College of Excellence, nirf 2023– 4th Rank
(An Autonomous Institution Affiliated to Bharathiar University)
(Accredited with 'A++' Grade by NAAC , An ISO 9001:2015 Certified Institution)
Peelamedu, Coimbatore – 641004

DEPARTMENT OF MATHEMATICS (PG)

CHOICE-BASED CREDIT SYSTEM & LEARNING OUTCOME BASED

CURRICULAR FRAMEWORK

MASTER OF MATHEMATICS

2023-2025 Batch

(III SEMESTER)

PROGRAMME   EDUCATIONAL OBJECTIVES

The M. Sc Mathematics curriculum is dedicated to preparing students for productive careers after 3-5 years of graduation.

1. Apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate programs in mathematics.

2. Development in their chosen profession and/or progress toward an advanced degree

3. The trust and respect of others as effective and ethical team members.

4. Graduates will become effective collaborators and innovators, leading or participating in efforts to address social, technical and business challenges.

5. Promote the culture of interdisciplinary research among all disciplines and applied mathematics.

PROGRAMME LEARNING OUTCOMES

On the successful completion of the programme, the following are the expected outcomes

PLO1: Students acquire sound analytical and practical knowledge to formulate and solve challenging problems.

PLO2: Students will be able to read and identify mathematical and computational methods in order to solve comprehensive problems.

PLO3: Students are well prepared to take jobs in schools and colleges as Mathematics teachers and Professors, Software Industries, Research and Development Organizations.

PLO4: Students to purse higher studies in Mathematical and Computing Sciences and to clear Competitive exams like SET/ NET/ TET etc.

PLO5: Students to learn and apply Mathematics in real life situations aiming at service to the society.

PROGRAMME SPECIFIC OUTCOMES

PSO1: Provide Strong foundation and inculcate ample knowledge on topics in pure and applied mathematics, empowering the students to pursue higher degrees at reputed academic institutions

PSO2: Advanced mathematical topics provide opportunities to research students for communication and discussion.

PSO3: Demonstrate the highest standard of ethics in research.

PSO4: Provide scope for interaction with international researchers and developing collaborations.

PSO5: Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.

PSO6: Nurture problem solving skills, thinking, creativity through assignments, project work.

PSO7: Generate publications in reputed mathematical journals.

DEPARTMENT OF MATHEMATICS (PG)
CHOICE BASED CREDIT SYSTEM & LEARNING OUTCOME BASED
CURRICULAR FRAMEWORK
SYLLABUS & SCHEME OF EXAMINATION
MASTER OF MATHEMATICS
2023 -2025 BATCH & ONWARDS

Sem	Course Code	Title of the course	Instruction hours/ Week	Contact hours	Tutorial	Duration of Examination	Examination Marks			Credits
							CA	ESE	Total	
II/III	MTH23CEA	Graph Theory Or	3+3	41/ 43	4/2	-	100	-	100	5
	MTH2309	Complex Analysis	6	88	2	3	25	75	100	5
III	MTH2310	Topology	6	88	2	3	25	75	100	5
	MTH2311	Basics of Cryptography **	6	88	2	3	25	75	100	5
	MTH2312	Fluid Dynamics	6	88	2	3	25	75	100	5
	MTH23S1	General Course-Research Methodology	2	30	-	3	-	100	100	2
	MTH23E5 MTH23E6	**Elective III**: Mathematical Modelling / Tensor Analysis	4	58	2	3	25	75	100	3
	MTH23COM	Comprehensive Examination	-	-	-	-	-	100	100	Grade
I - III	17MONL1	Online Course #	-	-	-	-	-	-	-	1*

** Open Book Examination – CIA

*   Students completing online course through NPTEL and IIT MUMBAI will get a credit of 1, for others

completed status will be given

Self study

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
MTH2309	COMPLEX ANALYSIS	THEORY	88	2	-	5

Preamble

➢ To present students the elements and importance of the Complex analysis.
➢ To define and recognize the basic properties of the complex numbers.
➢ To enable the students to the differentiability of complex functions and its related theorems.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the fundamental properties of the complex numbers that lead to the development of complex analysis	K2
CLO2	Apply the line integrals, curve integrals, singularities and determine the values of integrals using residues.	K3
CLO3	Analysis about limits and to know how they are used in series and problems	K4
CLO4	Evaluate the functions of complex variable in terms of continuity, differentiability and analyticity. Apply Cauchy-Riemann equations and harmonic functions to solve problems	K5
CLO5	Create a rigorous arguments developing the theory underpinning complex analysis	K5

Mapping with Programme Learning Outcomes

PLOs \ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	S	S	S	S
CLO3	S	S	M	S	M
CLO4	S	M	S	S	M
CLO5	S	S	M	S	S

S- Strong; M-Medium; L-Low

CORE IX - SEMESTER III - COMPLEX ANALYSIS (MTH2309)

Unit I (17 Hrs)

Introduction to the concept of analytic function: Limits and continuity - **Analytic functions**- Polynomials - Rational functions - **Conformality: Arcs** and closed Curves - **Analytic functions in regions** - **Conformal Mapping** - Length and Area - Linear Transformations: The Linear group - The Cross-ratio - Elementary Riemann Surfaces.

Unit II (18 Hrs)

Complex integration: Line integrals **Rectifiable Arcs** - Line Integrals as Functions of Arcs- **Cauchy's theorem for a rectangle** - Cauchy's theorem in a disk - Cauchy's integral formula: The index of a point with respect to a closed curve - The integer formula - Higher derivatives - **Removable singularities** - Taylor's Theorem - **Zeros and Poles** - The local mapping - The Maximum Principle - chains and cycles.

Unit III (18 Hrs)

The Calculus of Residues: The Residue theorem - The Argument principle - Evaluation of definite integrals - Harmonic functions: The Definitions and basic Properties - **Mean value property** - Poisson's Formula.

Unit IV (17 Hrs)

Series and Product Developments: **Weierstrass theorem** - The Taylor Series - The Laurent Series - Partial fractions and Factorization: Partial Fractions - Infinite Products - **Canonical Products**.

Unit V (18 Hrs)

The Riemann Mapping Theorem - Statement and Proof- Boundary Behavior - Use of the reflection principle - Analytic arcs - **Conformal mapping of Polygons**: The Behavior at an angle - **the Schwartz - Christoffel Formula** - Mapping on a rectangle.

TextBook

S. No	Author	Title of the book	Publishers	Year & Edition
1.	L.V. Ahlfors	Complex Analysis	McGraw Hill, NewYork	2013, III

Unit I : Chapter - 2 Sections 1.1-1.4

       Chapter - 3 Sections 2.1-2.4- 3.1-3.2 and 3.4

Unit II : Chapter - 4 Sections 1.1-1.5, 2.1-2.3, 3.1-3.4 and 4.1

Unit III: Chapter - 4   Sections 5.1-5.3,6.1-6.3
Unit IV: Chapter - 5   Sections 1.1-1.3,2.1-2.3

Unit V :   Chapter - 6   Sections 1.1-1.4,2.1-2.3

Reference Books

S. No	Author	Title of the book	Publishers	Year & Edition
1.	S. Ponnusamy	Foundations of Complex Analysis	Narosa Publisher	2003, II
2.	A.R.Vasistha and Etal	Complex Analysis	Krishna prakashan media pvt ltd	2008, I
3.	A.F.Beardon	Complex Analysis	John Wiley and Sons	1979, I

Course Designer

1. Mrs. K. Sharmilaa, Assistat Professor

2.Mrs. R. Sakthikala, Assistant Professor

Course content and Lecture schedule

Module No.	Topic	No.of hours	CLO's	Content Delivery Method	Student Engagement	Participatory Learning / Experiential Learning / Problem based Learning
				MTH2309 - COMPLEX ANALYSIS		
				UNIT I		
1.	Introduction to the concept of analytic function: Limits and continuity	1	CLO2, CLO4	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
2.	Analytic functions	1	CLO2 CLO3	Lecture, Chalk and Talk, Video Lecture , PPT**https://www.youtube.com/watch?v=P51wtDp7GjA**	Post it parade	Experiential Learning
3.	Polynomials	2	CLO2, CLO3, CLO4	Lecture , Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning
4.	Rational functions	2	CLO2,CLO4	Lecture, Chalk and Talk	Quizalize Diagrams, Sketchboard	Experiential Learning
5.	Conformality: Arcs and closed Curves	1	CLO2,CLO4	Video Lecture Chalk and Talk **https://www.youtube.com/watch?v=RT3Yh_jxjYo**	Presentation, Group reading and discussion.	Problem-based Learning
6.	Analytic functions in regions	2	CLO1,CLO2, CLO4	Video Lecture , OER **https://www.youtube.com/watch?v=RT3Yh_jxjYo**	Quescussion, Pro-con grid	Problem-based Learning
7.	Conformal Mapping	2	CLO2,CLO3, CLO5	Video Lecture Demonstration **https://www.youtube.com/watch?v=RT3Yh_jxjYo**	Presentation	Problem-based Learning
8.	Length and Area	1	CLO3,CLO4	Lecture, Quiz	Diagrams, Sketchboard	Experiential Learning
9.	Linear TransformationThe Linear group	2	CLO2,CLO4, CLO5	Lecture , Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning

10.	The Cross-ratio	2	CLO2,CLO3	Demonstration	Presentation	Problem-based Learning
11.	Elementary Riemann Surfaces.	1	CLO3,CLO4	Lecture PPT	Peer teaching	Participatory Learning
	UNIT - II					
12.	Complex integration: Line integrals	1	CLO1, CLO2, CLO3	Lecture, PPT	Group discussion	Experiential Learning
13.	Rectifiable Arcs	1	CLO1, CLO2, CLO3	Video Lecture , PPT **https://www.youtube.com/watch?v=XcDIjRet5hw**	Think write and share	Experiential Learning
14.	Line Integrals as Functions of Arcs	2	CLO1, CLO2, CLO3, CLO4,	Demonstration	Presentation	Problem-based Learning
15.	Cauchy's theorem for a rectangle	2	CLO2, CLO3, CLO4,	Video Lecture, Group Discussion **https://www.youtube.com/watch?v=AruIhF83CIY**	Diagrams, Sketchboard	Participatory Learning
16.	Cauchy's theorem in a disk	2	CLO2, CLO3, CLO4,	Lecture / OER Seminar	Flipped classroom, Presentation	Participatory Learning
17.	Cauchy's integral formula: The index of a point with respect to a closed curve	2	CLO2, CLO3, CLO4,	Lecture / OER Seminar	Flipped classroom, Presentation	Participatory Learning
18.	The integer formula - Higher derivatives	1	CLO2, CLO3, CLO4,	Lecture, PPT	Group discussion	Experiential Learning
19.	Removable singularities	1	CLO2, CLO3	Video Lecture, Lecture **https://www.youtube.com/watch?v=rbE6EuQLZbY**	Presentation, Group reading and discussion.	Problem-based Learning

20.	Taylor's Theorem	1	CLO2, CLO3, CLO4, CLO5	Lecture, PPT	Group discussion	Experiential Learning
21.	Zeros and Poles	1	CLO2, CLO4	Video Lecture , PPT **https://www.youtube.com/watch?v=UhZ5UjR5NPE**	Group discussion	Experiential Learning
22.	The local mapping	2	CLO2, CLO3, CLO4,	Lecture, Chalk and talk	Presentation, Group reading and discussion.	Problem-based Learning
23.	The Maximum Principle - chains and cycles.	2	CLO2, CLO3, CLO4,	Lecture, Chalk and talk	Presentation, Group reading and discussion.	Problem-based Learning
	UNIT-III					
24.	The Calculus of Residues: The Residue theorem	3	CLO2, CLO4	Lecture, PPT	Group discussion	Experiential Learning
25.	The Argument principle	2	CLO2, CLO3	Lecture PPT	Peer teaching	Participatory Learning
26.	Evaluation of definite integrals	2	CLO3, CLO4	Lecture, Demonstration	Student seminar	Experiential Learning
27.	Harmonic functions: The Definitions and basic Properties	3	CLO1, CLO4, CLO5	Lecture, Quiz, PPT	Student seminar, One Minute presentation	Participatory Learning
28.	Mean value property	3	CLO2, CLO3	Video Lecture, PPT **https://www.youtube.com/watch?v=oASPjtmFANw**	Group discussion	Experiential Learning
29.	Poisson's Formula.	5	CLO3, CLO4	Lecture, Chalk and talk	Presentation, Group reading and discussion.	Problem-based Learning
	UNIT IV					

30.	Series and Product Developments: Weierstrass theorem	4	CLO1, CLO2, CLO3, CLO4	Video Lecture Demonstration **https://www.youtube.com/watch?v=d3TCJjIH5Jo**	Student seminar	Experiential Learning
31.	The Taylor Series - The Laurent Series	3	CLO2, CLO3, CLO4	Research article reading, Lecture, Demonstration	Group reading and discussion, Student Seminar	Experiential Learning
32.	Partial fractions Factorization: Partial Fractions - Infinite Products	4	CLO2, CLO3, CLO4	Lecture, PPT	Flipped Class room, Discussion	Participatory Learning
33.	Canonical Products.	6	CLO2, CLO3, CLO4	Video Lecture **https://www.youtube.com/watch?v=aybXLm5hVao**	Design thinking	Problem-based Learning
	UNIT-V					
34.	The Riemann Mapping Theorem - Statement and Proof-	1	CLO2, CLO4	Video Lecture,PPT **https://www.youtube.com/watch?v=EJ5dfUIYdFw**	Group reading and discussion	Experiential Learning
35.	Boundary Behavior	1	CLO2, CLO4	Lecture, Discussion, Spotter's	Group discussion, Hand's on	Experiential Learning
36.	Use of the reflection principle	3	CLO2, CLO3	Lecture, Assignment	Flipped Class room, Discussion	Participatory Learning
37.	Analytic arcs	2	CLO3, CLO4	Lecture, Seminar	Flipped Class room, Discussion	Participatory Learning
38.	Conformal mapping of Polygons**:** The Behavior at an angle	5	CLO2, CLO3, CLO4	Video Lecture PPT, Socrative https://www.youtube.com/watch?v=DGQIS3jhLlw	Design thinking	Problem-based Learning
39.	The Schwartz - Christoffel Formula - Mapping on a rectangle.	6	CLO2, CLO3, CLO4	Video Lecture, Assignment **https://www.youtube.com/watch?v=VqpFEgKD6c8**	Brainstorming, Optimization and Presentation	Problem-based Learning

Name of the course	Complex Analysis
Name of the Faculty	Dr. M. NILA
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
MTH2310	TOPOLOGY	THEORY	88	2	-	5

Preamble

> Students will learn the fundamental concepts of point-set topology.

> Introduce students to the concepts of open and closed sets abstractly, not necessarily only on the real line approach.

> Provide the awareness of tools to students to carrying out advanced research work in pure mathematics

Course Learning Outcomes

Upon the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the concept of topological spaces and continuous functions, concept of product topology and quotient topology	K2
CLO2	Apply the concepts of distance between two sets, connectedness, denseness, compactness and separation axioms.	K3
CLO3	Analyze the concepts to read and write theorem proofs in topology	K4
CLO4 S	Evaluate that a given point in a topological space is either a limit point of not for a given subset of a topological space.	K5
CLO5 S-Strong; M-Medium, L-Low	Create the proofs to do variety of examples and counter examples in topology	K5

CLOs\PLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	S	S	S	S
CLO3	S	S	M	S	M
CLO4	S	M	S	S	M
CLO5	S	S	M	S	S

Mapping with Programme Learning Outcomes

S- Strong; M-Medium; L-Low

CORE X – SEMESTER III – TOPOLOGY (MTH2310)

Unit I   **(18 Hrs)**
Topological Spaces - Basis for a Topology - The Order Topology - **Closed Sets and Limit Points**- **Continuous Functions** - Product Topology - Metric Topology.

Unit II   **(17 Hrs)**
Connectedness and Compactness: Connected Spaces - Connected sets in R -**Components and Path Components - Local Connectedness** - **Compact Spaces** - Limit Point Compactness - Local Compactness.

Unit III   **(17 Hrs)**
Countability and Separation Axioms: Countability Axioms - Separation Axioms - **Urysohn's Lemma – Urysohn Metrization Theorem**.

Unit IV   **(17 Hrs)**
The Tychonoff Theorem - Completely Regular spaces - **The Stone-Cech Compactification**.

Unit V   **(19 Hrs)**
Complete Metric Spaces - Compactness in Metric Spaces - Point-wise and Compact Convergences – **Ascoli's Theorem - Baire spaces**.

Text Book

S. No	Author	Title of the book	Publishers	Year & Edition
1.	James R.Munkres	Topology A First Course	Prentice Hall of India Pvt. Ltd, New Delhi	2000,II
	Unit I : Chapter 2 -Sections 12 -15,17 -20 Unit II : Chapter 3 -Sections 23 -29 Unit III : Chapter 4 -Sections 30,31,33,34 Unit IV : Chapter 5 -Sections 37,38 Unit V : Chapter 7 -Sections 43,45,46,47,48			

Reference Books

S. No	Author	Title of the book	Publishers	Year & Edition
1.	George F. Simmons	Introduction to Topology and Modern Analysis	Tata Mc Graw -Hill Edition	2004, II
2.	J.Dugundji	Topology	Prentice Hall of India	1966, II
3.	J.L.Kelley	General Topology	Van Nostrand, Reinhold Co,New York	1995, I
4.	L.Steen and J.Seebach	Counterexamples in Topology	Holt -Rinehart and Winston, New York	1978, II

Course Designers

1. Mrs. C.R. Parvathy, Assistant Professor

2. Mrs. M. Deepa, Assistant Professor

Course content and Lecture schedule

<table>
<tr><td colspan="7" align="center">MTH2310 - TOPOLOGY</td></tr>
<tr>
<td>Module. No.</td>
<td>Topic</td>
<td>No. of periods</td>
<td>CLOs</td>
<td>Content delivery methods</td>
<td>Student engagement</td>
<td>Participatory Learning / Experiential Learning / Problem based Learning</td>
</tr>
<tr><td colspan="7" align="center">Unit – I</td></tr>
<tr>
<td>1</td>
<td>Basis for a Topology</td>
<td>2</td>
<td>CLO1 CLO2 CLO3</td>
<td>Lecture, PPT</td>
<td>Word cloud/ Mind map / Think Write and Share</td>
<td>Participatory Learning</td>
</tr>
<tr>
<td>2</td>
<td>The Order Topology</td>
<td>3</td>
<td>CLO1 CLO2 CLO3</td>
<td>Lecture, PPT</td>
<td>Flipped classroom, Presentation</td>
<td>Participatory Learning</td>
</tr>
<tr>
<td>3</td>
<td>Closed Sets and Limit Points</td>
<td>4</td>
<td>CLO1 CLO2 CLO3</td>
<td>Video Lecture https://www.youtube.com/watch?v=q6698vWK3ts</td>
<td>Quiz(Quizalize)</td>
<td>Experiential Learning</td>
</tr>
<tr>
<td>4</td>
<td>Continuous Functions</td>
<td>3</td>
<td>CLO1 CLO2 CLO3 CLO4</td>
<td>Video Lecture https://www.youtube.com/watch?v=ePUvjsmYzVU</td>
<td>Diagrams, Sketch board</td>
<td>Problem Based Learning</td>
</tr>
<tr>
<td>5</td>
<td>Product Topology</td>
<td>3</td>
<td>CLO1 CLO2 CLO3 CLO4</td>
<td>Lecture</td>
<td>Pro/con grid</td>
<td>Problem Based Learning</td>
</tr>
<tr>
<td>6</td>
<td>Metric Topology</td>
<td>3</td>
<td>CLO1 CLO2 CLO3 CLO4 CLO5</td>
<td>Lecture, PPT</td>
<td>Word cloud/ Mind map / Think Write and Share</td>
<td>Participatory Learning</td>
</tr>
<tr><td colspan="7" align="center">Unit – II</td></tr>
</table>

7	Connected Spaces	2	CLO2 CLO3 CLO4	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Experiential Learning
8	Connected sets in R	3	CLO1 CLO2 CLO3 CLO4	PPT / OER	One minute paper	Problem Based Learning
9	Components and Path Components	3	CLO2 CLO3 CLO4	Video Lecture https://www.youtube.com/watch?v=2i-49Ymf_14	Quiz(Quizalize/Socrative)	Experiential Learning
10	Local Connectedness	2	CLO2 CLO3 CLO4	Video Lecture. https://www.youtube.com/watch?v=NkMpQw1_hW8	Optimization, and Presentation	Problem-based Learning
11	Compact Spaces	2	CLO1 CLO2 CLO4 CLO5	OER	Flipped classroom, Presentation	Participatory Learning
12	Limit Point Compactness	3	CLO1 CLO2 CLO3 CLO4	Spotters	Hand's on(Socrative)	Experiential Learning
13	Local Compactness	2	CLO1 CLO2 CLO3 CLO4	Lecture – Chalk and Talk/Discussion	Quiz(Quizalize/Socrative)	Participatory Learning
Unit – III						
14	Countability Axioms	4	CLO1 CLO2 CLO3 CLO4	Lecture, PPT	Quiz(Quizalize/Socrative)	Problem Based Learning
15	Separation Axioms	4	CLO1 CLO2 CLO3	Lecture, PPT	Flipped classroom, Presentation	Participatory Learning

16	Urysohn's Lemma	4	CLO1 CLO2 CLO4 CLO5	Video Lecture https://www.youtube.com/watch?v=JUzssGzr-44	Discussion	Experiential Learning
17	Urysohn Metrization Theorem	5	CLO4 CLO5	Video Lecture https://www.youtube.com/watch?v=FyYmppkacu0	Discussion	Experiential Learning
Unit – IV						
18	The Tychonoff Theorem	5	CLO2 CLO3 CLO4	Lecture, PPT	Quiz(Quizalize/Socrative)	Problem-based Learning
19	Completely Regular spaces	6	CLO1 CLO2 CLO3 CLO4	Lecture, PPT	Word cloud	Participatory Learning
20	The Stone-Cech Compactification	6	CLO2 CLO3 CLO4	Video Lecture https://www.youtube.com/watch?v=k6KeIU7QWz8	Discussion	Experiential Learning
Unit –V						
21	Compactness in Metric Spaces	5	CLO1 CLO2 CLO3 CLO4	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
22	Point-wise and Compact Convergences	4	CLO1 CLO3 CLO4	OER	Flipped classroom, Presentation	Problem Based Learning
23	Ascoli's Theorem	5	CLO2 CLO3 CLO4	Video Lecture https://www.youtube.com/watch?v=aNCJZt_WTxs	Quiz(Quizalize/Socrative)	Participatory Learning
24	Baire spaces	5	CLO1 CLO2 CLO3 CLO4	Lecture / Seminar	Diagrams, Sketch board	Participatory Learning

Name of the course	Topology
Name of the Faculty	Dr R Sasirekha
Participatory Learning	42 %
Experiential Learning	31 %
Problem-based Learning	27 %

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
MTH2311	BASICS OF CRYPTOGRAPHY	THEORY	88	2	-	5

Preamble

➢ Gain cyber security skills required for senior level careers by focusing on principles and best management techniques.
➢ Provides a deeper understanding into cryptography, its application to network security, threats/vulnerabilities to networks and countermeasures.
➢ To work for financial institutions and consultancies, and as security specialists within a wide range of companies and R&D organizations.

Course Learning Outcomes

Upon the successful completion of course, the students will be able to

CLO No.	CLO Statement	Knowledge level
CLO1	Understand the basic concept of Cryptography and Network Security, their mathematical models.	K_2
CLO2	Apply the mathematical foundation required for various cryptographic Algorithms. Identify and classify computer and security threats	K_3
ClO3	Aanalyze existing authentication protocols for two party Communications.	K_4
CLO4	Evaluate the issues and structure of Authentication Service and Electronic Mail Security, web security and IP security.	K_5
CLO5	Create a security model to prevent, detect and recover from attacks.	K_6

Mapping with Programme Learning Outcomes

CLOS\PLOS	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	S	S	M	S
CLO3	M	S	S	S	S
CLO4	S	S	S	S	S
CLO5	S	S	S	S	S

S- Strong, M- Medium, L-Low

CORE XI – SEMESTER III - BASICS OF CRYPTOGRAPHY (MTH2311)

Unit I **(19 hrs)**

Introduction to Information Security: Introduction, security, critical characteristics of information, **NSTISSC security model**, components of an information system, security components, Approaches to information security implementation. The system development life cycle, **The Security System Development life cycle.** The need for security: Business needs first, threats, attacks, secured software development.

Cryptography : Basic concepts of cryptography, Cryptograph tools. Authentication, Passwords, keys versus passwords, **Attacking Systems via passwords**, Password verification.

Unit II **(19 hrs)**

Classical Encryption Techniques: Symmetric cipher model, substitution techniques, Transposition Techniques. Block Ciphers and the **Data Encryption Standard**: Block cipher principles, the strength of DES. Introduction to Number Theory: Prime the data encryption standard Numbers, **Fermat's and Euler's Theorem**, Testing for primality, Miller-Rabin Algorithm. Chinese Remainder Theorem, Discrete Logarithms, Algorithms. (Except Problems)

Unit III **(18 hrs)**

Public Key Crypto Systems : Principles of public-key cryptography, **public-key cryptosystems**, Applications for public-key cryptosystems, Requirements for public-key cryptography, public, key cryptanalysis, RSA Algorithm, Description of the Algorithm, Computational Aspects, Security of RSA.

Key Management: Diffie – Hellman Key Exchange – Algorithm, Key exchange protocols, Elliptic Curve Arithmetic, **Elliptic Curve cryptography**. (Except Problems)

Unit IV **(16 hrs)**

Digital Signatures and Authentication Protocols : Requirements, Direct Digital Signature, Arbitrated Digital Signature, Authentication Protocols, Mutual Authentication, One Way Authentication, Digital Signature Standard, **DSS Approach and Digital Signature Algorithm** (Except Problem)

Unit V **(16 hrs)**

Virus: **Viruses** and Related threats, Virus Counter measure Fire Walls: **Firewalls**, Types of Firewall, Design Principles of Firewall, Trusted Systems.

TextBooks

S.No	Author	Title of the book	Publishers	Year & Edition
1	Dr.Michael E. Whitman Herbers J.Mattord	Principles and Practices of Information Security	Course Technology Cengage Learning	2009, IV
Unit I : Chapter 1 : Upto SSDLC & Chapter 2 Chapter 8 : Upto Cryptographic Tools				
2	William Stallings	Cryptography and Network Security	Pearson Education	2006, IV
Unit II : Chapter 2 : 2.1 – 2.3 Chapter 3 : 3.1 – 3.3 & Chapter 8 : 8.1 – 8.5 Unit III : Chapter 9 : 9.1 – 9.2 Chapter 10 : 10.1 – 10.4 Unit IV : Chapter 13 : 13.1 – 13.3 Unit V : Chapter 19 : 19.1, 19.2 Chapter 20 : 20.1, 20.2				

ReferenceBooks

S.No	Author	Title of the book	Publishers	Year & Edition
1	Straub D.W	Information Security	Prentice Hall of India, New Delhi	2009, I
2	Pachghare V.K.	Cryptography and Information Security	PHI Learning Pvt Ltd, New Delhi	2009, I
3	Boris Ryabko, AndreyFionov	Basics of Contemporary Cryptography for IT practitioners, series on coding theory and cryptology – Vol I	World Scientific Publishing Co.Re.Ltd, Singapore	2005, I

CourseDesigner

1. Mrs. R.Panneerselvi, Assistant Professor
2. Mr. K.Kavitha, Assistant Professor

Course content and Lecture schedule

Module No.	Topic	No. of periods	CLO level	Content delivery method	Student engagement	Participatory Learning/ Experiential Learning/ Problem based Learning
MTH2311 - BASICS OF CRYPTOGRAPHY					
UNIT I					
1	Introduction to Information Security : Introduction, security	1	CLO1, CLO2, CLO3	Lecture – Chalk and Talk	Word cloud/ Mind map / Think Write and Share	Participatory Learning
2	critical characteristics of information,	2	CLO2, CLO3	PPT / OER	One minute paper	Participatory Learning
3	NSTISSC security model	3	CLO3, CLO4, CLO5	Video / Observation https://youtu.be/zd0U1zNBYNk https://youtu.be/BrDETY0eyJ8	Group discussion	Experiential Learning
4	Components of an information system, security components,	2	CLO1, CLO2, CLO4, CLO5	Lecture PPT	Quiz	Participatory Learning
5	Approaches to information security implementation.	2	CLO2, CLO3, CLO4, CLO5	Lecture – Chalk and Talk/ Group readings	Optimization, and Presentation, Brainstorming	Problem-based Learning
6	The system development life cycle	2	CLO3,CLO4,CLO5	Lecture – Chalk and Talk	Diagrams, Sketchboard	Participatory Learning

7	The Security System Development life cycle. The need for security: Business needs first, threats, attacks, secured software development	3	CLO2, CLO3, CLO4, CLO5	Video /Observation https://youtu.be/-UcjG5f_FEA	Group discussion	Experiential Learning
8	Basic concepts of cryptography, Cryptograph tools. Authentication, Passwords, keys versus passwords,	2	CLO2, CLO3, CLO4, CLO5	Seminar / PPT	Flipped classroom	Participatory Learning
9	Attacking Systems via passwords, Password verification	2	CLO2, CLO3, CLO4	Video / Observation https://youtu.be/6gyf_FSx5O4	Group discussion	Experiential Learning
UNIT II						
10	Classical Encryption Techniques: Symmetric cipher model,	3	CLO1, CLO2, CLO3, CLO4, CLO5	Lecture & PPT	Think Write and Share	Experiential Learning
11	Substitution techniques, Transposition Techniques.	3	CLO2, CLO3, CLO4, CLO5	Lecture & Discussion	Flipped classroom	Participatory Learning
12	Block cipher principles.	3	CLO3, CLO4	Lecture & PPT	Quiz	Experiential Learning
13	the data encryption standard, the strength of DES	3	CLO3, CLO4, CLO5	Video Lecture https://youtu.be/SaZGjQBItBc	Group discussion	Participatory Learning
14	Introduction to Number Theory: Prime Numbers, Testing for primality,	2	CLO2, CLO3, CLO4	Lecture & Problem solving	Optimization, and Presentation, Brainstorming	Problem-based Learning

15	Fermat's and Euler's Theorem,	2	CLO1, CLO2, CLO3	Video Lecture https://youtu.be/_Y1c4JViJDI https://youtu.be/sDrXeCs3ghQ	Diagrams, Sketchboard	Participatory Learning
16	Miller-Rabin Algorithm. Chinese Remainder Theorem, Discrete Logarithms, Algorithms. (Except Problems)	3	CLO3, CLO4, CLO5	Lecture & PPT	Group discussion	Experiential Learning
UNIT III						
17	Public Key Cryptosystems : Principles of public-key cryptography, public-key cryptosystems	4	CLO1, CLO2, CLO3	Video Lecture https://youtu.be/1Nejm_xaPbI	Optimization, and Presentation, Brainstorming	Problem-based Learning
18	Applications for public-key cryptosystems, Requirements for public-key cryptography, public, key cryptanalysis	3	CLO1, CLO2, CLO3, CLO4	Lecture & PPT	Diagrams, Sketchboard	Participatory Learning
19	RSA Algorithm, Description of the Algorithm, Computational Aspects, Security of RSA.	3	CLO3, CLO4	Lecture & Discussion	Post it parade	Experiential Learning
20	Key Management: Diffie – Hellman Key Exchange – Algorithm, Key exchange protocols,	4	CLO3, CLO4, CLO5	Lecture & PPT	Diagrams,Sketchboard	Participatory Learning
21	Elliptic Curve Arithmetic, Elliptic Curve cryptography. (Except Problems)	4	CLO2, CLO3, CLO4	Video Lecture https://youtu.be/2RVLBUncHJk https://youtu.be/_BCYCNYgXm8	One minute paper	Participatory Learning
UNIT IV						

22	Digital Signatures and Authentication Protocols : Requirements, Direct Digital Signature, Arbitrated Digital Signature,	4	CLO2, CLO3, CLO4, CLO5	Lecture & PPT	Presentation	Problem-based Learning
23	Authentication Protocols, Mutual Authentication,	4	CLO2, CLO3, CLO4	Lecture & Discussion	Optimization, and Presentation	Problem-based Learning
24	One Way Authentication,	3	CLO1, CLO2, CLO3	Lecture & Assignment	Post it parade	Experiential Learning
25	Digital Signature Standard , DSS Approach and Digital Signature Algorithm (Except Problem)	4	CLO3, CLO4, CLO5	Video Lecture https://youtu.be/FOWYDeTNRQ4 https://youtu.be/EYOmHSxSOMA	Diagrams,Sketchboard	Participatory Learning
UNIT V						
26	Virus:Viruses and Related threats	4	CLO1, CLO2, CLO3	Video Lecture https://www.coursera.org/lecture/aruba-network-security-basics/viruses-UPwsb	Student seminar	Experiential Learning
27	Virus Countermeasure	3	CLO1, CLO2, CLO3, CLO4	Lecture & PPT	Optimization, and Presentation, Brainstorming	Problem-based Learning
28	Fire Walls: Firewalls, Types of Firewall	4	CLO1, CLO2 , CLO3, CLO4, CLO5	Video Lecture https://youtu.be/j8X8kiGalYI	Student seminar	Experiential Learning
29	Design Principles of Firewall, Trusted Systems.	4	CLO2, CLO4, CLO5	Lecture & Assignment	Optimization, and Presentation	Problem-based Learning

Name of the course	**BASICS OF CRYPTOGRAPHY**
Name of the Faculty	Dr R Anitha Cruz
Participartory Learning	40%
Experiential Learning	20%
Problem based Learning	40%

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
MTH2312	FLUID DYNAMICS	THEORY	88	2	-	5

Preamble

- To familiarize the students with basic concepts of Fluid Dynamics as the subject has got application in medical, astrophysical, geophysical, agricultural, aero dynamical and other related disciplines.
- To develop the problem-solving skills essential to fluid dynamics in practical applications.

Course Learning Outcomes

Upon the successful completion of the course, students will be able to

CLO Number	CLO Statement	KnowledgeLevel
CLO1	Understand the fundamental knowledge of fluids and its properties	K2
CLO2	Apply the concepts and equations of fluid dynamics	K3
CLO3	Analyze thermodynamic control volume concepts in fluid dynamics for applications that include momentum, mass and energy balances	K4
CLO4	Evaluate the approximate solutions of the Navier-Stokes equation	K5
CLO5	Create a role of fluid dynamics in day-to-day life	K6

Mapping with Programme Learning Outcomes

CLOs\PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	M	S	S	M
CLO2	S	S	S	S	M
CLO3	S	S	S	S	S
CLO4	S	S	S	S	S
CLO5	S	S	M	S	S

S- Strong; M-Medium; L-Low

CORE XII – SEMESTER III - FLUID DYNAMICS (MTH2312)

Unit-I (17 hrs)

Introductory Notions - Velocity - Streamlines and path lines - Stream tubes and filaments- Fluid body - **Density - Pressure - Differentiation following the fluid** - Equation of continuity - Boundary condition - Kinematical and physical - Rate of change of linear momentum - Equation of motion of an inviscid fluid.

Unit-II (18 hrs)

Euler's momentum theorem - **conservative forces** - Bernoulli's theorem in steady motion - **Energy equation for inviscid fluid** - Circulation - Kelvin's theorem - Vortex motion - Helmholtz equation.

Unit-III (18 hrs)

Two dimensional motion - Two dimensional functions - **Complex potentia**l - basic singularities - Source and sink vortex - Doublet - circle theorem - flow past a circular cylinder with circulation - **Conformal transformation** - Blasius theorem - Lift force.

Unit-IV (18 hrs)

Viscous flows - Navier-stokes equations - Vorticity and circulation in a viscous fluid - Steady flow through an arbitrary cylinder under pressure - **Steady couette flow** between cylinders in relative motion - **Steady flow between parallel planes**.

Unit-V (17 hrs)

Laminar boundary layer in incompressible flow - Boundary layer concept - boundary layer equations - displacement thickness - **momentum thickness - kinetic energy thickness** - integral equation of boundary layer - flow parallel to semi-infinite flat plate - Blasius equationand its solution in series.

TextBooks

S. No	Author	Title of the book	Publishers	Year & Edition
1.	L.M. Milne Thomson Units I & II	Theoretical Hydro Dynamics	Dover Publications, New edition	2011, V
2.	N. Curle and H.J. Davies Units III , IV & V	Modern Fluid Dynamics Volume I	D.Van Nostrand Company Ltd, London	1998, I
	Unit I & II : Chapter I : 1.0 -1.3 Chapter III: 3.10 – 3.53 omit 3.32 -3.44 Unit III-IV & V: Chapter III : 3.1 –3.7.5. omit 3.4(full) and 3.5 -3.5.3 Chapter V : 5.1 –5.3.3 Chapter VI : 6.1 - 6.3.1. Omit 6.2.2				

Reference Books

S. No	Author	Title of the book	Publishers	Year & Edition
1	F.D Shanti Swarup	Fluid Dynamics	Krishna Prakashan media P (Ltd) Meerut	2000, XIII
2	M.D Raisinghania	Fluid Dynamics (with Hydrodynamics)	S.Chand & Company	2003, V

Course Designer

1. Mrs.R.Panneerselvi, Assistant Professor
2. Mrs.S.Aiswarya, Assistant Professor

Course content and Lecture schedule

<table>
<tr><th colspan="8">MTH2312 - FLUID DYNAMICS</th></tr>
<tr>
<th>Module No.</th>
<th>Topic</th>
<th>No. of periods</th>
<th>CLO level</th>
<th>Content delivery method</th>
<th>Student engagement</th>
<th>Participatory Learning / Experiential Learning / Problem based Learning</th>
</tr>
<tr><td colspan="7" align="center">UNIT I</td></tr>
<tr>
<td>1</td>
<td>Introductory Notions - Stream tubes and filaments</td>
<td>3</td>
<td>CLO1, CLO2, CLO4</td>
<td>Chalk and talk, Lecture</td>
<td>Quiz (Quizalize/ Socrative)</td>
<td>Participatory Learning</td>
</tr>
<tr>
<td>2</td>
<td>Velocity - Streamlines and path lines</td>
<td>3</td>
<td>CLO2, CLO3, CLO4, CLO5</td>
<td>Lecture, Chalk and talk</td>
<td>Word cloud/ Mind map / Think Write and Share</td>
<td>Participatory Learning</td>
</tr>
<tr>
<td>3</td>
<td>Fluid body - Density Pressure</td>
<td>3</td>
<td>CLO3, CLO4</td>
<td>Video Lecture https://nptel.ac.in/courses/112104118</td>
<td>Post it parade</td>
<td>Experiential Learning</td>
</tr>
<tr>
<td>4</td>
<td>Differentiation following the fluid - Equation of continuity -</td>
<td>2</td>
<td>CLO2, CLO4</td>
<td>Video Lecture, Quiz https://nptel.ac.in/courses/112104118</td>
<td>Diagrams, Sketchboard</td>
<td>Participatory Learning</td>
</tr>
<tr>
<td>5</td>
<td>Boundary condition - Kinematical and physical -</td>
<td>3</td>
<td>CLO3, CLO4, CLO5</td>
<td>Lecture, PPT</td>
<td>Diagrams, Sketchboard</td>
<td>Experiential Learning</td>
</tr>
<tr>
<td>6</td>
<td>Rate of change of linear momentum. Equation of motion of an inviscid fluid</td>
<td>3</td>
<td>CLO3, CLO4, CLO5</td>
<td>Chalk and talk</td>
<td>Think write and share</td>
<td>Experiential Learning</td>
</tr>
<tr><td colspan="7" align="center">UNIT II</td></tr>
</table>

7	Euler's momentum theorem - conservative forces -	4	CLO1, CLO2, CLO3	Chalk and talk and video Lecture **https://nptel.ac.in/courses/112104118/14**	Think write and share	Experiential Learning
8	Bernoulli's theorem in steady motion	4	CLO2, CLO3, CLO5	Lecture and chalk and talk	Presentation	Problem-based Learning
9	Energy equation for inviscid fluid	3	CLO2, CLO4	Video Lecture, Assignment https://nptel.ac.in/courses/112104118/14	Flipped classroom, Presentation	Participatory Learning
10	Circulation Kelvin's theorem	4	CLO2, CLO3, CLO5	Lecture, Quiz	Diagrams, Sketchboard	Experiential Learning
11	Vortex motion - Helmholtz equation.	3	CLO2, CLO4	Lecture, PPT	Presentation	Problem-based Learning
UNIT III						
12	Two dimensiona l motion - Two dimensiona l functions	4	CLO1, CLO3, CLO4	Lecture,chalk and talk	Group discussion	Experiential Learning
13	Complex potential - basic singularities - Source and sink vortex	4	CLO2, CLO3, CLO5	Video Lecture**http://web.mit.edu/16.unified/www/FALL/fluids/Letures/f15.pdf**	Peer teaching	Participatory Learning
14	Doublet - circle theorem	3	CLO2, CLO4	Lecture chalk and talk	Group discussion	Experiential Learning

15	flow past a circular cylinder with circulation	3	CLO3, CLO4, CLO5	Lecture, Assignment	Group discussion	Experiential Learning
16	Conformal transformat ion - Blasius theorem - Lift force .	4	CLO1, CLO4, CLO5	Video Lecture, Quiz http://web.mit.edu/16.u nified/www/FALL/fluid s/Letures/f15.pdf	Group reading and discussion	Problem-based Learning
UNIT IV						
17	Viscos flows - Navier-stokes equations - Vorticity and circulation in a viscous fluid	4	CLO1, CLO3, CLO4	Lecture, chalk and talk	Student seminar, One Minute presentation	Participatory Learning
18	Steady flow through an arbitrary cylinder under pressure -	5	CLO1, CLO2, CLO4	Lecture, PPT chalk and talk	Group reading and discussion	Problem-based Learning
19	Steady couette flow between cylindersin relative motion	5	CLO2, CLO5	Lecture, Assignment https://nptel.ac.in/cou rses/101103004/27	Flipped Class room, Discussion	Participatory Learning
20	Steady flow between parallel planes.	4	CLO1, CLO3, CLO5	Lecture, Quiz https://nptel.ac.in/courses/	Peer teaching	Participatory Learning
UNIT V						
21	Laminar boundary layer in incompressible flow	5	CLO2, CLO3	Lecture,PPT	Group reading and discussion	Experiential Learning

22	Boundary layer concept - boundary layer equations - displacement thickness	4	CLO3, CLO5	Lecture, Assignment	Group discussion	Experiential Learning
23	momentum thickness - kinetic energy thickness - integral equation of boundary layer - flow parallel to semi infinite flat plate	4	CLO1, CLO4	Lecture, Quiz https://nptel.ac.in'courses/Webcourses-contents/IIT-KANPUR/FLUID-MECHANICS/ui/courses_home-9.htm	Group discussion	Experiential Learning
24	Blasius equationand its solution in series.	4	CLO2, CLO3	Lecture, chalk and talk	Hand's on	Experiential Learning

Name of the course	Fluid Dynamics
Name of the Faculty	Dr.P.M.Mahalakshmi
Participatory Learning	41 %
Experiential Learning	35 %
Problem-based Learning	24 %

RESEARCH METHODOLOGY (MTH23S1)

Credits : 2   **Total duration : 30 Hrs**

Objective   To motivate the students in Research Oriented Topics.

Unit I   (5 Hrs)

Research Methodology: An **Introduction Meaning, Objectives, and Types of research**, Research Process, Criteria of Good Research Interpretation and Report Writing Meaning of Interpretation: why Interpretation? Technique of Interpretation, Precaution of Interpretation, Significance of Report Writing, different steps in Writing report, Layout of the research Report, **Types of Reports, Oral Presentation**, Mechanics of writing a Research report, Precautions of Writing Research Reports

Unit II   (6 Hrs)

Text, Symbols, and Commands: Command names and arguments-Environments-Declarations -Lengths -Special characters -**Fine-tuning text** - Word division Document Layout   and   Organization: Document class - Page style - **Parts of the document** - Table of contents.

Unit III   (6 Hrs)

Displayed Text: **Changing font** - Centering and indenting - Lists - Generalized lists - Theorem-like declarations - Tabulator stops - Boxes - **Tables** - Printing literal text - **Footnote** and marginal notes - Comments within text. Mathematical Formulas: Mathematical environments - Main   elements   of math mode - **Mathematical symbols** Additional elements - Fine-tuning mathematics.

Unit IV   (6 Hrs)

Post Script and PDF : LATEX and PostScript - **Portable Document Format Math** Extensions with AMS-LATEX: Invoking AMS-LATEX - Standard features of AMS- LATEX - Further AMS-LATEX packages - The AMS fonts

Unit V   (5 Hrs)

Research Ethics and Responsible Conduct in Research: **Brief history** and analytical basis of research ethics, responsible conduct in research (**Honesty in Science: Integrity, Authorship, Conflicts of Interest, Privacy and Confidentiality, Informed Consent, Risk/BenefitAssessment**), The legal regulation of research ethics in India (From UGC, MHRD and other governing agencies), Regulatory requirements relevant to international research.

Text books

S. No	Author	Title of the book	Publishers	Year & Edition
1.	C.R.Kothari	Research Methodology (Methods and Technique)	New Age International Pvt. Ltd.	Reprint 2010, I
	Unit I: Chapters : 1,14			
2.	H.Kopka & P.W.Daly	A Guide to Latex	Addition Wiley, London	2003, IV
	Unit II : Chapter 2 & 3 Unit III : Chapter 4 & 5 Unit IV : Chapters 10 & 12			
3.	Unit V https://www.glos.ac.uk/docs/download/Research/handbook-of-principles-and-procedures.pdf			

Reference Books

S. No	Author	Title of the book	Publishers	Year & Edition
1.	S.D.Sharma	A Text Book of Scientific and Technical Communication Writing for Engineers and Professionals	Sarup& Sons, New Delhi	2007, I
2.	George A. Gratzer	Math Into LaTeX: An Introduction to LaTeX and AMS-LaTex	Springer-Verlag	1998, I
3.	Stefan Kottwitz	LaTeX Beginner's Guide	Packt Publishing L	2011, I

Course Designer

1. Dr. S.Aiswarya, Assistant Professor
2. Mrs. R. Meenambiga, Assistant Professor

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
MTH23E5	MATHEMATICAL MODELLING	THEORY	58	2	-	3

Preamble

- ➢ To enable the students to learn mathematical concepts
- ➢ To build mathematical models of real-world systems, analyze them and make predictions about behavior of these systems.

Course Learning Outcomes

Upon the successful completion of the course, students will be able to

CLO No	CLO Statement	Knowledge Level
CLO1	Understand the importance of Mathematical modeling in the real world	K2
CLO2	Apply and articulate what type of modeling techniques are appropriate for a given physical system	K3
CLO3	Analyses a mathematical model of a given physical system and analyze it, make predictions	K4
CLO4	Evaluate the findings from the methods applied for the problem	K5
CLO5	Create a analyze and simulate mathematical models	K6

Mapping with Programme Learning Outcomes

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	M
CLO2	S	S	S	M	S
CLO3	S	M	S	S	S
CLO4	S	S	M	S	S
CLO5	S	S	S	S	M

S- Strong; M-Medium; L-Low

ELECTIVE III – SEMESTER III - MATHEMATICAL MODELLING (MTH23E5)

Unit- (12 hrs)

Mathematical Modeling through Systems of Ordinary differential Equations of the First Order : Mathematical modeling in population dynamics, ***Mathematical modeling in Arms Race**, Battles and international Trade in terms of systems of ordinary differential equations*-Mathematical modeling in dynamics through systems of ordinary differential equations of first order.

Unit-II (11 hrs)

Mathematical Modeling through difference equations: The need for Mathematical modeling through difference equations - Some simple models - Basic theory of linear difference equations with constant coefficients - **Mathematical modeling through difference equations in economics and finance**.

Unit III (12 hrs)

Mathematical Modeling through difference equations (contd.): **Mathematical modeling through difference equation** in population dynamics and genetics - Mathematical modeling through difference equations in probability theory - **Miscellaneous examples of mathematical modeling through difference equations**.

Unit-IV (12 hrs)

Mathematical modeling through Graphs: Situations that can be modeled through graphs – Mathematical models in terms of directed graphs - **mathematical models in terms of signed graphs** - **Mathematical models in   terms of weighted graphs**.

Unit-V (11 hrs)

Mathematical Modeling through calculus of Variations and Dynamic Programming: Optimization principles and techniques - Mathematical modeling through calculus of variations – **Mathematical Modeling through dynamic programming**.

TextBook

S. No	Author	Title of the book	Publishers	Year & Edition
1.	J.N. Kapoor	Mathematical Modelling	Willey Eastern Limited	Reprint 2000, I

	Unit I: Chapter 3: 3.1,3.2, 3.5 and 3.6
	Unit II: Chapter 5:5.1 - 5.3
	Unit III: Chapter 5: 5.4- 5.6
	Unit IV: Chapter 7:7.1 to 7.4
	Unit V: Chapter 9:9.1 to 9.3

ReferenceBooks

S. No	Author	Title of the book	Publishers	Year & Edition
1	D.J.G James and J.J Macdonald	Case studies in mathematical Modeling	Stanly Thames, Cheltenham	2003, I
2	C. Dyson, Elvery	Principles of Mathematical Modeling	Academic Press ,New York	2001, II

Course Designer:

1. Mrs. R. Panneerselvi, Assistant Professor
2. Mrs. D. Narmadha, Assistant Professor

Course content and Lecture schedule

Module No	Topic	No.of hours	CLOs	Content Delivery Methods	Student engagement	Participatory Learning/Experiential Learning/Problem based Learning
Unit I						
1.	Mathematical Modeling through Systems of Ordinary differential Equations of the First Order : Mathematical modeling in population dynamics	4	CLO1, CLO2	Lecture,Discussion	Discussion	Participatory Learning
2.	Mathematical modeling in Arms Race, Battles and international Trade in terms of systems of ordinary differential equations-	4	CLO1, CLO2, CLO3, CLO4	Lecture, video Lecture https://slideplayer.com/slide/3553004/ http://bionics.seas.ucla.edu/education/MAE_182A/MAE182A_Project_09.pdf https://slideplayer.com/slide/3422456/	Presentation/ Quiz	Experimental Learning
3.	Mathematical modeling in dynamics through systems	4	CLO1, CLO2, CLO3, CLO4	Lecture,Discussion, PPT, Chalk & Talk	Brainstorming	Problem based Learning

	of ordinary differential equations of first order.					
Unit II						
4.	Mathematical Modeling through difference equations: The need for Mathematical modeling through difference equations	3	CLO1, CLO2, CLO3, CLO4	Lecture,Discussion, video Lecture https://youtu.be/_4KMohr9iCU https://youtu.be/8qGYdGLbwpc https://www-users.york.ac.uk/~pjh503/mathematical_model/math_model10.pdf	Flipped Classroom,Presentation	Participatory Learning
5.	Some simple models	3	CLO2, CLO3, CLO4	PPT, https://onlinecourses.nptel.ac.in/noc22_ma20/preview https://towardsdatascience.com/gans-vs-odes-the-end-of-mathematical-modeling-ec158f04acb9		Experimental Learning
6.	Basic theory of linear difference equations with constant coefficients	2	CLO2, CLO3, CLO4	Lecture, PPT	Optimization and Presentation	Problem based Learning
7.	Mathematical modeling through difference equations in economics and finance	3	CLO2, CLO3, CLO4	Lecture,Discussion, video Lecture https://youtu.be/v2Pvki35H0U	Quiz,One minute paper	Participatory Learning

				https://youtu.be/VzlBEcs1fj4		
Unit III						
8.	Mathematical Modeling through difference equations (contd.): Mathematical modeling through difference equation in population dynamics and genetics	4	CLO2, CLO3, CLO4, CLO5	Lecture,PPT,video Lecture https://www.slideshare.net/arupparia/introduction-to-mathematical-modelling-42588379 https://www.coursera.org/lecture/ordinary-differential-equations/4-2-population-dynamics-i-LNhAl	Hands on (Socrative)	Experimental Learning
9.	Mathematical modeling through difference equations in probability theory	4	CLO1, CLO2, CLO3, CLO4	Lecture,Discussion,	Optimization and Presentation	Problem based Learning
10	Miscellaneous examples of mathematical modeling through difference equations.	4	CLO1, CLO2, CLO3, CLO4, CLO5	Lecture,Discussion, video Lecture https://web.ma.utexas.edu/users/m408s/m408d/CurrentWeb/LM9-1-2.php https://math.libretexts.org/Bookshelves/Calculus/Map%3A_Calculus__Early_Transcendentals_(Stewart)/09%3A_Differential_Equations/9.01%	Discussion and Hands on (Socrative)	Experimental Learning

				3A_Modeling_with_Differential_Equations		

<table>
<tr><td colspan="7" align="center">Unit IV</td></tr>
</table>

11	Mathematical modeling through Graphs: Situations that can be modeled through graphs	3	CLO1, CLO2, CLO3, CLO4, CLO5	Lecture,Discussion, Quiz	Pro/con grid, Quiz	Participatory Learning
12	Mathematical models in terms of directed graphs	2	CLO2, CLO3, CLO4	Lecture,PPT	Hands on (Socrative)	Experimental Learning
13	Mathematical models in terms of signed graphs -	4	CLO1, CLO2, CLO3, CLO4, CLO5	Lecture,Discussion, video Lecture https://youtu.be/CIwfCxkZ5Wk	Optimization, Brainstorming	Problem based Learning
14	Mathematical models in terms of weighted graphs.	3	CLO1, CLO2, CLO3, CLO4, CLO5	Lecture, video Lecture https://study.com/academy/lesson/graphs-in-discrete-math-definition-types-uses.html	Word cloud/Mind map	Participatory Learning

<table>
<tr><td colspan="7" align="center">Unit V</td></tr>
</table>

| 15 | Mathematical Modeling through calculus of Variations and Dynamic Programming : Optimization principles and techniques | 4 | CLO2, CLO3, CLO4 | Lecture,Discussion, video Lecture https://youtu.be/o-fPT0HyF2U https://youtu.be/5dRGRueKU3M\ | One minute paper, Quiz | Participatory Learning |

16	Mathematical modeling through calculus of variations	3	CLO2, CLO3, CLO4	Lecture,PPT,Synthetic	Hands on (Socrative)	Experimental Learning
17	Mathematical Modeling through dynamic programming.	4	CLO3, CLO4, CLO5	Lecture,Discussion, video Lecture https://youtu.be/dND9IsjL1lo https://www.coursera.org/lecture/operations-research-algorithms/5-6-mathematical-modeling-2-0ruoh	Brainstorming	Problem based Learning

Name of the Course	MATHEMATICAL MODELLING
Name of the Faculty	Dr.T.Brindha
Participatory Learning	33%
Experiential Learning	36%
Problem based Learning	31%

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
MTH23E6	TENSOR ANALYSIS	THEORY	58	2	-	3

Preamble

- To introduce students to the fundamentals of tensor algebra.
- To expose students to mathematical applications of tensor algebra which helps them to solve diverse problems which occur in real life situations

Course Learning Outcomes

Upon the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the concept of tensor variables and difference from scalar or vector variables.	K2
CLO2	Apply the base vectors, metric tensors and strain tensors in an arbitrary Coordinate system.	K3
CLO3	Analyze the Christoffel symbols which provide a concrete representation of the connection of (pseudo) Riemannian geometry in terms of coordinates on the Manifold.	K4
CLO4	Evaluate the Riemannan- Christoffel tensor to problems of differential geometry, Electro dynamics and relativity.	K5
CLO5	Create a tensor representation from interdisciplinary areas.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	S	S	S	S
CLO3	S	S	M	S	M
CLO4	S	M	S	S	M
CLO5	S	S	M	M	S

S- Strong; M-Medium; L-Low

ELECTIVE - III- SEMESTER III – TENSOR ANALYSIS (MTH23E6)

Unit I   **(12 Hrs)**

   Tensor theory: Scope of Tensor Analysis – transformation of coordinates - properties of admissible transformations of coordinates- transformation by invariance- transformation by covariance and contra variance – contra variant tensor –**covariant tensor**- tensor character of covariant and contra variant laws – algebra of tensors.

Unit II   **(12 Hrs)**

   Quotient law – symmetric and skew-symmetric tensors – relative tensors – **the metric tensor**- the fundamental and associated tensors.

Unit III   **(12 Hrs)**

   Christoffel's symbols – transformation of **Christoffel's symbols** – covariant differentiation of tensors – Ricci's theorem.

Unit IV   **(11 Hrs)**
   Riemann – Christoffel tensor – properties of **Riemann-Christoffel tensors** –Ricci tensor – Bianchi identitites –Einstein tensor.

Unit V   **(11 Hrs)**
   Riemannian and Euclidean spaces – existence theorem – the E-Systems and the generalized Kronecker deltas – application of the E-Systems to determinants – tensor **character of generalized Kronecker deltas**

Text Book

S. No	Author	Title of the book	Publishers	Year & Edition
1.	I.S.Sokolnikoff	Tensor Analysis Theory and Applications	John Wiley and sons	1952, II
	Unit I Chapter – 2 Sections: 18 -25			
	Unit II Chapter – 2 Sections: 26 -30			
	Unit III Chapter – 2 Sections: 31 – 35			
	Unit IV Chapter –2 Sections: 36 – 38			
	Unit V Chapter – 2 Sections: 39 -41			

Reference Books

S. No	Author	Title of the book	Publishers	Year & Edition
1.	A.W.Joshi	Matrices and tensors in Physics	New age international private limited	2003, IV
2.	A.I.Borisenko and I.E.Tarapov	Vector and tensor analysis with applications	Dover publication, New York	1968, III
3.	Pavel Grinfled	An introduction to tensor analysis and the calculus of moving surfaces	Springer, New York	2013, III

Course Designer:

1. Mrs. R. Panneerselvi, Assistant Professor
2. Mrs. D. Narmadha, Assistant Professor

Course content and Lecture schedule

<table>
<tr><td colspan="8" align="center">MTH23E6 - Tensor Analysis</td></tr>
<tr>
<th>Module No.</th>
<th>Topic</th>
<th>CLO level</th>
<th>No. of periods</th>
<th>Content delivery method</th>
<th>Student engagement</th>
<th>Participatory Learning / Experiential Learning / Problem based Learning</th>
</tr>
<tr><td colspan="7" align="center">Unit – I</td></tr>
<tr>
<td>1</td>
<td>Tensor theory: Scope of Tensor Analysis – transformation of coordinates - properties of admissible transformations of coordinates-</td>
<td>CLO1, CLO2, CLO3, CLO5</td>
<td>4</td>
<td>Lecture, Problem solving</td>
<td>Quiz (Quizalize/ Socrative)</td>
<td>Participatory Learning</td>
</tr>
<tr>
<td>2</td>
<td>transformation by invariance- transformation by covariance and contravariance</td>
<td>CLO2, CLO3</td>
<td>4</td>
<td>Lecture, Assignment</td>
<td>Word cloud/ Mind map / Think Write and Share</td>
<td>Participatory Learning</td>
</tr>
<tr>
<td>3</td>
<td>contravariant tensor –covariant tensor- tensor character of covariant and contravariant laws – algebra of tensors</td>
<td>CLO1, CLO2, CLO3</td>
<td>3</td>
<td>Video Lecture

https://youtu.be/JgaksKQOIsQ

https://youtu.be/JgaksKQOIsQ</td>
<td>Post it parade</td>
<td>Experiential Learning</td>
</tr>
<tr>
<td>4</td>
<td>algebra of tensors</td>
<td>CLO2, CLO3, CLO4</td>
<td>1</td>
<td>Lecture, PPT</td>
<td>Diagrams, Sketchboard</td>
<td>Participatory Learning</td>
</tr>
<tr><td colspan="7" align="center">Unit – II</td></tr>
</table>

5	Quotient law – symmetric and skew-symmetric tensors	CLO1, CLO2, CLO4	3	Video Lecture https://youtu.be/15lOIXgFkPE	Think write and share	Experiential Learning
6	relative tensors	CLO2, CLO3, CLO4	3	Lecture, Discussion	Presentation	Problem-based Learning
7	the metric tensor-	CLO3, CLO5	3	Video Lecture https://youtu.be/Dn0ZZRVuJcU	Flipped classroom, Presentation	Participatory Learning
8	the fundamental and associated tensors	CLO2, ClO3, CLO4	3	Lecture &PPT	Group discussion	Experiential Learning
Unit – III						
9	Christoffel's symbols – transformation of Christoffel's symbols	CLO1, CLO2, CLO4	4	Video Lecture https://youtu.be/aZFrbahsyUQ	Group discussion	Experiential Learning
10	covariant differentiation of tensors	CLO2, CLO3, CLO4	4	Lecture &PPT	Peer teaching	Participatory Learning
11	Ricci's theorem	CLO3, CLO5	4	Lecture, Assignment	Group discussion	Experiential Learning
Unit – IV						
12	Riemann – Christoffel tensor to Inner Product Spaces	CLO1, CLO2, CLO4	4	Lecture, PPT	Student seminar, One Minute presentation	Participatory Learning
13	properties of Riemann-Christoffel tensors –Ricci tensor	CLO2, CLO3	4	Video Lecture https://youtu.be/MkxGFNtLiS0 https://youtu.be/ZhDNijOEw0Y	Group reading and discussion	Problem-based Learning

14	Bianchi identitites –Einstein tensor	CLO1, CLO2, CLO4	3	Lecture, Quiz	Flipped Class room, Discussion	Participatory Learning
Unit –V						
15	Riemannian and Euclidean spaces	CLO1, CLO2, CLO3, CLO4, CLO5	3	Lecture, PPT	Group reading and discussion	Experiential Learning
16	existence theorem	CLO3, CLO5	2	Lecture, Assignment	Group discussion	Experiential Learning
17	the e-systems and the generalized Kroneckerdelats – application of the e-systems to determinants	CLO1, CLO2, CLO4	3	Lecture, PPT	Group discussion	Experiential Learning
18	tensor character of generalized Kronecker deltas	CLO2, CLO3, CLO4, CLO5	3	Video Lecture https://youtu.be/0HuzJLwkfaY	Hand's on	Experiential Learning

Name of the course	Tensor Analysis
Name of the Faculty	Dr. K. Krishnaveni
Participatory Learning	47 %
Experiential Learning	33 %
Problem-based Learning	20 %

QUESTION PAPER PATTERN (PG)

CA Pattern

Section A – 3 x 2 = 6
Section B – 3 x 5 = 15 (either or – same CLO Level)
Section C – 3 x 8 = 24 (either or – same CLO Level)
Total   45

ESE Pattern

Section A – 5 x 2 = 10
Section B – 5 x 5 = 25 (either or – same CLO Level)
Section C – 5 x 8 = 40(either or – same CLO Level)
Total   75

I Year PG

CIA Test   -   5   Conducted for 45 marks after 50 days
  Model Exam   -   7   Conducted for 75 marks
(Q.P. Pattern (2,5,8) Each Unit 15 Marks)
  Sem/Ass/Quiz   -   5
Class Participation -   5
Attendance   -   3
        25   + ESE 75 Marks