DWARAKA DOSS GOVERDHAN DOSS VAISHNAV COLLEGE
(Autonomous)
College with Potential for Excellence
Linguistic Minority Institution. Affiliated to University of Madras

POST GRADUATE AND RESEARCH DEPARTMENT OF

MATHEMATICS

M.Sc. Mathematics

CURRICULUM AND SCHEME OF EXAMINATIONS

Learning Outcome – based Curriculum Framework

(with Effect from the Academic Year 2025-2026)

I – II Semesters

SCHEME AND SYLLABUS

INSTITUTION

VISION

To impart value-based quality academia; to empower students with wisdom and to charge them with rich Indian traditions and culture; to invoke the self, to broaden the same towards nation building, harmony and Universal brotherhood.

MISSION

To ensure sustained progress and development in imparting quality education, to pioneer new avenues of teaching and research and to emerge as an institution with potential for excellence.

DEPARTMENT OF MATHEMATICS

VISION

- To promote and support a comprehensive, innovative and dynamic learning environment.
- To assist students in acquiring a conceptual understanding of the nature and structure of mathematics, its processes and applications

MISSION

M1	Encourage partnerships across disciplines to spark innovative projects and enrich learning.
M2	Support significant research and the development of novel solutions for the benefit of our community
M3	Promote informal discussions and knowledge sharing among students, faculty, and the wider community

PROGRAM EDUCATION OBJECTIVES (PEOs)

PEO1	Students will possess comprehensive knowledge, essential skills, and insightful understanding in Mathematics and related disciplines.
PEO2	Students will be prepared for successful careers as mathematical professionals or as scientific researchers.
PEO3	Students will be able to effectively utilize mathematical problem-solving methods, including analysis, modeling, programming, and software applications, to address practical problems.
PEO4	Students will recognize the importance of and be equipped for continuous learning and professional development.
PEO5	Develop reputed professionals in the field of Mathematics with an ethical attitude and the ability to engage in lifelong learning.

PEO TO MISSION STATEMENT MAPPING

MISSION STATEMENTS	PEO1	PEO2	PEO3	PEO4	PEO5
M1	3	2	2	3	3
M2	2	3	3	2	3
M3	2	3	3	2	3

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

PROGRAM OUTCOMES (PO) IN RELATION TO GRADUATE ATTRIBUTES

PO1	Attain a high level of proficiency and understanding in all aspects of the subject
PO2	Identify and resolve problems efficiently, applying critical thinking to everyday situations
PO3	Develop strategies to mitigate public health and safety risks and promote community welfare
PO4	Execute lab experiments in accordance with safety guidelines and best practices.
PO5	Establish a solid grounding in life sciences to pave the way for a thriving career and entrepreneurial ventures
PO6	Prepare for Research and development success by cultivating expertise and staying attuned to emerging industry requirement.

Mapping of POs TO PEOs

PEO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
PEO 1	3	2	3	2	3	2
PEO 2	2	3	2	3	2	2
PEO 3	2	3	3	3	2	2
PEO 4	2	3	2	2	3	3
PEO 5	3	2	3	3	3	3

3-Strong Correlation 2- Medium Correlation 1- Low Correlation

PROGRAM SPECIFIC OUTCOMES

PSO1	Get a good theoretical insight into major areas of Mathematics.
PSO2	Analyze different methods and techniques and apply effectively in problem solving.
PSO3	Enhance critical thinking and problem solving ability.
PSO4	Relate and identify the use of mathematics in different fields and in everyday life.
PSO5	Motivate to clear NET/JRF examination and take up research in mathematics.

DEPARTMENT OF MATHEMATICS

ELIGIBILITY FOR ADMISSION

Candidates for admission to the first year of the degree of M. Sc. course should have Bachelor's degree in Mathematics of University of Madras or some other University accepted by the syndicate as equivalent

DURATION OF THE COURSE

The duration of the course for two academic years consisting of four semesters and each semester comprises of 90 days.

MATHEMATICS CURRICULUM

DISSERTATION

Semester IV consists of project and dissertation for 100 marks. Students are allocated individually to dissertation with the faculty of department. The format for dissertations is similar to the thesis style incorporating introduction, materials & methods, results, discussion and bibliography. The dissertation is submitted in a type written and bound form after plagiarism check and a copy of each dissertation is submitted to the Department for permanent record. Each student should present/ publish a paper on his/her project.

ELIGIBILITY FOR THE AWARD OF DEGREE

The candidate shall be eligible for the award of degree only if he/she has undergone the prescribed course of study for a period of not less than two academic years, passed the examinations of all the four semesters prescribed, earning 91 credits.

SCHEME ON EXAMINATIONS

As per the University Regulation the following split up of marks are to be followed.

(i) SPLIT UP FOR INTERNAL AND EXTERNAL MARKS FOR THEORY AND PRATICAL PAPER:

Sl. No.	Paper	Internal	External	Total
1.	Theory	50	50	100
2.	Practical	50	50	100

(ii) SPLIT UP FOR INTERNAL ASSESSMENT MARKS FOR THEORY

CIE- Continuous Internal Evaluation (50 Marks)

CIA	30
Generic Skill	15
Attendance	5
Total	50

SPLIT UP FOR INTERNAL ASSESSMENT MARKS FOR Practical

Model practical	25
Classroom practical	20
Attendance	5
Total	50

SCHEME OF I SEMESTER

SEMESTER I												
Component	**Course Category**	**Course Code**	**Name of the course**	**Over All Credits**	**Hrs Distribution**				**Total contact Hours**	**Marks**		
					L	T	P	S		CIA	ESE	Total
Part I	**Core Course I**		Algebra I	4	4	2	0	0	6	50	50	100
	Core Course II		Real Analysis I	4	4	2	0	0	6	50	50	100
	Core Course III		Probability Theory	4	4	2	0	0	6	50	50	100
	Core Course IV		Differential Geometry	4	4	2	0	0	6	50	50	100
	Discipline Specific Elective I Employability Course I (A)		Cryptography and crypt analysis	3	4	0	2	0	6	50	50	100
		OR										
	Discipline Specific Elective I Employability Course I (B)		Formal Languages and Automata Theory	3	4	0	2	0	6	50	50	100
		OR										
	Discipline Specific Elective I Employability Course I (C)		Lie groups and lie algebras	3	4	0	2	0	6	50	50	100
Part II	**Soft Skill I**		Quantitative Aptitude	2						50	50	100
Total				**21**					**30**			

SCHEME OF II SEMESTER

SEMESTER II												
Component	**Course Category**	**Course Code**	**Name of the course**	**Over All Credits**	**Hrs Distribution**				**Total contact Hours**	**Marks**		
					L	T	P	S		CIA	ESE	Total
Part I	**Core Course V**		Algebra II	4	4	2	0	0	6	50	50	100
	Core Course VI		Real Analysis II	4	4	2	0	0	6	50	50	100
	Core Course VII		Ordinary Differential Equations	4	4	2	0	0	6	50	50	100
	Core Course VIII		Mechanics	4	4	2	0	0	6	50	50	100
	Discipline Specific Elective II Entrepreneurship Course II (A)		Fuzzy sets and their Applications	3	5	1	0	0	6	50	50	100
		OR										
	Discipline Specific Elective II Entrepreneurship Course II (B)		Discrete Mathematics	3	5	1	0	0	6	50	50	100
		OR										
	Discipline Specific Elective II Entrepreneurship Course II (C)		Machine Learning And Artificial Intelligence	3	5	1	0	0	6	50	50	100
Part II	**Soft Skill II**		Analytical Reasoning	2						50	50	100
Total				**21**					**30**			

VALUE ADDED COURSE

- Image processing using open CV
- Machine learning using python

FIRST SEMESTER

CORE COURSE - I

ALGEBRA – I

Course Code:	**Credits : 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

Students will acquire knowledge about the concepts of Counting principle, Modules, linear transformations and real quadratic form.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Explain counting principle and discuss its applications.
CO2	Explain solvable groups, direct products, finite abelian groups and modules.
CO3	Describe linear Transformations , Canonical forms ,Triangular form and Nilpotent transformations
CO4	Demonstrate Jordan form , rational canonical form with some examples
CO5	Determine Trace and transpose of Hermitian, unitary, normal transformations and real quadratic form.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	3	3	2	3	3
CO2	3	3	2	2	1	2	3	2	3	3	3
CO3	3	3	1	1	1	2	3	1	2	3	3
CO4	3	3	1	1	1	2	2	2	2	3	3
CO5	3	2	1	2	1	2	3	2	2	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	Another Counting Principle, Sylow's theorems Chapter 2: Sections 2.11and 2.12	16	CO1
2	Direct products - Finite abelian groups- Modules Chapter 2: Sections 2.13 and 2.14 Chapter 4: Section 4.5	16	CO2
3	Linear Transformations - Canonical forms -Triangular form – Nilpotent transformations. Chapter 6: Sections 6.4 , 6.5	16	CO3
4	Jordan form - rational canonical form. Chapter 6 : Sections 6.6 and 6.7	16	CO4
5	Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form. Chapter 6 : Sections 6.8, 6.10 and 6.11 (Omit 6.9)	16	CO5

TEXT BOOKS:

I.N. Herstein. Topics in Algebra (II Edition) Wiley, 2002.

REFERENCE BOOKS:

1. M.Artin, Algebra, Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, Algebra, Vol. I –Groups(1996); Vol. II Rings, (1999) Narosa Publishing House , New Delhi.
4. D.S.Dummit and R.M.Foote, Abstract Algebra, 2nd edition, Wiley, 2002.
5. N.Jacobson, Basic Algebra, Vol. I & II Hindustan Publishing Company, New Delhi.
6, John. B. Fraleigh, Abstract Algebra. 7. Birkhoff, Mac Lane – A Brief Survey of Modern Algebra.

e-resources: https://nptel.ac.in

FIRST SEMESTER

CORE COURSE – II

Real Analysis I

Course Code:	**Credits : 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- To introduce the ideas of adherent and accumulation points, compactness, connectedness, uniform continuity, function of bounded variation, total variation, cesaro summation, Riemann – Stieltjes Integrals.
- The content of this course is viewed as extension of the ideas presented in Under Graduate course in Real Analysis. The course contains brief analysis of topological properties of sets in the space R^n and the concept of Riemann – Stieltjes integrals.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Explain the concepts of Adherent points, Accumulation points and prove The Bolzano-Weierstrass theorem, The Cantor intersection theorem,The Lindeloff covering theorem, The Heine Borel covering theorem, Formulating the concept of Compactness in R^n with suitable examples
CO2	Point out the relationship between connectedness and Arc-wise connectedness, Homeomorphisms and Isometry and use contractions to prove fixed point theorem.
CO3	Categorize the concepts of Monotonic functions, functions of Bounded variation and Total variation and construct the proofs of Additive property of total variation, Functions of bounded variation expressed as the difference of two increasing functions, Continuous functions of bounded variation and define multiplication of Infinite Series and Infinite products with illustrations
CO4	Define the concept of Riemann – Stieltjes (RS) Sum and Riemann – Stieltjes (RS) Integral and discuss its properties
CO5	Proving properties of Riemann - Stieltjes integrals, establish its existence and prove mean value theorems and two fundamental theorems of calculus regarding Riemann – Stieltjes integrals.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**3**	**2**	**2**	**3**	**2**	**1**	**3**	**2**	**1**	**3**	**2**
CO2	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**2**	**1**	**2**	**2**
CO3	**3**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**2**
CO4	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**
CO5	**3**	**2**	**2**	**3**	**2**	**1**	**3**	**2**	**2**	**3**	**2**

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	**Elements of Point set Topology** Definition of Adherent points, Accumulation points, Closed sets and adherent points with suitable illustrations, Constructing the proofs of: The Bolzano-Weierstrass theorem ,The Cantor intersection theorem ,The Lindeloff covering theorem , The Heine Borel covering theorem, Formulating the concept of Compactness in R^n with suitable examples. Chapter 3: sections: 3.6 - 3.12	16	CO1
2	**Limits and Continuity** Definition and Explanation of Connectedness, Components of a metric space, arc wise connectedness, uniform continuity, Formulating the concept of compact sets through uniform continuity, Construction of the proof of fixed point theorem with respect to contraction mappings. Chapter 4: sections: 4.16 – 4.21	16	CO2
3	**Functions of bounded variation** Classifying and explaining the Properties of monotonic functions, Explanation of Functions of bounded variation, Total variation with suitable illustrations. Constructing the proofs of Additive property of total variation, Total variation on [a, *x*] as a function of *x*, Functions of bounded variation expressed as the difference of two increasing functions, Continuous functions of bounded variation. Defining the Infinite Series, Explaining Multiplication of series and Illustrating the concept of Cesaro summability with examples and proofs. Chaper 6: Sections: 6.1 to 6.8 Chapter 8: Sections: 8.24, 8.25.	16	CO3
4	The Riemann - Stieltjes Integral Definition of the Riemann - Stieltjes integral, Constructing the proofs of Linear Properties, Integration by parts, Change of variable in a Riemann-Stieltjes integral, Reduction to a Riemann Integral, Step functions as integrators, Reduction of a Riemann – Stieltjes integral to a finite sum, Euler's summation formula. Definition of Monotonically increasing integrators upper and lower integrals and classifying Riemann's condition with equivalent conditions. Chapter 7: Sections: 7.3 to 7.14	16	CO4
5	**The Riemann-Stieltjes Integral** Explanation of Integrators of bounded variation, Construction of proofs of Sufficient conditions for the existence of Riemann-Stieltjes integrals, Necessary conditions for the existence of Riemann-Stieltjes integrals, First and Second Mean value theorems for Riemann - Stieltjes integrals, The integrals as a function of the interval, First and Second fundamental theorem of integral calculus. Chapter 7: Sections: 7.15 to 7.22	16	CO5

TEXT BOOKS:

Tom M.Apostol : Mathematical Analysis, 2nd Edition, Narosa,1989.

REFERENCE BOOKS:

1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976.
2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976.
3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991.
5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964.
6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.
7. Ganapathi Iyar, Real Analysis

e-resources: **https://nptel.ac.in**

FIRST SEMESTER

CORE COURSE- III

PROBABILITY THEORY

Course Code:	**Credits : 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- Understand basic knowledge of the Random events, random variables, and Parameters of the distributions
- Understand the concepts of Characteristics functions and its properties.
- Understand the probability distributions and application of limit theorem.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Solve problems on Random Variables and functions of random variable.
CO2	Demonstrate the concepts of expectations and moments.
CO3	Apply the concepts of characteristics functions.
CO4	Derive standard discrete and continuous distributions.
CO5	Establish the limit theorems.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	**3**	**3**	**3**	**2**	**2**	**2**
CO2	3	3	2	2	2	**3**	**3**	**3**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO4	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO5	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	**Random Events and Random Variables:** Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables. **Chapter 1: Sections 1.1 to 1.7 Chapter 2 : Sections 2.1 to 2.9**	16	CO1
2	**Parameters of the Distribution:** Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types. **Chapter 3 : Sections 3.1 to 3.8 (**Generalization of Regression line of second type is omitted)	16	CO2
3	**Characteristic functions :** Properties of characteristic functions – Characteristic functions and moments – semi invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function –Characteristic function of multidimensional random vectors – Probability generating functions. **Chapter 4: Sections 4.1 to 4.7**	16	CO3
4	**Some Probability distributions:** One point, two point, Binomial – Polya – Hypergeometric – Poisson distributions (**Discrete distributions)** – Uniform – Normal – Gamma – Beta – Cauchy and Laplace distributions (**Continuous distributions)**. **Chapter 5 : Section 5.1 to 5.10 (Omit Section 5.11)** (Omit examples 5.5.1 and 5.5.2)	16	CO4
5	**Limit Theorems :** Stochastic convergence – Bernoulli law of large numbers – Levy-Cramer Theorems (only one part of the theorem can be asked) – De Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem –Lapunov Theorem – Borel- Cantelli Lemma – Kolmogorov Inequality and Kolmogorov Strong Law of large numbers. **Chapter 6: Sections 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12. (Omit Sections 6.5, 6.10,6.13 to 6.15)** (Omit example 6.9.1)	16	CO5

TEXT BOOKS:

M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.

REFERENCE BOOKS:

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K. L. Chung, A course in Probability, Academic Press, New York, 1974.
3. R. Durrett, Probability: Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
4. V. K. Rohatgi: An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
5. S. I. Resnick, A Probability Path, Birhauser, Berlin, 1999.
6. B. R. Bhat, Modern Probability Theory (3rd Edition), New Age International (P) Ltd, New Delhi, 1999

e-resources: **https://nptel.ac.in**

FIRST SEMESTER

CORE COURSE - IV

DIFFERENTIAL GEOMETRY

Course Code:	**Credits 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- Know and use geometric quantities such as length, curvature, and torsion associated to planar and spatial curves
- Understand the technical definition of a smooth surface and its significance
- Use the first and second fundamental form for a surface and give formal and informal definitions of it.
- To define, use, and articulate the differences between normal curvature, geodesic curvature, Gaussian curvature, and mean curvature
- To define a geodesic on a surface and prove the basic properties of geodesics

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Diagnose the concepts of space curve,tangent, normal and binormal associated with tangent, normal, rectifying plane leading to formulae of Serret-Frenet and Examine the concepts of curves, surfaces,involutes and evolutes
CO2	Examine the concept of surfaces and their properties, surface of revolution and metric
CO3	Analyze isometric correspondence with intrinsic properties, and Recognize geodesic on a surface, canonical geodesic equation and its normal property
CO4	Describe geodesic curvature leading to Gauss-Bonnet theorem and analyze the curvatures
CO5	Analyse the developable surfaces, compare the minimal and the ruled surfaces.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**3**	**2**	**3**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**2**
CO2	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**3**	**3**	**2**
CO3	**2**	**3**	**3**	**1**	**2**	**2**	**3**	**2**	**2**	**2**	**3**
CO4	**3**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**3**	**3**	**2**
CO5	**3**	**2**	**2**	**1**	**2**	**2**	**3**	**2**	**2**	**3**	**2**

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module. No.	CONTENTS OF MODULE	Hrs	Cos
1	Space curves: Definition of a space curve – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces- tangent surface- involutes and evolutes Chapter I : Sections 1 to 7	16	CO1
2	Intrinsic equations – Fundamental Existence Theorem for space curves- Helices. Intrinsic properties of a surface: Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric- Direction coefficients Chapter I : Sections 8 and 9 Chapter II: Sections 1 to 6	16	CO2
3	Families of curves- Isometric correspondence- Intrinsic properties. Geodesics: Geodesics – Canonical geodesic equations – Normal property of geodesics- Chapter II : Sections 7 to 12	16	CO3
4	Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature- surface of constant curvature. Non-intrinsic properties of a surface: The second fundamental form- Principal curvature – Lines of curvature- Developables Chapter II: Sections 15 to 18 Chapter III : Sections 1 to 4	16	CO4
5	Developable associated with space curves and with curves on surfaces - Minimal surfaces – Ruled surfaces. Chapter III: Sections 5 to 8	16	CO5

TEXT BOOKS:

***T.J.Willmore, An Introduction to Differential Geometry, Oxford University Press, (17th Impression) New Delhi 2002. (Indian Print*)**

REFERENCE BOOKS:

1. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison – Wesley, Mass.1950.
2. Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry*, Interscience Publishers, 1963.
3. Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts inMathematics, Springer-Verlag 1978.
4. J.A. Thorpe *Elementary topics in Differential Geometry*,Under- graduate Texts in Mathematics, Springer - Verlag 1979.

e-resources: **https://nptel.ac.in**

FIRST SEMESTER

DISCIPLINE SPECIFIC ELECTIVE- I (a)

CRYPTOGRAPHY AND CRYPT ANALYSIS

Course Code:	**Credits : 3**
L:T:P:S: 3:3:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- Develop a foundational understanding of number theory and finite fields as they apply to modern cryptographic systems.
- Apply theoretical concepts to design, analyze, and evaluate classical and modern cryptographic algorithms and secure communication protocols.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Understand and apply concepts from elementary number theory such as congruence's, Euler's phi function, and Fermat's Little Theorem to solve arithmetic and factoring problems.
CO2	Demonstrate knowledge of finite fields and quadratic residues, including the use of Legendre and Jacobi symbols, in the context of cryptographic applications.
CO3	Analyze and implement classical cryptographic methods such as substitution, transposition, and affine ciphers, and evaluate their vulnerabilities through cryptanalysis techniques.
CO4	Apply public-key cryptographic algorithms like RSA and Rabin, and understand associated number-theoretic algorithms and attacks including factorization and discrete log problems.
CO5	Explain and assess methods of key distribution, digital certification, and trust models used in public key infrastructure and secure communication protocols.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	3	3	2	3	3
CO2	3	3	2	2	1	2	3	2	3	3	3
CO3	3	3	1	1	1	2	3	1	2	3	3
CO4	3	3	1	1	1	2	2	2	2	3	3
CO5	3	2	1	2	1	2	3	2	2	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	Introduction to Number Theory Topics in Elementary Number Theory: O and notations, time estimates for doing arithmetic-divisibility and the Euclidean algorithm, Congruence: Definitions and properties, linear congruence, residue classes, Euler's phi function, Fermat's Little Theorem and Chinese Reminder Theorem, Applications to factoring, **T1: Chapter 1 - Sections 1.1,1.2,1.3 and 1.4**	16	CO1
2	Finite fields, Quadratic residues and Reciprocity: Quadratic residues, Legendre symbol, Jacobi Symbol. **T1: Chapter 2 - sec 2.1 (Theorems without proof) and sec - 2.2**	16	CO2
3	Simple Cryptosystems, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, Stream Cipher, Cryptanalysis - Affine Cipher, Substitution Cipher, Vigenere Cipher and Hill Cipher, Hash Functions and Data Integrity, Security of Hash Functions, Secure Hash Algorithm and Message Authentication Code. (Theorem, Propositions without Proof). **T2: CH – 1: 1.1, 1.1.1 to 1.1.7, 1.2, 1.2.1 to 1.2.4** **T2: CH – 4: 4.1, 4.2, 4.3.2, 4.4**	16	CO3
4	RSA Cryptosystem - The RSA Algorithm, The Miller-Rabin Algorithm, Factoring Algorithm: The pollard p-1 Algorithm, Dixon's Random Squares Algorithm, Attacks on RSA, The Rabin Cryptosystem. The Pollard Rho Discrete Logarithm Algorithm, Elliptic Curves, Knapsack problem. (Theorem, Propositions without Proof). **T2: CH – 5: 5.3, 5.3.1, 5.6, 5.6.1, 5.6.3, 5.7, 5.7.1, 5.8, 6.2.2, 6.5, 6.5.1, 6.5.2, 6.5.3**	16	CO4
5	Key Distribution - Diffie-Hellman Key predistribution, Public-Key Infrastructure: What is PKI?, Secure Socket Layer, Certificates, Certificate Life cycle, Trust Models: Strict Hierarchy Model, Networked PKIs, The web browser Model, Pretty Good Privacy. **T2: CH -10:10.1, 10.2** **T2: CH -12:12.1, 12.1.1, 12.2, 12.2.1, 12.3, 12.3.1, 12.3.2, 12.3.3, 12.3.4.**	16	CO5

TEXT BOOKS:

1. Neal Koblitz, A Course in Number Theory and Cryptography (Edn 2), Springer Verlag, 1994.
2. Cryptography Theory and Practice, 3rd Edition, Douglas R. Stinson, 2005.

REFERENCE BOOKS:

1. Discrete Mathematics and Its Applications, Kenneth H. Rosen, 7th Edition, McGraw Hill, 2012.

E-resources: **https://nptel.ac.in**

FIRST SEMESTER

DISCIPLINE SPECIFIC ELECTIVE – 1(b)

Formal Languages and Automata Theory

Course Code:	**Credits : 3**
L:T:P:S: 3:3:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

Course objectives

- Understand basic Finite automata and regular sets
- Understand the fundamental concepts of Grammars.
- Understand the concepts of Languages

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

CO1	Able to Solve problems on finite automata and non-deterministic automata.
CO2	Able to regular sets using their properties
CO3	Able to understand the concepts of context free grammars and its normal form
CO4	Able to solve problems on context free languages.
CO5	Demonstrate the concepts of pumping lemma, closure properties for CFL.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	3	3	2	3	3
CO2	3	3	2	2	1	2	3	2	3	3	3
CO3	3	3	1	1	1	2	3	1	2	3	3
CO4	3	3	1	1	1	2	2	2	2	3	3
CO5	3	2	1	2	1	2	3	2	2	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	*Finite automata, regular expressions and regular grammars Finite state systems – Basic definitions – Non deterministic finite automata – Finite automata with moves – Regular expressions – Regular grammars.* *Chapter 2 : 2.1- 2.4 ,* *Chapter 3: 3.1-3.3*	16	CO1
2	***Properties of regular sets.*** *The Pumping lemma for regular sets – Closure proper ties of regular sets – Decision algorithms for regular sets – The Myhill-N erode Theorem and minimization of finite automata.* *Chapter 4: 4.1- 4.3*	16	CO2
3	***Context-free grammars*** *Motivation and introduction – Context-free grammars – Derivation trees- Simplification of context-free grammars – Chomsky normal form – Greibach normal form.* *Chapter 5 : 5.1, 5.2* *Chapter 6: 6.1, 6.2*	16	CO3
4	***Pushdown automata*** *Informal description- Definitions-Pushdown automata and context- free languages – Normal forms for deterministic pushdown automata.* *Chapter 7 : 7.1-7.3*	16	CO4
5	***Properties of context-free languages*** *The pumping lemma for CFL's – Closure properties for CFL's – Decision algorithms for CFL's.* *Chapter 8 : 8.1, 8.2*	16	CO5

Recommended Text:

Peter Linz, AnIntroduction to formal Languages amd Automata, Jones and Bartlett Learning 2019

Reference Books:

1. A. Salomaa, Formal Languages, Academic Press, New York, 1973.
2. John C. Martin, Introduction to Languages and theory of Computations (2nd Edition) Tata-McGraw Hill Company Ltd., New Delhi, 1997
3. *John E.Hopcraft and Jeffrey D.Ullman, Introduction to Automata Theory, Languages and Computation, Narosa Publishing House, New Delhi,1987*

e-resources: **https://nptel.ac.in**

FIRST SEMESTER

DISCIPLINE SPECIFIC ELECTIVE – I(C)

LIE GROUPS AND LIE ALGEBRAS

Course Code:	**Credits : 3**
L:T:P:S: 3:3:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

Course objectives

- Understand basic Lie groups of transformations
- Understand the fundamental concepts of Lie Algebras
- Understand the concepts of Semisimple Lie algebras

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

CO1	Develop a foundational understanding of basic Lie groups of transformations.
CO2	Acquire a fundamental understanding of Lie algebra concepts.
CO3	Comprehend the core ideas related to group transformations and infinitesimal transformations.
CO4	Understand the fundamental notions of Ideals and homomorphisms
CO5	Develop a comprehension of the concept of Semisimple Lie algebras.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	1	2	3	3	2	3	3
CO2	3	3	2	2	1	2	3	2	3	3	3
CO3	3	3	1	1	1	2	3	1	2	3	3
CO4	3	3	1	1	1	2	2	2	2	3	3
CO5	3	2	1	2	1	2	3	2	2	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	Introduction - Lie groups of transformations - infinitesimal transformations	16	CO1
2	Extended group transformations and infinitesimal transformations (one independent and one dependent variables).	16	CO2
3	Basic Concepts of Lie Algebras	16	CO3
4	Ideals and homomorphisms and Solvable and nilpotent Lie algebras	16	CO4
5	Semisimple Lie algebras : Theorems of Lie and Cartan, Killing form and Complete reducibility of representations and representation of sl(2,F).	16	CO5

Recommended Text:

G.W. Bluman and S. Anco, Symmetry and Integration for Differential Equations, Springer, (Berlin)2002.

Reference Books:

P.J. Olver, Applications of Lie groups to Differential equations, Springer (1998) Berlin

e-resources: **https://nptel.ac.in**

FIRST SEMESTER

SOFT SKILLS-1

QUANTITATIVE APTITUDE

Course Code:	**Credits : 2**
	CIA Marks : 50
Exam Hours: 90 min	**ESE Marks : 50**

LEARNING OUTCOME:

- To develop Knowledge to meet the *competitive examinations*
- To help them acquire skills in solving quantitative aptitude by simple methods
- To recall the basic concepts of Arithmetic and logical reasoning.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Analyze the problems on Square roots and Cube Roots, Surds and Indices, Logarithms
CO2	Develop the mathematical ideas to solve problems on Ratio, Proportion and Variation, Averages, Mixtures and Allegations
CO3	Recall the fundamental concepts and to solve problems on Profit and Loss, Partnership – Chain Rule, Linear Equations, Time, Speed and Distance – basics, Time and work
CO4	To develop the arithmetic and logical reasoning.
CO5	To solve the problem on Probability, Permutation & Combination

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3	2	3	3	2	3	3
CO2	3	3	2	2	2	2	3	2	3	3	3
CO3	3	3	3	2	2	2	3	3	2	3	3
CO4	3	3	3	2	3	2	2	2	2	3	3
CO5	3	2	3	2	2	2	3	2	2	3	2

CORRELATION: 3- STR3ONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Cos
1	Number System I & II – HCF, LCM, Decimal Fractions - Simplifications, Square roots and Cube Roots, Surds and Indices, Logarithms	CO1
2	Ratio, Proportion and Variation, Averages, Problems on Ages, Mixtures and Allegations, Percentages, Simple Interest and Compound Interest	CO2
3	Profit and Loss, Partnership – Chain Rule, Linear Equations, Areas and Volumes – Basics, Quadratic Equations, Time, Speed and Distance – basics, Time and work	CO3
4	Time, Speed and Distance – intermediate & advanced, Pipes & Cistern, Problems on Trains, Boats & Streams, Height and Distance	CO4
5	Probability, Permutation & Combination – basics, intermediate & advanced, Calendar and Clocks.	CO5

REFERENCE BOOKS:

1. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examinations", S Chand Publisher, 20th edition (2013), ISBN-13: 978-8121924986
2. Arun Sharma, "How to Prepare for Quantitative Aptitude for the CAT", Mcgraw Hill Education, 6 th Edition, ISBN-13: 9789339205126
3. Abhijit Guha, "Quantitative Aptitude for Competitive Examinations", Mcgraw Hill Education, 5th Edition, ISBN-13: 9789351343554 4.
4. R.V Praveen, "Quantitative Aptitude and Reasoning", PHI, 2nd Edition (2013), ISBN-978-81-203- 4777-9

e-resources:

1. http://www.indiabix.com
2. http://www.geeksforgeeks.com
3. http://www.examveda.com
4. http://www.javatpoint.com
5. http://www.aptitudeschool.com

SECOND SEMESTER

CORE COURSE- V

Algebra - II

Course Code:	**Credits : 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

Students will acquire knowledge about the extension fields, Galois theory, Finite fields and Four - Square theorem.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Prove theorems applying algebraic ways of thinking.
CO2	Connect groups with graphs and understanding about Hamiltonian graphs.
CO3	Compose clear and accurate proofs using the concepts of Galois Theory.
CO4	Bring out insight into Abstract Algebra with focus on axiomatic theories.
CO5	Demonstrate knowledge and understanding of fundamental concepts including extension

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	1	2	3	3	2	3	3
CO2	3	3	2	1	1	2	3	2	3	3	3
CO3	3	3	1	1	1	2	3	1	2	3	3
CO4	3	3	1	1	1	2	2	2	2	3	3
CO5	3	2	1	2	1	2	3	2	2	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	Extension fields – Transcendence of e. Chapter 5: Section 5.1 and 5.2	16	CO1
2	Roots of Polynomials.- More about roots Chapter 5: Sections 5.3 and 5.5	16	CO2
3	Elements of Galois theory. Chapter 5 : Section 5.6	16	CO3
4	Finite fields - Wedderburn's theorem on finite division rings. Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)	16	CO4
5	Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem. Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1) Chapter 7 : Sections 7.3 and 7.4	16	CO5

TEXT BOOKS:

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

REFERENCE BOOKS:

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

e-resources: **https://nptel.ac.in**

SECOND SEMESTER

CORE COURSE- VI

REAL ANALYSIS II

Course Code:	**Credits : 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- To introduce the ideas of Measure Theory, Lebesgue Integrals, Functions of Several Variables and Fourier Series, Fourier Integrals and their convergence aspects.
- The content of this course is viewed as extension of the ideas presented in previous semester in Real Analysis. Overall, the content forms the core of understanding Real Analysis at Advanced Level.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Demonstrate important theorems regarding measures and expressing measure in terms of open sets and closed sets.
CO2	Discuss theorems concerned with integration of non-negative measurable functions and demonstrate one of the classical result in analysis namely Lebesgue Montone Convergence Theorem
CO3	Point out properties related to Lebesgue Integrals, Fatou's Lemma and Dominated convergence theorem and establish the relation between Lebesgue and Riemann Integrable functions and solve problems using Lebesgue Dominated Convergence Theorem.
CO4	Prove several important theorems concerned with Fourier Series and their coefficients.
CO5	Solve problems concerned with computation of directional and partial derivatives, Jacobian Matrix, Chain Rule and establish the sufficient condition for Mean Value theorem for functions of several variables and other related theorems namely Taylor's Formula for functions of several variables

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	**Measure on the Real line** Definition of Lebesgue Outer Measure, Measurable sets with suitable examples. Developing Regularity conditions and constructing the proofs regarding measurable sets. Chapter 2: Section 2.1 to 2.3	16	CO1
2	**Measure on the real line and Integration of Functions of a Real variable** Definition of Measurable Functions, Borel and Lebesgue Measurability, Explanation of Integration of Non- negative functions and constructing proofs of properties of such functions. Chapter 2: Section 2.4, 2.5 Chapter 3.1	16	CO2
3	**Integration of Functions of a Real variable** Definition of the general integral, Developing Integration of series, Classifying and Distinguishing between the concepts of Riemann and Lebesgue integrals. Chapter 3 : Section 3.2, 3.4 (Omit section 3.3)	16	CO3
4	**Fourier Series and Fourier Integrals** Restating Orthogonal system of functions, Constructing the proofs of: The theorem on best approximation, The Fourier series of a function relative to an orthonormal system, Properties of Fourier Coefficients, The Riesz-Fischer Theorem, Developing the convergence and representation problems in for trigonometric series, Explanation of the proofs of: The Riemann - Lebesgue Lemma, The Dirichlet Integrals, An integral representation for the partial sums of Fourier series, Riemann's localization theorem, Sufficient conditions for convergence of a Fourier series at a particular point, Explanation of Cesaro summability of Fourier series, Consequences of Fejes's theorem, Constructing the proof of Weierstrass approximation theorem . Chapter 11: Section 11.1 to 11.15	16	CO4
5	**Multivariable Calculus** Definition of the concepts like Directional derivative, Continuity, The total derivative, The total derivative expressed in terms of partial derivatives with illustration of suitable examples, Definition of the matrix of linear function, The Jacobian matrix. Construction of the proofs of: The chain rule, The mean - value theorem for differentiable functions, Sufficient condition for differentiability, Sufficient condition for equality of mixed partial derivatives, Taylor's theorem for functions of R^n to R^1 Chapter 12 : Section 12.1 to 12.14 (Omit section 12.10)	16	CO5

TEXT BOOKS:

1. D. G. de Barra, *Measure Theory and Integration*, New Age International, second Edition, 2013 (for Units I ,II and III)
2. Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Narosa 1989 (for Units IV and V)

REFERENCE BOOKS:

1. Burkill,J.C. *The Lebesgue Integral*, Cambridge University Press,
2. Munroe,M.E. *Measure and Integration*. Addison-Wesley, Mass.1971.
3. Royden,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979.
5. Malik,S.C. and Savita Arora. *Mathematical Analysis*, Wiley Eastern Limited. New Delhi, 1991.
6. I.K.Rana. *Measure Theory and Integration*
7. Halmos, Measure Theory

e-resources: **https://nptel.ac.in**

SECOND SEMESTER
CORE COURSE- VII

ORDINARY DIFFERENTIAL EQUATIONS

Course Code:	**Credits : 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- To develop a strong background on finding solutions to linear differential equations with constant and variable coefficients and with singular points.
- To study the existence and uniqueness of the solutions of first order differential equations.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Apply the fundamental concepts of ordinary differential equations. Obtain the solutions of second order homogeneous and nonhomogeneous linear differential equations with constant coefficients.
CO2	Understand the utility of Wronskian, linear independence and independence of solutions.
CO3	To solve homogeneous and nonhomogeneous differential equations with variable coefficients and homogeneous equations with analytic coefficients.
CO4	Understand the concepts of regular singular points and solve the Euler equation and the Bessel equation.
CO5	Understand the concepts of successive approximations, The Lipschitz condition and prove local and Nonlocal existence theorems.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	2	2	2	1	2	2	2	2
CO2	3	3	2	1	2	1	1	2	2	3	3
CO3	2	2	2	1	2	1	2	3	2	2	2
CO4	2	3	2	2	3	2	2	2	3	2	3
CO5	3	2	3	2	2	2	2	2	2	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	**Linear Equations with Constant Coefficients**: Introduction - Second order homogeneous equation - Initial value problems for second order equations - Linear dependence and independence - A formula for the Wronskian - Non-homogeneous equation of order two. Chapter 2: Sections 1 to 6.	16	CO1
2	**Linear Equations with Constant Coefficients**: (Cont'd) Homogeneous and non-homogeneous equation of order *n* –Initial Value problems for *n*-th order equations - Equations with real constants - Annihilator method to solve non-homogeneous equation. Chapter 2: Sections 7 to 11. (omit section 12).	16	CO2
3	**Linear Equations with Variable Coefficients**: Introduction-Initial value problems for the homogeneous equation - Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – The Wronskian and linear independence – reduction of the order of a homogeneous equation – homogeneous equations with analytic coefficients - The Legendre equation. Chapter- 3: Sections 1 to 8 (omit section 9).	16	CO3
4	**Linear Equations with Regular Singular Points**: Introduction-The Euler equation - Second order equations with regular singular points - The Bessel equation – The Bessel equation contd. Chapter 4: Sections 1 to 4 and 7 to 8 (Omit Sections 5, 6 and 9).	16	CO4
5	**Existence and Uniqueness of Solutions to First Order Equations**: Equations with variables separated – Exact equations – The method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem. Chapter 5: Sections 1 to 6 (Omit Sections 7 to 9).	16	CO5

TEXT BOOKS:

Earl A. Coddington, *An Introduction to Ordinary Differential Equations*, Prentice – Hall of India Private Limited, New Delhi 2008.

REFERENCE BOOKS:

1. Williams E. Boyce and Richard C. Diprima, Elementary Differential Equations and Boundary Value Problems, 10th edition John Wiley and Sons, New York 2012.
2. M.D. Raisinghania, Advanced Differential Equations, S. Chand & Company Ltd., New Delhi 2012
3. George F. Simmons, Differential Equations with Application and Historical Notes, Tata McGraw Hill, New Delhi 1974
4. B. Rai, D.P. Choudhury and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House Pvt. Ltd, New Delhi 2012.

Web Resources:

1. https://www.coursera.org/learn/ordinary-differential-equations
2. https://www.youtube.com/watch?v=XtFWTjJrfoY&list=PLbwJuBHc3YzUIgPk82CIm-doYjZa_SeKe
3. https://www.youtube.com/watch?v=2tDT8cmcUw&list=PLQl6rqKYit6m3obWqH4U7mYEjIwt-iK-E

SECOND SEMESTER

CORE COURSE- VIII

MECHANICS

Course Code:	**Credits : 4**
L:T:P:S: 4:2:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- Recognize and use basic concepts and principles of classical mechanics, and apply them to simple examples.
- To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics, Legendre transformations, Canonical transformations and Poisson brackets.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Recall the concept of Newtonian Mechanics for a system of particles,demonstrate D' Alembert's Principle and to classify the constraints (holonomic, non-holonomic, Sceleronomic,Rheonomic)
CO2	Derive Lagrangian Formulation for both Holonomic and Non-Holonomic System and discuss its applications
CO3	Derive Hamilton's principle for both holonomic and non holonomic system
CO4	Define and demonstrate Hamilton- Jacobi equation,Separability,orthogonal system and discuss its applications.
CO5	Define Canonical transformation and discuss about various forms of generating function , Lagrange and Poisson Brackets with an illustration.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	1	2	3	3	2	3	3
CO2	3	3	2	1	1	2	3	2	3	3	3
CO3	3	3	1	1	1	2	3	1	2	3	3
CO4	3	3	1	1	1	1	2	2	2	3	3
CO5	3	2	1	2	1	1	3	2	2	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	Mechanical Systems: The Mechanical system- Generalized coordinates – Constraints - Virtual work - Energy and Momentum Chapter 1: Sections 1.1 to 1.5	16	CO1
2	Lagrange's Equations: Derivation of Lagrange's equations- Examples- Integrals of motion. Chapter 2: Sections 2.1 to 2.3	16	CO2
3	Hamilton's Equations: Hamilton's Principle - Hamilton's Equation - Other variational principles. Chapter 4: Sections 4.1 to 4.3	16	CO3
4	Hamilton-Jacobi Theory: Hamilton Principle function – Hamilton-Jacobi Equation – Separability Chapter 5: Sections 5.1 to 5.3	16	CO4
5	Canonical Transformation: Differential forms and generating functions – Special Transformations– Lagrange and Poisson brackets. Chapter 6: Sections 6.1, 6.2 and 6.3	16	CO5

TEXT BOOKS:

D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

REFERENCE BOOKS:

1. H. Goldstein, Classical Mechanics, (2nd Edition) Narosa Publishing House, New Delhi.
2. N.C.Rane and P.S.C.Joag, Classical Mechanics, Tata McGraw Hill, 1991.
3. J.L.Synge and B.A.Griffth, Principles of Mechanics (3rd Edition) McGraw Hill Book Co., New York, 1970.

e-resources: **https://nptel.ac.in**.

SECOND SEMESTER

DISCIPLINE SPECIFIC ELECTIVE-II (a)

FUZZY SETS AND THEIR APPLICATIONS

Course Code:	**Credits : 3**
L:T:P:S: 3:3:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- To apply the concepts of fuzzy sets and fuzzy relations
- Apply analysis of function of fuzzy variable using fuzzy logic
-

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Solve problems on simple operations of fuzzy subsets
CO2	Demonstrate the concepts of fuzzy relations
CO3	Infer the properties of fuzzy binary relation
CO4	Simplify fuzzy variables using properties of fuzzy logic
CO5	Construct various types of fuzzy numbers using operations.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	2	3	3	3	3	3	2
CO2	3	3	1	1	2	3	3	3	3	3	2
CO3	3	3	1	1	2	3	3	3	3	3	2
CO4	3	3	1	1	2	3	3	3	3	3	2
CO5	3	3	1	1	2	3	3	3	3	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	**Fundamental Notions:** Introduction, review of the notion of membership, the concept of a fuzzy subsets, dominance relations, simple operations on fuzzy subsets, sets of fuzzy subsets for **E** and **M** finite, properties of the set of fuzzy subsets, product and algebraic sum of two fuzzy subsets. Chapter I: Sec. 1 to 8.	16	CO1
2	**Fuzzy Graphs:** Introduction, fuzzy graphs, fuzzy relation composition of two fuzzy relation, fuzzy subsets induced by a mapping, conditioned fuzzy subsets, properties of fuzzy binary relation, transitive closure of fuzzy binary relation and paths in a finite fuzzy graph. Chapter II: Sec. 10 to 18	16	CO2
3	**Fuzzy Relations:** Fuzzy pre order relation, similitude relation, similitude sub relations in a fuzzy preorder, antisymmetric, fuzzy order relations, antisymmetric relations without loops, dissimilitude relations, resemblance relation. Chapter II: Sec. 19 to 26.	16	CO3
4	**Fuzzy Logic:** Introduction, characteristic function of a fuzzy subset, Polynomial forms, analysis of a function of fuzzy variables, logical structure of a function of fuzzy variables, composition of intervals. Chapter III: Sec.31 to 36	16	CO4
5	**The Laws of Fuzzy Composition:** Introduction, review of the notion of a law of composition, law of Fuzzy internal composition, fuzzy groupoids, principal properties of fuzzy groupoids, fuzzy monoids, fuzzy external composition and operations of fuzzy numbers. Chapter IV: Sec.43 to 49.	16	CO5

TEXT BOOKS:

A. *Kaufmann*, Introduction to the theory of Fuzzy subsets,Vol.I, Academic Press, New York, 1975.

REFERENCE BOOKS:

1. *H.J.Zimmermann*, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996.
2. *George J.Klir and Bo Yuan*, Fuzzy sets and Fuzzy Logic- Theory and Applications, Prentice Hall India, New Delhi,2001.

e-resources: https://nptel.ac.in.

SECOND SEMESTER
CORE COURSE- DISCIPLINE SPECIFIC ELECTIVE – II(b)

DISCRETE MATHEMATICS

Course Code:	**Credits : 3**
L:T:P:S: 3:3:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- Develop an understanding of the basic concepts related to Lattices.
- Comprehend the various applications of Lattice theory.
- Understand the fundamental concepts within coding theory.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Learn the basic concepts of Lattices.
CO2	Explore and understand the applications of Lattices.
CO3	Grasp the fundamental principles of coding theory.
CO4	Develop an understanding of the basic theory of finite fields.
CO5	Comprehend the concepts related to irreducible polynomials within finite fields.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	2	3	3	3	3	3	2
CO2	3	3	1	1	2	3	3	3	3	3	2
CO3	3	3	1	1	2	3	3	3	3	3	2
CO4	3	3	1	1	2	3	3	3	3	3	2
CO5	3	3	1	1	2	3	3	3	3	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	**Lattices:** Properties of Lattices: Lattice definitions – Modular and distributive lattice; Boolean algebras: Basic properties– Boolean polynomials, Ideals; Minimal forms of Boolean polynomials. **Chapter 1:**§1A and B§2A and B. §3	16	CO1
2	**Applications of Lattices:** Switching Circuits: Basic Definitions -Applications **Chapter 2:**§1 A and B	16	CO2
3	**Finite Fields Chapter 3:**§ 2	16	CO3
4	**Polynomials :** Irreducible Polynomials over Finite fields – Factorizationo f Polynomials **Chapter3:**§3 and §4	16	CO4
5	**Coding Theory:** Linear Codes and Cyclic Codes **Chapter 4**§ 1 and2	16	CO5

TEXT BOOKS:

RudolfLidland GunterPilz,AppliedAbstractAlgebra,Spinger- Verlag,New York,1984.

REFERENCE BOOKS:

1. A.Gill, Applied Algebra for Computer Science, Prentice Hall Inc., NewJersey.
2. J.L.Gersting, Mathematical Structures for Computer Science(3rd Edn.),ComputerSciencePress, NewYork.
3. S.Wiitala,DiscreteMathematics-AUnifiedApproach, McGrawHillBookCo.

e-resources: **https://nptel.ac.in**.

SECOND SEMESTER
DISCIPLINE SPECIFIC ELECTIVE – II (C)

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Course Code:	**Credits : 3**
L:T:P:S: 3:3:0:0	**CIA Marks : 50**
Exam Hours: 3hrs	**ESE Marks : 100**

LEARNING OUTCOME:

- Understand the fundamentals of Artificial Intelligence and its applications.
- Comprehend the principles of Probabilistic Reasoning and Bayesian Inference.
- Understand the basic concepts of Neural Networks.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Develop an understanding of the core concepts of AI and its diverse applications.
CO2	Comprehend the theoretical foundations of Probabilistic Reasoning and Bayesian Inference.
CO3	Develop an understanding of Ensemble Techniques
CO4	Gain an understanding of Unsupervised Learning methods.
CO5	Acquire a foundational understanding of Neural Networks.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	2	3	3	3	3	3	2
CO2	3	3	1	1	2	3	3	3	3	3	2
CO3	3	3	1	1	2	3	3	3	3	3	2
CO4	3	3	1	1	2	3	3	3	3	3	2
CO5	3	3	1	1	2	3	3	3	3	3	2

CORRELATION: 3- STRONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Hrs	Cos
1	**PROBLEM SOLVING** Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP)	16	CO1
2	**PROBABILISTIC REASONING** Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.	16	CO2
3	**SUPERVISED LEARNING** Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests	16	CO3
4	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING** Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization	16	CO4
5	**NEURAL NETWORKS** Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks – Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.	16	CO5

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education, 2021.
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.

REFERENCE BOOKS:

1. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, Pearson Education,2007
2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013
(http://nptel.ac.in/)
5. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.

e-resources: **https://nptel.ac.in**.

SECOND SEMESTER

SOFT SKILLS-2

ANALYTICAL REASONING

Course Code:	**Credits : 2**
	CIA Marks : 50
Exam Hours: 90 min	**ESE Marks : 50**

LEARNING OUTCOME:

- To develop Knowledge to meet the *competitive examinations*
- To help them acquire skills in solving Analytical reasoning by simple methods
- To recall the basic concepts of Arithmetic and logical reasoning.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Analyze the problems on Series , Stocks and Shares, Race and Games
CO2	Develop the mathematical ideas to solve problems on Data interpretation
CO3	Recall the fundamental concepts and to solve problems on Blood relations, pattern perceptions, mirror images, water images, paper cutting.
CO4	To develop the concepts of Analytical Reasoning, Syllogism, Puzzle test, Critical reasoning.
CO5	To solve the problem on Deductive logic, Rule detection, Cause and effect.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcome:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3	2	3	3	2	3	3
CO2	3	3	2	2	2	2	3	2	3	3	3
CO3	3	3	3	2	2	2	3	3	2	3	3
CO4	3	3	3	2	3	2	2	2	2	3	3
CO5	3	2	3	2	2	2	3	2	2	3	2

CORRELATION: 3- STR3ONG, 2- MEDIUM, 1- LOW

Module No.	CONTENTS OF MODULE	Cos
1	Series – AP, GP, HP, Mixed progression, Set Theory, Conditional Probability, Areas and Volumes – intermediate & advanced, Geometry, Trigonometry, Stocks and Shares, Race and Games.	CO1
2	Data interpretation – Data tables, pie charts, bar charts, line graphs, mixed diagrams, Analogy, Classification, Series completion - Number Series, Letter Series, Coding & Decoding.	CO2
3	Blood relations, Symbol based statement conclusion, Cubes and Dices, Directions Sense Test, Visual reasoning – figure formation, pattern perceptions, mirror images, water images, paper cutting	CO3
4	Analytical Reasoning, Syllogism, Puzzle test, Critical reasoning, Seating arrangements and cases, Alphabetical quibble, Number, Ranking and Sequence test	CO4
5	Deductive logic, Rule detection, Cause and effect, Statement and course of action, Statement and assumptions, Statement and arguments, Statement and conclusions.	CO5

REFERENCE BOOKS:

1. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examinations", S Chand Publisher, 20th edition (2013), ISBN-13: 978-8121924986
2. Arun Sharma, "How to Prepare for Quantitative Aptitude for the CAT", Mcgraw Hill Education, 6 th Edition, ISBN-13: 9789339205126
3. Abhijit Guha, "Quantitative Aptitude for Competitive Examinations", Mcgraw Hill Education, 5th Edition, ISBN-13: 9789351343554 4.
4. R.V Praveen, "Quantitative Aptitude and Reasoning", PHI, 2nd Edition (2013), ISBN- 978-81-203- 4777-9

e-resources:

1. http://www.indiabix.com
2. http://www.geeksforgeeks.com
3. http://www.examveda.com
4. http://www.javatpoint.com
5. http://www.aptitudeschool.com