MANONMANIAM SUNDARANAR UNIVERSITY

Tirunelveli 627012, INDIA

Department of Mathematics

Vision of the University

To provide quality education to reach the un-reached

Mission of the University

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To create an academic environment that honours women and men of all races, caste, creed, cultures an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled.

Vision of the Department

To attain academic excellence at the international level at par with leading research institutions.

Mission of the Department

To develop mathematical skills, knowledge and critical thinking in the minds of young students.

1. Name of the Programme **:** M. Sc Mathematics

2. Preamble of the Programme:

Mathematics is one of the fundamental disciplines in science. It is the basic for all the disciplines. This two year program, consisting four semesters, aims at providing basic tools and exposure to students who intend to pursue Master Degree in Mathematics at the inter- national level.

- ❖ Elective courses in the fourth and fifth years are planned to suit competitive examinations like NET and SLET.
- ❖ Students undergoing this programme will have the opportunity of choosing research / teaching at leading research institutions or a career in corporate sectors.
- ❖ To enable the students to have a thorough exposure to the different branches of Mathematics so as to gain a comprehensive knowledge of Mathematics.
- ❖ To cultivate logical thinking and analytical skills which sharpens their concentration and provides patience to grapple with life outside the campus.

Any graduate with an aggregate of 50% marks in Mathematics or Applied Mathematics is eligible to apply for admission to the course. Relaxation for SC/ST students will be given as per norms of the Government of Tamil Nadu.

An entrance examination (objective type questions) will be conducted for eligible applicants. The merit list will be prepared with 50% marks for entrance examination and 50% marks for Part III score in B.Sc. Then admission will be based on merit and reservation policy of the Government of Tamil Nadu.

3. Programme Structure:

Semester	Course Code	Course	Course Nature	Credits	Contact Hours Per Week	Continuous Internal Assessment (CIA)	End Semester Exam (ESE)
I		Group theory	Core	4	4	25	75
		Real Analysis I	Core	4	4	25	75
		Ordinary Differential Equations*	Core	4	4	25	75
		Number Theory	Core	4	4	25	75
		Elective I	Elective	3	3	25	75
		Practical - I	Practical	2	2	50	50
II		Rings and Modules	Core	4	4	25	75
		Real Analysis II	Core	4	4	25	75
		Graph Theory	Core	4	4	25	75
		Mathematical statistics	Core	4	4	25	75
		Elective II	Elective	3	3	25	75
		Supportive Course I	Supportive	3	3	25	75
III		Topology	Core	4	4	25	75
		Complex Analysis	Core	4	4	25	75
		Linear Algebra	Core	4	4	25	75
		Measure and integration	Core	4	4	25	75
		Elective III	Elective	3	3	25	75
		Supportive Course II	Supportive	3	3	25	75
IV		Functional Analysis*	Core	4	4	25	75
		Field Theory	Core	4	4	25	75
		Combinatorial Theory	Core	4	4	25	75
		Elective IV	Elective	4	4	25	75
		Practical - I	Practical	2	2	50	50
		Project	Project	7	7	25	75
		Total		90	90		

* - Courses with contents from e-PG Pathshala

LIST OF ELECTIVE PAPERS

1. Programming in C++
2. Partial Differential Equations
3. Design and Analysis of Algorithms
4. Calculus of variations and Integral Equations
5. Mechanics
6. Representation theory of finite groups
7. Coding Theory

8. Graph Algorithms
9. Differential Geometry
10. MATLAB Programming
11. Cryptography
12. Numerical Analysis
13. Fuzzy Theory and Their Applications
14. Operations Research
15. Commutative Algebra
16. Python Programming
17. Mathematical Modelling

SUPPORTIVE COURSES FOR OTHER DEPARTMENT STUDENTS

NPTEL – MOOC COURSES

4. Scheme of Evaluation:

This program is under Choice Based Credit System of the University and a successful candidate should score a minimum of 90 credits in 4 semesters. Each paper is evaluated for 100 marks with Internal 25 marks and External 75 marks. The internal assessment comprises of 3 components -15 marks for written test (average of the best two of 3 tests), 5 marks for Seminar and 5 marks for Assignment.

The semester Question paper pattern for external examination is as follows:

Section A - 10 x 1 = 10 (no choice)
Section B - 5 x 5 = 25 (Internal choice questions)
Section C - 5 x 8 = 40 (Internal choice questions)

The duration of the examination is 3 hours. In order to train the students for National level examinations and Research, End semester examination question paper for each course shall contain 20% questions from problems and 80% questions from theory in Part B and Part C.

Passing minimum in the external examination is 50 % (38 out of 75). Passing minimum in the aggregate (internal and external marks put together) is 50% (50 out of 100). No passing minimum for the internal marks.

Examination, evaluation and classification will be made as per the rules and regulations of the University in force.

5. Programme Outcomes*(POs):

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

PO 1	estimate the values of arithmetic, algebraic and statistical expressions, functions and problems using appropriate technology.
PO 2	adapt logical reasoning and critical thinking , become familiar with enough number of subjects including application oriented ones to suit the present needs of various allied branches in Basic Sciences, Applied Sciences and Engineering.
PO 3	apply Mathematical skills in interdisciplinary areas such as Computer Science, Actuarial Science, Social Sciences and other areas of inquiry so that they can pursue their future career either in the core field or in the applied field.
PO 4	develop analytic and problem solving skills for careers.
PO 5	select methodology of scientific investigation objectively without being biased with preconceived notions.
PO 6	analyze mathematical and Statistical models, drawing conclusions and making inferences based on these models.
PO 7	develop intellectually and to become involved with Professional Organizations.
PO 8	discuss mathematical theories and ideas effectively and concisely with others and can understand new informations and concepts independently, thereby gain the ability to pursue higher studies and to conduct research independently.

K1- Remembering	**K2- Understanding**	**K3- Applying**	**K4- Analyzing**	**K5- Evaluating**	**K6- Creating**
PO5	PO8	PO3	PO6	PO1	PO2, PO4, PO7

6. **Programme Specific Outcomes (PSOs):**

Students will be able to

PSO 1	appreciate the emphasis given on teaching the fundamentals, the basic concepts, definitions with a variety of examples.
PSO 2	adapt the skill to facilitate with abstract reasoning and make ideas precise by formulating them mathematically.
PSO 3	develop a positive attitude towards Mathematics as an interesting and valuable subject of study.
PSO 4	define all the arithmetic, algebraic, analytic and geometric concepts.
PSO 5	promote logical reasoning, critical thinking and familiarize with various subjects to suit all the needs of various allied branches in basic and applied sciences.
PSO 6	develop analytic and problem solving skills and getting acquainted with computational Techniques.
PSO 7	develop the skill to solve problems which appear in the various examinations based on the concepts learned which in turn will hone the problem solving skills of students and help them to pass competitive examinations including CSIR-NET, SET, IAS, etc
PSO 8	able to pursue higher studies and multi-disciplinary research.

COURSE DESCRIPTION

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		GROUP THEORY	Core	4	3	1	-	4

Course Objectives:

1. This course deals basic concepts of groups starting from the special group's viz., Dihedral groups, General linear group, Quaternion group, and Symmetric groups.
2. It mainly deals the fundamental concepts of groups through the generalized tool of group actions and finally ends with structure of finite abelian groups.
3. To understand the fundamental concepts of group theory which include Sylow theorems and relative this concept to the direct products and abelian groups.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Describe all symmetries of a regular polygon in the plane with origin as the centroid.	**K1 & K2**
CO2	Explain the significance of the notions of cosets, normal subgroups, and factor groups.	**K2, K3 & K4**
CO3	Evaluate the class equation of finite group of order n.	**K4 & K5**
CO4	Construct the finite abelian groups of given order using Sylow theorem.	**K3 & K6**
CO5	Distinguish internal direct product and internal semi direct product.	**K4 & K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: Introduction to Groups – Groups – Finite Groups; Subgroups – Cyclic groups (12 hrs)

Unit II: Permutation Groups – Isomorphism – Cosets and Lagrange's Theorem (12 hrs)

Unit III: External Direct Products – Normal Subgroups and Factor Groups (12 hrs)

Unit IV: Group Homomorphisms – Fundamental Theorem of Finite Abelian Groups (12 hrs)

Unit V: Sylow Theorems – Finite Simple Groups (12 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	2	3	3	2	3	2	3	3	2.63
CO2	3	3	3	2	2	2	3	3	2.63
CO3	3	3	3	3	3	2	3	3	2.86
CO4	3	3	3	3	3	1	3	3	2.63
CO5	2	3	3	3	3	2	3	3	2.75
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	3	3	3	3	3	3	3.00
CO2	3	3	3	3	3	2	3	3	2.88
CO3	2	3	3	2	3	3	3	3	2.75
CO4	3	3	3	3	3	3	3	3	3.00
CO5	2	2	3	3	3	2	3	3	2.63
Mean Overall Score									**2.78 High**

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

Joseph A. Gallian, Contemporary Abstract Algebra (Seventh Edition), Brooks/Cole-Cengage Learning, USA, 2010.

Unit I to V: Chapters 1 to 11, 24 and 25

Reference Books:

1. I. N. Herstein, Abstract Algebra (Third Edition), Prentice-Hall, USA, 1990.
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, Pearson Education India, New Delhi, 2008.
3. David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition), John Wiley & Sons, New Delhi, 2011.

Webliography:

1. https://nptel.ac.in/courses/111/106/111106113/
2. https://nptel.ac.in/courses/111/106/111106137/
3. https://nptel.ac.in/courses/111/105/111105112/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		REAL ANALYSIS - I	Core	4	3	1	-	4

Course Objective:

1. To understand the fundamental concepts in Analysis which are based on the notion of distance
2. To feel the idea of approximation of solutions in terms of sequence and series.
3. To understand the concept of continuity and differentiability both in terms of geometrically and analytically to encounter basic problems in Analysis.

Course Outcome (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Classify various Mathematical components of Metric space structure and relate them logically	K2
CO2	Analyzing suitable methods to conclude the convergence of the real sequences	K4
CO3	Discuss several criteria to establish the convergence of the real series	K5
CO4	Create new continuous and discontinuous functions and apply its properties to solving simple real-life problems	K6
CO5	Appraise the geometric idea of derivatives and its applications	K5
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I Basic Topology: Finite, Countable and uncountable sets - Metric Spaces - Compact Sets - Perfect sets - Connected Sets. (12 hrs)

Unit II Numerical sequences and series: Convergent sequences - Subsequences - Cauchy sequences - Upper and lower limits - Some special sequences - Series - Series of nonnegative terms. (12 hrs)

Unit III The number e - The root and ratio tests - Power series - Summation by parts - Absolute convergence - Addition and multiplication of series - Rearrangements. (12 hrs)

Unit IV Continuity: Limits of functions - Continuous functions - Continuity and compactness - Continuity and connectedness - Discontinuities - Monotonic functions - Infinite limits and limits at infinity. (12 hrs)

Unit V Differentiation: The Derivative of a real function - Mean value theorems - The continuity of derivatives - L'Hospital's rule - Derivatives of Higher order - Taylor's theorem -Differentiation of vector valued functions. (12 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	-	3	2	3	2	2	3	2.57
CO2	3	-	3	3	3	2	2	3	2.71
CO3	3	-	3	3	3	2	2	3	2.71
CO4	3	-	3	3	3	2	2	3	2.71
CO5	3	-	3	3	3	2	2	3	2.71

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	2	3	3	2.87
CO2	3	3	3	3	3	3	3	3	3.00
CO3	3	3	3	3	3	3	3	3	3.00
CO4	3	3	3	3	3	2	3	3	2.87
CO5	3	3	3	3	3	2	3	3	2.87
Mean Overall Score									**2.82 High**

Level of correlation: 3-High, 2-Medium, 1-Low

Text Book:

Walter Rudin, Principles of Mathematical Analysis (Third edition), McGraw Hill, 1976.

Unit I to V: Chapters 2, 3, 4 and 5.

Reference Books:

1. Ajith Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014
2. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, Wiley Publication, 2015
3. Kenneth A. Ross, Elementry Analysis :Theory of Calculus, Springer, 2010

Webliography:

1. https://nptel.ac.in/courses/111/106/111106053/
2. https://nptel.ac.in/courses/111/106/111106142/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		ORDINARY DIFFERENTIAL EQUATIONS	Core	4	3	1	-	4

Course Objectives:

1. To give clear knowledge of existence of solutions of n^{th} order initial value problems with constant coefficients.
2. Using the gained knowledge of solving ODE with constant coefficients, we develop systematic approach to solve ODE with variable coefficients and to study the series solutions of ODE with singular points.
3. To construct an algorithm to approximate the exact solution of the initial value problems with the predefined error.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Explore the fundamental methodology to solve second order IVP and understand the nature of solutions of ODE	K2
CO2	Develop several procedure to solve n^{th} order homogeneous and non-homogeneous equations	K6
CO3	Apply the gained knowledge to solve ODE with variable coefficients	K4
CO4	Detect the regular singular points and obtain series solution of ODE at regular singular points	K4
CO5	Compare the exact solution with approximate solutions and explore algorithms to obtain approximate solutions with predefined error	K5
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I Linear equations with constant co-efficients - Introduction - Second Order non-homogeneous Equations - Initial value problems - linear dependence and independence -formula for Wronskian.

Unit II Nonhomogeneous equations of order two - Homogeneous and Non-homogeneous equations of order n - Initial value problems - annihilator method to solve anon-homogeneous equation.

Unit III Linear equations with variable co-efficients - Initial value problems for the homogeneous equation - solution of the homogeneous equations - Wronskian and linear independence - reduction of the order of a homogeneous equation of first order.

Unit IV Linear equations with regular singular points - Euler equation - Second order

equations with regular singular points - solutions and properties of Legendre and Bessel's equation.

Unit V Existence and uniqueness of solutions of first order equations - introduction - Equations with variables separated - Exact equations - method of successive approximations - Lipschitz condition - convergence of successive approximations.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	2	2	3	3	3	2	2	3	2.50
CO2	2	-	3	3	3	2	3	3	2.71
CO3	3	-	3	3	3	2	3	3	2.85
CO4	3	-	3	3	3	2	3	3	2.85
CO5	3	-	3	3	3	2	3	3	2.85

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	3	3	3.00
CO2	3	3	3	3	3	3	3	3	3.00
CO3	3	3	3	3	3	3	3	3	3.00
CO4	3	3	3	3	3	3	3	3	3.00
CO5	3	3	3	3	3	3	3	3	3.00
Mean Overall Score									**2.88 High**

Level of correlation: 3-High, 2-Medium, 1-Low

Text Book:

E. A. Codington, An introduction to Ordinary Differential Equations, Prentice Hall of India, 2007.

Unit I to V: Chapter 2 (Sections 1-8, 10 &11), Chapter 3 (Sections 1-5 & 8) Chapter 4 (Sections1-5), Chapter 5 (Sections 1-6)

Reference Books:

1. A.K. Nandakumaran&P.S.Datti, Ordinary Differential Equations : Principles and Applications, Cambridge IISc Series, 2017
2. G. Simmons, Differential Equations with Applications and Historical Notes (2nd Edition), Tata McGraw Hill Publications, 2009
3. S.G. Deo, V. Raghavendra, R.Kar& V. Lakshmikantham, Text Book of Ordinary Differential Equations, Tata McGraw Hill Publications, 2017

Webliography:

1. https://nptel.ac.in/courses/111/108/111108081/
2. https://nptel.ac.in/courses/111/104/111104031/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		NUMBER THEORY	Core	4	3	1	-	4

Course Objectives:

1. This course was studied for its long and rich history.
2. It is well known for its wealth of easily accessible and fascinating questions, and its intellectual appeal.
3. In recent years it has been studied for the reason that it has become essential for Cryptology.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	KnowledgeLevel Upto
CO1	Illustrate the implications of Properties of divisibility and primes	K3
CO2	Analyse the conceptualization of prime power modulli	K4
CO3	Examine the properties of congruence of degree two	K5
CO4	Understanding the Law of Quadratic Reciprocity & Quadratic Residues	K2
CO5	Examine the concept of variety of arithmetic functions	K5
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I : Divisibility and Congruence: Divisibility, Primes, Congruence. (12 hrs)

Unit II : Solutions of congruence - the Chinese Remainder theorem - Prime power moduli. (12 hrs)

Unit III : Prime modulus - Primitive roots and Power Residues- congruence of degree two – Power Residues, prime modulus. (12 hrs)

Unit IV: Quadratic residues - Quadratic reciprocity -The Jacobi symbol. (12 hrs)

Unit V : Some functions of number theory: Greatest integer function - Arithmetic functions -The Moebius inversion formula- Recurrence functions. (12 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	-	3	2	2.71
CO2	3	3	3	3	2	-	3	2	2.71
CO3	3	3	3	3	2	-	3	2	2.71
CO4	3	3	3	3	2	-	3	2	2.71
CO5	3	3	3	3	2	-	3	2	2.71
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	3	3	3	2	2	3	2.75
CO2	3	3	3	3	3	2	2	3	2.75
CO3	3	3	3	3	3	2	2	3	2.75
CO4	3	3	3	3	3	2	2	3	2.75
CO5	3	3	3	3	3	2	2	3	2.75
Mean Overall Score									**2.70 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Ivan Niven and H. S. Zuckerman, An Introduction to the Theory of Numbers, Fifth Edition, Wiley Eastern Limited, New Delhi, 1994.

Unit I to V: Chapter 1(Sections 1.1 to 1.3), Chapter 2 (Sections 2.1 to 2.3, 2.6 to 2.9), Chapter 3 (Sections 3.1 to 3.2) and Chapter 4 (Sections 4.1 to 4.4).

Reference Books:

1. T.M. Apostol, Introduction to Analytic Number Theory, Narosa Publ. House, Chennai, 1980.
2. J. H. Silverman, A friendly introduction to number theory, Pearson Prentice Hall, 2006.
3. D. M. Burton, Elementary Number Theory, Universal Book, Stall, New Delhi 2001.

Webliography: **https://nptel.ac.in/courses/111/101/111101137/**

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		RINGS and MODULES	Core	4	3	1	-	4

Course Objectives:

1. This course starts with basic concepts of rings and discuss about special rings viz., matrix rings, ring of quaternion's, group ring etc.
2. It shall discuss and analyze the properties and interlinks between the concepts of Euclidean ring, Principal Ideal Domain, Unique Factorization Domain and Integral Domain.
3. In this course a new algebraic structure, namely, Modules is introduced and studied in detail. Modules are the generalization of vector spaces when the underlying field is replaced by an arbitrary ring.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Determine the number of zero-divisor of a finite ring	K3
CO2	Infer the irreducible element and prime element.	K4 & K6
CO3	Define Dedekind-Hasse norm and give an example.	K1 & K2
CO4	Locate and use Eisenstein criterion to solve problems in polynomial ring.	K4
CO5	Analyze different algebraic structures and their properties	K4
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: Introduction to Rings – Integral Domains (12 hours)

Unit II: Ideals and Factor Rings – Ring Homomorphisms (12 hours)

Unit III: Polynomial Rings – Factorization of Polynomials (12 hours)

Unit IV: Divisibility in Integral Domains (12 hours)

Unit V: Introduction to Module Theory: Basics definitions and examples - Quotient modules and Module homomorphism - Generation of modules, Direct sums, and Free modules. (12 hours)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	2	3	3	2.75
CO2	1	3	3	2	2	2	3	3	2.38
CO3	2	3	3	2	2	2	3	3	2.50
CO4	3	3	3	3	2	1	3	3	2.63
CO5	2	3	3	2	2	2	3	3	2.50
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	2	2	3	3	3	3	2.75
CO2	3	2	2	3	3	2	3	3	2.63
CO3	2	3	2	2	3	2	3	3	2.50
CO4	3	3	2	3	3	3	3	3	2.88
CO5	3	2	3	3	3	2	3	3	2.75
Mean Overall Score									**2.63 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

1. Joseph A. Gallian, Contemporary Abstract Algebra (Seventh Edition), Brooks/Cole-Cengage Learning, USA, 2010.

   Unit I to IV: Chapters 12 to 18

2. David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition), John Wiley & Sons, New Delhi, 2011

   Unit V: Chapter 10(Sections 10.1 to 10.3)

Reference Books:

1. I. N. Herstein, Abstract Algebra (Third Edition), Prentice-Hall, USA, 1990.
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, Pearson Education India, New Delhi, 2008.
3. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press

Webliography:

1. https://nptel.ac.in/courses/111/106/111106131/
2. https://nptel.ac.in/courses/111/102/111102009/
3. https://nptel.ac.in/courses/111/106/111106098/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		REAL ANALYSIS II	Core	4	3	1	-	4

Course Objectives:

1. To develop the theory of Integration of real functions and to establish its properties to understand the Fundamental Theorem of Calculus.
2. To distinguish the properties of pointwise and uniform convergence of a sequence of functions to appreciate the compactness in the function spaces.
3. To extend the concept of derivative to vector valued functions with several variables.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Build a mathematical approach called Riemann integration, to find the area of the given bounded region and to establish the fundamental theorem of Calculus	K6
CO2	Classify uniform and pointwise convergence of a sequence of function and differentiate their properties	K4
CO3	Investigate the compact sets in function spaces and explain that every continuous function can be approximated by a polynomials	K5
CO4	Determine the concept of derivative in higher dimensional space	K5
CO5	Explore the definition of determinant in natural way and use it in higher dimensional integration	K3
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I The Riemann-Stielitjes integral: Definition and existence of the integral - Properties of the integral - Integration and Differentiation - Integration of vector - Valued functions -Rectifiable Curves.

Unit II Sequences and Series of functions: Discussion of Main problem - Uniform convergence - Uniform convergence and continuity-Uniform convergence and Integration.

Unit III Uniform convergence and differentiation - Equicontinuous families of functions - The Stone - Weierstrass theorem.

Unit IV Functions of Several Variables: Linear transformations - Differentiation - The Contraction Principle - The Inverse function theorem - The Implicit function theorem.

Unit V Determinants - Derivatives of higher order - Differentiation of Integrals -

Integration of Differential forms: Integration - Primitive Mappings - Partitions of unity - Change of Variables.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	-	3	3	3	2	3	3	2.86
CO2	3	-	3	3	3	2	1	3	2.57
CO3	3	-	3	3	3	2	1	3	2.57
CO4	3	-	3	3	3	2	3	3	2.86
CO5	3	-	3	3	3	2	3	3	2.86

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	3	3	3.00
CO2	3	3	3	3	3	3	3	3	3.00
CO3	3	3	3	3	3	3	3	3	3.00
CO4	3	3	3	3	3	3	3	3	3.00
CO5	3	3	3	3	3	3	3	3	3.00
Mean Overall Score									**2.87 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Walter Rudin, Principles of Mathematical Analysis (Third edition), McGraw Hill, 1976.

Unit I to V: Chapters 6, 7, 9 (except 9.1-9.5, 9.30, 9.31 and 9.32) and Chapter 10 (10.1 to 10.9 only).

Reference Books:

1. Tom M. Apostol, Mathematical Analysis (2nd Edition), Narosa Publication, 2002
2. Sudhir R. Ghorpade & B.V. Limaye, A Course in Multivariable Calculus and Analysis, Springer 2014
3. N.L. Carothers, Real Analysis, Cambridge University Press , 2006

Webliography: https://nptel.ac.in/courses/111/104/111104125/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		GRAPH THEORY	Core	4	3	1	-	4

Course Objectives:

1. This is a standard course in graph theory, whose aim is to present all usual basic concepts of graph theory, graph properties (with simplified proofs) and formulations of typical graph problems.
2. In recent years it has been studied for the reason that it has become essential for Graph Algorithms, Design and Analysis of Algorithms, Data Structure and many real world problems.
3. It develops the mathematical sophistication needed to understand what properties to search for in graphs (simple networks), and prove results about them using the knowledge about graphs' structure.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Achieve command of the fundamental definitions and concepts of graph theory and exposed to emerging areas of research	**K1, K6**
CO2	Understand in depth proofs of some fundamental statements on graphs and able to solve new graph problems	**K2, K5**
CO3	Familiar with the major viewpoints and goals of graph theory: classification, extremality, optimization and sharpness, algorithms, and duality.	**K1**
CO4	Achieve proficiency in writing proofs, including those using basic graph theory proof techniques such as bijections, minimal counterexamples, and loaded induction and analyze them	**K2, K4**
CO5	Apply this knowledge in (especially) computer science applications and other branches of mathematics	**K3**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I : Graphs - Graph isomorphism-Incidence and adjacency matrices – Subgraphs - Vertex degrees - Path and Connection cycles -Trees - Cut edges and bonds - Cut vertices - Cayley's formula. (12 hrs)

Unit II : Connectivity - Blocks - Euler tours – Hamilton cycles. **(12 hrs)**

Unit III : Matchings - Matching and coverings in bipartite graphs-Perfect matchings – Edge colorings: Edge chromatic number - Vizing's theorem. **(12 hrs)**

Unit IV: Independent sets-Ramsey's theorem-Vertex colorings: Chromatic number-Brook's theorem-Hajos' conjecture-Chromatic polynomials-Girth and chromatic number. **(12 hrs)**

Unit V : Plane and planar graphs -Dual graphs-Euler's formula- The Five Color theorem and The Four Color conjecture -Directed graphs. **(12 hrs)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	1	3	3	2.62
CO2	3	3	3	3	2	1	3	3	2.62
CO3	3	3	3	3	3	1	3	3	2.75
CO4	3	3	3	3	2	1	3	3	2.62
CO5	3	3	3	3	2	2	3	3	2.75

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	2	1	3	2.62
CO2	3	3	3	3	3	2	1	3	2.62
CO3	3	3	3	3	3	2	1	3	2.62
CO4	3	3	3	3	3	2	2	3	2.75
CO5	3	3	3	3	3	2	1	3	2.62
Mean Overall Score									**2.70 High**

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

J.A. Bondy and U.S.R. Murty, Graph Theory with Applications by, The Macmillan Press Ltd, 1976.

Unit I to V: Sec. 1.1 - 1.7, 2.1 - 2.4, Sec.3.1 &3.2, 4.1& 4.2,
Sec. 5.1- 5.3, 6.1 &6.2, Sec. 7.1, 7.2, 8.1 – 8.5,
Sec. 9.1 – 9.3 & 9.6 and 10.1.

Reference Books:

1. D.B. West, Introduction to Graph Theory, New Delhi: Prentice-Hall of India, 2011.
2. G. Chatrand and L. Lesniak, Graphs and Digraphs, Fourth Edition, Boca Raton: CRC Press, 2004
3. R. Balakrishnan and K. Ranganathan, A Text Book of Graph Theory, New Delhi: Springer, 2008.

Webliography:

1. https://nptel.ac.in/courses/111/106/111106050/#
2. https://nptel.ac.in/courses/111/106/111106102/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		MATHEMATICAL STATISTICS	Core	4	3	1	-	4

Course Objectives:

1. This course lays the foundation to probability theory and statistical modelling of outcomes of real life random experiments through various statistical distributions.
2. It enables students maneuver mathematical probabilistic models for different problems, to analyze them and to interpret the results.
3. After completing this course, the student will be able qualified to join as statistical officer in department of survey and apply the concepts in data analysis.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Illustrating the implications of the concepts of probability	K3
CO2	Comparing distributions of various kinds of discrete or continuous distributions	K4
CO3	Creating new distributions using the existing distributions	K6
CO4	Understanding t and F distributions and moment generating functions	K2
CO5	Determining solutions to the problems using central limit theorem	K5
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I : The probability set function - Random variables - Probability density function - Distribution function - Mathematical expectation - Special mathematical expectations - Chebyshev's Inequality **(12 hours)**

Unit II : Conditional probability - Marginal and conditional distributions - Stochastic independence Some special distributions: The Binomial, Trinomial and Multinomial distributions - The Poisson distribution. **(12 hours)**

Unit III : The Gamma and Chi-Square Distributions - The Normal distribution - The Bivariate normal distribution. Distributions of functions of random variables - Sampling theory - Transformations of variables of the discrete type - Transformations of variables of the continuous type. **(12 hours)**

Unit IV: The t and F distributions - Distributions of order statistics - The moment generating function technique. The distributions of $\bar{X}$ and nS^2/σ^2 - Expectations of functions of random variables. **(12 hours)**

Unit V : Limiting distributions, Stochastic convergence - Limiting moment generating functions - The Central limit theorem - Some theorems on limiting distributions. **(12 hours)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	2	3	3	3	2	2	3	2	2.5
CO2	2	3	3	3	2	3	3	2	2.5
CO3	2	3	3	3	2	1	3	2	2.37
CO4	3	3	3	3	2	2	3	2	2.5
CO5	1	3	3	3	2	2	3	2	2.37

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	2	2	2	3	3	2	3	2.5
CO2	3	3	2	2	3	3	1	3	2.5
CO3	3	2	2	2	3	3	2	3	2.5
CO4	3	3	2	2	3	3	3	3	2.75
CO5	3	2	2	2	3	3	2	3	2.5
Mean Overall Score									**2.50 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (Fourth Edition),

Unit I to V: Chapters 1, 2 (except 1.1, 1.2, 1.3, 1.8 and 2.3),

Chapters 3, 4 (except 4.5) and Chapter 5.

Reference Books:

1. K. L. Chung, A course in Probability, Academic Press, New York, 1974.
2. R. Durrett, Probability: Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
3. Y. S. Chow and H. Teicher, Probability Theory, 2nd Edition, Springer Verlag, Berlin, 1988.

Webliography:

https://nptel.ac.in/courses/111/101/111101004/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
III		TOPOLOGY	Core	4	3	1	-	4

Course Objectives:

1. Topology has emerged as a major branch of mathematics in the middle of 20th century as a result of the developments in Geometry and Set Theory.
2. To prepare the students to understand the meaning of a topology and to study various other concepts of Topological Spaces.
3. This course lays the foundation for future study in Analysis, Geometry and Algebraic Topology.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Understand various kinds of topologies with illustrations	K2, K3
CO2	Analyze the implications of product topology and connectedness	K4
CO3	Infer on the concept of compactness and its related theorems	K2, K4
CO4	Examine the interventions of countability axioms	K5
CO5	Remember the implications of separation axioms in proving Urysohnlemma,Tietze Extension and Tychonoff theorems.	K1
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I : Topological spaces - Basis for a topology - The order topology - The product topology on X x Y - The subspace topology - Closed sets and limit points - Continuous functions. **(12 hours)**

Unit II : The product topology - connected spaces, components and local connectedness. **(12 hours)**

Unit III : Compact spaces - Local compactness. **(12 hours)**

Unit IV: The Countability axioms - The Separation axioms - Normal spaces. **(12 hours)**

Unit V : The Urysohn lemma - The Tietze Extension theorem - Tychonoff theorem. **(12 hours)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	1	3	3	2	2	-	3	3	2.42
CO2	1	3	3	2	2	-	3	3	2.42
CO3	1	3	3	2	3	-	3	3	2.57
CO4	2	3	3	2	2	-	3	3	2.57
CO5	1	3	3	2	2	-	3	3	2.42
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	3	3	3	2	2	3	2.75
CO2	3	3	3	3	3	2	2	3	2.75
CO3	3	3	3	3	3	2	3	3	2.87
CO4	3	3	3	3	3	2	2	3	2.75
CO5	3	3	3	3	3	2	2	3	2.75
Mean Overall Score									**2.60 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

J. R. Munkres, Topology (second edition), Pearson Prentice Hall, (2000).

Unit I to V: Sections 12 to 19, 23, 25, 26, 29 to 33, 35 and 37.

Reference Books:

1. J. Dugundji , Topology , Prentice Hall of India, New Delhi, 1975.
2. G. F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963.
3. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.

Webliography:

https://onlinecourses.swayam2.ac.in/ugc19_ma04

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
III		COMPLEX ANALYSIS	Core	4	3	1	-	4

Course Objectives:

1. To have fair knowledge of Analytic Functions and to establish Cauchy-Riemann equation to find whether the given function is Analytic or not.
2. To understand and apply the standard theorems on Analytic functions theory to solve contour integrations.
3. To introduce and appreciate the power series expansions of complex functions and the infinite product of complex numbers.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Apply Cauchy-Riemann equation to identify the analyticity of complex functions	K3
CO2	Construct new analytic functions and bilinear transformations	K5
CO3	Apply standard theorems on complex function theory to solve Contour integrals	K3
CO4	Develop methodology to solve Contour integrals using Residues Calculus.	K6
CO5	Construct power series representation of analytic functions and explore the notion of infinite product of complex numbers.	K6
K1=Remember,K2=Understand, K3=Apply,K4=Analyze, K5=Evaluate,K6= Create		

Course Outline:

Unit I Analytic Functions - Power Series.

Unit II Conformality - Linear Transformation - Elementary Conformal mapping.

Unit III Fundamental Theorems - Cauchy's Integral formula - Local properties of Analytic Functions.

Unit IV General form of Cauchy's theorem (except proof of Cauchy's theorem) -Calculus of Residues.

Unit V Power Series Expansions - Partial fractions and factorizations.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	-	3	3	3	-	-	3	3.00
CO2	3	-	2	3	3	-	-	3	2.80
CO3	2	3	3	3	3	-	-	3	2.83
CO4	3	3	3	3	3	-	3	3	3.00
CO5	3	3	3	3	3	-	-	3	3.00

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	3	3	3.00
CO2	3	3	3	3	3	3	3	3	3.00
CO3	3	3	3	3	3	3	3	3	3.00
CO4	3	3	3	3	3	3	3	3	3.00
CO5	3	3	3	3	3	3	3	3	3.00
Mean Overall Score									**2.96 High**

Level of correlation: 3-High, 2-Medium, 1-Low

Text Book:

Lars V. Ahlfors, Complex Analysis (Third edition), McGraw Hill.

Unit I to V: Chapters 2 to 4 (except section 4.5) and Chapter 5 (Sections 5.1, 5.2.1).

Reference Books:

1. Churchill & Brown, Complex Variables and Applications, McGraw Hill, 2019
2. J.H.Mathews& R.W. Howell, Complex Analysis for Mathematics and Engineering, Narosa Publication, 2011
3. J.B. Convey, Functions of One Complex Variables, Springer &Narosa, 2009

Webliography:

1. https://nptel.ac.in/courses/111/106/111106141/
2. https://nptel.ac.in/courses/111/103/111103070/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
III		LINEAR ALGEBRA	Core	4	3	1	-	4

Course Objectives:

1. Problems in linear algebra arise in a wide variety of scientific and engineering applications including the design of structures, the analysis of electrical networks, and the modelling of chemical processes.
2. This course will cover the analysis and implementation of algorithms used to solve linear algebra problems in practice.
3. This course will enable students to acquire further skills in the techniques of linear algebra, as well as understanding of the principles underlying the subject.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	To understand the basic concept of various matrix row operation and row-reduced echelon matrices.	K1 & K2
CO2	To determine solutions to problems and investigate the theoretical aspects of Dimension, Basis, Ordered basis and various types of linear transformations	K3 & K4
CO3	Distinguish linear operator and linear functional.	K4 & K5
CO4	Recognize the concepts of the terms annihilating polynomial, invariant subspace, direct sum, invariant direct sum and apply these concept to various linear transformations.	K1
CO5	Develop an understanding of the algebra of matrices in order to solve applied and theoretical problems using inverses of matrices, determinants and other algebraic operations	K2 & K3
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create		

Course Outline:

Unit I: Fields -Systems of linear Equations - Matrices and Elementary Row operations - Row - Reduced echelon Matrices - Matrix Multiplication - Invertible Matrices. **(12 hours)**

Unit II: Vector spaces - Subspaces - Bases and Dimension - Coordinate - Summary of row-equivalence - Linear transformation - The algebra of linear transformations - Isomorphism of vector spaces. **(12 hours)**

Unit III: Representations of Linear Transformations by Matrices - Linear Functional - The Double Dual - The Transpose of a Linear Transformation - Characteristic value. **(12 hours)**

Unit IV: Annihilating polynomials - Invariant subspaces - Direct-sum Decompositions - Invariant Direct sums - The Primary Decomposition Theorem. **(12 hours)**

Unit V: Determinant functions - Permutations and the uniqueness of determinants - Additional properties of determinants. **(12 hours)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	2	3	3	2.75
CO2	3	3	3	3	2	2	3	3	2.75
CO3	2	3	3	3	3	2	3	3	2.75
CO4	3	3	3	3	2	2	3	3	2.75
CO5	3	3	3	3	1	2	3	3	2.63

PSO / CO	PSO1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	2.88
CO3	2	2	3	3	3	2	3	3	2.63
CO4	2	3	2	3	3	3	3	3	2.75
CO5	3	3	2	3	3	2	3	3	2.75
Mean Overall Score									**2.77 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book: Kenneth Hoffman and Ray Kunze, Linear Algebra (Second Edition), PHI Learning Private Limited, New Delhi: 2012

Unit I to V: Chapter 1, Chapter 2: (Sections 2.1 to 2.5) and Chapter 3: (Sections 3.1 to 8.3), Chapter 3: (Section 3.4 to 3.7) and Chapter 6: (Section 6.2) Chapter 6: (Sections 6.3, 6.4, 6.6 to 6.8), Chapter 5: (Sections 5.1 to 5.4)

Reference Books:

1. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India Ltd, 2004.
2. V. Krishnamurthy, V.P.Mainra, J.L.Arora, Introduction to Linear Algebra, East West Press Ltd, 1985.
3. S. Axler, Linear Algebra Done Right, 2nd Edition, John-Wiley, 1999

Webliography:

1. https://nptel.ac.in/courses/111/106/111106051/
2. https://nptel.ac.in/courses/111/104/111104137/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
III		MEASURE AND INTEGRATION	Core	4	3	1	-	4

Course Objectives:

1. This course is a basic necessity in many areas of Pure and Applied mathematics
2. The main objective is to familiarize with the Lebesgue outer measure; Measurable sets; Measurable functions, Integration.
3. It facilitates the students to undertake further studies in Mathematics and also helps them to face competitive examinations.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Identify whether a given subset of **R** or a real valued function is measurable	K2
CO2	understand the requirement and the concept of the Lebesgue integral (a generalization of the Reimann integration) along with its properties.	K2
CO3	explain the concepts of functions of bounded variations and the absolute continuity of functions with their relations.	K3
CO4	Generalize the concept of outer measure in an abstract space and integration with respect to a measure.	K6
CO5	Evaluate the Outer measure and by Measurability applying product measures, Fubini's theorem and Tonelli's theorem.	K5

Course Outline:

Unit I : Lebesgue Measure: Introduction-Outer measure-Measurable sets and Lebesgue measure- The non-measurable set - Measurable functions - Littlewood's threeprinciples. **(12 hours)**

Unit II: The Lebesgue Integral: The Riemann integral - The Lebesgue integral of a bounded function over a set of finite measure - The integral of a nonnegative function - The general Lebesgue integral. **(12 hours)**

Unit III: Differentiation and Integration: Differentiation of monotone functions-Functions of bounded variation - Differentiation of an integral - Absolute continuity. **(12 hours)**

Unit IV: Measure and Integration - Measure spaces - Measurable functions - Integration-Signed measures - The Radon-Nikodym theorem. **(12 hours)**

Unit V: Measure and Outer Measure: Outer measure and measurability-The Extension Theorem - Product measures. **(12 hours)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

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

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	3	2	
CO2	3	3	3	3	3	3	3	2	
CO3	3	3	3	3	3	3	3	2	
CO4	3	3	3	3	3	1	2	2	
CO5	3	3	3	3	3	1	2	2	
Mean Overall Score									**High**

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book: H.L. Royden, *Real Analysis*, Third Edition, Macmillan, New York, 1988

Unit I to Unit V: Chapters 3,4 (except 4.5),5 (except 5.5),11(except 11.4 and 11.7) and 12 (Sections 12.1, 12.2 and 12.4 only).

Reference Books:

1. G. de Barra, Measure Theory and Integration, New Age International Publishers, New Delhi, 2008.
2. Walter Rudin, Real and Complex Analysis, Mc-Graw Hill Book Company, New York, 1970.
3. Terence Tao, An Introduction to measure theory, Orient Blackswan, 2014

Webliography: https://www.mdpi.com

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
IV		FUNCTIONAL ANALYSIS	Core	4	3	1	-	4

Course Objectives:

1. To make students to feel the beauty of normed linear spaces which have metric structure on a vector space
2. To understand various kinds of linear operators and its properties.
3. To appreciate the concept of Banach Algebra and the generalization of eigen values known as spectral values, and its properties.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Combine the metric and vector space structure together to create normed linear spaces and Hilbert spaces	K6
CO2	Understand the embedding of a normed linear spaces into its second dual	K4
CO3	Explain the geometry of Hilbert spaces	K4
CO4	Determine various types of linear operators on Hilbert spaces	K5
CO5	Elaborate the notion of spectral values in natural manner by introducing Banach Algebra	K6
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I Banach Spaces - Definition and some examples – Continuous linear transformations – The Hahn-Banach theorem.

Unit II The natural imbedding of N in N** - Open mapping theorem – conjugate of an operator

Unit III Hilbert Spaces - Definition and some simple properties - Orthogonal complements – Orthonormal sets - Conjugate space H*

Unit IV Adjoint of an operator - Self-adjoint operators – Normal and unitary operators – Projections.

Unit V General Preliminaries on Banach Algebra - Definition and some examples – Regular and singular elements – Topological divisors of zero – Spectrum – The formula for the spectral radius – the radical and semi-simplicity.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	-	3	3	3	-	-	3	3.00
CO2	3	-	3	3	3	-	-	3	3.00
CO3	3	-	3	3	3	-	-	3	3.00
CO4	3	-	3	3	3	-	-	3	3.00
CO5	3	-	3	3	3	-	-	3	3.00
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	3	3	3	3	3	3	3.00
CO2	3	3	3	3	3	3	3	3	3.00
CO3	3	3	3	3	3	3	3	3	3.00
CO4	3	3	3	3	3	3	3	3	3.00
CO5	3	3	3	3	3	3	3	3	3.00
Mean Overall Score									**3.00 High**

Level of correlations: 3-High, 2-Medium, 1-Low

Text Book:

G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw -Hill Publishing Company, New Delhi, 2004.

Unit I to V: Chapter 9,10(section 46 – 59), Chapter 12(Section 64 – 69)

Reference Books:

1. S. Kesavan, Functional Analysis, Hindustan Book Agency, 2014
2. B. V. Limaye, Functional Analysis, New Age Publishers, 2008
3. M. Thamban Nair, Functional Analysis: A First Course(2nd Ed), PHI Publishers, 2021

Webliography: https://nptel.ac.in/courses/111/106/111106147/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
IV		FIELD THEORY	Core	4	3	1	-	4

Course Objectives:

1. This paper aims to an in depth knowledge about the algebraic structure of fields, which is vital in providing algebraic tools to find roots of equations.
2. This course starts with basic concepts of fields, existence and properties of extension fields of polynomials.
3. Also it aims to provide the use of Galois Theory in discussing the existence of roots of polynomials.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Facility with fields and their extensions, including expertise in explicit calculations with and constructions of examples with various relevant desired properties.	**K2, K3 & K6**
CO2	Verify/identify algebraically closed field, separable field and inseparable fields.	**K1**
CO3	Explain the fundamental concepts of field extensions and Galois theory and their role in modern mathematics and applied contexts	**K2, K3 & K4**
CO4	Construction of finite field and simple extension	**K3 & K6**
CO5	Compute Galois groups for Cyclotomic polynomial over a rational field	**K3**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I: Field theory: Basic Theory of field extensions - Algebraic Extensions. **(12 hours)**

Unit II: Splitting fields and Algebraic closures - Separable and inseparable extensions. **(12 hours)**

Unit III: Cyclotomic polynomials and extensions - Galois Theory: Basic definitions - The fundamental theorem of Galois Theory. **(12 hours)**

Unit IV: Finite Fields - Composite extensions and simple extensions. **(12 hours)**

Unit V: Cyclotomic extensions and abelian extensions over Q – Galois groups of polynomials. **(12 hours)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	2	3	3	2.75
CO2	2	3	3	2	3	2	3	3	2.63
CO3	3	3	3	3	2	2	3	3	2.75
CO4	3	3	3	3	2	2	3	3	2.75
CO5	3	3	3	3	2	2	3	3	2.75
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	2	3	3	3	3	3	2.88
CO2	3	2	2	3	3	3	3	3	2.75
CO3	3	3	3	3	3	3	3	3	3.00
CO4	3	3	2	3	3	3	3	3	2.88
CO5	3	3	2	3	3	3	3	3	2.88
Mean Overall Score									**2.80 High**

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition), Wiley Student Edition (2004).

Unit 1: Chapter 13: (Sections 13.1 to 13.2)
Unit 2: Chapter 13: (Sections 13.4 to 13.5)
Unit 3: Chapter 13: (Section 13.6) and Chapter 14: (Sections 14.1 to 14.2)
Unit 4: Chapter 14: (Sections 14.3 to 14.4)
Unit 5: Chapter 14: (Sections 14.5 to 14.6)

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra (Seventh Edition), Brooks/Cole-Cengage Learning, USA, 2010.
2. I. N. Herstein, Abstract Algebra (Third Edition), Prentice-Hall, USA, 1990.
3. Steven Roman, Field Theory, Springer, New York, 1995.

Webliography:

1. https://nptel.ac.in/courses/111/106/111106145/
2. https://nptel.ac.in/courses/111/101/111101117/
3. https://nptel.ac.in/courses/111/106/111106131/
4. https://nptel.ac.in/courses/111/101/111101001/
5. https://nptel.ac.in/courses/111/106/111106151/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
IV		COMBINATORIAL THEORY	Core	4	3	1	-	4

Course Objectives:

1. This course acquaints the students with the concepts of permutations and combinatorics, generating functions, recurrence relations, the principle of inclusion and exclusion and Polya's theory of counting.
2. It develops skills to apply the techniques of combinations and permutations for counting the number of certain configurations.
3. It makes the students familiar with fundamental combinatorial structures that naturally appear in various other fields of Mathematics and Computer Science.

Course Outcomes (CO):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Use formulas for counting basic combinatorial outcomes to construct solutions to complete combinatorial enumeration problems	**K1, K3**
CO2	Apply counting strategies to solve discrete probability problems	**K3**
CO3	Use specialized techniques to solve combinatorial enumeration problems: generating functions; recurrence relations; inclusion-exclusion principle	**K3,K5**
CO4	Understand the concepts of permutations with restrictions on relative positions and the rook polynomials	**K2**
CO5	Enumerate configuration using Polya's theory	**K5**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I : Permutations and Combinations - rule of sum and product - distributions of distinct objects - Distributions of non-distinct objects. (12 hrs)

Unit II : Generating functions for combinations - Enumerators for permutations - Distributions of distinct objects into non-distinct cells - partitions of integers - Ferrers graph - elementary relations. (12 hrs)

Unit III : Recurrence relations - Linear recurrence relations with constant co-efficients -solution by the technique of generating functions - a special class of non-linear difference equation - recurrence relations with two indices. (12 hrs)

Unit IV: The principle of inclusion and exclusion - general formula - derangements - rook polynomials - permutations with forbidden positions. (12 hrs)

Unit V : Polya's theory of counting Equivalence classes under a permutation groups - Equivalence classes of functions - Weights and inventories of functions - Polya's fundamental theorem - Generalization of Polya's theorem. (12 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	2	2	1	3	2	2.37
CO2	3	3	3	2	2	1	3	2	2.37
CO3	3	3	3	2	2	1	3	2	2.37
CO4	3	3	3	2	2	1	3	2	2.37
CO5	3	3	3	2	2	1	3	2	2.37

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	-	3	3	3	3	3
CO2	3	3	3	-	3	3	3	3	3
CO3	3	3	3	-	3	3	3	3	3
CO4	3	3	3	-	3	3	3	3	3
CO5	3	3	3	-	3	3	3	3	3
Mean Overall Score									**2.70 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

C.L. Liu, Introduction to Combinatorial Mathematics, McGraw Hill (1968)

Unit I to V: Chapters 1 to 5.

Reference Books :

1. M. Aigner, A Course in Enumeration, Springer-Verlag, Heidelberg, 2007.

2. R.P. Stanley, Enumerative Combinatorics, Volume I, 2nd Edition, Cambridge Studies in Advanced Mathematics , Cambridge University Press, 1997.

3. Miklos Bona, A Walk through Combinatorics, World Scientific Publishing Company, 2002.

Webliography:

https://nptel.ac.in/courses/111/106/111106155/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		PROGRAMMING IN C++	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To introduce the basics of object oriented programming and to give detailed branching and looping structure in C++.
2. To master in creating and handling classes and class functions. To provide fair confident on working with pointers and files in C++.
3. To make students to write C++ programs with their own algorithm to solve the given any simple problems.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Propose basics and fundamental controls in C++ Programming	K6
CO2	Explain the importance of classes in C++	K5
CO3	Appraise the usage of operator overloading	K5
CO4	Analyze the inheritance and Polymorphism of classes in C++	K4
CO5	Acquire the basic knowledge on working with pointers and files	K3
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I Tokens, Expressions and Control structures-Functions in C++.

Unit II Classes and Objects.

Unit III Constructors and Destructors- Operator overloading and type conversions.

Unit IV Inheritance: Extending classes-Pointers, \virtual Functions and Polymorphism.

Unit V Working with files.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	-	3	3	3	-	-	3.00
CO2	-	-	3	3	3	3	3	-	3.00
CO3	-	-	-	3	3	3	3	-	3.00
CO4	-	-	-	3	3	3	3	-	3.00
CO5	-	-	-	3	3	3	-	-	3.00
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	-	3	3	-	-	-	3.00
CO2	3	3	2	-	3	3	-	-	2.80
CO3	3	3	2	-	3	3	-	-	2.80
CO4	3	3	-	-	-	3	-	-	3.00
CO5	3	3	-	-	-	-	-	-	3.00
Mean Overall Score									**2.96 High**

Text Book:

E. Balagurusamy, Objected Oriented Programming with C++, (Third Edition), (2007), Tata Mc Graw Hill,

Unit I to V: Chapters 3 to 9 and 11.

Reference Books:

1. H. Schildt, C++: The Complete References(4th Ed.), McGraw Hill, 2017
2. Yashavant Kanetkar, Let us C++, BpB Publications, 2020

Webliography:

1. https://nptel.ac.in/courses/106/105/106105151/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		PARTIAL DIFFERENTIAL EQUATION	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To develop the mathematical skills to solve problems involving partial differential equations rather than general theory.
2. To solve linear second order PDEs using canonical variables for initial-value problems, separation of variables, and boundary value problems.
3. To understand the partial differential equations as models of various physical processes such as mechanical vibrations, transport phenomena, and electrostatics.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Know the various types of methods and their limitations to solve the first order PDEs	**K2**
CO2	Extract information from partial differential equations to interpret the reality.	**K3**
CO3	Understand different methods of solving second order partial differential equations.	**K4**
CO4	Identify the physical situations formulate mathematical models using PDEs.	**K4**
CO5	Apply the acquired knowledge to select the most appropriate method to solve the particular partial differential equations.	**K6**
K1=Remember, K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I: First order partial differential equations: PDE of first order in two independent variable – Formation of PDE –Lagrange's Method – Integral surfaces passing through a given curve – surface orthogonal to a given system of surfaces – Compatibility of first order PDE.

Unit II: Classification of the solutions of first order PDE – Solutions of Non-linear PDE of first order.

Unit III: Origin of second order PDE- Linear PDE with constant coefficients – Method of solving linear PDE.

Unit IV: Classification of Second order PDE – Adjoint operators – Second order Non-linear PDE.

Unit V: Occurrence of the Laplace and Poisson Equations – BVP – separation of variables method – Laplace equation in cylindrical and spherical coordinates.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	2	3	3	2.75
CO2	3	3	3	3	2	2	3	3	2.75
CO3	3	3	3	3	2	2	3	3	2.75
CO4	3	3	3	3	3	2	3	3	2.83
CO5	3	3	3	3	3	2	3	3	2.83
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3
Mean Overall Score									**2.89 High**

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

J. N. Sharma, Kehar Singh, Partial Differential Equations for Engineers and Scientists, Second Edition, Narosa Publishing House, New Delhi, 2009.

Unit I: Chapter 1 (Sections 1.1 to 1.7)
Unit II: Chapter 1 (Sections 1.8 to 1.9)
Unit III: Chapter 2 (Sections 2.1 to 2.3)
Unit IV: Chapter 2 (Sections 2.4 to 2.5)
Unit V: Chapter 3 (Sections 3.1 to 3.5)

Reference Books:

1. D. Bleecker and G. Csordas, Basic Partial Differential Equations, Van Nostrand Reinhold, New York, 1992.
2. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications, New York, 2006.
3. T. Amaranath , An Elementary Course in Partial Differential Equations, Narosa, New Delhi.

Webliography:

1. https://nptel.ac.in/courses/111/107/111107111/
2. https://nptel.ac.in/courses/122/107/122107037/
3. https://ocw.mit.edu/courses/mathematics/18-152-introduction-to-partial-differential-equations-fall-2011/lecture-notes/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		DESIGN & ANALYSIS OF ALGORITHMS	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. Design and Analysis of Algorithms provide the theoretical backbone of computer science and are must in the daily work of the successful programmer.
2. To provide a solid background in the design and analysis of the major classes of algorithms.
3. To understand importance of data structures in context of writing efficient programs.
4. To develop their own versions for a given computational task and to compare and contrast their performance.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Learn the basic types for data structure, implementation and application	**K2**
CO2	Understand stack, queue and linked list operations	**K2**
CO3	Know the strength and weakness of different data structures	**K1**
CO4	Apply the divide-and-conquer paradigm when an algorithmic design situation calls for it	**K3**
CO5	Apply searching and sorting techniques	**K3**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I :	Growth of functions-Recurrences	(12 hrs)
Unit II :	Heap sort- Quick sort.	(12 hrs)
Unit III :	Elementary data structures-Binary search trees-Red black trees.	(12 hrs)
Unit IV:	Elementary graph algorithms-Minimum spanning trees.	(12 hrs)
Unit V :	Single source shortest paths - All-pairs shortest paths.	(12 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	-	3	3	1	2	-	3	2	2.3
CO2	-	3	3	1	3	-	3	2	2.5
CO3	-	3	3	2	2	-	3	2	2.5
CO4	-	3	3	1	2	-	2	2	2.2
CO5	-	3	3	1	2	-	3	2	2.3

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	2	3	3	2	3	1	1	3	2.25
CO2	2	3	3	2	3	1	1	3	2.25
CO3	2	3	3	2	3	2	1	3	2.37
CO4	2	3	3	2	3	1	2	3	2.37
CO5	2	3	3	2	3	1	1	3	2.25
Mean overall score= $\frac{\text{Grant total of COs with POs \& □□□□}}{\text{(Number of COs relating with POs\&□□□□}} = \frac{161}{70}$									**2.3 (High)**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, 2nd Edition, 2007.

Unit I to V: Chapters 3, 4, 6 (6.1 to 6.4), 7 (7.1, 7.2), 10 (except 10.3), 12 (12.1-12.3), 13, 22, 23, 24 (except 24.5) and 25

Reference Books:

1. M. C. Golumbic, Algorithmic Graph Theory and Perfect Graphs, Academic Press, New York, 1980.
2. S S. Skiena, The Algorithm Design Manual, 2nd Edition, Springer, 2008.
3. S. Robert and W. Kevin, Algorithms, 4th Edition, Addison Wesley, 2011.

Webliography:

https://nptel.ac.in/courses/106/106/106106131/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To familiarize students with variations, which are small changes in functions and functionals, to find maxima and minima of functional.
2. To study methods to solve boundary value problems. It is aimed to nurture the students to the tools and methods to solve variation problems and with this they can attempt to solve real life problems.
3. It facilitates the students to undertake further studies in Mathematics and also helps them to face competitive examinations.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Estimate maxima and minima of functions	**K4**
CO2	Visualize Hamilton's principle and solve various problems	**K1**
CO3	Adapt knowledge about integral equations	**K6**
CO4	Examine methods to solve Fredholm equations with separable kernels	**K3**
CO5	Appraise knowledge about solving equations of the second kind - Fredholm theory.	**K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: Calculus of Variations and Applications: Maxima and Minima - The Simplest case- Illustrative examples - Natural boundary conditions and transition conditions - The variational notation-The more general case. (9 hrs)

Unit II: Constraints and Lagrange multipliers-Variable end points - Sturm- Liouville problems-Hamilton's principle - Lagrange's equations. (9 hrs)

Unit III: Integral Equations: Introduction - Relations between differential and integral equations - The Green's function - Alternative definition of the Green's function (9 hrs)

Unit IV: Linear equation in Fredholm equations with separable kernels cause and effect: The influence function - Fredholm equations with separable kernels - Illustrative example. (9 hrs)

Unit V: Hilbert - Schmidt theory - Iterative methods for solving equations of the second kind - Fredholm theory. (9 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	2	3	3	2	1	3	3	2.50
CO2	3	2	3	3	2	1	3	3	2.50
CO3	2	2	3	3	2	1	3	3	2.38
CO4	2	2	3	3	2	1	3	3	2.38
CO5	2	2	3	3	2	1	3	3	2.38

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	3	2	2.88
CO2	3	3	3	3	3	3	3	2	2.88
CO3	3	3	3	3	3	3	3	2	2.88
CO4	2	3	3	3	3	3	3	2	2.75
CO5	2	3	3	3	3	3	3	2	2.75
Mean Overall Score									**2.63 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Francis B. Hildebrand, Methods of Applied Mathematics (Second Edition), Dover Publications, (1952)

Unit I to V: Sections 2.1 to 2.11, 3.1 to 3.9 and 3.11.

Reference Books:

1. Krasnov, Kiselu and Marenko, Problems and Exercise in Integrals Equations, MIR Publishers 1971.
2. Francis. B. Hildebrand, Methods of Applied Mathematics, Prentice - Hall of India Pvt. Ltd., New Delhi, Second Edition 1968.
3. Ram. P. Kanwal, Linear Integral Equations – Theory and Techniques, Academic press, New York, 1971.

Webliography:

https://www.naukri.com>learning.integral-equations

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		MECHANICS	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. This course is to understand the Lagrangian and Hamiltonianequations for dynamical systems.
2. It develops familiarity with the physical concepts and facility with the mathematical methods of classical mechanics.
3. It acquires fundamental knowledge of classical mechanics and to study different applications of these concepts in the mechanical and electromagnetic problem

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Remember the mechanical system of generalized coordinates, virtual work, energy and momentum	**K1**
CO2	Infer the Derivation of Lagrange and Hamiltonian equations	**K2**
CO3	Determine the Hamilton form of the equation of motion and find the solutions of integral of equation by the Hamilton's Jacobi theory	**K5**
CO4	Understand the Hamilton's equations and Modified Hamilton's principle	**K2**
CO5	Analyze the Principle function of the generating function for canonical transformation, namely, Special Transformations, Lagrange and Poisson Brackets	**K4**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I :	Statics in space.	(12 hrs)
Unit II :	Kinematics, Kinetic Energy and Angular Momentum.	(12 hrs)
Unit III :	Methods of Dynamics in space.	(12 hrs)
Unit IV:	Applications in Dynamics in space-Motion of a particle.	(12 hrs)
Unit V :	Applications in Dynamics in space-Motion of a rigid body.	(12 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	1	3	3	3	2	-	3	2	2.4
CO2	1	3	3	3	2	-	3	2	2.4
CO3	1	3	3	3	2	-	3	2	2.4
CO4	1	3	3	3	2	-	3	2	2.4
CO5	1	3	3	3	2	-	3	2	2.4

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	2	3	3	3	2	2	2	3	2.5
CO2	2	3	3	3	2	2	2	3	2.5
CO3	2	3	3	3	2	2	2	3	2.5
CO4	2	3	3	3	2	2	2	3	2.5
CO5	2	3	3	3	2	2	2	3	2.5
Mean overall score= $\frac{\text{Grant total of COs with POs \& PSOs}}{\text{(Number of COs relating with POs\& PSOs)}} = \frac{185}{75}$									**2.5 (High)**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

John A. Synge and Byron A. Griffith, Principles of Mechanics, New York McGraw Hill, (1949).

Unit I to V: Chapters 10 to 14.

Reference Books:

1. R.D. Gregory, Classical Mechanics, Cambridge University Press, 2006.
2. D.T. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
3. H. Goldstein, Classical Mechanics, 2 nd Edition, Narosa Publishing House, New Delhi.

Webliography: https://nptel.ac.in/courses/115/106/115106123/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		REPRESENTATIONS THEORY OF FINITE GROUPS	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To give students a concrete introduction to groups theory through their representations.
2. One studies how groups can be realized as symmetry groups of a finite dimension space.
3. The ultimate goal of this course is to teach students how to construct complex representations for popular groups as well as their character tables which serve as invariants for group rings.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Observe the way of writing a group as group of matrices	**K3**
CO2	Know about the Wedderburn structure theorem and interwining number.	**K1**
CO3	Know the classification of complex semi-simple Lie algebras and their real forms	**K4**
CO4	Classify irreducible representations of symmetric groups via permutation representations	**K2 & K4**
CO5	Compute character tables of symmetric groups and alternating groups.	**K3 & K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze,K5=Evaluate, K6=Create		

Course Outline:

Unit I: Foundations: Introduction - Group characters - Representation modules - Regular representation. Representation theory of rings with identity: Some fundamental lemmas. (9 hrs)

Unit II: The principle indecomposable representations - The radical of a ring - Semi-simple rings - The Wedderburn structure theorems for semi-simple rings - Interwining numbers. (9 hrs)

Unit III: Multiplicities of the indecomposable representation - The generalized Burnside theorem. The representation theory of finite groups: The group algebra - The regular representation of a group - Semi-simplicity of the group algebra- The centre of the group algebra. (9 hrs)

Unit IV: The number of in-equivalent irreducible representations - relations on the irreducible characters - The module of characters over the integers - The Kronecker product of two presentations - Linear characters - Induced representations and induced characters. (9 hrs)

Unit V: Applications of the theory of characters: Algebraic numbers - Some results from the theory of characters - Normal subgroups and the character table - Some classical groups. (9 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	2	3	3	2.75
CO2	3	3	3	2	2	2	3	3	2.63
CO3	3	3	3	3	2	2	3	3	2.75
CO4	3	3	3	3	2	2	3	3	2.75
CO5	3	3	3	3	2	2	3	3	2.75

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	2	3	3	3	3	3	2.88
CO2	3	3	3	3	3	2	3	3	2.88
CO3	3	3	3	3	3	2	3	3	2.88
CO4	3	3	3	3	3	3	3	3	3.00
CO5	3	2	3	3	3	3	3	3	2.88
Mean Overall Score									**2.82 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Martin Burrow, Representation Theory of Finite groups, Academic Press, (1965)

Unit I to Unit V: Chapters 1 (except section 4), 2, 3, and 4.

Reference Books:

1. Benjamin Steinberg, Representation Theory of Finite Groups, An Introductory Approach, Springer, New York, 2012.
2. Jean-Pierre Serre, Linear Representations of Finite Groups, Springer Science, New York, 1977.
3. G. James. M. Liebeck. Representations and Characters of Groups (Second Edition), Cambridge University Press. 2001.

Webliography:

1. https://www.youtube.com/c/AmritanshuPrasad/videos
2. https://nptel.ac.in/courses/115/101/115101104/
3. https://nptel.ac.in/courses/115/101/115101122/
4. https://cosmolearning.org/courses/representation-theory-finite-groups/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		CODING THEORY	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. This course is the study of methods for efficient and accurate transfer of information from one place to another.
2. To introduce the basic concepts of Coding Theory such as, Double Error-Correcting B.C.H. code, Cyclic codes, The Group of a code, Quadratic residue codes and Bose-Chaudhuri- Hocquenghem codes.
3. To familiarize with the developments of Cryptography.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Recall the ideas of Algebra and Combinatorics needed for Coding theory	**K1**
CO2	Analyze and reproduce properties of linear codes	**K4**
CO3	Administer knowledge about Hadamard codes , binary Golay code ,the ternary Golay code Reed-Muller code , Kerdock codes.	**K3**
CO4	Explain cyclic codes	**K2**
CO5	Assemble all the properties of Cyclic Codes	**K6**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6=Create		

Course Outline:

Unit I: Mathematical Background: Algebra - Krawtchouk Polynomials - Combinatorial theory- Shannon's Theorem: Introduction - Shannon's Theorem. (9 hrs)

Unit II: Linear codes: Block codes - Linear codes - Hamming codes - Majority logic decoding - Weight Enumerators - The Lee metric. (9 hrs)

Unit III: Some good codes: Hadamard codes and generalizations - The binary Golay code - The ternary Golay code - Constructing codes from other codes - Reed-Muller code - Kerdock codes. (9 hrs)

Unit IV:. Bound on codes: The Gilbert bound - Upper bounds - Cyclic codes: Definitions - Generator matrix and check polynomial - Zeros of a cyclic code. (9 hrs)

Unit V: The idempotent of a cyclic code - Other Representations of cyclic codes - BCH codes - Decoding BCH codes - Binary cyclic codes of length 2n (n odd). (9 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	2	3	3	2	2	1	3	3	2.38
CO2	2	3	3	2	2	1	3	3	2.38
CO3	2	3	3	3	2	1	3	3	2.50
CO4	3	3	3	3	2	1	3	3	2.63
CO5	3	3	3	3	2	1	3	3	2.63
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	2	3	3	3	3	3	2	3	2.75
CO2	2	3	3	3	3	2	2	3	2.63
CO3	3	2	3	2	3	2	2	3	2.50
CO4	3	2	3	2	3	3	2	3	2.63
CO5	3	2	3	2	3	3	2	3	2.63
Mean Overall Score									**2.57 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

J. H. Van Lint, Introduction to Coding Theory, Cambridge University Press (2006).

Unit I to V: Chapters 1 (except 1.4), 2 (Sections 2.1 and 2.2 only), 3, 4, 5 (except 5.3), and Chapter 6 (except 6.8, 6.9 and 6.11)

Reference Books:

1. Vera Pless, Introduction to the Theory of Error-Correcting Codes, John Wiley & Sons, New York, 1982.
2. I.F. Blake and R.C. Mullin, Introduction to Algebraic and Combinatorial Coding Theory, Academic Press, INC, New York, 1977.
3. F.J. MacWilliams and N.J.A. Sloane, The Theory of Error-Correcting Codes, Vols. I and II, North-Holland, Amsterdam, 1977.

Webliography:

http://agnee.tezu.ernet.in>koha>opac-detail

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		GRAPH ALGORITHMS	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. It was studied for its efficient algorithms in networking problems and repertory of basic algorithmic solutions to problems in many domains.
2. It focuses on understanding basic properties of graphs that can be used to design efficient algorithms.
3. It provides the theoretical backbone of computer science and are must in the daily work of the successful programmer.

Course Outcomes (CO):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Understand the various types of basic graph algorithms like BFS and DFS	**K2**
CO2	Compute the distance in graphs and weighted graphs	**K5**
CO3	Create components and strong components in graphs and digraphs	**K6**
CO4	Apply effectively algorithmic techniques to solve the Chinese Postman and Travelling salesman problems	**K3**
CO5	Select appropriately an algorithmic paradigm for the problem at hand	**K5**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6=Create		

Course Outline:

Unit I : An introduction to algorithms: Algorithmic complexity. Trees: Depth-First search - DFS: a tool for finding blocks - Breath - First search. (12 hrs)

Unit II : Minimum spanning tree problem - Paths and Distance in graphs: Distance in graphs - Distance in weighted graphs. (12 hrs)

Unit III : Matchings and factorizations : An introduction to matching - Maximum Matchings in bipartite graphs - Maximum matchings in general graphs. (12 hrs)

Unit IV: Eulerian graphs : An introduction to Eulerian graphs - Characterizing Eulerian graphs again - The Chinese Postman (12 hrs)

problem - Eulerian Digraphs.

Unit V : Hamiltonian graphs: An introduction to Hamiltonian graphs - Characterizing Hamiltonian graphs - The Travelling salesman problem. (12 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	-	3	3	1	2	-	3	2	2.4
CO2	-	3	3	1	3	-	3	2	2.5
CO3	-	3	3	2	2	-	2	2	2.4
CO4	-	3	3	1	2	-	3	2	2.4
CO5	-	3	3	1	2	-	3	2	2.4

CO \ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	2	3	3	2	3	1	1	3	2.25
CO2	2	3	3	2	3	1	2	3	2.37
CO3	2	3	3	3	3	1	1	3	2.37
CO4	2	3	3	2	3	2	1	3	2.37
CO5	2	3	3	2	3	1	1	3	2.25
Mean overall score= $\frac{\text{Grant total of COs with POs \& □□□□}}{\text{(Number of COs relating with POs\&□□□□}} = \frac{164}{70}$									**2.3 (High)**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Gary Chartrand and Ortrud R. Oellermann, *Applied and Algorithmic Graph Theory*, Mc Graw Hill (1993),

Unit I to V: Sections 2.1, 3.2 - 3.6, 4.1, 4.2, 6.1 - 6.3, 7.1 - 7.4, 8.1 to 8.3.

Reference Books:

1. K. Thulasiraman and M. N. Swamy, Graphs: Theory and Algorithms**,** Wiley-Inter-science, 1992.

2. M. C. Golumbic, Algorithmic Graph Theory and Perfect Graphs, Academic Press, New York, 1980.

3. D.B. West, Introduction to Graph Theory, New Delhi: Prentice-Hall of India, 2011.

Webliography:

https://www.digimat.in/nptel/courses/video/128106001/L01.html

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		DIFFERENTIAL GEOMETRY	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To provide the geometric interpretation of vector fields on surfaces and its integral curves.
2. To understand the shortest path between two given points on the surface known as Geodesics
3. To compute how much the given curve curves at a given point on the curve.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Develop the geometric interlink between the given vector field and its integral curves	K6
CO2	Extend the notion of vector field on surfaces and its integral curves	K2
CO3	Explain the geometry in finding shortest path between two points on the surface	K5
CO4	Understand more on co-variant derivatives and weingarte map	K2
CO5	Develop the concept of curvature of the curve and surfaces in systematic manner	K6
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

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

Unit II Surfaces - Vector field on surfaces

Unit III Gauss map - Geodesics.

Unit IV Parallel Transport - Weingarten map.

Unit V Curvature of plane curves-Curvature of surface - Arc length and Line Integrals

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	-	3	-	3	-	-	3	3.00
CO2	3	-	3	-	3	-	-	3	3.00
CO3	3	-	-	-	3	-	-	3	3.00
CO4	3	-	-	-	3	-	-	3	3.00
CO5	3	-	-	-	3	-	-	3	3.00
PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	-	3	3.00
CO2	3	3	3	3	3	3	-	3	3.00
CO3	3	3	3	3	3	3	-	3	3.00
CO4	3	3	3	3	3	3	-	3	3.00
CO5	3	3	3	3	3	3	3	3	3.00
Mean Overall Score									**3.00 High**

Text Book:

A. Thorpe, Elementary topics in Differential Geometry, First Indian Reprint (2004), Springer.

Unit I to V: Chapters 1 to 12.

Reference Books:

1. E. Kreyszig, Differential Geometry, Dover Publications, 2003
2. T. J. Willmore, An Introduction to Differential Geometry, Dover Publication, 2012
3. D. Somasundaram, Differential Geometry: A First Course, Narosa, 2008

Webliography:

1. https://www.youtube.com/playlist?list=PL4fpys7KOcYg7TixVqy3F4ehhDNk97ZqL

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		CRYPTOGRAPHY	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To provide deeper understanding into cryptography, its application to network security, threats to networks and countermeasures.
2. To explain various approaches to Encryption techniques, strengths of Traffic Confidentiality, Message Authentication Codes
3. To familiarize with cryptographic techniques for secure (confidential) communication of two parties over an insecure (public) channel; verification of the authenticity of the source of a message.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Distinguish the DES and the AES	**K4 & K5**
CO2	Describe the basic issues around finding large prime numbers and factoring large composite numbers, including various techniques for both.	**K1**
CO3	Explain how elliptic curves are used in certain Crypto-graphic algorithms.	**K2, K3 & K4**
CO4	Select appropriate techniques and apply them to solve a give problem	**K3**
CO5	Define the fundamentals of cryptography, such as encryption, Authentication and digital signature.	**K1**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I: Classical Encryption Techniques Symmetric Cipher Model - Substitution Techniques - Transposition Techniques - Block Ciphers and the Data Encryption Standard - Block Cipher Principles - The Data Encryption Standard (DES) -The Strength of DES – Advanced Encryption Standard - The Origins AES -AES Structure. (9 hrs)

Unit II: Modular Arithmetic- Finite Fields of the Form GF(p) - Finite Fields of the Form GF(2^n) - Number Theory -Prime Numbers - Fermat's and Euler's Theorems -Testing for Primality - The Chinese Remainder Theorem -Discrete Logarithms. (9 hrs)

Unit III: Public-Key Cryptography and RSA - Principles of Public-Key Cryptosystems -The RSA Algorithm - Diffie-Hellman Key Exchange -ElGamal Cryptosystem -Elliptic Curve Arithmetic. (9 hrs)

Unit IV: Cryptographic Hash Functions - Applications of Cryptographic Hash Functions - Two Simple Hash Functions - Requirements and Security - Hash Functions Based on Cipher Block Chaining - Secure Hash Algorithm (SHA). (9 hrs)

Unit V: Message Authentication Codes - Message Authentication Requirements - Message Authentication Functions - Message Authentication Codes - Digital Signatures - Digital Signatures - Signature Standard (DSS). (9 hrs)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	1	2	3	1	1	1	2	2	1.63
CO2	3	3	3	3	2	2	3	3	2.75
CO3	1	2	3	1	1	2	3	2	1.88
CO4	1	2	3	2	2	1	3	2	2.00
CO5	1	2	3	1	2	2	3	2	2.00

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	2	1	2	1	2	3	-	3	2.00
CO2	3	3	2	3	3	3	3	3	2.88
CO3	2	1	2	1	2	3	-	3	2.00
CO4	1	2	2	1	2	3	-	3	2.00
CO5	2	1	2	1	2	3	-	3	2.00
Mean Overall Score									**2.11 Medium**

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

W. Stallings, Cryptography and Network Security Principles and Practice, Pearson Education, 2005.

Unit I: Chapter 2 (Sections 2.1 to 2.3), Chapter 3 (Sections 3.1, 3.2, 3.4) Chapter 5 (Sections 5.1 to 5.2)
Unit II: Chapter 4 (Sections 4.3, 4.5, 4.7) and Chapter 8 (Sections 8.1 to 8.5)
Unit II: Chapter 9 (Sections 9.1 to 9.2) and Chapter 10(Sections 10.1 to 10.3)
Unit III: Chapter 11 (Sections 11.1. to 11.5)
Unit IV and V: Chapter 12(Sections 12.1 to 12.3) and Chapter 13(Sections 13.1, 13.4)

Reference Books:

1. C. Kaufman, R. Perlman, M. Speciner, Network Security- Private Communication in a public world, 2/e, Prentice Hall, 2002.
2. M. Welschenbach, Cryptography in C & C++, John Wiley, 2005.
3. K. N. Gupta, K. N. Agarwala, P. Agarwala, Digital Signature: Network security Practices, PHI, 2005.

Webliography:

1. https://nptel.ac.in/courses/106/105/106105162/
2. https://nptel.ac.in/courses/106/106/106106221/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		NUMERICAL ANALYSIS	**Elective**	**3**	**3**	**-**	**-**	**3**

Course Objectives:

1. To understand the notion of exact solution and to develop an algorithm to approximate the exact solution with acceptable error.
2. To develop various algorithm to approximate the exact solutions of transcendental equations, matrix equations etc.
3. To provide methodologies to compute the numerical solutions of ordinary and partial differential equations with standard algorithms.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Understand the concept of exact solutions, approximate solution, error on the approximate solution	K2
CO2	Predict the numerical value of polynomial by interpolation methods	K5
CO3	Compute and analyze the approximate solutions of transcedental equations	K4
CO4	Develop various algorithm to solve system of linear equations using Matrices	K6
CO5	Evaluate the numerical value of differentiation and integration	K5
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I Number Systems and Errors: The Representation of Integers -The Representation of Fractions - Floating point arithmetic- Loss of Significance and Error Propagation - Computational Methods for error estimation-Some comments on convergence of sequences-Some mathematical preliminaries.

Unit II Interpolation by polynomials: Polynomial forms- Existence and Uniqueness of the Interpolating polynomial-The divided difference table- The error of the interpolating polynomial-Interpolation in a function table based on equally spaced points.

Unit III The solution of nonlinear equations: A survey of iterative methods - Fixed point iteration - Polynomial Equations: Real roots - Complex roots and Muller's Method.

Unit IV Matrices and Systems of Linear equations: The solution of linear systems by elimination -The pivoting strategy - The triangular factorization.

Unit V Differentiation and Integration: Numerical differentiation - Numerical Integration: Some basic rules - Composite rules.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	3	3	-	3	3.00
CO2	3	3	3	3	3	3	2	3	2.87
CO3	3	3	3	3	3	3	3	3	3.00
CO4	3	3	3	3	3	3	2	3	2.87
CO5	3	3	3	3	3	3	3	3	3.00

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	-	2	2	-	3	2.67
CO2	3	3	3	2	3	3	-	3	2.86
CO3	3	3	3	3	3	3	-	3	3.00
CO4	3	3	3	2	3	3	-	3	2.86
CO5	3	3	3	3	3	3	-	3	3.00
Mean Overall Score									**2.88 High**

Level of correlation: 3-High, 2-Medium, 1-Low

Text Book:

Samuel D. Conte and Carl de Boor, Elementary Numerical Analysis - An algorithmic approach, Third Edition, Tata McGraw Hill Publishers (1980)

Unit I to Unit V: Sections 1.1 - 1.7, 2.1 - 2.3, 2.5, 2.6, 3.1, 3.3, 3.6, 3.7, 4.2 - 4.4, 7.1, 7.2 and 7.4.

Reference Books:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI Publishers, 2012
2. J.B. Scarborough, Numerical Mathematical Analysis, Oxford Publication, 2005
3. K. Atkinson, An Introduction to Numerical Analysis, Wiley Publications, 1989

Webliography:

1. https://nptel.ac.in/courses/111/106/111106101/
2. https://nptel.ac.in/courses/127/106/127106019/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		FUZZY THEORY AND THEIR APPLICATIONS	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To expose the students to Fuzzy theory as Fuzzy is one of the latest topic in Mathematics that has real life applications.
2. This topic introduces the concept of uncertainty and fuzziness in logic that will enable the student to develop their intuitive mind further.
3. The two years M.Sc. program is to prepare every student to face the competitive world outside. It will help them to acquire sufficient knowledge and skill in the subject that will make them competent in various areas of mathematics.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Observe the need for Fuzzy set	**K1**
CO2	To generalize the various operations on sets to Fuzzy sets	**K2**
CO3	To establish relations on Fuzzy sets	**K3**
CO4	To hypothesize decision making in Fuzzy environment	**K6**
CO5	To appraise applications of Fuzzy sets	**K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze,K5=Evaluate, K6= Create		

Course Outline:

Unit I: Crisp sets and fuzzy sets: Overview of Classical Sets, Membership Function, Height of a fuzzy set – Normal and sub normal fuzzy sets – Support – Level sets, fuzzy points –cuts – Decomposition Theorems, Extension Principle.
Unit II: Operation on fuzzy sets: Standard fuzzy operations – Union, intersection and complement – properties De. Morgan's laws - alpha–Cuts of fuzzy operations.
Unit III: Fuzzy relations: Cartesian Product, Crisp relations – cardinality – operations and properties of Crisp and Fuzzy relations. Image and inverse image of fuzzy sets - Various definitions of fuzzy operations – Generalizations – Non interacting fuzzy sets, Tolerance and equivalence relations.
Unit IV: Decision making in Fuzzy environments: General Discussion – Individual Decision making – multi person decision making – multi criteria decision making – multi stage decision making – fuzzy ranking methods – fuzzy linear programming.
Unit V: Applications: Medicine – Economics – Fuzzy Systems and Genetic Algorithms – Fuzzy Regression – Interpersonal Communication – Other Applications.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	1	3	3	2	2	1	3	3	2.50
CO2	1	3	3	2	2	1	3	3	2.50
CO3	1	3	3	2	2	1	3	3	2.50
CO4	1	3	3	2	2	1	3	3	2.50
CO5	1	3	3	2	2	1	3	3	2.50
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	3	2	3	1	2	2	2.38
CO2	3	3	3	2	3	1	2	2	2.38
CO3	3	2	3	2	3	2	2	2	2.50
CO4	3	2	3	2	3	2	2	2	2.50
CO5	3	2	3	2	3	1	2	2	2.38
Mean Overall Score									**2.46 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

George J.Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, PHI Leaning Private Limited, New Delhi (2009).

Reference Books:

1. A. K. Bhargava; Fuzzy Set Theory, Fuzzy Logic and their Applications, published by S. Chand Pvt. Limited (2013).
2. K.Pundir and R.Pundir, Fuzzy sets and their application, Published by A Pragati edition (2012)
3. H.J.Zimmermann, Fuzzy set theory and its applications, Springer (2012).

Webliography:

https://www.scientific.net>AMM.513-517.2186

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		OPERATIONS RESEARCH	**Elective**	**3**	**3**	**-**	**-**	**3**

Course Objectives:

1. To establish the real life applications of Linear Algebra and Analysis in terms of Linear, Integer and Dynamic programming
2. To understand the fundamentals of Inventory and Queuing Theory with suitable modelling
3. To provide fair knowledge on finding the solutions of real life problems which are not linear in nature.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Formulate basic real life problems into mathematical constrained linear equations and find its solutions	K6
CO2	Develop various techniques to solve integer programming problems	K6
CO3	Build basic tools and methods to solve dynamic programs	K3
CO4	Analyze the fundamental concepts of inventory and Queuing Theory.	K4
CO5	Understand and solve real life problems which involves non-linearity.	K2
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I Linear programming – Network problems: preliminary ideas – Network linear programme- ensuring total supply equals total demand – transportation problem – assignment problem – shortest route problem – maximum flow problem cuts in a network.

Unit II INTEGER PROGRAMMING: Introduction – Integer Programming Formulations – Gomory's construction–Fractional cut method(all integer)–The Cutting – Plane Algorithm – Branch–and–Bound Technique – Zero–One Implicit Enumeration Algorithm.

Unit III DYNAMIC PROGRAMMING: Introduction – Application of Dynamic Programming: Capital Budgeting Problem – Reliability Improvement Problem – Stage–coach Problem – Cargo Leading Problem – Minimizing Total Tardiness in Single Machine Scheduling Problem – Optimal Subdividing Problem – Solution of Linear Programming Problem through Dynamic Programming.

Unit IV **Inventory:** Introduction–Inventory Decisions–Cost Associated– with Inventories –Factors Affecting inventory–Economic Order Quantity–Deterministic Inventory Problems with No Shortages–Deterministic inventory Models with shortages–EOQ with Price Breaks–Multi Item Deterministic problems–Inventory Problems

with Uncertain Demand.

Queuing Theory: Introduction–Queuing System–Elements Of Queuing System–Operating Characteristics of Queuing System–Classification of Queuing Models–Model–I (M/M/1):(∞/FIFO), Model–II (M/M/1) : (N/FIFO), Model–III (M/M/C):(∞/FIFO), Model–IV (M/M/C) : (N/FIFO). Problems in above four models.

Unit V NON LINEAR PROGRAMMING: Introduction – Lagrangean Method –Jacobi Method– Kuhn–Tucker Method – Quadratic Programming – Separable Programming – Chance–Constrained Programming or Stochastic Programming.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	2	3	3	3	3	2	3	2.75
CO2	2	3	3	3	3	3	2	3	2.75
CO3	2	3	3	3	3	3	3	3	2.86
CO4	2	3	3	3	3	3	3	3	2.86
CO5	2	3	3	3	3	3	2	3	2.75

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	2	3	3	2	3	2.75
CO2	3	3	3	2	3	3	2	3	2.75
CO3	3	3	2	2	3	3	2	3	2.62
CO4	3	3	2	2	3	3	2	3	2.62
CO5	3	3	3	2	3	3	2	3	2.75
Mean Overall Score									High

Level of correlation: 3-High, 2-Medium, 1-Low

Text Book:

Hamdy A. Taha, Operations Research, (sixth edition) Prentice–Hall of India private Limited , New Delhi,1997.

Reference Books:

1. Kanti Swarup, P.K.Gupta& Man Mohan, Operation Research (14th Ed), S. Chand Publication, 2008
2. S. Kalavathy, Operation Research (4th Ed), Vikas Publications, 2015
3. J.K. Sharma, Operation Research :Theory& Applications, Lakshmi Publications, 2012

Webliography:

1. https://nptel.ac.in/courses/111/107/111107128/
2. https://nptel.ac.in/courses/110/106/110106062/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		COMMUTATIVE ALGEBRA	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. The main aim of this course is the study of commutative Noetherian rings, particularly, polynomial and power series rings with coefficients in the ring of integers or fields, and their quotient ring.
2. The course gives a relevant background for studies in algebraic geometry, but also relates the theory to problems in number theory.
3. Results from commutative algebra will introduced and proved as required and so no prior experience with commutative algebra will be assumed. After introducing the basic objects and techniques, they will be illustrated by application to the theory of algebraic curves.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Establishing the main connections between these theories, analyzing them and explaining them through the use of examples.	**K3**
CO2	Analyse the structure of modules over a principal ideal domain.	K4
CO3	Determine which primes are in the support of a module along with which ones are associate primes of a module.	**K5**
CO4	Define localization and give an example.	**K1 & K2**
CO5	Distinguish Noetherian ring and Artinian ring.	**K4 & K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: Rings and Ideals: Rings, ring homomorphism, ideals, quotients, zero divisors, nilpotents and units- Prime and maximal ideals, nil radical and Jacobson's radical

Unit II: Operations on ideals, extension and contraction. Modules and module homomorphisms, Submodules and quotient modules, Operations on submodules, Direct sum and product

Unit III: Finitely generated modules, Exact sequences, Tensor product of modules- Restriction and extension of scalars, Exactness properties of the tensor product

Unit IV: Localization Week 8: Integral dependence, Going-up and Going-down theorems.

Unit V: Chain conditions, Noetherian rings - Primary decomposition in Notherian rings - Artinian rings.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	2	2	3	3	2.75
CO2	3	3	3	3	2	2	3	3	2.75
CO3	3	3	3	3	2	2	3	3	2.75
CO4	3	3	3	3	2	2	3	3	2.75
CO5	3	3	3	3	2	2	3	3	2.75

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	3	3	3	3	3	3	3	3	3.00
CO2	3	3	3	3	3	2	3	3	2.88
CO3	2	3	3	2	3	3	3	3	2.75
CO4	3	3	3	3	3	3	3	3	3.00
CO5	2	2	3	3	3	2	3	3	2.63
Mean Overall Score									**2.80 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

M. F. Atiyah, I. G. Macdonald, Introduction to Commutative Algebra, Addison Wesley Publishing Co., 1969.

Unit I to Unit V: Chapters 1 to 9.

Reference Books:

1. R. Y. Sharp, Steps in Commutative Algebra, London Mathematical Society Student Texts, 51. Cambridge University Press, 2000.
2. D. S. Dummit, R. M. Foote, Abstract Algebra, Wiley-India edition, 2013.
3. Eisenbud, David, Commutative Algebra: With a View toward Algebraic Geometry, New York, NY: Springer-Verlag, 1999.

Webliography:

1. https://nptel.ac.in/courses/111/106/111106113/
2. https://nptel.ac.in/courses/111/105/111105112/
3. https://nptel.ac.in/courses/111/106/111106098/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		MATHEMATICAL MODELING	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. To gather and convert information of a physical phenomena into a mathematical framework.
2. To analyze a model and to apply an appropriate method to calculate a solution in– order to predict the behavior of the system.
3. To interpret results of modeling

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Analyze growth and decay models	**K4**
CO2	State applications in Economics, Medicine etc.	**K1**
CO3	Explain application in space Science	**K2**
CO4	Determine applications in Population dynamics and genetics	**K3**
CO5	Report applications in graph theory	**K6**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I : Linear growth and Decay Models - Non linear growth and Decay Models - Compartment Models - Dynamics Problems - Geometrical Problems. **(9 hours)**

Unit II : Population Dynamics - Epidemics - Compartment Models - Economics, Medicine, Arms Race, Battles and International Trade. **(9 hours)**

Unit III : Planetary Motion - Circular Motion - Motion of Satellites - Modeling through Linear difference equations of Second Order. **(9 hours)**

Unit IV : Basic theory of difference equation with Constant Coefficients - Economics and Finance - Population Dynamics and Genetics - Probability Theory. **(9 hours)**

Unit V: Solutions that can be Modelled through graphs - Models in terms of directed graphs, signed graphs, weighted digraphs and unoriented graphs. **(9 hours)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	2	2	1	3	3	2.50
CO2	3	3	3	2	2	1	3	3	2.50
CO3	3	3	3	2	2	1	3	3	2.50
CO4	2	3	3	1	2	1	3	3	2.25
CO5	2	3	3	1	2	1	3	3	2.25
PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**Mean Score**
CO1	3	3	3	3	3	1	3	2	2.63
CO2	3	3	3	3	3	1	3	2	2.63
CO3	3	3	3	3	3	1	3	2	2.63
CO4	3	3	3	3	3	1	2	2	2.63
CO5	3	3	3	3	3	1	2	2	2.63
Mean Overall Score									**2.52 High**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Kapur. J.N. - Treatment as in "Mathematical Modeling" by J.N.Kapur - New Age International Publishers, 2004.

Reference Books:

1. Rutherford, A. Mathematical Modelling Techniques. Courier Corporation, 2012.
2. Bender, E. A. An Introduction to Mathematical Modelling. Courier Corporation, 2000.
3. Clive, L. D. Principles of Mathematical Modelling. Elsevier, 2004.

Webliography:

http://mtm.ufsc.br/~daniel/matap/IntMatMod.pdf

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		PYTHON PROGRAMMIMG	**Elective**	**3**	**2**	**1**	**-**	**3**

Course Objectives:

1. Understand the basic components of computer programming using the Python language.
2. Demonstrate significant experience with the Python program development environment.
3. To learn and know the concepts of file handling, exception handling and database connectivity.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Develop algorithmic solutions to simple computational problems	**K3**
CO2	Read, write, execute by hand simple Python programs.	**K1, K3 & K6**
CO3	Represent compound data using Python lists, tuples, and dictionaries.	**K2**
CO4	Design and implement a program to solve a real world problem	**K6**
CO5	Use Python lists, tuples, dictionaries for representing compound data	**K3**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create		

Course Outline:

Unit 1: Introduction to Python - Why Python - Installing in various Operating Systems - Executing Python Programs - Basic Programming concepts - Variables, expressions and statements - Input/ Output –Operators. **(9 hours)**

Unit 2: Conditions - Functions - Arguments - Return values - Iteration - Loops - Strings -Data Structures - Lists - Dictionaries - Tuples - Sequences - Exception Handling. **(9 hours)**

Unit 3: File Handling - Modules - Regular Expressions - Text handling - Object Oriented Programming - Classes - Objects - Inheritance - Overloading – Polymorphism. **(9 hours)**

Unit 4: Introduction to Graphics programming - Introduction to GTK - PyGTK - Developing GUI applications using pyGTK - Scientific Programming using NumPy / SciPy - Image Processing - Processing multimedia files -Network Programming - Web services using SOAP, Introduction to Graphics programming – PyGame. **(9 hours)**

Unit 5: Introduction to Version Control Systems - Subversion/Git, Writing Unit Tests, Creating Documentation, Contributing to Open Source Projects. **(9 hours)**

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	2	3	2	1	1	3	2	2.13
CO2	2	3	3	2	1	2	3	2	2.25
CO3	1	3	3	2	2	2	2	3	2.25
CO4	2	3	3	1	2	1	2	3	2.00
CO5	2	2	3	1	2	2	2	3	2.13
PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	Mean Score
CO1	2	1	2	2	3	3	3	3	2.38
CO2	2	2	2	2	2	3	3	3	1.90
CO3	3	2	2	1	3	3	3	2	2.38
CO4	2	3	2	2	3	3	2	3	2.50
CO5	3	2	2	3	2	3	3	2	2.50
Mean Overall Score									**2.24 Medium**

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Allen B. Downey, Think Python: How to Think Like a Computer Scientist (Second Edition), Shroff /O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/)

Reference Books:

1. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013
2. John V Guttag, Introduction to Computation and Programming Using Python', Revised and expanded Edition, MIT Press, 2013.

3. Kenneth A. Lambert, Fundamentals of Python: First Programs, CENGAGE Learning, 2012.

Webliography:

1. https://nptel.ac.in/courses/106/106/106106182/
2. https://nptel.ac.in/courses/106/106/106106145/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		PYTHON PROGRAMMIMG	**Practical**	**2**	**1**	**-**	**1**	**2**

List of Practical's:

1. Implement a Python program to Calculate GCD of two numbers.
2. Implement a Python Program to calculate the square root of a number by Newton's Method.
3. Implement a Python program to calculate the exponentiation of a number.
4. Implement a Python Program to calculate the maximum from a list of numbers.
5. Implement a Python Program to perform Search
    - Implement a Python Program to perform Liner search
    - Implement a Python Program to perform Binary search
6. Implement a Python Program to perform insertion sort.
7. Implement a Python Program to perform selection sort.
8. Implement a Python program to multiply matrices.
9. Implement a Python program to Calculate the most frequent words in a text read from a file.
10. Implement function overloading with different function signatures.
11. Implement concept of class, instances and inheritance.
12. Solve algorithmic problems by program using different problem-solving strategies.
13. Implement Matrix multiplication using multi-threading in python.

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
		PROGRAMMIMG IN C++	**Practical**	**2**	**1**	**-**	**1**	**2**

List of Practical's:

1. Programs to evaluate sin x, cos x, e^{-x} to 0.0001% accuracy.
2. Program to calculate the variance and standard deviation of a set of numbers.
3. Program to find product of matrices, inverse of a matrix using functions.
   Macro that obtains largest of three numbers.
4. Define a class of students and prepare a statement containing name, total marks of Ranks (using functions).
5. Program to check whether a number/ string is a palindrome without using the corresponding standard function.
6. Define a class string and exhibit the use of string manipulations.
7. Create a class FLOAT that contains one float data. Overload all the four arithmetic.
8. Write a C++ program implement a class 'Complex' of complex numbers. The class should be include member functions to add and subtract two complex numbers.
9. Write a C ++ program to implement a class for complex numbers with add and multiply as member functions. Overload ++ operator to increment a complex number.
10. Write a program in C++ to demonstrate friend function.