5
CO5	Thoroughly understand the geometric ideas leading to implicit and inverse function theorems.	K2, K4 & K5
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Differentiation of single variable: Derivatives - The chain rule - local extrema - Rolle's theorem - Mean Value Theorem - Taylor's formula - Derivatives of vector - valued functions

Unit-II. Functions of Bounded variation and rectifiable curves - Total variation - Functions of bounded variation - Equivalence of paths - Change of parameter.

Unit-III. Riemann-Stieltjes integral: Definition - linear properties of the integral - Necessary conditions for the existence - First fundamental theorem of Integral calculus - Mean Value Theorems for integrals - Second fundamental theorem of Integral calculus- Change of variable in a Riemann integral - Second Mean value Theorem for Riemann integrals

Unit-IV. Functions of Severable variables - Directional derivative - Total derivative - Jacobian - Chain rule - Mean Value Theorem - Taylor's formula.

Unit-V. Inverse function theorem - Implicit function theorem - Extremum problems with side conditions.

Unit-VI (Advanced topics only for discussion). **Current Contours:** Calculus on Manifolds.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	3	2	3	2	3
CO2	2	3	3	3	2	3	2	3
CO3	2	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	3	3	3
CO2	3	3	3	2	2	3	3	3
CO3	3	3	3	2	2	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): Tom M. Apostol, Mathematical Analysis Second Edition, Narosa Publishing House, New Delhi, 1985.

Unit-I: Chapter 5

Unit-II: Chapter 6

Unit-III: Chapter 7 Section 7.1 -7.22

Unit-IV: Chapter 12

Unit-V: Chapter 13

References.

(1) Ajit Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, Third Indian Reprint, 2015.

(2) N.L. Carothers, Real Analysis, Cambridge University Press, South Asian Edition, 2006.

(3) M.H. Protter, C.B. Morrey, A First Course in Real Analysis, 2nd Edition, Springer Verlag International Edition, 1991.

(4) Tom Apostol, Calculas II, Wiley,2nd edition, 2007.

(5) Torrence Tao, Mathematical Analysis, Vol I & II, Hindustan Book Agency, 2006.

(6) J.E. Marsden, A.J. Tromba, A.Weinstein, Basic multivariable calculus, W.H.Freeman and Co Ltd, 2001.
(7) Robert T. Seeley, Calculas of Several Variables, Scott, Foresman and Co, 1970.
(8) T.W. Korner, A Companion to Analysis, AMS Indian edition, 2011.
(9) S. Kumaresan, A Course in Differential Geometry and Lie groups, Hindustan Book Agency, 2002.
(10) Walter Rudin, Principles of Mathematical Analysis,Third Edition, Mcgraw Hill, 2017.

TOPOLOGY

Course Code: 24S2M07CC
Prerequisite: 24S1M02CC

L	T	P	C
4	2	0	5

Objectives.

- To introduce the notion of topological spaces and to characterize the properties of convergence, continuity of functions, compactness and connectedness of the spaces. Emphasize is to bring out the intrinsic geometric ideas in the concepts.
- To lay strong foundation on obtaining weak topology induced by maps and to study product topology as a special case.
- To study in depth the ingenious idea of the construction of the continuous real valued functions on normal spaces.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Be familiar with the notion of topological space derived from metric space and generalize results using a vast class of examples	K2, K4 & K6
CO2	Explore the continuity of functions in various topological spaces. Understand generating topologies and product topology as a particular case of it.	K2 & K3
CO3	Master the concepts of connectedness with help of examples	K1, K2 & K6
CO4	Work on various properties of compact spaces and locally compact spaces	K2 & K6
CO5	Comprehend the implications of separation axioms in proving Urysohn's lemma, Tietze Extension and Tychonoff theorems.	K2, K4 & K5
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. 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.

Unit-II. CONTINUOUS FUNCTIONS : Continuous functions - the product topology - The metric topology.

Unit-III. CONNECTEDNESS: Connected spaces - connected subspaces of the Real line - Components and local connectedness.

Unit-IV. COMPACTNESS: Compact spaces - compact subspaces of the Real line - Arzela - Ascoli theorem -Limit Point Compactness - Local Compactness -Tychonoff's Theorem.

Unit-V. COUNTABILITY AND SEPARATION AXIOMS: The Countability Axioms - The separation Axioms - Normal spaces - The Urysohn Lemma - The Tietze extension theorem.

Unit-VI (Advanced topics only for discussion). Current Contours: Elementary concepts from Algebraic topology.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	3	3	3	2	3
CO2	2	3	2	3	3	3	2	3
CO3	2	3	2	3	2	3	3	3
CO4	3	3	3	3	2	3	3	3
CO5	3	3	3	3	2	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	2	3	2	3
CO2	3	3	3	3	2	3	2	3
CO3	3	3	3	2	2	3	2	3
CO4	3	3	3	2	1	3	2	3
CO5	3	3	3	2	1	3	2	3
3-Strong; 2-Medium; 1-Low								

Text book(s): James R. Munkres, Topology (2nd Edition) Pearson Education Pvt. Ltd., New Delhi-2002 (Third Indian Reprint)

Unit-I: Chapter 2: Sections 12 to 17

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

Unit-III: Chapter 3: Sections 23 to 25.

Unit-IV: Chapter 3: Sections 26 to 29 and Chapter 5: Section 37

Unit-V: Chapter 4: Sections 30 to 35.

References.

(1) Vikram Aithal and S. Kumaresan, Topology (A Core Course), Techno World, 2023.

(2) M.A. Armstong, Basic Topology, Springer Verlag, 2005

(3) J. Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.

(4) K.D. Joshi, Introduction to General Topology,New Age International Private Limited, 2017.

(5) O. Ya. Viro, Elementry Topology: Problem Textbook, AMS Indian Edition, 2012.

(6) J.L. Kelly, General Topology, Dover Publications Inc., 2017

(7) L.Steen and J.Seebach, Counterexamples in Topology, Holt, Rinehart and Winston, Dover Publications Inc., 1995..

(8) G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2017.

ALGEBRA - II

Course Code: 24S3M08CC
Prerequisite: 24S1M01CC, 24S2M05CC

L	T	P	C
4	2	0	5

Objectives.

- To gain expertise in basic ring theory
- To introduce Galois theory and obtain the fundamental Galois correspondence.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand the important concepts of prime ideal and maximal ideal and identify them in various examples.	K1, K3 & K4
CO2	Learn the fundamental concept in field theory of field extensions and workout the dimensions of various extension fields using tower law.	K1, K5 K7
CO3	Have clear cut idea in the notions of Galois groups, normal extensions and separable extensions.	K4 & K6
CO4	Prove the impossibility of certain geometric constructions.	K2 & K4
CO5	Able to understand the Fundamental theorem of Galois theory	K2 & K4
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Prime ideals and Maximal Ideals, Irreducible polynomials.

Unit-II. Classical Formulas, Splitting Fields.

Unit-III. The Galois Group, Roots of Unity, Solvability by Radicals.

Unit-IV. Independence of Characters, Galois Extensions.

Unit-V. The Fundamental theorem of Galois theory, Applications, Galois Great Theorem.

Unit-VI (Advanced topics only for discussion). Current Contours: Elementary concepts from commutative algebra. Applications of field theory to coding theory.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	3	2	3	2	3
CO2	2	3	2	3	2	3	2	3
CO3	2	3	1	3	2	3	2	3
CO4	3	3	2	3	2	3	2	3
CO5	3	3	3	3	3	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	3	3	3	3
CO2	3	3	3	2	3	3	3	3
CO3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): Joseph Rotman, Galois Theory, 2nd edition, Springer Verlag, 2001.

Unit-I: Pages 31 - 43

Unit-II: Pages 44 - 58

Unit-III: Pages 59 - 75

Unit-IV: Pages 76 - 82

Unit-V: Pages 83 - 95

References.

(1) David S. Dummit and Richard M. Foote, Abstract Algebra, Wiley, Third Edition, 2011.

(2) Serge Lang. Algebra - Revised third edition - Springer - Verlag - 2005.

(3) Ian Stewart, Galois Theory,Chapman and Hall/CRC,Fourth edition 2015.

(4) R. Solomon, Abstract Algebra, AMS Indian edition, 2010.

(5) C. Lanski, Concepts in Abstract Algebra, AMS Indian edition, 2010

(6) John B. Fraleigh, A First course in Abstract Algebra, Pearson, 7th Edition, 2013.

(7) M.Artin, Algebra,Pearson Education India, New Delhi, 2015.

(8) I.N.Herstein, Topics in Algebra, John Wiley, 2nd Edition, 2006.

COMPLEX ANALYSIS

Course Code: 24S3M09CC
Prerequisite: 24S1M02CC, 24S2M06CC

L	T	P	C
4	2	0	5

Objectives.

- To give a careful treatment of argument and logarithms and winding numbers
- To introduce analytic functions which are locally a power series and to study the profound Cauchy theory which says analytic functions are complex differentiable (holomorphic) functions on an open set.
- To emphasize that the subject is a amalgamation of ideas from analysis, geometry and topology

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand the complex number system from geometric view point. Will gain mastery in arguments on $\mathbb{C}^*$, logarithms and power series	K2, K4 & K5
CO2	Workout the path integrals on the complex plane and Understand the central theme of Cauchy theory	K2, K6 & K7
CO3	Get acquainted with various techniques of proving fundamental theorem of algebra, open mapping theorem, maximum modulus theorem and Liouville's theorem.	K2, K4 & K5
CO4	Classify singularities, compute poles and residues and understand the Laurent series expansion	K1, K3 & K7
CO5	Appreciate and work on the topology of extended complex plane.	K2, K4 & K5
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Power Series - Uniform Convergence and Continuity - Arguments on $\mathbb{C}^*$- Logarithms - Power Series and Analytic Functions-Cauchy-Riemann Equations - Rest of the sections from chapter 1 to chapter 5 are for self study.

Unit-II. Complex Integration:Integration of functions from $\mathbb{R}$ to $\mathbb{C}$ - Path Integrals - *ML*-inequality - A Preview of Cauchy Theory - Cauchy Theory: Cauchy's Theorem for Star-Shaped Domains - Applications of Cauchy's Theorem - An Extension of Cauchy's Theorem - Green's Theorem and Cauchy's Theorem.

Unit-III. Cauchy Integral Formula:Cauchy Integral Formula - Mean Value Property - Liouville's Theorem - Morera's Theorem - Identity Theorem - Maximum Modulus Theorem

Unit-IV. Isolated Singularities and Laurent Series:Isolated Singularities - Laurent Series - Characterization of Singularities - Meromorphic Functions - Winding Numbers of Closed Curves: Winding Numbers -I - Residue Theorem and its Applications: Residue Theorem - Arugument Principle.

Unit-V. Extended Complex Plane:Point at Infinity - Fractional Linear Transformations - Functions on the Extended Plane - Real Integrals: Improper Integrals - Evaluation of Real Integrals - Summation of Infinite Series

Unit-VI (Advanced topics only for discussion). Analytic Continuation - Global version of Cauchy's theorem

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	3	2	3	2	3
CO2	2	3	3	3	2	3	2	3
CO3	2	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	3	3	3
CO2	3	3	3	2	2	3	3	3
CO3	3	3	3	2	2	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Text book(s): S.Kumaresan, A Pathway to Complex Analysis, Techno world Publications, 2021.

Unit-I: Chapter 1 - Chapter 5: Emphasis on Sections 2.3, 3.2, 4.3, 4.4, 5.5 and 5.6 Rest of the sections from Chapters 1-5 are for self study.

Unit-II: Chapters 6 and 7.

Unit-III: Chapter 8

Unit-IV: Chapters 9,10 and 11. On Chapter 10 only Section 10.1 is included.

Unit-V: Chapters 13: 13.1 - 13.3 and Chapter 15

Unit-VI: Chapter 16 and 18.

References.

(1) Bak, J., Newman and D.J, Complex Analysis, 3rd edition, Springer Nature, New York, 2015.
(2) R. Priestely, Introduction to Complex Analysis, Oxford India, 2008.
(3) Theodore W. Gamelin, Complex Analysis, Springer Verlag, 2003.
(4) Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company, Tokyo, 2017.
(5) R.V. Churchill & J.W. Brown, Complex Variables and applications, 8th edition, McGraw-Hill, 2017.
(6) L.S. Hahn and B. Epstein, Classical Complex analysis, Jones and Barlett Student Edition, 2011.
(7) J.B. Conway, Functions of One Complex Variable, Narosa, 2 edn., 2000.
(8) S. Ponnusamy and H. Silverman, Complex Variables with applications, Birkhauser, 2006.
(9) Donald Sarason, Notes on Complex Function theory, Hindustan Book Agency, 1994.
(10) V. Karunakaran, Complex Analysis 2 edn, Narosa, New Delhi, 2005.

MEASURE THEORY AND INTEGRATION

Course Code: 24S3M10CC
Prerequisite: 24S1M02CC, 24S2M06CC

L	T	P	C
4	2	0	5

Objectives.

- To provide a concrete setting of Lebesgue measure and Lebesgue integral via the classical concepts of Jordan measure and the Riemann integration.
- To give an expert and thorough study on abstract measuresa and the modern integation theory including the standard convergence theorems.
- To introduce product measure and study the Fubini's theorem.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Identify whether a given subset of $\mathbb{R}$ or a real valued function is measurable	K2, K4 & K5
CO2	Gain expertise in the concept of sigma algebra and learn in depth that the set of all Lebesque measurable sets is a sigma algebra.	K2, K3, K6 & K7
CO3	Understand the importance of Monotone convergence theorem, Dominated convergence theorem and Fauto's lemma.	K1 & K4
CO4	Prove the completeness of L^p spaces	K4 & K5
CO5	Comprehend the idea of Hahn and Jordan decomposition and Radon-Nikodym theorems.	K2 & K4
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Measure on $\mathbb{R}$: - outer measure - measurable sets - Regularity- abstract Measures - elementary properties of abstract measures.

Unit-II. Integration of positive functions - Integration of complex functions - The role played by sets of measure zero.

Unit-III. Measurability on cartesian products - Product Measure- The Fubini's theorem - Completion of Product measures- convolutions.

Unit-IV. L^p spaces: - convex function and inqualities - completeness of L^p spaces .

Unit-V. Signed Measures - Hahn Decomposition - Jordan Decomposition - Radon Nikodym theorem.

Unit-VI (Advanced topics only for discussion). Current Contours: Riesz- Markov Kakutani Theorem

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	2	3	2	3	3	2
CO2	2	3	2	3	2	3	3	3
CO3	2	3	2	3	2	3	3	3
CO4	2	3	2	3	2	3	3	3
CO5	2	3	2	3	2	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	3	3	2	3
CO2	3	3	3	2	3	3	2	3
CO3	3	3	3	2	3	3	2	3
CO4	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	3	3	3

3-Strong; 2-Medium; 1-Low

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

Text book(s):

(1) G. de Barra, Measure Theory And Integration, NewAge International Pvt.Ltd, 2013.

(2) W. Rudin, Real and Complex Analysis 3edn, McGraw-Hill, 2017.

Unit-I: Chapter 2 - Section 2.1 to2.3 from [1] and Chapter 1 - pages 5 -19 (till the end of 1.22) from [2].

Unit-II: Chapter 1 - pages 19 -31 from [2].

Unit-III: Chapter 8 - pages 160-172 from [2].

Unit-IV: Chapter 3 - pages 62 -70 from [2].

Unit-V: Chapter 8 Sections 8.1 -8.3 from [1].

References.

(1) J R.G. Bartle, Elements of Integration and Lebesgue measure, Wiley India Ltd, 2014.

(2) C.D. Aliprantis and O.Burkinshaw, Priniciples of Real Analysis 3rd edn, Academic Press, Inc. New York, 1998.

(3) I.K.Rana, An Introduction to Measure and Integration, 2edn ,Narosa Publishing House, NewDelhi, 2007.

(4) H.L.Royden, Real Analysis, Pearson, Third edition, 2015.

(5) R.G. Bartle, Modern theory of integration, AMS, 2000.

FUNCTIONAL ANALYSIS

Course Code: 24S4M11CC
Prerequisite: 24S2M06CC, 24S2M07CC, 24S3M10CC

L	T	P	C
4	2	0	5

Objectives.

- The idea behind the course is to emphasize very basic results which are needed for analysts and to give typical applications.
- To study normed linear spaces, four pillars of functional analysis, weak topologies and duality, Hilbert space theory and algebra of bounded linear operators.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand functional analytic language required to study problems of practical interest.	K2 & k4
CO2	Gain mastery in basic Hilbert space theory: Projection theorem and Riesz representation theorem.	K2, K3 & K5
CO3	Comprehend the important of five pillars of functional analysis	K1 & K4
CO4	Understand and gain mastery in compact operators	K2, K6 & K7
CO5	Get a working knowledge on algebra of bounded linear operators. Study in detail the spectral properties of bounded linear operators.	K2, K3 K5 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Normed Linear Spaces - Examples - Normed Linear Spaces as Metric Spaces - Banach spaces - Hilbert Spaces - Bounded Linear Maps.

Unit-II. Riesz Representation Theorem for Hilbert Spaces - Finite Dimensional Spaces - Locally Compact Normed Linear Spaces - Quotient Spaces.

Unit-III. Five Pillars of Functional Analysis: Hahn-Banach Theorem - Open Mapping Theorem - Bounded Inverse Theorem - Closed Graph Theorem - Uniform Boundedness Principle.

Unit-IV. General Results on Compact Operators - Compact self-adjoint operators on Hilbert spaces - Dual spaces - Adjoint operators - Hilert space adjoint.

Unit-V. Banach Algebras - Spectrum of an element in a Banach Algebra - Spectrum of some standard operators - Finite Dimensional spectral theorem.

Unit-VI (Advanced topics only for discussion). Generating topologies - Weak and Weak* Topologies - Banach-Alaoglu Theorem.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	3	2	3	2	3
CO2	2	3	3	3	2	3	2	3
CO3	2	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	3	3	3
CO2	3	3	3	2	2	3	3	3
CO3	3	3	3	2	2	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Text book(s): S.Kumaresan and D.Sukumar, Functional Analysis A first course, Narosa Publishing House, 2020.

Unit-I: Chapter 1: 1.1-1.5.

Unit-II: Chapter 1: 1.6-1.9.

Unit-III: Chapter 2 except 2.5.1,2.6.1.4 & 2.6.1.5.

Unit-IV: Chapter 3:3.1 & 3.4 and Chapter: 4.1-4.3.

Unit-V: Chapter 5 and Chapter 6: 6.1.

Unit-VI: Chapter 7.

References.

(1) B. Bollobas, Linear Analysis an introductory course, 2nd edn, Cambridge Mathematical Texts, Cambridge University Press, 1999.

(2) B.V. Limaye, Functional Analysis, Revised 3rd edn, New Age International, 2014.

(3) C. Goffman and G. Pedrick, A First Course in Functional Analysis, AMS, Chelesea, 2017

(4) B. Rynne and M.A. Youngson, Linear Functional Analyis, Springer UMS, 2008

(5) E. Kreyszig, Introductory Functional Analysis with applications, John Wiley, 2007.

(6) S. Kesavan, Functional Analysis, Hindustan book agency, 2014.

(7) G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2017.

(8) M.Thamban Nair, Functional Analysis: A first course, Prentice Hall of India, 2002.

(9) K. Yosida, Functional Analysis, Springer-Verlag, 1995.

DIFFERENTIAL GEOMETRY

Course Code: 24S4M12CC
Prerequisite: 24S2M07CC

L	T	P	C
4	2	0	5

Objectives.

- To introduce the geometry of n-dimensional oriented surfaces on Euclidean spaces using calculus of vector fields as a tool.
- To study geodesics, parallel transport, curvature and convexity of surfaces.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Sketch and workout graphs, level sets, tangent space and surfaces of given smooth maps.	K4, K5 & K6
CO2	Gain knowledge on calculus of vector fields.	K2 & K4
CO3	Understand how Gauss map helps to identify the surfaces that are mapped onto the unit n-sphere.	K1, K2 & K4
CO4	Learn how parametrization of plane curves can be used to evaluate integrals over the curve.	K5 & K7
CO5	Compute the curvature of various surfaces	K3 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Graphs and Level sets - Vector fields - Tangent space.

Unit-II. Surfaces - Vector fields on surfaces

Unit-III. Gauss map - geodesics

Unit-IV. Parallel Transport - Weingarten map

Unit-V. Curvature of plane curves - arc length and Line integrals - Curvature of surfaces

Unit-VI (Advanced topics only for discussion). **Current Contours:** Elementary concepts from commutative algebra. Applications of field theory to coding theory. The Gauss Bonet theorems.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	3	2	3	2	3
CO2	2	3	3	3	2	3	2	3
CO3	2	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	3	3	3
CO2	3	3	3	2	2	3	3	3
CO3	3	3	3	2	2	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): J.A.Thorpe, Elementary topics in Differential geometry, UTM, Springer-Verlag, 4th reprint, 1994.

Unit-I: Chapters 1 to 3.

Unit-II: Chapters 4 and 5.

Unit-III: Chapters 6 and 7.

Unit-IV: Chapters 8 and 9.

Unit-V: Chapters 10 to 12.

References.

(1) S. Kumaresan, A Course in Differential Geometry, Hindustan Book Agency, 2002.

(2) Struik, D.T. Lectures on Classical Differential Geometry, Dover, 2003.

(3) Kobayashi S. and Nomizu. K. Foundations of Differential Geometry, Wiley Interscience Publishers, 1993.

(4) Wihelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer Verlag, 1978.

(5) T.J. Willmore, An Introduction to Differential Geometry, Dover, 2012.

ENTREPRENEURSHIP/INDUSTRY BASED COURSE

OPTIMIZATION TECHNIQUES

Course Code: 24S4M01IBC
Prerequisite: Nil

L	T	P	C
4	2	0	5

Objectives.

- To provide the insights into structures and processors that operations research can offer and the enormous practical utility of its various techniques.
- To explain the concepts and simultaneously to develop an understanding of problem solving methods based upon model formulation, solution procedures and analysis.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Formulate and solve Linear programming problem using various methods	K6 & K7
CO2	Find solutions to linear programming problem by dynamic programming.	K1, K3 & K5
CO3	Have the knowledge of Queueing system and classification of Queueing models	K2 & K4
CO4	Solve a variety of deterministic and probabilistic inventory control problems both with and without breaks	K1, K6 & K7
CO5	Solve nonlinear programming problems using Wolfs method and Beale's method.	K1 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Linear Programming Problem - Simplex method - Integer Programming - Gomory's all I.P.P method - Fractional Cut Method - All integer L.P.P - Mixed integer L.P.P- Branch and Bound method.

Unit-II. Dynamic Programming - The recursive equation approach- Solution of discrete D.P.P - Some applications- Solutions of L.P.P by Dynamic Programming.

Unit-III. Queueing system - Deterministic Queueing Systems - Probability distributions in Queueing systems - Classification of Queueing Models - Transient and Steady States - Poisson Queueing Systems - Non-Poisson Queueing systems - Cost Models in Queueing - Other Queueing Models - Queueing Constrol - Queueing Theory and inventory Control.

Unit-IV. Inventory models - the concept of EOQ - deterministic inventory problems- with no shortages, with shortages - problems of EOQ with price breaks - Inventory problems with uncertain demands - One period problem - One period problem - without set-up cost , with set-up cost.

Unit-V. Non-Linear Programming - Formulation - constrained optimization - with equaling constraints, with in-equaling constraints - saddle point problems - Methods - Graphical sign - kuhn - Tucker conditions with non- negative constrains - quadratic programming- wolfe's modified simplex method - Beale's method - separable convex programming.

Unit-VI (Advanced topics only for discussion). **Current Contours:** Geometric Programming -Goal Programming.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Text book(s): Kanti Swarup, P . K. Gupta, Man Mohan, Operations Research, Sultan Chand & sons, New Delhi, 2019.

Unit-I: Sections 4.1 to 4.4, 7.1 - 7.7
Unit-II: Sections 13.1 to 13.7
Unit-III: Sections 21.1 to 21.14
Unit-IV: Sections 19.1 to 19.12, 20.4 - 20.6
Unit-V: Sections 27.1 - 27.7, 28.1 - 28.8.

References.

(1) Hamdy A. Taha, Operations Research (10th Edn.), McGraw Hill Publications, New Delhi.2019.

(2) Bazaara, Jarvis and Sherali, Linear Programming and Network Flows, 4th ed., John Wiley, 2010

(3) O.L. Mangasarian, Non Linear Programming, McGraw Hill, New York, 1994.

(4) Mokther S. Bazaraa and C.M. Shetty, Non Linear Programming, Theory and Algorithms, 3rd edn, Willy, New York, 2013.

(5) Prem Kumar Gupta and D.S. Hira, Operations Research : An Introduction, S. Chand and Co., Ltd. New Delhi, 2014.

(6) S.S. Rao, Optimization Theory and Applications, 4th edn, Wiley, 2009.

(7) G. Hadley, Linear Programming, Narosa Publishing House, 2002

ELECTIVE COURSES

GRAPH THEORY

Course Code: 24S1M01ECA
Prerequisite: Nil

L	T	P	C
3	2	0	4

Objectives.

- To train the students to get expertise in the mathematical concepts involved in the field of Graph theory which has applications in diverse areas including Computer science and Electrical Engineering.
- In this course, the rudiments of Graph theory viz., Paths and connectedness of Graphs, Matching, Planarity, Vertex colourings, Edge colourings, are introduced.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Comprehend the basic concepts namely subgraph, automorphism of a simple graph and understand the operations on the graphs.	K2 & K4
CO2	Count the number of spanning trees and study connectivity of graphs	K4 & K7
CO3	Understand Halls Theorem on Bipartite graphs	K2, K4 & K5
CO4	Work in detail on the concepts of vertex colouring, edge colouring and chromatic polynomials.	K1, K3 & K6
CO5	Elucidate on the famous Four-Color theorem and discuss Heawood Five-Color theorem.	K2 & K5
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Graphs - Subgraphs - Isomorphism of graphs - Degrees of Vertices - Paths and Connectedness - Autumorphism of a Simple Graph - Operations on Graphs - Trees - Centers and Centroid.

Unit-II. Counting the Number of Spanning Trees - Cayley's Formula - Vertex Cuts and Edge Cuts - Connectivity and Edge-connectivity - Blocks - Cyclical Edge-connectivity of a Graph.

Unit-III. Vertex Independent sets and Vertex Coverings - Edge-Independent Sets - Matchings and Factors - M-Augmenting Paths - Matchings in Bipartite Graphs - Halls Theorem on Bipartite graphs - Tutte's 1-Factor Theorem.

Unit-IV. Vertex Coloring - Chromatic Number - Critical Graphs - Brooks' Theorem - Girth - Triangle-Free Graphs - Mycielski's Construction - Edge Colorings of Graphs - Vizing's Theorem - Chromatic Polynomials.

Unit-V. Planar and Nonplanar Graphs - Euler's Formula and its Consequences - K5 and K3,3 are Nonplanar graphs - Dual of a Plane Graph - The Four Color Theorem and the Heawood Five-Color Theorem - Kuratowski's Theorem (without proof).

Unit-VI (Advanced topics only for discussion). **Current Contours:** The Four Color Conjecture

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	2	3	3	2	2
CO2	3	3	3	2	3	3	2	2
CO3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	3	3	2	2
CO5	3	3	2	3	2	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	3	3	3	3
CO2	3	3	3	2	3	3	3	3
CO3	3	3	3	2	2	2	3	3
CO4	3	3	3	2	3	3	3	3
CO5	3	3	3	2	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): R, Balakrishnan and K.Ranganathan, A Textbook of Graph Theory, Second Edition, Springer, New York, 2012.

Unit-I: Chapter 1: 1.1-1.6, 1.8 and Chapter 3:3.1-3.5

Unit-II: Chapter 4: 4.1-4.5

Unit-III: Chapter 5: 5.1-5.5

Unit-IV: Chapter 7: 7.1,7.2,7.3.1, 7.5,7.6.2,7.9

Unit-V: Chapter 8: 8.1-8.7

References.

(1) Bondy J.A. and U.S.R. Murty, Graph Theory with Applications. North Holland, New York ,1976.

(2) Douglas B. West, Introduction to Graph Theory, Second Edition, PHI Learning Private Ltd, New Delhi-2011.

(3) G. Chartrand, Linda Lesniak and Ping Zhang, Graphs and Digraphs, Fifth Edition, CRC press, 2011.

COMPUTATIONAL MATHEMATICS

Course Code: 24S1M01ECB
Prerequisite: Nil

L	T	P	C
3	0	2	4

Objectives.

- To develop python programming skill and learn to apply it to numerical methods
- Thoroughly learn to solve system of linear equations, least square approximation and interpolation numerically.
- In this course, the rudiments of numerical differentiation and root finding techniques are all also emphasized.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Write simple codes in Python to carry out the scientific computing task. Master the technique of plotting functions, curves in 2D and 3D.	K3 & K5
CO2	Apply the art of programming to various computational tasks such as, iteration, recursion and understand various data structures involved.	K1 & K2
CO3	Develop codes for numerical computation in linear algebra. Writing codes for solving Least square regression problems	K3, K2 & K6
CO4	Workout numerical differentiation and its application to practical problems. Comprehend and work on the Taylor series and root finding techniques.	K1, K5 & K7
CO5	Solve numerical integration and ODE using python programming	K5 & K6
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Python Basics - Variables and basic data structures- Functions-Branching statement.

Unit-II. Iteration - Recursion - Representation of numbers- visualization plotting - Error types

Unit-III. Linear algebra and system of linear equation - Least square regression - Interpolation

Unit-IV. Taylor series - Root finding - Numerical differentiation

Unit-V. Numerical integration - ODE

Unit-VI (Advanced topics only for discussion). Current Contours: Numerical integration - PDE

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	2	3	3	3	2
CO2	3	3	3	2	3	3	3	2
CO3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	3	2

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	2	1	3	2
CO2	3	3	3	3	2	1	3	2
CO3	2	2	2	3	3	1	3	2
CO4	2	2	2	3	3	1	3	2
CO5	2	2	2	3	3	1	3	2
3-Strong; 2-Medium; 1-Low								

Text book(s): Qingkai Kong, Timmy Siauw and Alexandre M. Bayen, Python Programming and Numerical Methods A Guide for Engineers and Scientist , Elsevier.

Unit-I: Chapter 1,2,3 and 4

Unit-II: Chapter 5,6,9,12 (Review Chapter 10)

Unit-III: Chapter 14 (Section 14.6 can be omitted) Chapter 16 and 17

Unit-IV: Chapter 18,19 and 20 (section 20.4 can be omitted)

Unit-V: Chapter 21 and 22 (Section 22.7 can be omitted)

References.

(1) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th edn., New Age International, 2019.

(2) Real Python, A Practical introduction to Python, https://static.realpython.com/python-basics-sample-chapters.pdf

(3) Brian Heinold, A Practical Introduction to Python Programming
https://www.brianheinold.net/python/A_Practical_Introduction_to_Python_Programming_Heinold.pdf

(4) A. Downey, J. Elkner and C. Meyers, Learning with Python (Dreamtech Press, New Delhi, 2015)

(5) S. Taneja and N. Kumar, Python Programming: A modular Approach (Pearson India, Noida, 2018).

DISCRETE MATHEMATICS

Course Code: 24S1M01ECC
Prerequisite: Nil

L	T	P	C
3	2	0	4

Objectives.

- To train the students to get expertise in the mathematical concepts involved in the field Discrete Mathematics which has applications in diverse areas including Computer science and Electrical Engineering.
- To learn the basic concepts in combinatorics and the idea of tackling problems using generating functions and recurrence relation.
- Also, in this course, the rudiments of Graph theory viz., Paths and connectedness of Graphs, Matching, Planarity, Vertex colourings, Edge colourings, are introduced.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Review and explain the techniques required in addressing problems on permutations and combinations.	K2, K4 & K5
CO2	Solve recursions by finding generating functions and will be able to solve simultaneous recursions	K3 & K7
CO3	Understand and work on the elementary concepts of graphs namely, subgraph, cut vertex, blocks.	K2 & K3
CO4	Discuss matching problems and its applications elsewhere.	K5 & K6
CO5	Comprehend and work on the concepts of planarity and discuss the dual of a plane graph.	K1 & K2
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Combinatorics; Sequences: Stirling Numbers: A Preview - Ordinary Generating Functions - Synthesizing Generating Functions.

Unit-II. Solving Recurrences: Types of Recurrences - Finding Generating Functions - Partial Fractions - Characterstic Roots - Simultaneous Recursions.

Unit-III. Graph Theory ; Basic results: Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness

Connectivity : Vetex Cuts and Edges Cuts - Connectivity and Edge connectivity - Blocks - Cyclical Edge Connectivity of a graph - Menger's Theorem.

Unit-IV. Independent Sets and Matchings: Vertex Independent Sets and Vertex Coverings - Edge - Independent Sets - Matchings and Factors - Matchings in Bipartite Graphs.

Unit-V. Planarity: Planar and Nonplanar Graphs - Euler Formula and its Consequences - K5 and K(3,3) are Nonplanar Graphs - Dual of a Plane Graph - The Four-Color theorem and the Heawood Five-Color Theorem - Kuratowski's Theorem - Hamiltonian Plane Graphs - Tait Coloring.

Unit-VI (Advanced topics only for discussion). Current Contours: Perron -Frobenius theorem and Google's Page rank.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	2	3	2	3
CO2	3	3	2	3	2	3	2	3
CO3	3	3	2	3	3	3	2	3
CO4	3	3	2	3	3	3	2	3
CO5	3	3	2	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	3	2	3	3
CO2	3	3	3	2	3	2	3	3
CO3	3	3	3	3	3	1	3	2
CO4	3	3	3	3	3	1	3	2
CO5	3	3	3	3	3	1	3	2
3-Strong; 2-Medium; 1-Low								

Text book(s):

(1) Jonathan L. Gross, Combinatorial Methods with Computer Applications, Chapman & Hall /CRC, New York, 2008.

(2) R, Balakrishnan and K.Ranganathan, A Textbook of Graph Theory, Second Edition, Springer, New York, 2012.

Unit-I: Chapter 1 (Section 1.6 - 1.8) of [1]
Unit-II: Chapter 2 (Section 2.1 - 2.5) of [1]
Unit-III: Chapter 1 and Chapter 3 of [2]
Unit-IV: Chapter 5 (Sections 5.1 -5.5) and Chapter 7 (Section 7.1 - 7.3) of [2]
Unit-V: Chapter 8 of [2]

References.

(1) C.L. Liu, Elements of Discrete Mathematics, 4th edn, McGraw-Hill, 2017.

(2) P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill, 2017

(3) Bondy J.A. and U.S.R. Murty, Graph Theory with Applications. North Holland, New York ,1976.

PARTIAL DIFFERENTIAL EQUATIONS

Course Code: 24S2M02ECA
Prerequisite: 24S1M03CC

L	T	P	C
3	2	0	4

Objectives.

- The problem arising in physical phenomena widely involve partial differential equations (PDEs). The main objective is to equip students to classify partial differential equations and solve linear Partial Differential equations using different methods.
- To give a detailed study of Heat equation, Wave equation and Laplace equation.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Classify first order partial differential equations and their solutions. Use the method of characteristics to solve first order PDE.	K2 & K5
CO2	Solve first order equations and nonlinear PDE using various methods.	K3, K6 & K7
CO3	Identify and solve the three main classes of second order equations, elliptic, parabolic and hyperbolic.	K1, K4 & K7
CO4	Classify the boundary value problems and analyze its solutions. Solve one dimensional wave equations using method of separation of variables.	K1, K3 & K7
CO5	Solve Heat conduction problem using Fourier series and cosines. Illustrate the use of pde in problems from Engineering and Biological Sciences.	K1 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. First Order P.D.E. - Curves and Surfaces - Genesis of First Order P.D.E. - Classification of Integrals - Linear Equations of the First Order - Pfaffian Differential Equations - Compatible Systems - Charpit's Method - Jacobi's Method.

Unit-II. Integral Surfaces Through a Given Curve - Quasi-Linear Equations - Non-linear First Order P.D.E.

Unit-III. Second Order P.D.E.: Genesis of Second Order P.D.E. - Classification of Second Order P.D.E. One-Dimensional Wave Equation - Vibrations of an Infinite String - Vibrations of a Semi-infinite String - Vibrations of a String of Finite Length (Method of separation of variables).

Unit-IV. Laplace's Equation: Boundary Value Problems - 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 .

Unit-V. Heat Conduction Problem - Heat Conduction - Infinite Rod Case - Heat Conduction Finite Rod Case - Duhamel's Principle - Wave Equation - Heat Conduction Equation.

Unit-VI (Advanced topics only for discussion). **Current Contours:** Greens function - Theory of distributions.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): T.Amarnath, An Elementary Course in Partial Differential Equations, 2nd edn, Narosa Publishing Company, 2010.

Unit-I: Chapter 1: Sections 1.1 to 1.8

Unit-II: Chapter 1: Sections 1.9 to 1.11

Unit-III: Chapter 2: Sections 2.1 to 2.3.5, except 2.3.4

Unit-IV: Chapter 2: Sections 2.4.1 to 2.4.10

Unit-V: Chapter 2: Sections 2.4.11 to 2.6.2

References.

(1) Tyn Myint-U, Lokenath Debnath, Linear Partial Differential equations for scientists and engineers, 3rd edn, Birkhauser, 2007 .

(2) I.N. Snedden, Elements of Partial Differential Equations, Dover, 2006.

(3) F. Treves, Basic Linear Partial Differential Equations, Dover, 2006.

(4) A.K. Nandakumaran and P.S. Datti, Partial Differential Equations, Classical Theory with a Modern Touch, Cambridge University Press, 2020.

(5) K.S. Rao, Introduction to Partial Differential Equations, Prentice Hall of India, 2011.

(6) I.C. Evans, Partial Differential Equations, Orient Blackswan, 2014.
(7) F. John, Partial Differential Equations, Springer Verlag, 1991.
(8) Phoolan Prasad and Renuka Ravindran, Partial Differential Equations, New Age International, 2011.

INTEGRAL TRANSFORMS

Course Code: 24S2M02ECB
Prerequisite: 24S1M03CC

L	T	P	C
3	2	0	4

Objectives.

- The central theme of the course is to get an intensive training in the techniques of integral transforms and to apply them in practical problems eminating from various fields.
- The Laplace transforms and the Fourier transforms are dealt both with rigour and with lot examples and applications.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand Laplace transforms and get expertise in simple applications. Watson's lemma will be understood in depth.	K2 & K4
CO2	Get inverse Laplace transforms for a wide range functions. Understand the Heaviside series expansion.	K1, K2, K6 & K7
CO3	Apply the theory to ODE and PDE. Discuss in detail the application to Heat and diffusion equations.	K4 & K5
CO4	Appreciate the theory of Fourier transform and its mathematical depth.	K2 & K5
CO5	Solve problems formulated in mathematical modeling of water waves	K3 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Laplace transforms - Important properties - Simple Applications- Asymptotic Properties - Watson's Lemma.

Unit-II. Inversion Integral- The Riemann - Lebesgue Lemma - Dirichlet Integrals - the Inversion - Watson's Lemma for loop integrals- Heaviside series expansion.

Unit-III. Application to ordinary differential equations - Elementary examples - Higher order equations - Partial differential equations - Heat diffusion integral equations.

Unit-IV. Fourier transforms - Exponential- Sine and Cosine transforms- Important properties - Spectral analysis.

Unit-V. Partial differential equations - Potential problems-Water waves - Basic equations - Waves generated by a Surface displacement.

Unit-VI (Advanced topics only for discussion). Current Contours: Functional and complex analytic ideas developed.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

Text book(s): B. Davies, Integral Transforms and Their Applications,Springer, Texts in Applied Mathematics, 41 Third Edition, 2009.

Unit-I: Chapter 2

Unit-II: Chapter 3

Unit-III: Chapter 4,5 and 6

Unit-IV: Chapter 7

Unit-V: Chapter 8

References.

(1) Ian N. Snedden, The Use of Integral Transforms, McGraw Hill, 1972.

(2) Lokenath Debnath and D. Bhatta, Integral Transforms and Their Applications, 2nd edn., CRC, 2006.

CLASSICAL DYNAMICS

Course Code: 24S2M02ECC
Prerequisite: 24S1M03CC

L	T	P	C
3	2	0	4

Objectives.

- To develop familiarity with the dynamical concepts of Newton, Lagrange and Hamilton.
- To develop skills in formulating and solving physics problems.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand the important definitions and introductory concepts like the ideas of virtual work and d'Alembert's principle.	K2 & K4
CO2	Derive Lagrange's equations of motion using d'Alembert's principle. Understand the nature of equations of motion for holomorphic and non-holomorphic systems.	K2 & K5
CO3	Understand the Hamiltonian view point of dynamics in canonical equations of motion and phase space.	K4 & K5
CO4	Understand the concepts of Hamilton - Jacobi theory.	K1 & K2
CO5	Obtain some concrete procedure for solving problems using the theory of canonical transformations.	K3, K6 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Introductory concepts: The mechanical system - Generalised Coordinates - constraints - virtual work - Energy and momentum.

Unit-II. Lagrange's equation: Derivation and examples - Integrals of the Motion.

Unit-III. Hamilton's equations: Hamilton's principle - Hamilton's equations - Other variational principles - phase space.

Unit-IV. Hamilton - Jacobi Theory: Hamilton's Principal Function - The Hamilton - Jacobi equation - Separability.

Unit-V. Canonical Transformations: Differential forms and Generating functions - Special Transformations - Lagrange and Poisson Brackets.

Unit-VI (Advanced topics only for discussion). Current Contours: Introduction to relativity

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	3	3	3	2	2
CO2	3	2	2	3	3	3	2	2
CO3	3	2	2	3	3	3	2	2
CO4	3	2	2	3	3	3	2	3
CO5	3	2	2	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	2
CO2	3	2	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	2
CO4	3	2	3	3	3	3	3	2
CO5	3	2	3	3	3	3	3	2
3-Strong; 2-Medium; 1-Low								

Text book(s): Donald T. Greenwood, Classical Dynamics, Dover, 1997.

Unit-I: Chapter 1: Sections 1.1 to 1.5

Unit-II: Chapter 2: Sections 2.1 to 2.4

Unit-III: Chapter 3: Sections 3.1 - 3.2 and 3.4 (section 3.3 omitted)

Unit-IV: Chapter 4: Sections 4.1 to 4.4

Unit-V: Chapter 5: Sections 5.1 to 5.3

References.

(1) H. Goldstein, Classical Mechanics, (2nd Edition), Narosa Publishing House, New Delhi, 1998.

(2) John L Synge and Byron A Griffith, Principles of Mechanics, 3rd edn., McGraw-Hill, New York, 2017.

(3) Narayan Chandra Rana & Promod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.

INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS

Course Code: 24S3M03ECA
Prerequisite : 24S1M03CC

L	T	P	C
3	2	0	4

Objectives.

- To obtain thorough analysis of various aspects of calculus of variations.
- To acquire the knowledge of solving problems in the fields of mechanics and mathematical physics.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Gain insight into both fixed and moving boundary problems, including extremals with corners and conditional extremum problems.	K2, K4 & K5
CO2	Understanding these contexts will allow for more accurate modeling and problem-solving in practical engineering and scientific scenarios.	K2 & K6
CO3	Gain mastery in solving extremum problems and conditional extremum problems.	K5 & K7
CO4	Develop a solid understanding of linear integral equations, kernels, eigenvalues/eigenfunctions, and methods for solving these equations.	K1, K3 & K7
CO5	Learn iterative and approximate methods for solving integral equations, including the method of successive approximations and Fredholm theory.	K1, K5 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Problems with fixed boundaries.

Unit-II. Problems with moving boundaries - Extremals with corners - One sided variations.

Unit-III. Sufficient conditions for Extremum - Conditional Extremum Problems.

Integral Equations.

Unit-IV. Linear Integral Equations - Definition, Regularity conditions - special kind of kernels - eigen values and eigen functions - convolution Integral - the inner and scalar product of two functions - Notation - reduction to a system of Algebraic equations - examples - Fredholm alternative - examples - an approximate method.

Unit-V. Method of successive approximations: Iterative scheme - examples - Volterra Integral equation - examples - some results about the resolvent kernel. Classical Fredholm Theory: the method of solution of Fredholm - Fredholm's first theorem - second theorem - third theorem(Statements Only)-Applications to ODE-Initial value problems -Boundary value problems.

Unit-VI (Advanced topics only for discussion). Current Contours: Variational problems in fluid flow and Heat transfer.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Text book(s):

(1) Ram.P.Kanwal - Linear Integral Equations Theory and Practice,Birkhäuser, 2012.

(2) L. Elsgolts, Differential equations and the calculus of variations, University Press of the Pacific, 2003.

Unit-I: Chapter 6 of [2]

Unit-II: Chapter 7,8 of [2]

Unit-III: Chapter 9,10 of [2]

Unit-IV: Chapters 1 and 2 of [1]

Unit-V: Chapters 3, 4 and Section 5.1, 5.2 of [1]

References.

(1) S.J. Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.

(2) I.N. Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966.

NUMERICAL ANALYSIS

Course Code: 24S3M03ECB
Prerequisite: 24S1M03CC

L	T	P	C
3	2	0	4

Objectives.

- To introduce the field of numerical analysis as the design and analysis of techniques to give approximate solutions to difficult problems.
- The indispensable error analysis part has to be emphasized in the course.
- Various numerical methods are used to solve algebraic equations and differential equations.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Solve algebraic and transcendental equations using various iterative methods and study the rate of convergence of those problems.	K5 & K7
CO2	Solve System of Linear Algebraic equations using direct methods and indirect methods.	K2, K3 & K7
CO3	Solve algebraic equations and differential equations using the techniques of interpolation like Lagrange Interpolation, Hermite Interpolation etc..	K1, K4 & K5
CO4	Calculate the numerical value of a definite integral using methods like quadrature rules in numerical integration.	K1 & K5
CO5	Identify the suitable numerical method and perform error analysis.	K6 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Transcendental and polynomial equations: Iteration Methods based on Second degree equation - Rate of convergence of iterative methods - Methods for finding complex roots - Polynomial equations - Birge-Vieta method, Bairstow's method.

Unit-II. System of Linear Algebraic equations and Eigen Value Problems: Direct Methods- Gauss Jordan Elimination Method - Triangularization method - Cholesky method - Error Analysis - Iteration Methods - Jacobi iteration method - Gauss - Seidal iteration method - Eigenvalues and Eigen vectors.

Unit-III. Interpolation, Approximation and Differentiation: - Introduction - Hermite Interpolations - Piecewise and Spline Interpolation - Approximation - Least square approximation - Differentiation - Numerical Differentiation - Optimum choice of Step- length - Extrapolation methods

Unit-IV. Differentiation and Integration: - Methods based on interpolation - Methods based on undetermined coefficients - Gauss Legendre integration methods - Lobatto Integration Methods - Radau integration methods.

Unit-V. Ordinary differential equations: Introduction - Numerical Methods- Local truncation error - Euler, Backward Euler, Taylor's Method and second order Runge-Kutta method

Unit-VI (Advanced topics only for discussion). **Current Contours:** Methods for partial differential equations

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	3	3	2	2
CO2	3	2	3	3	3	3	2	2
CO3	2	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	2	2
CO5	3	3	3	3	3	3	2	2

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	2	2
CO2	3	2	3	3	3	3	2	2
CO3	3	3	3	3	2	3	2	2
CO4	3	2	2	3	3	3	2	2
CO5	3	2	2	3	3	3	2	2

3-Strong; 2-Medium; 1-Low

Text book(s): M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th edn., New Age International, 2019.

Unit-I: Chapter 2 - 2.4 to 2.8 of [1].

Unit-II: Chapter 3 - 3.2 to 3.5 of [1].

Unit-III: Chapter 4 - 4.1, 4.5 , 4.6, 4.8,4.9 and 5.2 - 5.4 of [1].

Unit-IV: Chapter 5 - 5.6 - 5.8 of [1].

Unit-V: Chapter 6 - 6.2 and 6.3 of [1].

References.

(1) Kendall E. Atkinson, An Introduction to Numerical Analysis, II Edn., John Wiley & Sons, 1988.

(2) M.K. Jain, Numerical Solution of Differential Equations, 4th edn., New Age International Pvt Ltd., 2018.

(3) Samuel. D. Conte, Carl. De Boor, Elementary Numerical Analysis; An Algorithmic Approach (Updated with MatLab), SIAM, 2018.

(4) George A. Anastassiou, Razvan A. Mezei, Numerical Analysis Using Sage, Springer (UTM), 2016

STOCHASTIC PROCESSES

Course Code: 24S3M03ECC
Prerequisite: Nil

L	T	P	C
3	2	0	4

Objectives.

- To motivate stochastic processes and in particular Markov chains are the ones which are widely used as mathematical models of systems and phenomena that appear to vary in a random manner.
- To study Markov chainsRiemann-Stieltjes integrals - Po, Markov processes with discrete and continuous state space, renewal processes in continuous time and Morkovian queuing models.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Gain proficiency in formulating and solving problems related to stochastic processes, queuing systems, and renewal theory.	K2 & K3
CO2	Apply theoretical knowledge to real-world problems, enhancing problem -solving capabilities in operations research, economics, and engineering.	K1, K6 & K7
CO3	Develop strong analytical skills to model and analyze complex stochastic systems.	K4 & K6
CO4	Exploring models like birth-death processes or non-Markovian queuing systems, develop the ability to think creatively to extended it in new ways.	K1, K5 & K6
CO5	Engaging with advanced topics like branching processes will stimulate creative thinking about complex systems and their behavior.	K2, K4 & K5
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Stochastic Processes: Some notions - Specification of Stochastic processes Stationary processes - Markov Chains - Definitions and examples - Higher Transition probabilities - Generalization of Independent Bernoulli trails - Sequence of chain - Dependent trails.

Unit-II. Markov chains: Classification of states and chains - determination of Higher transition probabilities - stability of a Markov system - Reducible chains - Markov chains with continuous state space.

Unit-III. Markov processes with Discrete state space : Poisson processes and their extensions - Poisson process and related distribution - Generalization of Poisson process- Birth and Death process - Markov processes with discrete state space (continuous time Markov Chains).

Unit-IV. Renewal processes and theory : Renewal process - Renewal processes in continuous time - Renewal equation - stopping time - Wald's equation - Renewal theorems.

Unit-V. Stochastic processes in Queuing - Queuing system - General concepts - the queuing model $M/M/1$ - Steady state behaviour - transient behaviour of $M/M/1$ Model - Non-Markovian models - the model $GI/M/1$.

Unit-VI (Advanced topics only for discussion). **Current Contours:** Branching Processes

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): J. Medhi, Stochastic Processes, 5th edn., New Age International, 2020.

Unit-I: Ch. II : Sec 2.1 to 2.3, Ch III : Sec 3.1 to 3.3

Unit-II: Ch III - Sec 3.4 to 3.6, 3.8, 3.9 and 3.11

Unit-III: Ch IV : Sec 4.1 to 4.5

Unit-IV: Ch VI : Sec 6.1 to 6.5

Unit-V: Ch X : Sec 10.1 to 10.3, 10.7 and 10.8 (omit sec 10.2.3 & 10.2.3.1)

References.

(1) Samuel Karlin, Howard M. Taylor, A first course in stochastic processes, 2nd edition, Academic Press, 1975.

(2) Narayan Bhat , Elements of Applied Stochastic Processes, 2nd edn, John Wiley, 1984.

(3) S.K. Srinivasan and K.Mehata, Stochastic Processes, Tata McGraw Hill, 1976.

(4) N.U. Prabhu, Stochastic Processes: Basic Theory and its Applications, World Scientific Publishers, 2007.

PROBABILITY AND STATISTICS

Course Code: 24S4M04ECA
Prerequisite: Nil

L	T	P	C
3	2	0	4

Objectives.

- To study sample moments of distribution functions, concept of statistical test, and methods of finding estimates.
- To gain a working knowledge on analysis of variance and performing sequential analysis.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Gain strong numerical skills for calculating probabilities, moments, and other statistical measures, which are fundamental for rigorous analysis.	K3 & K5
CO2	Understand different probability distributions and their properties, such as probability mass functions and probability density functions.	K2 & K4
CO3	Gain ability to critically evaluate the performance and appropriateness of different statistical models and techniques for various applications.	K1, K6 & K7
CO4	Acquire skills in applying statistical theory to real-world problems and using statistical software for data analysis.	K2, K6 & K7
CO5	Ability to analyze and interpret probability distributions and statistical data.	K1 & K4
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Probability: Sample Space, Probability Axioms, Probability on Finite Sample Spaces, Conditional Probability and Bayes Theorem, Independence of Events.

Unit-II. Random Variables and their Probability Distribution: Random Variables, Probability Distribution of a Random Variable, Discrete and Continuous Random Variables, Functions of a Random Variable.

Unit-III. Moments and Generating Functions: Moments of a Distribution Function, Generating Functions, Some Moment Inequalities.

Unit-IV. Multiple Random Variables: Multiple Random Variables, Independent Random Variables, Functions of Several Random Variables, Covariance, Correlation and Moments, Conditional Expectation.

Unit-V. Some Special Distributions: Discrete Distributions - Degenerate Distribution, Two-Point Distribution, Uniform Distribution on n Points, Binomial Distribution, Negative Binomial Distribution (Pascal or Waiting Time Distribution), Hypergeometric Distribution, Negative Hypergeometric Distribution, Poisson Distribution, Multinomial Distribution, Multivariate Hypergeometric Distribution, Multivariate Negative Binomial Distribution. Continuous Distributions - Uniform Distribution (Rectangular Distribution), Gamma Distribution, Beta Distribution, Cauchy Distribution, Normal Distribution (the Gaussian Law), Some Other Continuous Distributions.

Unit-VI (Advanced topics only for discussion). Current Contours: Usage of package R

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Text book(s): V.K.Rohatgi and A.K.Md.E. Saleh, An Introduction to Probability and Statistics, Wiley series of probability and Statistics, 2nd edn., 2001.

Unit-I: Chapter 1
Unit-II: Chapter 2
Unit-III: Chapter 3
Unit-IV: Chapter 4, except Section 4.7
Unit-V: Chapter 5, except Sections 5.2.9 - 5.2.11, 5.4, 5.5

References.

(1) M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 2012

(2) E.J.Dudewicz and S.N.Mishra, Modern Mathematical Statistics, Jobn Wiley and Sons, New York, 1988.

(3) D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, John Wiley & Sons, 6th edn., 2016.

(4) G.G.Roussas, A First Course in Mathematical Statistics, Addison Wesley Publishing Company, 1973.

(5) B.L.Vander Waerden, Mathematical Statistics, G.Allen & Unwin Ltd., London, 1968.

OPERATOR THEORY

Course Code: 24S4M04ECB
Prerequisite: 24S2M06CC

L	T	P	C
3	2	0	4

Objectives.

- The idea behind the second course on functional analysis is to emphasize very basic results which are left out in the first course and are important for analysts who apply these tools.
- To study compact operators, spectral theory of Banach space operators and Hilbert space operators, Banach algebras and Gelfand Naimark theorem.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understanding of the foundational concepts in functional analysis, including compact operators, dual spaces, and adjoint operators.	K1, K2 & K4
CO2	have a deep understanding of the advanced concepts in functional, analysis including operators, Banach algebras, and spectral theory.	K2 & K5
CO3	Analyze and interpret mathematical results and proofs related to functional analysis and operator theory.	K1, K4 & K6
CO4	Apply the theory of compact operators and spectral theorems to solve problems involving linear operators and their spectra.	K3 & K7
CO5	Learn weak topologies on a normed linear space and understand. the importance of Banach Alaoglu Theorem	K2, K4 & K5
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Review of Five Pillars of Functional Analysis - Compact operators

Unit-II. Dual Spaces - Adjoint Operators - Hilbert Space Adjoint

Unit-III. Banach Algebras - Spectrum of an Element in a Banach Algebra - Spectrum of Some Standard Operators

Unit-IV. Finite dimensional Spectral theorem - Spectral theorem for Hermitian Operators - Corollaries of the Spectral theorem -Spectral Measures

Unit-V. Generating topologies - Weak and Weak* topologies - Banach Alaoglu Theorem

Unit-VI (Advanced topics only for discussion). **Current Contours:** Locally Convex Topological Vector spaces

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	3	2	3	2	3
CO2	2	3	3	3	2	3	2	3
CO3	2	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	2	2	3	3	3
CO2	3	3	3	2	2	3	3	3
CO3	3	3	3	2	2	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3
3-Strong; 2-Medium; 1-Low								

Text book(s): S.Kumaresan and D.Sukumar, Functional Analysis A first course, Narosa Publishing House, 2020.

Unit-I: Chapter 2, Chapter 3: Skip Subsections 2.1.1, 2.5.1, 2.6.1.3-2.6.1.5

Unit-II: Chapter 4

Unit-III: Chapter 5

Unit-IV: Chapter 6

Unit-V: Chapter 7

Unit-VI: Chapter 8

References.

(1) B. Bollobas, Linear Analysis an introductory course, 2nd edn, Cambridge Mathematical Texts, Cambridge University Press, 1999.

(2) B.V. Limaye, Functional Analysis, Revised 3rd edn, New Age International, 2014.

(3) C. Goffman and G. Pedrick, A First Course in Functional Analysis, AMS, Chelesea, 2017

(4) B. Rynne and M.A. Youngson, Linear Functional Analyis, Springer UMS, 2008

(5) E. Kreyszig, Introductory Functional Analysis with applications, John Wiley, 2007.

(6) S. Kesavan, Functional Analysis, Hindustan book agency, 2014.

(7) G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2017.

(8) M.Thamban Nair, Functional Analysis: A first course, Prentice Hall of India, 2002.

(9) K. Yosida, Functional Analysis, Springer-Verlag, 1995.

FLUID DYNAMICS

Course Code: 24S4M04ECC
Prerequisite: 24S1M03CC

L	T	P	C
3	2	0	4

Objectives.

- To understand the dynamics of real fluids.
- To acquire the knowledge of solving problems using partial differential equations.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Grasp the principles of fluid dynamics, the distinction between real and ideal fluids also the concepts of velocity,flow types and boundary conditions.	K2 & K4
CO2	Understand the behavior of fluids under various conditions both steady and unsteady flows, and the implications of different forces acting on the fluid.	K2 & K5
CO3	Derive images in three dimension. Solve problems using Milne-Thomson circle theorem.	K1 & K7
CO4	Develop the ability to critically analyze fluid flow problems,apply appropriate theories and mathematical models, and interpret results in a practical context.	K3, K4 & K6
CO5	Enhance problem-solving skills through worked examples and real-world applications.	K1, K3 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Real Fluids and Ideal Fluids - Velocity of a Fluid at a point - Streamlines and Path lines; Steady and Unsteady Flows - The Velocity potential - The Vorticity vector - Local and Particle Rates of Change - The Equation of continuity - Worked examples - Acceleration of a Fluid - Conditions at a rigid boundary - General analysis of fluid motion - Pressure at a point in a Fluid at Rest - Pressure at a point in Moving Fluid - Conditions at a Boundary of Two Inviscid Immiscible Fluids -Euler's equations of motion - Bernoulli's equation - worked examples.

Unit-II. Discussion of a case of steady motion under conservative body forces - Some potential theorems-Some Flows Involving Axial Symmetry - Some special two- Dimensional Flows - Impulsive Motion. Some three-dimensional Flows: Introduction - Sources, Sinks and Doublets - Images in a Rigid Infinite Plane - Axi-Symmetric Flows; Stokes stream function

Unit-III. Some Two-Dimensional Flows: Meaning of a Two-Dimensional Flow - Use of cylindrical Polar coordinates - The stream function - The Complex Potential for Two- Dimensional, Irrotational, Incompressible Flow - complex velocity potentials for Standard Two-Dimensional Flows - Some worked examples - The Milne-Thomson circle theorem and applications - The Theorem of Blasius.

Unit-IV. The use of conformal Transformation and Hydrodynamical Aspects - Vortex rows. Viscous flow: Stress components in a Real fluid - relations between Cartesian components of stress - Translational Motion of Fluid Element - The Rate of Strain Quadric and Principal Stresses - Some Further properties of the Rate of Strain Quadric - Stress Analysis in Fluid Motion - Relations Between stress and rate of strain - The coefficient of viscosity and Laminar Flow - The Navier - Stokes equations of Motion of a Viscous Fluid.

Unit-V. Some solvable problems in Viscous Flow - Steady Viscous Flow in Tubes of Uniform cross section - Diffusion of Vorticity - Energy Dissipation due to Viscosity - Steady Flow past a Fixed Sphere - Dimensional Analysis; Reynolds Number - Prandtl's Boundary Layer.

Unit-VI (Advanced topics only for discussion). Current Contours: Gas Dynamics and Magnetohydrodynamics.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	3	3	3	2	2
CO2	3	2	2	3	3	3	2	2
CO3	3	2	2	3	3	3	2	2
CO4	3	2	2	3	3	3	2	3
CO5	3	2	2	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	2
CO2	3	2	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	2
CO4	3	2	3	3	3	3	3	2
CO5	3	2	3	3	3	3	3	2
3-Strong; 2-Medium; 1-Low								

Text book(s): F. Chorlton, Text Book of Fluid Dynamics, CBS Publishers & Distributors, New Delhi, 1985.

Unit-I: Chapter 2 and Chapter 3: Sections 3.1 to 3.6

Unit-II: Chapter 3: Sections 3.7 to 3.11 and Chapter 4: Sections 4.1, 4.2, 4.3, 4.5

Unit-III: Chapter5 : Sections: 5.1 to 5.9 except 5.7

Unit-IV: Chapter 5: Section 5.10 , 5.12 and Chapter 8: Sections 8.1 to 8.9

Unit-V: Chapter 8: Sections 8.10 to 8.16

References.

(1) J.F. Wendt, J.D. Anderson, G.Degrez and E. Dick, Computational Fluid Dynamics : An Introduction, Springer-Verlag, 1996.

(2) J.D. Anderson, Computational Fluid Dynamics, The Basics with Applications, Mc-Graw Hill, 2017.

(3) G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 2005.

(4) A.J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics, Springer-Verlag, New York, 1993.

(5) S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Pvt Limited, New Delhi, 1976.

(6) R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.

NON-MAJOR ELECTIVE COURSES

PROGRAMMING IN C

Course Code: 24S2M01NMEA
Prerequisite: Nil

L	T	P	C
2	0	1	2

Objectives.

- To introduce basic art of programming and train them in programming skills.
- To have a basic working knowledge on structured programming.
- To expose the learners in powerful, efficient and compact use of pointers.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand the history and importance of C and learn basic scientific programming	K2
CO2	Gain proficiency in decision-making constructs, understand the concept of control structure and to know different types of control structure statements in C.	K2 & K4
CO3	Learn the concept of constants, variables and their types and perform mathematical or logical manipulations using operators.	K1, K3 & K6
CO4	Understand the use of pointers and learn how to use it, acquire flexible approaches to manage data in C.	K2 & K5
CO5	Gain knowledge dynamic data structures in conjunction with dynamic memory management techniques	K2, K3 & K4
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Overview of C – Constants, Variables and Data Types – Operators and Expression

Unit-II. Managing I/O Operators – Decision Making and Branching

Unit-III. Decision Making and Looping – Arrays

Unit-IV. User-Defined functions – Structures and Unions

Unit-V. Pointers – File Management

Unit-VI (Advanced topics only for discussion). Current Contours: Dynamic Memory Allocation and linked lists.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	2	3	3	2	2
CO2	3	3	3	3	3	3	2	3
CO3	3	2	2	2	3	3	2	2
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	2	3	3	1	2	3
CO2	3	3	2	3	3	1	2	3
CO3	3	3	2	3	3	1	2	3
CO4	3	3	2	3	3	1	2	3
CO5	3	3	2	3	3	1	2	3

3-Strong; 2-Medium; 1-Low

Text book(s): E. Balagurusamy, Programming in ANSI C Second Ed., TMH, New Delhi, 2004.

Unit-I: Chapters 1, 2 and 3
Unit-II: Chapters 4 and 5
Unit-III: Chapters 6 and 7
Unit-IV: Chapters 9 and 10
Unit-V: Chapters 11 and 12

References.

(1) Brain W. Kernighan and Dennis M. Ritchie, A C Program Language, 2nd Edition (ANSI Features), Prentice Hall, 1989.

(2) Peter A. Darnel and Philip E. Margolis, C : Software Engineering Approach, Narosa Publishing House (Springer International Student Edition, 1993)

(3) Samuel P. Harkisonand Gly L. Steele Jr., C: A Reference Manual, 2nd Edn. Prentice Hall of India, 1984.

(4) Schaum series, Programming with C, McGraw Hill, 2002.

RESOURCE MANAGEMENT TECHNIQUES

Course Code: 24S2M01NMEB
Prerequisite: Nil

L	T	P	C
2	1	0	2

Objectives.

- To introduce operations research and study the techniques which offers enormous practical.
- To have a basic working knowledge on Linear programming, Transportation problems, game theory and network scheduling.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Solve linear programming problem using graphical method and understand basic feasible solution and optimal solution geometrically.	K3 & K7
CO2	Understand duality in linear programming problem and solve them.	K2, K4 & K7
CO3	Understand simplex method and revised simplex method and apply the algorithms to solve a plenty of problems.	K1, K4 & K7
CO4	Understand the use of pointers and learn how to use it, acquire flexible approaches to manage data in C.	K2, K3 & K6
CO5	Gain knowledge dynamic data structures in conjunction with dynamic memory management techniques	K4 & K5
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Linear programming problem - Mathematical formulation - Graphical solution and extension - Simplex method.

Unit-II. Duality in Linear programming.

Unit-III. Transportation problem - Assignment problem.

Unit-IV. Game Theory.

Unit-V. Network Scheduling by PERT/CPM.

Unit-VI (Advanced topics only for discussion). Current Contours: Network flows

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	2	3	2	3	3
CO2	3	2	3	2	3	2	3	3
CO3	3	2	3	2	3	2	3	3
CO4	3	2	3	2	3	2	3	3
CO5	3	2	3	2	3	2	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3
3-Strong; 2-Medium; 1-Low								

Text book(s): Kanti Swarup, P. K. Gupta, Man Mohan, Operations Research, Sultan Chand and Sons, 2010.

Unit-I: Chapters 2, 3 and 4

Unit-II: Chapter 5

Unit-III: Chapters 10 and 11

Unit-IV: Chapters 17

Unit-V: Chapters 25

References.

(1) Bazaara, Jarvis and Sherali, Linear Programming and Network Flows, 2th ed., John Wiley.

(2) Hamdy Taha, Operations Research, Pearson Education.

MATHEMATICAL MODELLING

Course Code: 24S2M01NMEC
Prerequisite: Nil

L	T	P	C
2	1	0	2

Objectives.

- To introduce the concepts of mathematical modelling .
- To give a wide range view of applications of mathematics in science and technology.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand the concept of a mathematical model and explain the series of steps involved in mathematical modeling .	K1, K2 & K4
CO2	Solve problems in engineering, physical, biological, social and behavioral sciences.	K3, K5 & K7
CO3	Model the problems in economics and finance, population dynamics and genetics.	K6 & K7
CO4	Identify some simple real-life problems that can be solved using mathematical models.	K4 & K7
CO5	Use the ideas of directed graphs, weighted digraphs and unoriented graphs for modeling real life problems.	K4, K5 & K6
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Mathematical Modelling through Ordinary Differential Equations of First order : Linear Growth and Decay Models - Non-Linear Growth and Decay Models - Compartment Models - Dynamics problems - Geometrical problems.

Unit-II. Mathematical Modelling through Systems of Ordinary Differential Equations of First Order : Population Dynamics - Epidemics - Compartment Models - Economics - Medicine, Arms Race, Battles and International Trade - Dynamics.

Unit-III. Mathematical Modelling through Ordinary Differential Equations of Second Order: Planetary Motions - Circular Motion and Motion of Satellites - Mathematical Modelling through Linear Differential Equations of Second Order - Miscellaneous Mathematical Models.

Unit-IV. Mathematical Modelling through Difference Equations : Simple Models - Basic Theory of Linear Difference Equations with Constant Coefficients - Economics and Finance - Population Dynamics and Genetics - Probability Theory.

Unit-V. Mathematical Modelling through Graphs : Solutions which can be Modelled through Graphs - Mathematical Modelling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs and Unoriented Graphs.

Unit-VI (Advanced topics only for discussion). Mathematical Modelling through mathematical programming, maximum principle and maximum entropy principle.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): J.N. Kapur, Mathematical Modelling, Wiley Eastern Limited, New Delhi, 1988.

References.

(1) Mike Mesterton-Gibbons, A Concrete Approach to Mathematical Modelling (Wiley-Interscience Paperback Series), Wiley-Interscience, 2007.

(2) Edward A. Bender, An Introduction to Mathematical Modelling, Wiley. 1978.

(3) J. N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East - West Press Pvt Limited, New Delhi, 1981.

STATISTICS

Course Code: 24S3M02NMEA
Prerequisite: Nil

L	T	P	C
2	1	0	2

Objectives.

- To introduce the concepts involved in basic statistics and learn them with plenty of demonstrating examples
- To emphasize the correct statistical tools required to analyze and understand the results based on them.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Collect, classify and tabulate a given data and study graphical and diagrammatic representations.	K2, K4 & K5
CO2	Understand measures of central tendency, viz., Mean, Median and Mode in series of individual observations.	K1, K2 & K3
CO3	Analyze measures of dispersion namely range, quartile deviation, Mean deviation about an mean, standard deviation and co-efficient of variation for individual, discrete and continuous type data	K4 & K6
CO4	Thoroughly understand and analyze the given problems with the standard regression types.	K1 & K4
CO5	Compute partial and multiple regression coefficient for a plenty of problems.	K5 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Collection, classification and tabulation of data, graphical and diagrammatic representation - Bar diagrams, Pie diagram, Histogram, Frequency polygon, frequency curve and Ogives.

Unit-II. Measures of central tendency - Mean, Median and Mode in series of individual A short introduction on the use of statistical package RobseUnderstand the concept of a mathematical model and explain the series of steps involved in mathematical modelling .

Unit-III. Measures of dispersion - Range, Quartile deviation, Mean deviation about an average, Standard deviation and co-efficient of variation for individual, discrete and continuous type data.

Unit-IV. Correlation - Different types of correlation - Positive, Negative, Simple, Partial Multiple, Linear and non-Linear correlation. Methods of correlation - Karlpearson's Spearman's correlations and Concurrent deviation .

Unit-V. Regression types and method of analysis, Regression line, Regression equations, Deviation taken from arithmetic mean of X and Y, Deviation taken from assumed mean, Partial and multiple regression coefficients - Applications

Unit-VI (Advanced topics only for discussion). **Current Contours:** A short introduction on the use of statistical package R

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3

3-Strong; 2-Medium; 1-Low

Text book(s): S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi, 1994.

References.

(1) Freund J.E.(2001); Mathematical Statistics, Prentice Hall of India.

(2) Goon, A.M., Gupta M.K., Dos Gupta, B, (1991), Fundamentals of Statistics, Vol.I, World Press, Calcutta.

QUANTITATIVE APTITUDE

Course Code: 24S3M02NMEB
Prerequisite: Nil

L	T	P	C
2	1	0	2

Objectives.

- To gain quantitative aptitude required in the present scenario.
- To emphasize the right perceptive needed to crack such problems and understand the recurring pattern in those problems.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Solve a lot of problems on numbers and averages and problems on ages.	K2, K3 & K7
CO2	Crack problems on calculating simple interest and compound Interest.	K1, K6& K7
CO3	Get working knowledge on ratios and proportions.	K1, K3 & K6
CO4	Work on a plenty of problems on time and work.	K1, K3 & K5
CO5	Calculate time, distance, speed given the other two and solve lot of problems.	K1, K3 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Problems on Numbers- Average-Problems on Ages.

Unit-II. Percentage-Profit & Loss-Simple Interest-Compound Interest.

Unit-III. Ratio & Proportion-Partnership-Calender-Clocks.

Unit-IV. Time and work-Pipes & Cistern

Unit-V. Time & Distance-Problems on Trains-Boats and Streams

Unit-VI (Advanced topics only for discussion). Current Contours: Simple problems using sets, functions, group theory etc.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	2	3	2	3
CO2	3	3	3	3	2	3	2	3
CO3	3	3	3	3	2	3	2	3
CO4	3	3	3	3	2	3	2	3
CO5	3	3	3	3	2	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	2	2	3	2	2	2
CO2	3	2	2	2	3	2	2	2
CO3	3	2	2	2	3	2	2	2
CO4	3	2	2	2	3	2	2	2
CO5	3	2	2	2	3	2	2	2
3-Strong; 2-Medium; 1-Low								

Text book(s): Dinesh Khattar, The Pearson Guide To Quantitative Aptitude For Competitive Examinations, Pearson Education, 3 edition, 2015.

References.

(1) R. V. Praveen, Quantitative Aptitude and Reasoning,-PHI Learning Private Ltd, 2013.
(2) Jaggan Saneja, Quantitative Aptitude Simplified, Notion Press, 2020.
(3) R. S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publishing, 2017.

OBJECT ORIENTED PROGRAMMING USING C++

Course Code: 24S3M02NMEC
Prerequisite: +2 level Mathematics

L	T	P	C
2	0	1	2

Objectives.

- To introduce programming style that is associated with the concept of class, objects and other concepts revolving around these two, like inheritance and polymorphism.
- To realize object-oriented programming is a vast improvement over procedural programs.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Learn programming basics, viz., simple functions, call by value and reference, returning values of different type, function overloading, and recursive functions.	K1 & K2
CO2	Understand that object oriented programs are organized around objects, which contain both data and functions that act on that data and a class is a template for a number of objects.	K2 & K4
CO3	Appreciate with examples structures and classes, static data, static function and array of objects.	K3 & K5
CO4	Master the concept in files and streams and error handling during file operations	K4 & K6
CO5	Have a working knowledge of Disk I/O operations with member functions.	K1, K3 & K6
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Programming Paradigms - Introduction to OOP - Advantages of OOP-Characteristics of OO languages - Overview of C++ - C++ programming basics - Functions: Simple Functions - Call by value - Call by reference - Returning values of different type - Function overloading - inline functions - Default arguments - Recursive functions.

Unit-II. Class - Objects - Constructors - Destructors - Objects as function arguments - Returning objects from functions - Structures and Classes - Static data - Static function - Array of objects.

Unit-III. Access specifiers - Friend function - Friend class - Operator overloading - Type casting - Pointers - Template.

Unit-IV. Inheritance - Derived class constructors - Class hierarchies - Types of inheritance - Virtual base class - Function overriding - Virtual functions - Pure virtual functions - Abstract class.

Unit-V. Files and Streams: I/O manipulators - Streams - Error handling during file operations String I/O - Character I/O - Object I/O - I/O with multiple objects - File pointers - Disk I/O with member functions.

Unit-VI (Advanced topics only for discussion). **Current Contours:** Object oriented software development

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	2	3	3	2	2
CO2	3	3	3	3	3	3	2	3
CO3	3	2	2	2	3	3	2	2
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	2	3	3	1	2	3
CO2	3	3	2	3	3	1	2	3
CO3	3	3	2	3	3	1	2	3
CO4	3	3	2	3	3	1	2	3
CO5	3	3	2	3	3	1	2	3

3-Strong; 2-Medium; 1-Low

Text book(s): Robert Lafore, Object-Oriented Programming in Microsoft C++, Galgotia Publications, New Delhi, 2000.

Unit-I: Chapters 1, 2 and 3
Unit-II: Chapters 4 and 5
Unit-III: Chapters 6 and 7
Unit-IV: Chapters 9 and 10
Unit-V: Chapters 11 and 12

References.

(1) E.Balagurusamy, Object-Oriented Programming with C++, Second Edition, 2002.
(2) Bjarne Stroustrup, The C++ Programming Language, Addison-Wesley, New York,1999.
(3) StephenPrata,"C++ Primer Plus", 6th Edition ,Addison-Wesley Professional, 2011.

VALUE ADDED COURSES

INTRODUCTION TO LATEX

Course Code:24S2M01VACA
Prerequisite: Nil

L	T	P	C
1	0	1	2

Objectives.

- To make the students learn the art of typing mathematics text on their own.
- To inculcate professional training required to become a scholar in mathematics

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Will motivate them to meticulously prepare their own mathematical notes.	K2 & K4
CO2	Students can type their own mathematical article/notes/book/ journal paper/ project work	K6
CO3	Use various style files and in particular amsmath, amsfonts, amsthm.	K1, K3 & K5
CO4	Include the figures in various formats into their latex document and compile it sucessfully	K2 & K6
CO5	Utilize bibtex feature of including bibliographies and indexes.	K2 & K3
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Basic Structure of Latex 2e - Input file structure - Layout -Editors - Forward Search - Inverse Search -Compling - Conversion to various formats.

Unit-II. Typesetting simple documents - sectioning - Titles- page layout -listing -enumerating - quote -letter formats

Unit-III. Using package amsmath typing equations labeling and refreing

Unit-IV. Figure inclusion - Table inclusion

Unit-V. Bibliography - Index typing - Beamer presentation Styles

Unit-VI (Advanced topics only for discussion). Current Contours: Type a mathematical article using various journal style files

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	1	1	1	3	3	3	3
CO2	1	1	1	1	3	3	3	3
CO3	1	1	1	1	3	3	3	3
CO4	1	1	1	1	3	3	3	3
CO5	1	1	1	1	3	3	3	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1	1	2	3	2	1	2	3
CO2	1	1	2	3	2	1	2	3
CO3	1	1	2	3	2	1	2	3
CO4	1	1	2	3	2	1	2	3
CO5	1	1	2	3	2	1	2	3
3-Strong; 2-Medium; 1-Low								

Text book(s): Leslie Lamport. LATEX: A Document Preparation System, Addison-Wesley, Read- ing, Massachusetts, second edition, 1994.

References.

(1) George Gratzer, Math into LaTeX: An introduction to LaTeX and AMS-LaTeX (pages 3-56,345-432), Birkhauser, Boston, 1995.

(2) Helmut Kopka, Patrick W. Daly, A guide to LATEX: Document preparation for beginners and advanced users, Addison-Wesley (1999)

(3) Michel Goossens, Sebastian Rahtz, Frank Mittelbach, The LaTex graphics companion: Illustrating documents with TeX and PostScript (Addison-Wesley series on tools and techniques for computer typesetting), 1999.

(4) Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl., The (Not So) Short Introduction to LATEX2e, Samurai Media Limited (or available online at http://mirrors.ctan.org/info/lshort/english/lshort.pdf)

(5) LATEX Tutorials - A Primer, Indian TeX Users Group, available online at https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf

(6) H. J. Greenberg. A Simplified introduction to LATEX, available online at https://www.ctan.org/tex-archive/info/simplified-latex/

(7) Using Kile - KDE Documentation, https://docs.kde.org/trunk4/en/extragear_office/kile/quick-using.html

(8) Amsmath and geometry package available in Ctan org.

GENERAL INTELLIGENCE

Course Code:24S2M01VACB
Prerequisite: Nil

L	T	P	C
1	1	0	2

Objectives.

- To gain quantitative aptitude required in the present scenario.
- To emphasize the right perceptive needed to crack such problems and understand the recurring pattern in those problems.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Solve a lot of problems on numbers and averages and problems on ages.	K1, K3 & K7
CO2	Crack problems on calculating simple interest and compound Interest.	K1, K6 & K7
CO3	Get working knowledge on ratios and proportions.	K1, K3 & K6
CO4	Work on a plenty of problems on time and work.	K1, K3 & K5
CO5	Acquire problem solving ideas on trains, boats and streams.	K1, K3 & K7
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Problems on Numbers- Average-Problems on Ages.

Unit-II. Percentage-Profit & Loss-Simple Interest-Compound Interest.

Unit-III. Ratio & Proportion-Partnership-Calender-Clocks.

Unit-IV. Time and work-Pipes & Cistern.

Unit-V. Time & Distance-Problems on Trains-Boats and Streams.

Unit-VI (Advanced topics only for discussion). Current Contours: Simple problems using sets, functions, group theory etc.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	2	3	2	3
CO2	3	3	3	3	2	3	2	3
CO3	3	3	3	3	2	3	2	3
CO4	3	3	3	3	2	3	2	3
CO5	3	3	3	3	2	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	2	2	3	2	2	2
CO2	3	2	2	2	3	2	2	2
CO3	3	2	2	2	3	2	2	2
CO4	3	2	2	2	3	2	2	2
CO5	3	2	2	2	3	2	2	2
3-Strong; 2-Medium; 1-Low								

Text book(s): Dinesh Khattar, The Pearson Guide To Quantitative Aptitude For Competitive Examinations, Pearson Education, 3 edition, 2015.

References.

(1) R. V. Praveen, Quantitative Aptitude and Reasoning,-PHI Learning Private Ltd, 2013.
(2) Jaggan Saneja, Quantitative Aptitude Simplified, Notion Press, 2020.
(3) R. S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publishing, 2017.

INTRODUCTION TO SAGEMATH

Course Code: 24S2M01VACC
Prerequisite: Nil

L	T	P	C
1	0	1	2

Objectives.

- To learn one of the powerful open source software
- To visualize the mathematical concepts
- To train the students to become a professional mathematician

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Evaluate elementary functions such as polynomials, square root, trigonometric, exponential, logarithmic etc	K1 & K6
CO2	Plotting tools helps students to get easier plots and include it in their project cum paper work.	K3 & K6
CO3	Students will be comprehend the theoretical concept and visualize them in much more better way.	K2, K4 & K5
CO4	Gain expertise on the computations involving matrices and linear algebra in general.	K1, K2 & K6
CO5	Use the plotting ideas and others to work on basic real analysis problems.	K2 & K6
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Using sagemath as a advanced engineering calculator. Evaluation of elementary functions (polynomials, square root, trigonometric, exponential, logarithmic etc) Basic usage in Combinatorcs & Number theory

Unit-II. Plotting : simple plots of known functions, polar plotting, plotting implicit functions, contour plots, level sets, parametric 2D plotting, vector fields plotting, gradients.

Unit-III. Advanced plotting 3D plots

Unit-IV. Basic usages in Linear Algebra and Vector Calculas

Unit-V. Basic usage in Real Analysis and Algebra

Unit-VI (Advanced topics only for discussion). **Current Contours:** Learning advanced computing in topics selected areas like numerical analysis, linear algebra, number theory, coding theory, cryptography, graph theory.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	2	3	3	3	2
CO2	3	2	2	2	3	3	3	2
CO3	3	2	2	2	3	3	3	2
CO4	3	2	2	2	3	3	3	2
CO5	3	2	2	2	3	3	3	2

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	2	2	3	3	3	1	2	3
CO2	2	2	3	3	3	1	2	3
CO3	2	2	3	3	3	1	2	3
CO4	2	2	3	3	3	1	2	3
CO5	2	2	3	3	3	1	2	3
3-Strong; 2-Medium; 1-Low								

Text book(s): Gregory V. Bard. Sage for Undergraduates, American Mathematical Society, available online at http://www.gregorybard.com/Sage.html

References.

(1) Tuan A. Le and Hieu D. Nguyen. SageMath Advice For Calculus available online at http://users.rowan.edu/~nguyen/sage/SageMathAdviceforCalculus.pdf

(2) Ajit Kumar, Vikas Bist, Group Theory An expedition with Sage Math, Narosa Publications, New Delhi, 2021.

(3) Sage for Abstract Algebra, Robert Beezer, Avalialbe online at http://abstract.ups.edu/sage-aata.html

(4) Sergei Kurgalin and Sergei Borzunov, Algebra and Geometry with Python, Springer International Publishing, 2021.

(5) Cooper, Steven, Data science from scratch: the #1 data science guide for everything a data scientist needs to know Python, linear algebra, statistics, coding, applications, neural networks, and decision trees, Steven Cooper; Data Science, 2018.

INTRODUCTION TO PYTHON PROGRAMMING

Course Code:24S3M02VACA
Prerequisite: Nil

L	T	P	C
1	0	1	2

Objectives.

- To learn the basics of scientific computing through Python Programming.
- To inculcate professional training in algorithmic approach of Problem Solving.

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Able to understand basic various formats of listing.	K1 & K2
CO2	Will make them learn basic tools, functions and loops.	K3, K4 & K6
CO3	Students can comprehend Python Programming and basic commands.	K3 & K6
CO4	Able to get expertise in various data types .	K1, K5 & K6
CO5	Simple programs will make them confident in learning the algorithmic approach of problem solving.	K3 & K6
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Review of Linux commands; File management and permissions; Using VI editor; Introducing a programming language, syntax, basic tools, simple programmes, etc.

Unit-II. Basic Tools; First Program file; Handling complex numbers; Functions and loops; Standard math functions; Conditionals; Python keywords and finction names; Defining Names;

Unit-III. Lists in Python;Defining and accessing lists; Loops with lists; Range function; for loop with lists for sorting; Built-in sort functions; else class in loops; slicing lists; lists as stacks; using lists as queues; new lists from old;

Unit-IV. Data types; Numeric Types; Tuples; Accepting tuple inputs; sorting iterables; the lambda function; Sets; Dictionaries; Input and output; Output formatting; Format specifiers; align, sign, width, precision, type; File operations; Functions from Numpy and Scipy libraries.

Unit-V. Math problems for practice which includes the following:
(a) Finding GCD of two or more integers;
(b) Primality checking; Finding primes upto a given integer;
(c) Plotting curves;
(d) Area of a triangle;
(e) Angle between vectors;
(f) Convert a number in decimal to a given base n.
(g) Transpose of a matrix; Product of two matrices;
(h) Finding the mean; median; mode; standard deviation etc., of a given data;

Unit-VI (Advanced topics only for discussion). Current Contours: Object Oriented Programming

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	2	3	3	2	2
CO2	3	3	3	3	3	3	2	3
CO3	3	2	2	2	3	3	2	2
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	2	3	3	1	2	3
CO2	3	3	2	3	3	1	2	3
CO3	3	3	2	3	3	1	2	3
CO4	3	3	2	3	3	1	2	3
CO5	3	3	2	3	3	1	2	3
3-Strong; 2-Medium; 1-Low								

Text book(s): Real Python, A Practical introduction to Python 3, https://static.realpython.com/python-basics-sample-chapters.pdf

References.

(1) Qingkai Kon et all, Python Programming and Numerical Methods - A Guide for Engineers and Scientists, https://pythonnumericalmethods.berkeley.edu/notebooks/Index.html

(2) Brian Heinold, A Practical Introduction to Python Programming, https://www.brianheinold.net/python/A_Practical_Introduc- tion_to_Python_Programming_Heinold.pdf

(3) Son, Hyun-Seok, Linear Algebra Coding with Python: Python's application for linear algebra, 2020.

(4) Makoto Tsukada, Yuji Kobayashi, et al., Linear Algebra with Python: Theory and Applications, Springer Nature Singapore, 2019.

INTRODUCTION TO R PROGRAMMING

Course Code:24S3M02VACB
Prerequisite: Nil

L	T	P	C
1	0	1	2

Objectives.

- To make the students learn the art of R Programming.
- To inculcate professional training required to understand basic statistical programming

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Comprehend R language and basic commands.	K1 & K2
CO2	Understand Correlation Analysis through R programming.	K2, K3 & K4
CO3	Gain experience creating Frequency distributions	K1 & K6
CO4	Able Get expertise in comparing various statistical diagrams.	K4 & K5
CO5	Analyze the figures obtained through Bivariate Regression.	K3, K4 & K6
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Introduction to R Langauage - Basic commands - Data slicing

Unit-II. Importing and Exporting Data - Creating Frequency Distribution - Relative Frequency Distribution.

Unit-III. Plots: Bar - Pie Chart -Boxplot - Histogram

Unit-IV. Descriptive Statistics using R

Unit-V. Correlation Analysis -T-Test - Bivariate Regression -Multiple Regression

Unit-VI (Advanced topics only for discussion). Current Contours: Applications to Data Science.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	2	3	3	2	2
CO2	3	3	3	3	3	3	2	3
CO3	3	2	2	2	3	3	2	2
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	2	3

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	2	3	3	1	2	3
CO2	3	3	2	3	3	1	2	3
CO3	3	3	2	3	3	1	2	3
CO4	3	3	2	3	3	1	2	3
CO5	3	3	2	3	3	1	2	3
3-Strong; 2-Medium; 1-Low								

Text book(s): W. John Braun and Duncan J. Murdoch, A First Course in Statistical Programming with R, Cambridge University Press, Newyork, 2007

References.

(1) J H Maindonald, Using R for Data Analysis and Graphics: Introduction, Code and Commentary, 2008, https://cran.r-project.org/doc/contrib/usingR.pdf

(2) Kim Seefeld and Ernst Linder, Statistics Using R with Biological Examples, https://cran.r-project.org/doc/contrib/Seefeld_StatsRBio.pdf

SAGEMATH FOR ABSTRACT ALGEBRA

Course Code: 24S3M02VACC
Prerequisite: Nil

L	T	P	C
1	0	1	2

Objectives.

- To learn one of the powerful open source software for Algebra in particular
- To visualize the mathematical concepts
- To appreciate the applications of computer algebra system (CAS)

Course Outcomes:

On completion of the course the students will be able to

COs	Course Outcome	Knowledge Level
CO1	Understand how to code various groups and subgroups.	K2 & K3
CO2	Work on basic problems in normal subgroups and homomorphism theorems.	K1, K4 & K5
CO3	Attain mastery in group actions through CAS	K3 & K6
CO4	Use the programming idea to code Rings and lattices.	K5 & K6
CO5	Gain expertise on the computations involving matrices and linear algebra in general.	K3 & K6
K1-Remember; K2-Understand; K3-Practice; K4-Analyze; K5-Synthesize; K6-Create; K7-Evaluate		

Course Outline:

Unit-I. Groups -subgroups - Permutations - Lagrange's theorem

Unit-II. Basic cryptography - isomorphism - Normal subgroups - factor groups.

Unit-III. Structure of groups - group action - The sylow theorems

Unit-IV. Rings - Polynomial - Integral domains - Lattices

Unit-V. Vector spaces -fields -finite fields -Galois theory

Unit-VI (Advanced topics only for discussion). **Current Contours:** Learning advanced computing in topics selected areas like numerical analysis, linear algebra, number theory, coding theory, cryptography, graph theory.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes.

Text book(s):

(1) Ajit Kumar, Vikas Bist, Group Theory An expedition with Sage Math, Narosa Publications, New Delhi, 2021

(2) Sage for Abstract Algebra, Robert Beezer, Avalialbe online at http://abstract.ups.edu/sage-aata.html

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	2	3	3	3	2
CO2	3	2	2	2	3	3	3	2
CO3	3	2	2	2	3	3	3	2
CO4	3	2	2	2	3	3	3	2
CO5	3	2	2	2	3	3	3	2

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	2	2	3	3	3	1	2	3
CO2	2	2	3	3	3	1	2	3
CO3	2	2	3	3	3	1	2	3
CO4	2	2	3	3	3	1	2	3
CO5	2	2	3	3	3	1	2	3
3-Strong; 2-Medium; 1-Low								

References.

(1) Richard Brent and Paul Zimmermann, Modern Computer Arithmetic, Cambridge University Press, 2010.

(2) Amit Saha, Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More!, No Starch Press, 2015.

(3) Sergei Kurgalin and Sergei Borzunov, Algebra and Geometry with Python, Springer International Publishing, 2021.

(4) Cooper, Steven, Data science from scratch: the #1 data science guide for everything a data scientist needs to know Python, linear algebra, statistics, coding, applications, neural networks, and decision trees, Steven Cooper; Data Science, 2018.