SYLLABUS

PG PROGRAMME IN MATHEMATICS

Under Choice Based Credit Semester System

FAROOK COLLEGE

(AUTONOMOUS)

Effective from 2022 admission onwards

www.farookcollege.ac.in

CERTIFICATE

I hereby certify that the documents attached are the bona fide copies of the syllabus of M.Sc. Mathematics Programme to be effective from the academic year 2022-23 onwards.

Principal

Date: 10-03-2022
Place: Farook College

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PROGRAMME SPECIFIC OUTCOMES (PSO)

Upon completion of M.Sc Mathematics programme, the students will be able to:

PSO 01 Understand concepts and skills related knowledge about scientific and numerical methods and skills, in mathematical computation.

PSO 02 Creating academic excellence in theoretical and applied mathematics.

PSO 03 Develop abstract mathematical thinking, problem-solving skills and apply them independently to problems in pure and applied mathematics.

PSO 04 Ability to identify, formulate and solve challenging problems in Mathematics and propose solutions using research-based knowledge. They assimilate complex mathematical ideas and arguments.

PSO 05 Provide a systematic understanding of the concepts and theories of mathematics and their application in the real world- to an advanced level, and enhance career prospects in a huge array of fields, viz. in industry, commerce, education, finance and research.

PSO 06 Recognize the need to engage in lifelong learning through continuous education, and research leading to higher degree like PhD.

PSO 07 Qualify national level tests like NET/GATE etc.

PSO 08 Effectively communicate and explore ideas of mathematics for propagation of knowledge and popularization of mathematics in society.

SCHEME OF THE PROGRAMME

Credit and Weightage Distribution in Each Semester Total Credits: 88

Semester	Course	Credit	Internal Weightage	External Weigtage	Total Weightage
I	Core Course: Algebra- I	4	5	30	35
	Core Course: Linear Algebra	4	5	30	35
	Core Course: Real Analysis I	4	5	30	35
	Core Course: Discrete Mathematics	4	5	30	35
	Core Course: Number Theory	4	5	30	35
	Audit Course: Ability Enhancement Course [a]	4			
	Total	**24**			**175**
II	Core Course: Algebra- II	4	5	30	35
	Core Course: Real Analysis II	4	5	30	35
	Core Course: Topology	4	5	30	35
	Core Course: ODE & calculus of variations	4	5	30	35
	Core Course: Operations Research	4	5	30	35
	Audit Course: Professional Competency Course [a]	4			
	Total	**24**			**175**
III	Core Course: Multivariable Calculus & Geometry	4	5	30	35
	Core Course: Complex Analysis	4	5	30	35

	Core Course: Functional Analysis	4	5	30	35
	Core Course: PDE & Integral Equations	4	5	30	35
	Elective Course I*	3	5	30	35
	Total	**19**			**175**
IV	Core Course: Advanced Functional Analysis	4	5	30	35
	Elective Course II**	3	5	30	35
	Elective Course III**	3	5	30	35
	Elective Course IV**	3	5	30	35
	Core: Project	4	5	20	25
	Core: Viva Voce	4		15	15
	Total	**21**			**180**
	Grand Total for all Semesters	**88**			**705**
Core Course:		60			525
Elective Course		12			140
Ability Enhancement Course		4			
Professional Competency Course		4			
Project		4			25
Viva Voce		4			15
Total		**88**			**705**

Credit Distribution

Semester	Core Course	Elective Course	Project	Viva Voce	Audit Course	Total
1	4+4+4+4+4				4	**24**
2	4+4+4+4+4				4	**24**
3	4+4+4+4	3				**19**
4	4	3+3+3	4	4		**21**
Total	**60**	**12**	**4**	**4**	**8**	**88**

CORE COURSE STRUCTURE

Total Credits: 68 (Internal: 20%; External: 80%)

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Credit	Weightage
I	MMT1C01	Core Course I: Algebra- I	5	80	4	35
	MMT1C02	Core Course II: Linear Algebra	5	80	4	35
	MMT1C03	Core Course III: Real Analysis I	5	80	4	35
	MMT1C04	Core Course IV: Discrete Mathematics	5	80	4	35
	MMT1C05	Core Course V: Number Theory	5	80	4	35
II	MMT2C06	Core Course VI: Algebra- II	5	80	4	35
	MMT2C07	Core Course VII: Real Analysis II	5	80	4	35
	MMT2C08	Core Course VIII: Topology	5	80	4	35

	MMT2C09	Core Course IX: ODE & calculus of variations	5	80	4	35
	MMT2C10	Core Course X: Operations Research	5	80	4	35
III	MMT 3C11	Core Course XI: Multivariable Calculus & Geometry	5	80	4	35
	MMT3C12	Core Course XII: Complex Analysis	5	80	4	35
	MMT3C13	Core Course XIII: Functional Analysis	5	80	4	35
	MMT3C14	Core Course XIV: PDE & Integral Equations	5	80	4	35
IV	MMT4C15	Core Course XV: Advanced Functional Analysis	5	80	4	35
	MMT4P01	Project	5		4	25
	MMT4 V01	Viva Voce			4	15
Total					**68**	**705**

ELECTIVE COURSE STRUCTURE

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Credit	Weigtage
III	MMT3E01	Elective Course I: Coding theory	5	80	3	35
	MMT3E02	Elective Course II: Cryptography				
	MMT3E03	Elective Course III: Measure & Integration				
	MMT3E04	Elective Course IV: Probability Theory				
	MMT4E05	Elective Course V: Advanced Complex Analysis				
	MMT4E06	Elective Course VI: Algebraic Number Theory				

	MMT4E07	Elective Course VII: Algebraic Topology				
IV	MMT4E08	Elective Course VIII: Commutative Algebra	5+5+5	80	3+3+3	35+35+35
	MMT4E09	Elective Course IX: Differential Geometry				
	MMT4E10	Elective Course X: Fluid Dynamics				
	MMT4E11	Elective Course XI: Graph Theory				
	MMT4E12	Elective Course XII: Representation Theory				
	MMT4E13	Elective Course XIII: Wavelet Theory				
	MMT4E14	Elective Course XIV: Computer Oriented Numerical Analysis				
Total					**12**	**140**

AUDIT COURSE STRUCTURE

Semester	Code No	Course Title	Hrs/ Week	Total Hrs	Credit	Marks
I	MMT1A01	Audit course: Ability Enhancement Course[a]			4	
II	MMT2A02 MMT2A03 MMT2A04	Professional Competency Course[a]			4	

ABILITY ENHANCEMENT COURSE(AEC)

Successful fulfillment of any one of the following shall be considered as the completion of **AEC**.

(i) Internship (ii) Class room seminar presentation (iii) Publications (iv) Case study analysis (v) Paper presentation (vi) Book reviews.

A student can select any one of these as **AEC**.

Internship: Internship of duration 5 days under the guidance of a faculty in an institution/department other than the parent department. A certificate of the same should be obtained and submitted to the parent department.

Class room seminar: One seminar of duration one hour based on topics in Mathematics beyond the prescribed syllabus.

Publications: One paper published in conference proceedings/ Journals. A copy of the same should be submitted to the parent department.

study analysis: Report of the case study should be submitted to the parent department.

Paper presentation: Presentation of a paper in a regional/ national/ international seminar/conference. A copy of the certificate of presentation should be submitted to the parent department.

Book Reviews: Review of a book. Report of the review should be submitted to the parent department.

PROFESSIONAL COMPETENCY COURSE (PCC)

A student can select any one of the following as Professional Competency course:

1. MMT2A02: Technical writing with LaTeX.
2. MMT2A03: Scientific Programming with Scilab.
3. MMT2A04: Scientific Programming with C++.

EVALUATION AND GRADING

The evaluation scheme for each course except audit courses shall contain two parts.

(a)**Internal Evaluation:** **20% Weightage**

(b) **External Evaluation:** **80% Weightage**

Both the Internal and the External evaluation shall be carried out using direct grading system as per the general guidelines of the University.

Internal evaluation must consist of

(i) 2 tests

(ii) one assignment

(iii) one seminar and

(iv) attendance,

with weightage 2 for tests (together) and weightage 1 for each other component.

Each of the two internal tests is to be a **10-weightage examination of duration one hour** in direct grading.

Attendance of each course will be evaluated as follows

ATTENDANCE	GRADE POINT
95-100	5
90-94.9	4
85-89.9	3
80-84.9	2
75-79.9	1

The average of the final grade points of the two tests can be used to obtain the final consolidated letter grade for tests (together) according to the following table.

Average grade point (2 tests)	Grade for Tests	Grade Point for Tests
4.5 to 5	A+	5
3.75 to 4.49	A	4
3 to 3.74	B	3
2 to 2.99	C	2
Below 2	D	1
Absent	E	0

Table 1: Internal Grade Calculation: Examples

Tests	Grade Point of Test1	Grade Point of Test2	Average Test Grade Point	Test Grade	Test Grade Point	Test Weightage	Test Weighted Grade Point
Student1	4.8	3.5	4.15	A	4	2	8
Student2	5	4.8	4.9	A+	5	2	10
Student3	2.3	4.7	3.5	B	3	2	6

Assignment	Assignment Grade	Assignment Grade Point	Assignment Weightage	Assignment Weighted Grade Point
Student1	A+	5	1	5
Student2	A	4	1	4
Student3	C	2	1	2

Seminar	Seminar Grade	Seminar Grade Point	Seminar Weightage	Seminar Weighted Grade Point
Student1	B	3	1	3
Student2	A+	5	1	5
Student3	D	1	1	1

Attendance	Attendance Grade	Attendance Grade Point	Attendance Weightage	Attendance Weighted Grade Point
Student1	A+	5	1	5
Student2	A+	5	1	5
Student3	C	2	1	2

Consolidation	Total Weighted Grade Point	Total Weightage	Total Internal Grade Point	Final Internal Grade
Student1	21	5	21/5 = 4.2	A
Student2	24	5	24/5 = 4.8	A+
Student3	11	5	11/5 = 2.2	C

MMT4P01: PROJECT

The Project Report (Dissertation) should be self-contained. It should contain table of contents, introduction, at least three chapters, bibliography and index. The main content may be of length not less than 30 pages in the A4 format with one and half line spacing. The project report should be prepared preferably in LaTeX. There must be a project presentation by the student followed by a viva voce. The components and weightage of External and Internal valuation of the Project are as follows:

Components	**External(weightage)**	**Internal (weightage)**
Relevance of the topic & statement of problem	4	1
Methodology & analysis	4	1
Quality of Report & Presentation	4	1
Viva Voce	8	2
Total weightage	**20**	**5**

The external project evaluation shall be done by a Board consisting two External Examiners. The Grade Sheet is to be consolidated and must be signed by the External Examiners.

MMT4 V01: VIVA VOCE EXAMINATIONS

The Comprehensive Viva Voce is to be conducted by a Board consisting of two External Examiners. The viva voce must be based on the core papers of the entire programme. There should be questions from at least one course of each of the semesters I, II, and III. Total weightage of viva voce is 15. The same Board of two External Examiners shall conduct both the project evaluation and the comprehensive viva voce examination. The Board of Examiners shall evaluate at most 10 students per day.

CORE COURSE SYLLABUS

SEMESTER 1

COURSE CODE: MMT1C01 CORE COURSE I: ALGEBRA I				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	**Learn** factor group computation, group presentation, isomorphism theorems and their applications.	Evaluate	PSO1 PSO2 PSO8
CO2	**Understand** the notion of simple groups, free groups, series of the groups and group action on a set and their application	Understand	PSO3 PSO6 PSO7
CO3	**Understand** the concept rings of polynomials	Understand	PSO1 PSO5 PSO7
CO4	**Learn** factorization of polynomial over a field.	Remember	PSO1 PSO5 PSO7

CO5	**Able** to work with different non commutative examples.	Apply	PSO3 PSO4

TEXT	JOHN B. FRALEIGH, A FIRST COURSE IN ABSTRACT ALGEBRA (7th Edn.), Pearson Education Inc., 2003.

COURSE CONTENT	
Module 1: Direct Products and Factor Groups	**30 Hours**
Plane Isometries, Direct products & finitely generated Abelian Groups, Factor Groups, Factor-Group Computations and Simple Groups, Group action on a set, Applications of G-set to counting [Sections 12, 11, 14, 15, 16, 17].	
Module 2: Advanced Group Theory	**25 Hours**
Isomorphism theorems, Series of groups, (Omit Butterfly Lemma and proof of the Schreier Theorem), Sylow theorems, Applications of the Sylow theory, Free Groups (Omit Another look at free abelian groups) [Sections 34, 35, 36, 37, 39].	
Module 3: Rings	**25 Hours**
Group Presentations, Rings of polynomials, Factorization of polynomials over a field, non-commutative examples, Homomorphism and factor rings [sections 40, 22, 23, 24, 26].	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT

Internal Assessment (5 Weightage)

a. Classroom participation (20%): 1 Weightage

b. Test papers 2 (40%): 2 Weightage

c. Assignment (20%): 1 Weightage

d. Seminar/ Viva (20%): 1 Weightage

External Assessment (30 Weightage) **Duration: 3 Hours, No of Questions: 21**

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
				30

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Direct Products and Factor Groups	12
Module II: Advanced Group Theory	10
Module III: Rings	8

REFERENCES:

1. N. Bourbaki Elements of Mathematics: Algebra I, Springer; 1998
2. Dummit and Foote: Abstract algebra (3rd edn.); Wiley India; 2011
3. P.A. Grillet: Abstract algebra (2nd edn.); Springer; 2007
4. I.N. Herstein: Topics in Algebra (2nd Edn); John Wiley & Sons, 2006
5. T.W. Hungerford: Algebra; Springer Verlag GTM 73(4th Printing); 1987
6. N. Jacobson: Basic Algebra-Vol. I; Hindustan Publishing Corporation (India), Delhi; 1991.
7. T.Y. Lam: Exercises in classical ring theory (2nd edn); Springer; 2003
8. C. Lanski: Concepts in Abstract Algebra; American Mathematical Society; 2010.
9. N.H. Mc Coy: Introduction to modern algebra, Literary Licensing, LLC; 2012
10. S. M. Ross: Topics in Finite and Discrete Mathematics; Cambridge; 2000
11. J. Rotman: An Introduction to the Theory of Groups (4th edn.); Springer, 1999.

COURSE CODE: MMT1C02 CORE COURSE II: LINEAR ALGEBRA				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Recall*** the definitions and basic concepts of Linear Algebra, including vector spaces linear transformations and inner product spaces	Remember	PSO1 PSO3 PSO4
CO2	***Discuss*** the key concepts of Linear Algebra, including the algebraic properties of matrices and linear transformations, and vector spaces and subspaces.	Understand	PSO1 PSO3 PSO7
CO3	***Understand*** the concept of diagonalizable and triangulable operators and various fundamental results of these operators.	Understand	PSO1 PSO3 PSO7
CO4	***Use*** the concepts of Linear Algebra to solve problems in algebra, geometry, physics, and engineering.	Apply	PSO3 PSO4 PSO5 PSO8
CO5	***Illustrate*** the properties of matrices, linear transformations, and vector spaces using the tools of Linear Algebra.	Analyze	PSO5 PSO6 PSO8

TEXT	HOFFMAN K and KUNZE R., LINEAR ALGEBRA (2nd Edn.), Prentice-Hall of India, 1991.

COURSE CONTENT	
Module 1: Vector Spaces & Linear Transformations	**28 Hours**
Vector Spaces- (Chapter 2: Sections 2.1 - 2.4) Linear Transformations - (Chapter 3, Sections 3.1 - 3.3)	
Module 2: Linear Transformations (continued) and Elementary Canonical Forms	**32 Hours**
Linear Transformations (Chapter 3, Sections 3.4 - 3.7) Elementary Canonical Forms (Chapter 6, Sections 6.1 to 6.4)	
Module 3: Elementary Canonical Forms (continued) and Inner Product Spaces	**20 Hours**
Elementary Canonical Forms (Chapter 6, Sections 6.6 & 6.7) Inner Product Spaces (Chapter 8, Sections 8.1 & 8.2)	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers 2 (40%):	2 Weightage
c. Assignment (20%):	1 Weightage

d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	Duration: 3 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Vector Spaces & Linear Transformations	10
Module II: Linear Transformations (continued) and Elementary Canonical Forms	13
Module III: Elementary Canonical Forms (continued) and Inner Product Spaces	7

REFERENCES:

1. P. R. Halmos: Finite Dimensional Vector spaces; Narosa Pub House, New Delhi; 1980.
2. A. K. Hazra: Matrix: Algebra, Calculus and generalised inverse- Part I; Cambridge International Science Publishing; 2007.
3. I. N. Herstein: Topics in Algebra; Wiley Eastern Ltd Reprint; 1991.
4. S. Kumaresan: Linear Algebra-A Geometric Approach; Prentice Hall of India; 2000.
5. S. Lang: Linear Algebra; Addison Wesley Pub.Co.Reading, Mass; 1972.
6. S. Maclane and G. ikhrkhoff: Algebra; Macmillan Pub Co NY; 1967.
7. N. H. McCoy and R. Thomas: Algebra; Allyn Bacon Inc NY; 1977.
8. R. R. Stoll and E.T.Wong: Linear Algebra; Academic Press International Edn; 1968.
9. G. Strang: Linear algebra and its applications (4th edn.); Cengage Learning; 2006.

COURSE CODE –MMT1C03 CORE COURSE III: REAL ANALYSIS I				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No.
CO1	***Determine*** the basic topological properties of subsets of the real numbers.	Evaluate	PSO1 PS03
CO2	***Use*** the definitions of convergence of sequences, series, and functions.	Apply	PSO2 PSO7
CO3	***Analyze*** the continuity, differentiability, and integrability of functions defined on subsets of the real line.	Analyze	PSO4 PSO5 PSO6
CO4	***Produce*** rigorous proofs of results that arise in the context of real analysis.	Create	PSO2 PSO3 PSO8

TEXT: RUDIN W., PRINCIPLES OF MATHEMATICAL ANALYSIS (3rd Edn.), Mc. Graw-Hill, 1986.

COURSE CONTENT	
Module 1 - Basic Topology, Continuity	**24 Hours**
Basic Topology Finite, Countable and Uncountable sets Metric Spaces, Compact Sets, Perfect Sets, Connected Sets. Continuity - Limits of function, Continuous functions, Continuity and compactness, continuity and connectedness,	

Discontinuities, Monotonic functions, Infinite limits and Limits at Infinity [Chapter 2 & Chapter 4]	
Module 2 – Differentiation, The Riemann Stieltjes Integral	**28 Hours**
Differentiation The derivative of a real function, Mean Value theorems, The continuity of Derivatives, L Hospitals Rule, Derivatives of Higher Order, Taylors Theorem, Differentiation of Vector valued functions. The Riemann Stieltjes Integral, - Definition and Existence of the integral, properties of the integral, Integration and Differentiation [Chapter 5 & Chapter 6 up to and including 6.22]	
Module 3 - Sequences and Series of Functions	**28 Hours**
The Riemann Stieltjes Integral (Continued) - Integration of Vector vector-valued Functions, Rectifiable curves. Sequences and Series of Functions - Discussion of Main problem, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform convergence and Differentiation. Equicontinuous Families of Functions, The Stone Weierstrass Theorem [Chapters 6 (from 6.23 to 6.27) & Chapter 7 (upto and including 7.27 only)].	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning**: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback. **Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage):	Duration: 3 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Basic Topology, Continuity	12
Module II: Differentiation, The Riemann Stieltjes Integral	7
Module III: Sequences and Series of Functions	11

REFERENCES:

1. H. Amann and J. Escher: Analysis-I; Birkhuser; 2006.
2. T. M. Apostol: Mathematical Analysis (2nd Edn.); Narosa; 2002.
3. R. G. Bartle: Elements of Real Analysis (2nd Edn.); Wiley International Edn.; 1976.
4. R. G. Bartle and D.R. Sherbert: Introduction to Real Analysis; John Wiley Bros; 1982.
5. J. V. Deshpande: Mathematical Analysis and Applications- an Introduction; Alpha Science International; 2004.
6. V. Ganapathy Iyer: Mathematical analysis; Tata McGrawHill; 2003.
7. R. A. Gordon: Real Analysis- a first course (2nd Edn.); Pearson; 2009.
8. F. James: Fundamentals of Real analysis; CRC Press; 1991.
9. A. N. Kolmogorov and S. V. Fomin: Introductory Real Analysis; Dover Publica- tions Inc; 1998.
10. S. Lang: Under Graduate Analysis (2nd Edn.); Springer-Verlag; 1997.
11. M. H. Protter and C. B. Moray: A first course in Real Analysis; Springer Verlag UTM; 1977.
12. C. C. Pugh: Real Mathematical Analysis, Springer; 2010.
13. K. A. Ross: Elementary Analysis- The Theory of Calculus (2nd edn.); Springer; 2013.
14. A. H. Smith and Jr. W.A. Albrecht: Fundamental concepts of analysis; Prentice Hall of India; 1966
15. V. A. Zorich: Mathematical Analysis-I; Springer; 2008.

COURSE CODE – MMT1C04 CORE COURSE IV: DISCRETE MATHEMATICS				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***State*** concepts of order relations	Remember	PSO1 PSO3 PSO7
CO2	***Interpret*** Boolean algebra and their properties	Understand	PSO3 PSO4 PSO8
CO3	***Develop*** concepts of graph and related terms	Analyze	PSO2 PSO3 PSO4
CO4	***Analyze*** characterization of special graph	Analyze	PSO5 PSO6
CO5	***Construct*** concepts of automata and formal languages	Create	PSO3 PSO4 PSO6

TEXTS	**TEXT 1**: R. BALAKRISHNAN and K. RANGANATHAN, A TEXT BOOK OF GRAPH THEORY, Springer-Verlag New York, Inc., 2000. (2 nd Edn.).
	TEXT 2: K. D JOSHI, FOUNDATIONS OF DISCRETE MATHEMATICS, New Age International(P) Limited, New Delhi, 1989.

	TEXT 3: PETER LINZ, AN INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA (2 nd Edn.), Narosa Publishing House, New Delhi, 1997.

COURSE CONTENT		
Module1: Basic concepts of Graph Theory	**TEXT 1**	**32 Hours**
Basic concepts, Subgraphs, Degree of vertices, Paths and connectedness, Automorphism of a simple graph, Operations on graphs, Vertex cuts and Edge cuts, Connectivity and Edge connectivity, Trees-Definition, Characterization and Simple properties, Eulerian graphs, Planar and Non planar graphs, Euler formula and its consequences, K5 and K3,3 are non-planar graphs, Dual of a plane graph. [TEXT 1- Chapter 1: Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, Chapter 3 Sections 3.2, 3.3, Chapter 4: Section 4.2(up to and including 4.2.10), Chapter 6; Section 6.2 (up to and including 6.2.2), Chapter 8: Sections 8.2(up to and including 8.2.7), 8.3 (up to and including 8.3.7), 8.4, 8.5]		
Module 2: Boolean Algebra	**TEXT 2**	**24 Hours**
Order Relations, Lattices; Boolean Algebra Definition and Properties, Boolean Functions. [TEXT 2 - Chapter 3 (section.3 (3.1-3.11), chapter 4 (sections 1 & 2)].		
Module 3: Automata and Formal Languages	**TEXT 2**	**24 Hours**
Automata and Formal Languages: Introduction to the theory of Computation: Three basic concepts, some applications, Finite Automata: Deterministic finite accepters, Non deterministic accepters, Equivalence of deterministic and nondeterministic finite accepters. [TEXT 3 - Chapter 1 (sections 1.2 & 1.3); Chapter 2 (sections 2.1, 2.2 & 2.3)]		
MODE OF TRANSACTION		

Lecture Method

Problem Solving Method

Questioning Method and Flipped learning

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
e. Classroom participation (20%):	1 Weightage
f. Test papers 2 (40%):	2 Weightage
g. Assignment (20%):	1 Weightage
h. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	Duration: *3 Hours,* No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE Weightage DISTRIBUTION

Module	Weightage
Module I: Basic concepts of Graph Theory	12
Module II: Boolean Algebra	9
Module III: Automata and Formal Languages	9

REFERENCES:

1. J. C. Abbot: Sets, lattices and Boolean Algebras; Allyn and Bacon, Boston; 1969.

2. J. A. Bondy, U.S.R. Murty: Graph Theory; Springer; 2000.

3. S. M. Cioaba and M.R. Murty: A First Course in Graph Theory and Combinatorics; Hindustan Book Agency; 2009.

4. J. A. Clalrk: A first look at Graph Theory; World Scientific; 1991.

5. Colman and Busby: Discrete Mathematical Structures; Prentice Hall of India; 1985.

6. C. J. Dale: An Introduction to Data base systems (3rd Edn.); Addison Wesley Pub Co.,Reading Mass; 1981.

7. R. Diestel: Graph Theory (4th Edn.); Springer-Verlag; 2010

8. S. R. Givant and P. Halmos: Introduction to boolean algebras; Springer; 2009.

9. R. P. Grimaldi: Discrete and Combinatorial Mathematics- an applied introduction (5thedn.); Pearson; 2007

10. J. L. Gross: Graph theory and its applications (2nd edn.); Chapman & Hall/CRC; 2005.

11. F. Harary: Graph Theory; Narosa Pub. House, New Delhi; 1992.

12. D. J. Hunter: Essentials of Discrete Mathematics (3rd edn.); Jones and Bartlett

Publishers; 2015.

13. A. V. Kelarev: Graph Algebras and Automata; CRC Press; 2003

14. D. E. Knuth: The art of Computer programming -Vols. I to III; Addison Wesley Pub Co., Reading Mass; 1973.

15. C. L. Liu: Elements of Discrete Mathematics (2nd Edn.); Mc Graw Hill International Edns. Singapore; 1985.

16. L. Lovsz, J. Pelikn and K. Vesztergombi: Discrete Mathematics: Elementary and beyond; Springer; 2003.

17. J. G. Michaels and K.H. Rosen: Applications of Discrete Mathematics; McGraw- Hill International Edn. (Mathematics & Statistics Series); 1992.

18. Narasing Deo: Graph Theory with applications to Engineering and Computer Science; Prentice Hall of India; 1987.

19. W. T. Tutte: Graph Theory; Cambridge University Press; 2001

20. D. B. West: Introduction to graph theory; Prentice Hall; 2000.

21. R. J. Wilson: Introduction to Graph Theory; Longman Scientific and Technical Essex(co-published with John Wiley and sons NY); 1985.

COURSE CODE –MMT1CO5 CORE COURSE V: NUMBER THEORY				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Be able*** to effectively express the concepts and results of number theory.	Understand	PSO1 PSO2 PSO3 PSO4
CO2	***Learn*** basic theory of arithmetical functions and Dirichlet multiplication, averages of some arithmetical functions.	Learn	PSO3 PSO4 PSO7 PSO8
CO3	***Understand*** distribution of prime numbers and prime number theorem.	Understand	PSO1 PSO3 PSO4
CO4	***Learn*** the concept of quadratic residues and quadratic reciprocity laws.	Learn	PSO1 PSO2 PSO3
CO5	***Get*** a basic knowledge of cryptography, and students can use cryptography as a tool for solving problems in related applied subjects.	Apply	PSO3 PSO4 PSO5

TEXT 1: APOSTOL T.M., INTRODUCTION TO ANALYTIC NUMBER THEORY, Narosa Publishing House, New Delhi, 1990.

TEXT 2: KOBLITZ NEAL A., COURSE IN NUMBER THEROY AND CRYPTOGRAPHY, Springer Verlag, New York, 1987.

COURSE CONTENT	
Module 1: Arithmetical Functions	**40 Hours**
Arithmetical functions and Dirichlet multiplication; Averages of arithmetical functions [Chapter 2: sections 2.1 to 2.14, 2.18, 2.19; Chapter 3: sections 3.1 to 3.4, 3.9 to 3.12 of Text 1]	
Module 2: Some Elementary Theorems on the Distribution of Prime Numbers	**20 Hours**
Some elementary theorems on the distribution of prime numbers [Chapter 4: Sections 4.1 to 4.10 of Text 1]	
Module 3: Quadratic Residues	**20 Hours**
Quadratic residues and quadratic reciprocity law [Chapter 9: sections 9.1 to 9.8 of Text 1] Cryptography, Public key [Chapters 3; Chapter 4 sections 1 and 2 of Text 2.]	

MODE OF TRANSACTION

Active Learning: Active learning is an approach that emphasizes student-centred learning. This method encourages students to participate in the learning process actively. Teachers can use a variety of techniques such as group work, discussions, and problem-based learning to facilitate active learning.

Visual Aids: Mathematics is a subject that involves a lot of abstract concepts and symbols. Visual aids such as diagrams, graphs, charts, and videos can help students understand and remember mathematical concepts.

Real-Life Applications: Students often struggle with understanding the relevance of mathematical concepts. By using real-life examples and applications, teachers can make the subject more engaging and meaningful to students.

Cooperative Learning: Cooperative learning involves students working together in small groups to solve problems or complete tasks. This method helps students develop teamwork and communication skills, while also reinforcing their understanding of mathematical concepts.

Technology: Technology can be a powerful tool in teaching mathematics. Tools such as interactive whiteboards, graphing calculators, and educational software can help students visualize and understand mathematical concepts better.

Differentiated Instruction: Students have different learning styles, abilities, and interests. Teachers can differentiate instruction by providing different learning materials and activities that cater to the individual needs of each student.

MODE OF ASSESSMENT

Internal Assessment (5 Weightage)

a. Classroom participation (20%): 1 Weightage
b. Test papers II (40%): 2 Weightage
c. Assignment (20%): 1 Weightage
d. Seminar/ Viva (20%): 1 Weightage

External Assessment (30 Weightage)

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Arithmetical Functions	12
Module II: Some Elementary Theorems on the Distribution of Prime Numbers	9
Module III: Quadratic Residues	9

REFERENCES:

1. A. Beautelspacher: Cryptology; Mathematical Association of America (Incorporated); 1994
2. H. Davenport: The higher arithmetic (6th Edn.); Cambridge Univ. Press; 1992
3. G. H. Hardy and E.M. Wright: Introduction to the theory of numbers; Oxford International Edn; 1985
4. A. Hurwitz & N. Kritiko: Lectures on Number Theory; Springer Verlag, Universi- text; 1986
5. T. Koshy: Elementary Number Theory with Applications; Harcourt / Academic Press; 2002
6. D. Redmond: Number Theory; Monographs & Texts in Mathematics No: 220; Marcel Dekker Inc.; 1994
7. P. Ribenboim: The little book of Big Primes; Springer-Verlag, New York; 1991
8. K.H. Rosen: Elementary Number Theory and its applications (3rd Edn.); Addison Wesley Pub Co.; 1993
9. W. Stallings: Cryptography and Network Security-Principles and Practices; PHI; 2004
10. D.R. Stinson: Cryptography- Theory and Practice (2nd Edn.); Chapman & Hall / CRC (214. Simon Sing: The Code Book The Fourth Estate London); 1999
11. J. Stopple: A Primer of Analytic Number Theory-From Pythagorus to Riemann; Cambridge Univ Press; 2003.
12. S.Y. Yan: Number Theroy for Computing (2nd Edn.); Springer-Verlag; 2002.

SEMESTER 2

COURSE CODE: MMT2C06 CORE COURSE VI: ALGEBRA II				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

TEXT	JOHN B. FRALEIGH, A FIRST COURSE IN ABSTRACT ALGEBRA (7th Edn.), Pearson Education Inc., 2003.

CO No.	**Expected Course Outcome** Upon completion of this course, students will be able to;	**Learning Domain**	**PSO No**
CO1	***Learn*** different types of extensions of fields.	Understand	PSO1 PSO4 PSO5
CO2	***Learn*** automorphisms of fields.	Understand	PSO1 PSO7
CO3	***Get*** a basic knowledge in Galois Theory.	Understand	PSO1 PSO5 PSO7
CO4	***Learn*** how to apply Galois Theory in various contexts.	Understand & Apply	PSO1 PSO5

COURSE CONTENT	
Module 1: Maximal Ideals and Extension Fields	**30 Hours**
Prime and Maximal Ideals, Introduction to Extension Fields, Algebraic Extensions (Omit Proof of the Existence of an Algebraic Closure), Geometric Constructions. [27,29, 31, 32]	
Module 2: Automorphisms and Separable Extensions	**30 Hours**
Finite Fields, Automorphisms of Fields, The Isomorphism Extension Theorem, Split ting Fields, Separable Extensions. [33, 48, 49, 50, 51]	
Module 3: Galois Theory	**20 Hours**
Galois Theory, Illustration of Galois Theory, Cyclotomic Extensions, Insolvability of the Quintic. [53, 54, 55, 56]	

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage**)**	Duration: 3 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE Weightage DISTRIBUTION	
Module	**Weightage**
Module I: Maximal Ideals and Extension Fields	12
Module II: Automorphisms and Separable Extensions	10
Module III: Galois Theory	8

REFERENCES:

1. N. Bourbaki: Elements of Mathematics: Algebra I, Springer; 1998
2. Dummit and Foote: Abstract algebra (3rd edn.); Wiley India; 2011
3. P.A. Grillet: Abstract algebra (2nd edn.); Springer; 2007
4. M.H. Fenrick: Introduction to the Galois correspondence (2nd edn.); Birkhuser; 1998
5. I.N. Herstein: Topics in Algebra (2nd Edn); John Wiley & Sons, 2006
6. T.W. Hungerford: Algebra; Springer Verlag GTM 73(4th Printing); 1987
7. C. Lanski: Concepts in Abstract Algebra; American Mathematical Society; 2010.
8. N.H. Mc Coy: Introduction to modern algebra, Literary Licensing, LLC; 2012
9. J. Rotman: An Introduction to the Theory of Groups (4th edn.); Springer, 1999.
10. I. Stewart: Galois theory (3rd edn.); Chapman & Hall/CRC; 2003.
11. R. Lidl and G. Pilz Appli:ed abstract algebra(2nd edn.); Springer; 1998

COURSE CODE – MMT2C07 CORE COURSE VII: REAL ANALYSIS II				
Credits	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** why and in what context the theory of measure was introduced.	Understand	PSO1 PSO2 PSO4
CO2	***Learn*** the concept of measures and measurable functions.	Learn	PSO2 PSO3 PSO4
CO3	***Learn*** Lebesgue integration and its various properties.	Learn	PSO1 PSO5 PSO7
CO4	***Discover*** how to generalize the concept of measure theory.	Create	PSO1 PSO2 PSO3 PSO4
CO5	***Understand*** that the Lebesgue integration is a more general theory than the Riemann integration theory and will be aware of some examples of functions which are not integrable in the sense of Riemann theory of integration, but they are integrable in the sense of Lebesgue integration.	Understand	PSO2 PSO3 PSO4 PSO6

TEXT: H. L.Royden ,P. M. FitzpatrickH.L. REAL ANAYLSIS (4th Edn.), Prentice Hall of India, 2000.

COURSE CONTENT	
Module 1: Lebesgue Measure	40 Hours
The Real Numbers: Sets, Sequences and Functions Chapter 1: Sigma Algebra, Borel sets Section 1.4: Proposition 13 **Lebesgue Measure Chapter 2: Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 up to preposition 19.** **Lebesgue Measurable Functions Chapter 3: Sections 3.1, 3.2, 3.3**	
Module 2: Lebesgue Integration	20 Hours
Lebesgue Integration Chapter 4: Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6 **Lebesgue Integration: Further Topics Chapter 5: Sections: 5.1, 5.2, 5.3**	
Module 3: Differentiation, Integration and L^p spaces	20 Hours
Differentiation and Integration Chapter 6: Sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6 **The L^p spaces: Completeness and Approximation Chapter 7: Sections 7.1 ,7.2 ,7.3**	

MODE OF TRANSACTION

Active Learning: Active learning is an approach that emphasizes student-centred learning. This method encourages students to participate in the learning process actively. Teachers can use a variety of techniques such as group work, discussions, and problem-based learning to facilitate active learning.

Visual Aids: Mathematics is a subject that involves a lot of abstract concepts and symbols. Visual aids such as diagrams, graphs, charts, and videos can help students understand and remember mathematical concepts.

Real-Life Applications: Students often struggle with understanding the relevance of mathematical concepts. By using real-life examples and applications, teachers can make the subject more engaging and meaningful to students.

Cooperative Learning: Cooperative learning involves students working together in small groups to solve problems or complete tasks. This method helps students develop teamwork and communication skills, while also reinforcing their understanding of mathematical concepts.

Technology: Technology can be a powerful tool in teaching mathematics. Tools such as interactive whiteboards, graphing calculators, and educational software can help students visualize and understand mathematical concepts better.

Differentiated Instruction: Students have different learning styles, abilities, and interests. Teachers can differentiate instruction by providing different learning materials and activities that cater to the individual needs of each student.

MODE OF ASSESSMENT

Internal Assessment (5 Weightage)

a. Classroom participation (20%): 1 Weightage
b. Test papers II (40%): 2 Weightage
c. Assignment (20%): 1 Weightage
d. Seminar/ Viva (20%): 1 Weightage

External Assessment (30 Weightage) Duration: 3 Hours, No of Questions: 21

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage

Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Lebesgue Measure	12
Module II: Lebesgue Integration	9
Module III: Differentiation, Integration and L^p spaces	9

REFERENCES:

1. K B. Athreya and S N Lahiri:, Measure theory, Hindustan Book Agency, New Delhi,(2006).
2. R G Bartle: The Elements of Integration and Lebsgue Mesure , Wiley(1995).
3. S K Berberian:measure theory and Integration, The Mc Millan Company, New York,(1965).
4. L M Graves:The Theory of Functions of Real Variable Tata McGraw-Hill Book Co(1978)
5. P R Halmos: Measure Theory, GTM, Springer Verlag
6. W Rudin: Real and Complex Analysis,Tata McGraw Hill, New Delhi,2006
7. I K Rana: An Introduction to Measure and Integration, Narosa Publishing Company, New York.
8. Terence Tao: An Introduction to Measure Theory, Graduate Studies in Mathematics, Vol 126 AMS.

COURSE CODE –MMT2C08 CORE COURSE VIII: TOPOLOGY				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Recall*** the definitions of key topological concepts, such as open sets, closed sets, continuity, compactness, connectedness, metric spaces, topological product spaces, and separation axioms.	Remember	PSO1 PSO2 PSO7
CO2	***Explain*** the relationships between different topological concepts, such as the connection between open sets and continuous functions, and between separation axioms and topological properties of a space, and between product topologies and Cartesian products.	Understand	PSO2 PSO3 PSO4 PSO7
CO3	***Use*** topological concepts and theorems to solve problems, such as proving that a particular space is connected or that a space is metrizable, and finding the product topology of given spaces.	Apply	PSO3 PSO4 PSO5

CO4	***Analyze*** the properties of different topological spaces and their implications for mathematical structures, such as identifying the differences between various separation axioms and how they affect the properties of a space, and comparing the properties of different types of product topologies.	Analyze	PSO4 PSO5 PSO6
CO5	***Assess*** the strengths and limitations of various topological concepts and theorems, such as comparing different types of metric spaces and different notions of connectedness and their usefulness in different contexts, and evaluating the usefulness of separation axioms and product topologies in various applications.	Evaluate	PSO4 PSO5 PSO8
CO6	***Construct*** new examples of topological spaces, basic concepts, spaces with special properties, separation axioms, and products that satisfy certain criteria or have certain properties	Create	PSO4 PSO5 PSO6

TEXT	**JOSHI, K.D:** INTRODUCTION TO GENERAL TOPOLOGY (Revised Edn.), New Age International(P) Ltd., New Delhi, 1983.

COURSE CONTENT	
Module 1: Topological Spaces and Basic Concepts	**40 Hours**
A Quick Revision of Chapter 1,2 and 3. **Topological Spaces**: Definition of a Topological Space, Examples of a Topological Spaces, Bases and sub-bases, Subspaces. Basic Concepts: Closed sets and Closure, Neighbourhoods, Interior and Accumulation Points. [Chapter 4 and Chapter 5: Sections 1 & Section 2 (excluding 2.11 and 2.12) and Section 3 only]	
Module 2: Spaces with Special Properties	**20 Hours**
Basic Concepts: Making Functions Continuous, Quotient Spaces. **Spaces with Special Properties**: Smallness Conditions on a space, Connectedness. [Chapter 5: Section 4 and Chapter 6: Sections 1 & 2]	
Module 3: Separation Axioms and Products	**20 Hours**
Separation Axioms: Hierarchy of Separation Axioms. **Products and Coproducts**: Cartesian Products of Families of Sets, The Product Topology. [Chapter 7: Section 1; Chapter 8: Sections 1 & 2]	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT
Internal Assessment (5 Weightage)

a. Classroom participation (20%):	1 Weightage
b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	*Duration: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Topological Spaces and Basic Concepts	14
Module II: Spaces with Special Properties	8
Module III: Separation Axioms and Products	8

REFERENCES:

1. M.A. Armstrong: Basic Topology; Springer- Verlag New York; 1983
2. J. Dugundji: Topology; Prentice Hall of India; 1975
3. M. Gemignani: Elementary Topology; Addison Wesley Pub Co Reading Mass; 1971
4. M.G. Murdeshwar: General Topology (2nd Edn.); Wiley Eastern Ltd; 1990
5. G.F. Simmons: Introduction to Topology and Modern Analysis; McGraw-Hill Inter- national Student Edn.; 1963
6. S. Willard: General Topology; Addison Wesley Pub Co., Reading Mass; 1976.

COURSE CODE –MMT2C09 CORE COURSE IX: ODE AND CALCULUS OF VARIATIONS				
Credits	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Create*** concepts of power series solutions	Create	PSO1 PSO4 PSO5 PSO8
CO2	***Explain*** special functions of mathematical physics	Understand	PSO1 PSO3 PSO4
CO3	***Develop*** idea of systems of first order equation	Analyze	PSO3 PSO4 PSO7
CO4	***Analyze*** non-linear equations	Analyze	PSO1 PSO3
CO5	***Demonstrate*** boundary value problems and related theorems	Understand	PSO4 PSO5 PSO6 PSO8

TEXT	SIMMONS, G.F, DIFFERENTIALEQUATIONS WITH APPLICATIONS AND HISTORICALNOTES(3rdEdn.), New Delhi, 1974

COURSE CONTENT

Module1: Power Series Solutions and Special functions	**30 Hours**
Power Series Solutions and Special functions; Some Special Functions of Mathematical Physics. [Chapter 5: Sections 27, 28, 29, 30, 31, 32; Chapter 8: Sections 44, 45]	
Module 2: Systems of First Order Equations and Non-linear Equations	**25 Hours**
Some special functions of Mathematical Physics (continued), Systems of First Order Equations; Non-linear Equations [Chapter 8: Sections 46, 47; Chapter 10: Sections 55, 56; Chapter 11: Sections 58, 59, 60, 61, 62]	
Module 3: The Existence, Uniqueness and properties of Solutions and Calculus of Variations.	**25 Hours**
Qualitative Properties of Solutions, The Existence and Uniqueness of Solutions, The Calculus of Variations. [Chapter 4: Sections 24, 25; Chapter 13: Sections 68, 69, 70: Chapter 12: Sections 65, 66, 67]	

MODE OF TRANSACTION

Lecture Method

Problem Solving Method

Questioning Method and Flipped learning

MODE OF ASSESSMENT

Internal Assessment (5 Weightage)

e. Classroom participation (20%): 1 Weightage

f. Test papers II (40%): 2 Weightage

g. Assignment (20%): 1 Weightage

h. Seminar/ Viva (20%): 1 Weightage

External Assessment (30 Weightage) *Duration: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Power Series Solutions and Special functions	11
Module II: Systems of First Order Equations and Non-linear Equations	9
Module III: The Existence, Uniqueness and properties of Solutions and Calculus of Variations.	9

REFERENCES

1. G. Birkhoff and G.C. Rota: Ordinary Differential Equations (3rd Edn.); Edn. Wiley & Sons; 1978
2. W.E. Boyce and R.C. Diprima: Elementary Differential Equations and boundary value problems (2nd Edn.); John Wiley & Sons, NY; 1969.
3. Chakrabarti: Elements of ordinary Differential Equations and special functions; Wiley Eastern Ltd., New Delhi; 1990
4. E.A. Coddington: An Introduction to Ordinary Differential Eqution; Printice Hall of India, New Delhi; 1974
5. R.Courant and D. Hilbert: Methods of Mathematical Physics- vol I; Wiley Eastern Reprint; 1975
6. P. Hartman: Ordinary Differential Equations; John Wiley & Sons; 1964
7. L.S. Pontriyagin: A course in ordinary Differential Equations Hindustan Pub. Corporation, Delhi; 1967.
8. Sneddon: Elements of Partial Differential Equations; McGraw-Hill International Edn.;1957.

COURSE CODE –MMT2C10 CORE COURSE X: OPERATIONS RESEARCH				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Develop*** linear programming models of real-life systems.	Create	PSO2 PSO3 PSO4
CO2	***Solve*** linear programming and integer programming problems using mathematical techniques.	Apply	PSO1 PSO2 PSO3 PSO7
CO3	Conduct and ***interpret*** sensitivity analysis.	Create	PSO4 PSO5 PSO6
CO4	***Model*** strategic situations as games.	Understand	PSO1 PSO2 PSO4
CO5	***Solve*** games using various techniques.	Apply	PSO3 PSO4 PSO5 PSO8

TEXT: K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS (3rd. Edn.), New Age International(P) Ltd., 1996.
(Pre requisites: A basic course in calculus and Linear Algebra)

COURSE CONTENT	
Module 1 – Convex Functions; Linear Programming	**26 Hours**
Convex Functions [Chapter 2: Sections 11 to 12] Linear Programming [Chapter 3: Sections 1 to 15, 17]	
Module 2 – Linear Programming; Transportation Problem	**20 Hours**
Linear Programming [Chapter 3: Sections 18 to 20, 22] Transportation Problem [Chapter 4 Sections 1 to 11, 13]	
Module 3 – Integer Programming; Sensitivity Analysis, Flow and Potential in Networks; Theory of Games	**34 Hours**
Integer Programming [Chapter 6: Sections 1 to 9] Sensitivity Analysis [Chapter 7: Sections 1 to 10] Flow and Potential in Networks [Chapter 5: Sections 1 to 4, 6 ,7] Theory of Games [Chapter 12: all sections]	

MODE OF TRANSACTION

Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT

Internal Assessment (5 Weightage)

a. Classroom participation (20%): 1 Weightage

b. Test papers II(40%): 2 Weightage

c. Assignment (20%): 1 Weightage

d. Seminar/ Viva (20%): 1 Weightage

External Assessment (30 Weightage) *Duration: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE MARK DISTRIBUTION

Module	Weightage
Module I: Convex Functions; Linear Programming	6
Module II: Linear Programming; Transportation Problem	11
Module III: Integer Programming; Sensitivity Analysis, Flow and Potential in Networks; Theory of Games	13

REFERENCES:

1. R.L. Ackoff and M.W. Sasioni: Fundamentals of Operations Research; Wiley Eastern Ltd. New Delhi; 1991
2. C.S. Beightler, D.T. Philiphs and D.J. Wilde: Foundations of optimization (2nd Edn.); Prentice Hall of India, Delhi; 1979
3. G. Hadley: Linear Programming; Addison-Wesley Pub Co Reading, Mass; 1975
4. G. Hadley: Non-linear and Dynamic Programming; Wiley Eastern Pub Co. Reading, Mass; 1964
5. H.S. Kasana and K.D. Kumar: Introductory Operations Research-Theory and Applications; Springer-Verlag; 2003
6. R. Panneerselvam: Operations Research; PHI, New Delh i(Fifth printing); 2004
7. Ravindran, D.T. Philips and J.J. Solberg: Operations Research-Principles and Practices (2nd Edn.); John Wiley & Sons; 2000
8. G. Strang: Linear Algebra and Its Applications (4th Edn.); Cengage Learning; 2006.
9. Hamdy A. Taha: Operations Research- An Introduction (4th Edn.); Macmillan Pub Co. Delhi; 1989.

SEMESTER 3

COURSE CODE –MMT3C11 CORE COURSE XI: MULTIVARIABLE CALCULUS AND GEOMETRY				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	Be ***proficient*** in differentiation of functions of several variables.	Understand	PSO3
CO2	***Understand*** curves in plane and in space.	Understand	PSO5
CO3	***Get*** a deep knowledge of Curvature, torsion, Serret-Frenet formulae	Apply	PSO2
CO4	***Learn*** Fundamental theorem of curves in plane and space.	Understand	PSO2
CO5	***Learn*** the concept of Surfaces in three-dimension, smooth surfaces, surfaces of revolution.	Understand	PSO2
CO6	***Learn*** explicitly tangent and normal to the surfaces.	Analyze	PSO5
CO7	***Get*** a thorough understanding of oriented surfaces, first and second fundamental forms surfaces, gaussian curvature and geodesic curvature and so on.	Create	PSO8

TEXT 1	RUDIN W., PRINCIPLES OF MATHEMATICAL ANALYSIS, (3rd Edn.), Mc. Graw Hill, 1986.

TEXT 2	ANDREW PRESSLEY, ELEMENTARY DIFFERENTIAL GEOMETRY (2nd Edn.), Springer-Verlag, 2010

COURSE CONTENT		
Module 1: Functions of Several Variables	**Text 1**	**25 Hours**
Functions of Several Variables Linear Transformations, Differentiation, The Contraction Principle, The Inverse Function Theorem, the Implicit Function Theorem. [Chapter 9 – Sections 1–29, 33–37 from Text -1]		
Module 2: Curves and Surfaces	**Text 2**	**30 Hours**
What is a curve? Arc-length, Reparametrization, Closed curves, Level curves versus parametrized curves. Curvature, Plane curves, Space curves What is a surface, Smooth surfaces, Smooth maps, Tangents and derivatives, Normals and orientability. [Chapter 1 Sections 1– 5, Chapter 2 Sections 1 – 3, Chapter 4 Sections 1 – 5 from Text - 2]		
Module 3: Applications of the inverse function theorem; Curvature	**Text 2**	**25 Hours**
Applications of the inverse function theorem, Lengths of curves on surfaces, The second fundamental form, The Gauss and Weingarten maps, Normal and geodesic curvatures. Gaussian and mean curvatures, Principal curvatures of a surface. [Chapter 5 & 6, Chapter 6 Sections 1 Chapter 7 Sections 1 – 3, Chapter 8 Sections 1 – 2 from Text - 2]		

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT
Internal Assessment (5 Weightage)

a. Classroom participation (20%):	1 Weightage
b. Test papers I (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	*Duration: 3 hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Functions of Several Variables	10
Module II: Curves and Surfaces	12
Module III: Applications of the inverse function theorem; Curvature	8

REFERENCES:

1. M. P. doCarmo: Differential Geometry of Curves andSurfaces
2. W. Klingenberg: A course in DifferentialGeometry
3. J. R. Munkres: Analysis on Manifolds; Westview Press;1997
4. C. C. Pugh: Real Mathematical Analysis, Springer;2010
5. M. Spivak: A Comprehensive Introduction to Differential Geometry-Vol. I; Publish or Perish, Boston; 1970
6. M. Spivak: Calculus on Manifolds; Westview Press;1971
7. V.A. Zorich: Mathematical Analysis-I; Springer;2008

COURSE CODE –MMT3C12 CORE COURSE XII: COMPLEX ANALYSIS				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Learn*** the concept of differentiability and analyticity of a function using limits.	Understand	PSO1
CO2	***Use*** the Cauchy-Riemann equation to determine whether/where a function is differentiable/analytic	Apply	PSO3
CO3	***Demonstrate*** the understanding of conformal mappings	Understand	PSO3
CO4	***Demonstrate*** knowledge of integration in complex plane	Understand	PSO1
CO5	***Understand*** and use the different versions of Cauchy's theorem and Cauchy's integral formulas	Understand	PSO2
CO6	***Manipulate*** and use the power series representation of analytic functions	Apply	PSO4
CO7	***Get*** an idea of singularities of an analytic function and their classification	Create	PSO3
CO8	***Understand*** residues and their use in integration	Understand	PSO3
CO9	***Understand*** and develop manipulation skills in the use of Rouche's Theorem	Understand	PSO4

CO10	***Understand*** certain theorems like open mapping theorem, maximum modulus principle, Hadamard's three circles theorem	Understand	PSO5

TEXT	JOHN B. CONWAY, FUNCTIONS OF ONE COMPLEX VARIABLE (2nd Edn.); Springer International Student Edition; 1992

COURSE CONTENT	
Module 1: Analytic Functions as Mappings	**30 Hours**
The extended plane and its spherical representation, Power series, Analytic functions, Analytic functions as mappings, Mobius transformations, Riemann-Stieltijes integrals [Chapt. I Section 6; Chapt. III Sections 1, 2 and 3; Chapter IV Section 1]	
Module 2: Power series representation of analytic functions	**30 Hours**
Power series representation of analytic functions, Zeros of an analytic function, The index of a closed curve, Cauchy's Theorem and Integral Formula, The homotopic version of Cauchy's Theorem and simple connectivity, Counting zeros; the Open Mapping Theorem and Goursat's Theorem. [Chapt. IV Sections 2, 3, 4, 5, 6, 7 and 8]	
Module 3: Singularities	**20 Hours**
The classification of singularities, Residues, The Argument Principle and The Maximum Principle, Schwarz's Lemma, Convex functions and Hadamard's three circles theorem [Chapt. V: Sections 1, 2, 3; Chapter VI Sections 1, 2, 3]	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT		
Internal Assessment (5 Weightage)		
a. Classroom participation (20%):	1 Weightage	
b. Test papers I (40%):	2 Weightage	
c. Assignment (20%):	1 Weightage	
d. Seminar/ Viva (20%):	1 Weightage	
External Assessment (30 Weightage)	*Duration: 3 Hours; No of Questions: 21*	

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Analytic Functions as Mappings	12
Module II : Power series representation of analytic functions	12
Module III: Singularities	6

REFERENCES:

1. H. Cartan: Elementary Theory of analytic functions of one or several variables; Addison - Wesley Pub. Co.; 1973
2. T.W. Gamelin: Complex Analysis; Springer-Verlag, NY Inc.; 2001
3. T.O. Moore and E.H. Hadlock: Complex Analysis, Series in PureMathematicsVol. 9; World Scientific; 1991
4. L. Pennisi: Elements of Complex Variables (2nd Edn.); Holf, Rinehart & Winston; 1976
5. R. Remmert: Theory of Complex Functions; UTM, Springer-Verlag, NY; 1991
6. W. Rudin: Real and Complex Analysis (3rd Edn.); Mc Graw - Hill International Editions; 1987
7. H. Sliverman: Complex Variables; Houghton Mifflin Co. Boston; 1975.

COURSE CODE –MMT3C13 CORE COURSE XIII: FUNCTIONAL ANALYSIS				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	4	20	80	100

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Recall*** the definitions and examples of metric spaces, normed spaces, Banach spaces, and bounded linear maps.	Remember	PSO2
CO2	***Explain*** the concepts of metric spaces, normed spaces, Banach spaces, and bounded linear maps using examples	Understand	PSO3
CO3	***Use*** metric spaces, normed spaces, Banach spaces, and bounded linear maps to solve problems involving convergence, continuity, compactness, and approximation	Apply	PSO4
CO4	***Compare*** and contrast different types of metric spaces, normed spaces, Banach spaces, and bounded linear maps, such as Euclidean, Hilbert spaces, and compact operators	Analyze	PSO5

TEXT	**LIMAYE B.V,** FUNCTIONAL ANALYSIS, (2nd Edn.) New Age International Ltd, Publishers, New Delhi, Bangalore (1996)

COURSE CONTENT	
Module 1: Metric spaces and Bounded spaces	**25 Hours**
Metric spaces and Continuous Functions: Completeness (section 3, 3.1 to 3.4, 3.11 to 3.13(without proof)), Lebesgue Measure and Integration on R: Lp spaces, Fourier series and Integrals (section 4.5 to 4.7, 4.8 to 4.11(without proof)), Normed spaces (section 5).	
Module 2: Continuity of linear maps	**35 Hours**
Continuity of linear maps: Bounded Linear Maps (section 6), Hahn-Banach Theorems: Unique Hahn- Banach extensions (section 7, omit Banach limits), Banach spaces (section 8).	
Module 3: Bounded Linear Maps on Banach Spaces	**20 Hours**
Uniform Boundedness Principle (section 9 (upto and including 9.3), omit Quadrature Formulae and Matrix Transformations and Summability Methods), Closed Graph and Open Mapping Theorems (section 10), Bounded Inverse Theorem (section 11.1).	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers I (40%):	2 Weightage
c. Assignment (20%):	1 Weightage

d. Seminar/ Viva (20%): 1 Weightage				
External Assessment (30 Weightage) *Duration: 3 Hours, No of Questions: 21*				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Metric spaces and Bounded spaces	10
Module II: Continuity of linear maps	13
Module III: Bounded Linear Maps on Banach Spaces	7

REFERENCES:

1. G. Bachman and L. Narici: Functional Analysis; Academic Press, NY; 1970
2. J. B. Conway: Functional Analysis; Narosa Pub House, New Delhi; 1978
3. J. Dieudonne: Foundations of Modern analysis; Academic Press; 1969
4. W. Dunford and J. Schwartz: Linear Operators - Part 1: General Theory; John Wiley & Sons; 1958
5. Kolmogorov and S.V. Fomin: Elements of the Theory of Functions and Functional Analysis (English translation); Graylock Press, Rochaster NY; 1972
6. E. Kreyszig: Introductory Functional Analysis with applications; John Wiley & Sons; 1978
7. F. Riesz and B. Nagy: Functional analysis; Frederick Unger NY; 1955

8. W. Rudin: Functional Analysis; TMH edition; 1978
9. G. Strang: Linear algebra and its applications (4th edn.); Cengage Learning; 2006.
10. Yuli Eidelman,Vitali Milman and Antonis Tsolomitis: Functional analysis An Introduction, Graduate Studies in Mathematics, Vol. 66 American Mathematical Society, 2004.

COURSE CODE –MMT3C14 CORE COURSE XIV: PDE and Integral Equations				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Summarize*** first order partial differential equations	Understand	PSO1
CO2	***Develop*** methods of solving first order partial differential equations	Analyze	PSO3
CO3	***Identify*** methods of solving second order partial differential equation	Remember	PSO3
CO4	***Apply*** second order partial differential equation	Apply	PSO2
CO5	***Demonstrate*** integral equations	Understand	PSO1

TEXTS	**TEXT 1:** AN INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS, YEHUDA PINCHOVER AND JACOB RUBINSTEIN, Cambridge University Press.
	TEXT 2: HILDEBRAND, F.B., METHODS OF APPLIED MATHEMATICS (2nd Edn.), Prentice-Hall of India, New Delhi, 1972.

COURSE CONTENT		
Module1: Partial Differential Equations	**TEXT 1**	**30 Hours**
First-order equations: Introduction, Quasilinear equations, The method of characteristics, Examples of the characteristics method, The existence and uniqueness theorem, The Lagrange method, The eikonal equation, General nonlinear equations. Second-order linear equations in two independent variables: Introduction, Classification, Canonical form of hyperbolic equations, Canonical form of parabolic equations, Canonical form of elliptic equations. **The one-dimensional wave equation**: Introduction, Canonical form and general solution, The Cauchy problem and d'Alemberts formula, Domain of dependence and region of influence, The Cauchy problem for the non-homogeneous wave equation [Chapter 2, 3 and 4 from Text 1].		
Module 2: Partial Differential Equations	**TEXT 1**	**25 Hours**
The method of separation of variables: Introduction, Heat equation: homogeneous boundary condition, Separation of variables for the wave equation, Separation of variables for nonhomogeneous equations, The energy method and uniqueness **Elliptic equations:** Introduction, Basic properties of elliptic problems, The maximum principle, Applications of the maximum principle, Greens identities, The maximum principle for the heat equation, Separation of variables for elliptic problems, Poissons formula [Chapter 5 and 7 from Text 1]		
Module 3: Integral Equations	**TEXT 2**	**25 Hours**
Integral Equations: Introduction, Relations between differential and integral equations, The Green's functions, Fredholom equations with separable kernels, Illustrative examples, Hilbert- Schmidt Theory, Iterative methods for solving		

Equations of the second kind. The Newmann Series, Fredholm Theory [Sections 3.1 3.3, 3.6 3.11 from the Text 2]

MODE OF TRANSACTION
Lecture Method, **Problem Solving Method,** **Questioning Method and Flipped learning**

MODE OF ASSESSMENT
Internal Assessment (5 Weightage) a. Classroom participation (20%): 1 Weightage b. Test papers I (40%): 2 Weightage c. Assignment (20%): 1 Weightage d. Seminar/ Viva (20%): 1 Weightage
External Assessment (30 Weightage) *Duration:3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Partial Differential Equations	11
Module II: Partial Differential Equations	9

Module III: Integral Equations	9

REFERENCES:

1. Amaranath T.:Partial Differential Equations, Narosa, New Delhi, 1997.
2. A. Chakrabarti: Elements of ordinary Differential Equations and special functions; Wiley Eastern Ltd, New Delhi; 1990.
3. E.A. Coddington: An Introduction to Ordinary Differential Equtions; Printice Hall of India, New Delhi; 1974
4. R.Courant and D. Hilbert: Methods of Mathematical Physics- vol I; Wiley Eastern Reprint; 1975
5. P. Hartman: Ordinary Differential Equations; John Wiley & Sons; 1964
6. F. John: Partial Differential Equations; Narosa Pub House New Delhi; 1986
7. Phoolan Prasad Renuka Ravindran: Partial Differential Equations; Wiley Eastern Ltd, New Delhi; 1985
8. L.S. Pontriyagin: A course in ordinary Differential Equations Hindustan Pub. Corporation, Delhi; 1967
9. I. Sneddon: Elements of Partial Differential Equations; McGraw-Hill International Edn.;1957.

SEMESTER 4

COURSE CODE – MMT4C15 CORE COURSE XV: Advanced Functional Analysis				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Identify*** spectrum, particularly eigen spectrum and approximate eigen spectrum	Analyze	PSO2
CO2	***Understand*** the concept of dual space of a normed linear space	Understand	PSO3
CO3	***Understand*** the concept of weak convergence of a sequence in a normed space	Understand	PSO3
CO4	***Understand*** and check the reflexivity of a space	Understand	PSO1
CO5	***Understand*** the concept of orthogonal projection and Riesz representation theorem	Understand and Apply	PSO3 PSO5
CO6	***Understand*** the concept of compact, positive, adjoint, self-adjoint, normal and unitary operators	Understand and Apply	PSO3 PSO5
CO7	***Understand*** the concept of compact self-adjoint operators and the spectral theorem	Understand and Apply	PSO3 PSO5

TEXT	LIMAYE B.V, FUNCTIONAL ANALYSIS, (2nd Edn.) New Age International Ltd, Publishers, New Delhi, Bangalore (1996)

COURSE CONTENT	
Module 1: Bounded Linear Functional	**30 Hours**
Spectrum of a Bounded Operator (Section 12), Duals and Transposes (section 13, upto and including 13.6), Weak Convergence (Section 15(15.1 (without proof) and 15.2 upto 15.2(c) (without proof))); Reflexivity (section 16(16.1 to 16.2, 16.4(a) and (b), 16.5(without proof), 16.6(without proof), Omit 16.3).	
Module 2: Normed Spaces and Hilbert Spaces	**20 Hours**
Compact Linear Map (Section 17 (upto and including 17.3)); Spectrum of a compact operator (Section 18 (18.1 to 18.5, 18.7(a)); Quick Review of Chapter 21 (Inner Product Space) and Chapter 22 (Orthonormal Sets); Projection and Riesz Representation Theorems. (Section 24 (up to and including 24.6))	
Module 3: Bounded Operator on Hilbert spaces	**30 Hours**
Bounded Operators and Adjoints (Section 25(omit 25.4(b))); Normal, Unitary and Self Adjoint Operators (section 26, omit Fourier-Plancherel Transform), Spectrum and Numerical Range (section 27(omit 27.6)); Compact self-Adjoint Operators (section 28 (omit 28.3(b), 28.7 and 28.8(b))).	

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT

Internal Assessment (5 Weightage)

a. Classroom participation (20%): 1 Weightage

b. Test papers I (40%): 2 Weightage

c. Assignment (20%): 1 Weightage

d. Seminar/ Viva (20%): 1 Weightage

External Assessment (30 Weightage) *Duration:3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Bounded Linear Functional	12
Module II: Normed Spaces and Hilbert Spaces	6
Module III: Bounded Operator on Hilbert spaces	12

REFERENCES:

1. Yuli Eidelman,Vitali Milman and Antonis Tsolomitis: Functional analysis An Introduction, Graduate Studies in Mathematics Vol. 66 American Mathematical Society 2004.
2. R. Bhatia: Notes on Functional Analysis TRIM series, Hindustan Book Agency
3. Kesavan S: Functional Analysis TRIM series, Hindustan Book Agency
4. S David Promislow: A First Course in Functional Analysis, John wiley & Sons, INC., (2008)
5. Sunder V.S: Functional Analysis TRIM Series, Hindustan Book Agency
6. George Bachman &LawrenceNarici: Functional Analysis Academic Press, NY (1970)
7. E.Kreyszig: Introductory Functional Analysis with Applications; John Wiley and Sons; 1978.
8. J.B.Conway: Functional Analysis; Narosa Pub House New Delhi; 1978
9. Walter Rudin: Functional Analysis TMH edition (1978)

ELECTIVE COURSE SYLLABUS

SEMESTER 3

COURSE CODE –MMT3E01 ELECTIVE COURSE I: CODING THEORY				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Analyse*** the basics of coding theory.	Analyse	PSO1
CO2	***Detect*** and correct the error patterns.	Analyse	PSO2
CO3	***Apply*** the fundamental concepts in linear algebra to coding theory.	Apply	PSO2 PSO6
CO4	***Compare*** different types of coding and decoding methods and develop the problem-solving ability.	Evaluate	PSO3 PSO4
CO5	***Represent*** cyclic codes in terms of polynomials.	Understand	PSO1 PSO2

TEXT	D.J. Hoffman, Coding Theory: The Essentials, Mareel Dekker Inc, 1991

COURSE CONTENT	
Module 1: Introduction to Coding Theory; Linear Codes	**Hours: 30**
Detecting and correcting error patterns, Information rate, the effects of error detection and correction, finding the most likely code word transmitted, weight and distance, MLD, Error detecting and correcting codes. linear codes, bases for C =< S > and C ⊥, generating and parity cheek matrices, equivalent codes, distance of linear code, MLD for a linear code, reliability of IMLD for linear codes [Chapter 1 & Chapter 2]	
Module 2: Perfect and Related Codes	**Hours: 22**
Perfect codes, hamming code, Extended code, Golay code and extended Golay code, Red Hulles codes [Chapter 3: Sections 1 to 8].	
Module 3: Cyclic linear codes and BCH codes	**Hours: 28**
Cyclic linear codes, polynomial encoding and decoding, dual cyclic codes, BCH linear codes, Cyclic Hamming code, Decoding 2 error correcting BCH codes [Chapter 4 and Appendix A of the chapter, Chapter 5]	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. **Peer to Peer learning**: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	*Duration: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Introduction to Coding Theory; Linear Codes	13
Module II: Perfect and Related Codes	6
Module III: Cyclic linear codes and BCH codes	11

REFERENCES:

1. E.R. Berlekamp: Algebraic coding theory, Mc Graw Hill, 1968
2. P.J. Cameron and J.H. Van Lint: Fundamentals of Wavelets Theory Algorithms and Applications, John Wiley and Sons, New York, 1999.
3. Yves Nievergelt: Graphs, codes and designs, CUP
4. H. Hill: A first Course in Coding Theory, OUP, 1986.

COURSE CODE –MMT3E02 ELECTIVE COURSE II: CRYPTOGRAPHY				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** the fundamentals of cryptography and cryptanalysis.	Understand	PSO1
CO2	***Acquire*** a knowledge of Claude Shanon's ideas to cryptography, including the concepts of perfect secrecy and the use of information theory to cryptography.	Analyze	PSO3
CO3	***Learn*** to use substitution -permutation networks as a mathematical model to introduce many of the concepts of modern block cipher design and analysis including differential and linear cryptoanalysis.	Understand	PSO1
CO4	***Familiarize*** different cryptographic hash functions and their application to the construction of message authentication codes.	Apply	PSO5

TEXT	Douglas R. Stinson, Cryptography Theory and Practice, Chapman & Hall, 2nd Edition

COURSE CONTENT	
Module 1: Classical Cryptography	**26 Hours**
Some Simple Cryptosystems, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, Stream Ciphers. Cryptanalysis of the Affine, Substitution, Vigenere, Hill and LFSR Stream Cipher	
Module 2: Shannons Theory	**22 Hours**
Elementary Probability Theory, Perfect Secrecy, Entropy, Huffman Encodings, Properties of Entropy, Spurious Keys and Unicity Distance, Product Cryptosystem.	
Module 3: Block Ciphers	**32 Hours**
Substitution Permutation Networks, Linear Cryptanalysis, Differential Cryptanalysis, Data Encryption Standard (DES), Advanced Encryption Standard (AES). Cryptographic Hash Functions: Hash Functions and Data integrity, Security of Hash Functions, iterated hash functions- MD5, SHA 1, Message Authentication Codes, Unconditionally Secure MAC s. [Chapter 1 : Section 1.1(1.1.1 to 1.1.7), Section 1.2 (1.2.1 to 1.2.5) ; Chapter 2 : Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 ; Chapter 3 : Sections 3.1, 3.2, 3.3 (3.3.1 to 3.3.3), Sect.3.4, Sect. 3.5(3.5.1,3.5.2), Sect.3.6(3.6.1, 3.6.2); Chapter 4 : Sections 4.1, 4.2 (4.2.1 to 4.2.3), Section 4.3 (4.3.1, 4.3.2), Section 4.4(4.4.1, 4.4.2), Section 4.5 (4.5.1, 4.5.2)]	

MODE OF TRANSACTION
Lecture Method, **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT
Internal Assessment (5 Weightage) a. Classroom participation (20%): 1 Weightage

b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	*Duration: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Modules 1: Classical Cryptography	10
Module 2: Shannons Theory	8
Module 3: Block Ciphers	12

REFERENCES:

1. Jeffrey Hoffstein: Jill Pipher, Joseph H. Silverman, An Introduction to Mathematical Cryptography, Springer International Edition.
2. H. Deffs & H. Knebl: Introduction to Cryptography, Springer Verlag, 2002.
3. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone: Handbook of Applied Cryptography, CRC Press, 1996.
4. William Stallings: Cryptography and Network Security Principles and Practice, Third Edition, Prentice-hall India, 2003.

COURSE CODE – MMT3E03 ELECTIVE COURSE III: Measure and Integration				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Learn*** how a measure will be helpful to generalize the concept of an integral.	Remember	PSO 3
CO2	***Learn*** how a smallest sigma algebra containing all open sets to be constructed on a topological space which ensures the measurability of all continuous functions.	Understand	PSO 1
CO3	***Learn*** how a measure called Borel measure is defined on the sigma algebra which ensures the integrability of a huge class of continuous functions.	Understand	PSO 1
CO4	***Understand*** the regularity properties of Borel measures.	Understand	PSO 1
CO5	***Realize*** a measure may take real values even complex values.	Apply	PSO 5
CO6	***Learn*** to characterize bounded linear functionals on L^p- Space.	Analyze	PSO 3
CO7	***Learn*** product measure and their completion.	Understand	PSO 1

TEXT	WALTER RUDIN, REAL AND COMPLEX ANALYSIS (3rd Edn.), Mc.Graw- Hill International Edn., New Delhi, 1987.

COURSE CONTENT	
Module 1: Elementary properties of measures	**32 Hours**
The concept of measurability, Simple functions, Elementary properties of measures, Arithmetic in [0, infinity], Integration of Positive Functions, Integration of Complex Functions, The Role Played by Sets of Measure zero, Topological Preliminaries, The Riesz Representation Theorem. (Chap. 1, Sections: 1.2 to 1.41 Chap. 2, Sections: 2.3 to 2.14)	
Module II: Measurable Functions and Total Variation	**24 Hours**
Regularity Properties of Borel Measures, Lebesgue Measure, Continuity Properties of Measurable Functions. Total Variation, Absolute Continuity, Consequences of Radon - Nikodym Theorem. (Chap. 2, Sections: 2.15 to 2.25 Chap. 6, Sections: 6.1 to 6.14)	
Module III: Measurability on Cartesian Products	**24 Hours**
Bounded Linear Functionals on LP, The Riesz Representation Theorem, Measurability on Cartesian Products, Product Measures, The Fubini Theorem, Completion of Product Measures. (Chap. 6, Sections: 6.15 to 6.19, Chap. 8, Sections: 8.1 to 8.11)	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
e. Classroom participation (20%):	1 Weightage
f. Test papers II (40%):	2 Weightage
g. Assignment (20%):	1 Weightage
h. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	*Duration:3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Modules 1. Elementary properties of measures	12
Module 2. Measurable Functions and Total Variation	9
Module 3. Measurability on Cartesian Products	9

REFERENCES:

1. P.R. Halmos: Measure Theory, Narosa Pub. House New Delhi (1981) Second Reprint.
2. H.L. Roydon: Real Analysis, Macmillan International Edition (1988) Third Edition.
3. E.Hewitt & K. Stromberg : Real and Abstract Analysis, Narosa Pub. House New Delhi (1978).
4. A.E.Taylor: General Theory of Functions and Integration, Blaidsell Publishing Co NY (1965).
5. G.De Barra : Measure Theory and Integration, Wiley Eastern Ltd. Bangalore (1981).

COURSE CODE –MMT3E04 ELECTIVE COURSE IV: PROBABILITY THEORY				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** the concept of random variables, probability and distribution function of a random variable.	Understand	PSO1
CO2	***Apply*** the knowledge of convergence a sequence of random variables almost surely, in probability and distribution.	Apply	PSO3
CO3	***Apply*** the knowledge of central limit theorem in relevant situations.	Apply	PSO3
CO4	***Develop*** problem solving techniques to solve real world problems.	Create	PSO2
CO5	***Transform*** Able to translate real world problems into probability models.	Create	PSO5
CO6	***Determine*** and apply moments and characteristic functions and understand the concept of inequalities.	Evaluate	PSO4

TEXT	D An Introduction to Probability Theory and Statistics (Second Edition), By Vijay K. Rohatgi and A.K. MD. Ehsanes Saleh, John Wiley Sons Inc. New York

COURSE CONTENT	
Module 1: Random Variables	**27 Hours**
Random Variables and Their Probability Distributions Random Variables. Probability Distribution of a random Variable. Discrete and Continuous Random Variables. Functions of a random Variable. Chapter 2 of Text. (Sections 2.1- 2.5) Moments and Generating Functions. Moments of a distribution Function. Generating Functions. Some Moment Inequalities. Chapter 3 of Text. (Sections 3.1- 3.4)	
Module 2: Multiple Random Variables	**20 Hours**
Multiple Random Variables. Multiple random Variables. Independent Random Vari- ables. Functions of several Random variables. Covariance, Correlation and Moments. Conditional Expectations Order statistics and their Distributions. Chapter 4 of Text. (Sections 4.1- 4.7)	
Module 3: Limit Theorems	**18 Hours**
Limit Theorems. Modes of Convergence. Weak law of Large Numbers. Strong Law of large Numbers. Limiting Moment Generating Functions. Central Limit Theorem. Chapter 6 of Text. (Sections 6.1- 6.6)	

MODE OF TRANSACTION
Face to Face Instruction: This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.
Peer to Peer learning: Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

Group Discussion: Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

MODE OF ASSESSMENT				
Internal Assessment (5 Weightage) a. Classroom participation (20%): 1 Weightage b. Test papers I (40%): 2 Weightage c. Assignment (20%): 1 Weightage d. Seminar/ Viva (20%): 1 Weightage				
External Assessment (30 Marks) *Duration 3 Hours, No of Questions: 21*				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Modules 1. Random Variables	13
Module 2. Multiple Random Variables	9
Module 3. Limit Theorems	8

REFERENCES:

1. B.R. Bhat: MODERN PROBABILITY THEORY (Second Edn.) Wiley Eastern Limited, Delhi (1988).

2. K.L. Chung: Elementary Probability Theory with Stochastic Processes Narosa Pub House, New Delhi (1980).

3. W.E.Feller: An Introduction to Probability Theory and its Applications Vols I & II- John Wiley & Sons, (1968) and (1971).

4. Rukmangadachari E.: Probability and Statistics, Pearson (2012).

5. Robert V Hogg, Allen Craig & Joseph W McKean: Introduction to Mathematical Statistics (Sixth Edn.), Pearson 2005.

SEMESTER 4

COURSE CODE –MMT4E05 ELECTIVE COURSE V: ADVANCED COMPLEX ANALYSIS				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	Get a deep knowledge about the space of continuous functions from an open set in the complex plane to a region of the complex plane.	Analyze	PSO3
CO2	Learn and apply a technique to extend the domain over which a complex analytic function is defined.	Apply	PSO4
CO3	Understand that there is a unique conformal map f of the unit disk onto a simply connected domain of the extended complex plane such that f(0) and arg f′ (0) take given values.	Understand	PSO1
CO4	Understand some functions as infinite series or products.	Understand	PSO1

TEXT	**JOHN B. CONWAY**, FUNCTIONS OF ONE COMPLEX VARIABLE (2nd Edn.), Springer International Student Edition, 1973

COURSE CONTENT	
Module 1: Space of Analytic Functions	**25 Hours**
The Space of continuous functions C (tt, Ω), Spaces of Analytic functions, Spaces of meromorphic functions, The Riemann Mapping theorem, Weierstrass Factorization Theorem [Chapter. VII: Sections 1, 2, 3,4 and 5]	
Module 2: Gamma Function; Riemann Zeta Function; Runge's Theorem	**25 Hours**
Factorization of the sine function, Gamma function, The Riemann Zeta function, Runge's theorem, Simple connectedness [Chapt. VII: Sections 6, 7 and 8, Chapter VIII Sections 1 and 2]	
Module 3: Analytic Continuation; Entire Functions	**30 Hours**
Mittage–Leffler's Theorem, Schwarz reflexion principle, Analytic continuation along a path, Monotromy theorem, Jensen's formula, The Genus and order of an entire function, Statement of Hadamards factorization theorem [Chapt. VIII: Section 3, Chapter 9 sections 1,2 and 3, Chapter 11 sections 1, 2, Section 3 Statement of Hadamards factorization theorem only]	

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
e. Classroom participation (20%):	1 Weightage
f. Test papers II (40%):	2 Weightage

g. Assignment (20%):	1 Weightage
h. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	*Duration: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Modules 1: Space of Analytic Functions	9
Module 2: Gamma Function; Riemann Zeta Function; Runge's Theorem	9
Module 3: Analytic Continuation; Entire Functions	12

REFERENCES:

1. Cartan H: Elementary Theory of Analytic Functions of one or Several Variables, Addison-Wesley Pub. Co.(1973).
2. ConwayJ.B: Functions of One Complex Variable, Narosa Pub. Co, New Delhi (1973).
3. MooreT.O.& Hadlock. E.H: Complex Analysis, Series in Pure Mathematics- Vol.9. World Scientific, (1991).
4. Pennisi L: Elements of Complex Variables, Holf, Rinehart & Winston, 2nd Edn. (1976).
5. Rudin W: Real and Complex Analysis, 3rd Edn. Mc Graw-Hill International Edn. (1987).
6. Silverman H: Complex Variables, Houghton Mifflin Co. Boston (1975).
7. RemmertR: Theory of Complex Functions, UTM, Springer- verlag, NY, (1991).

COURSE CODE: MMT4E06 ELECTIVE COURSE VI: ALGEBRAIC NUMBER THEORY				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** that abstract algebra may be used to solve certain problems in Number Theory.	Understand	PSO2
CO2	***Learn*** about arithmetic of algebraic number fields.	Understand	PSO2
CO3	***Understand*** that the familiar unique factorization property may fail in the case of ring of integers of some quadratic fields while a unique factorization theory holds for ideals of ring of integers of a number field.	Understand	PSO3
CO4	***Learn*** finiteness of class numbers.	Apply	PSO2
CO5	***Understand*** that the notions of algebraic numbers may be applied to prove Kummer's special case of Fermat's Last Theorem.	Analyze	PSO4

TEXT	**I. N. STEWART & D.O. TALL**, ALGEBRAIC NUMBER THEORY, (2nd Edn.), Chapman & Hall, (1987)

COURSE CONTENT	
Module 1: Algebraic Numbers; Quadratic Fields; Cyclotomic Fields	**30 Hours**
Symmetric polynomials, Modules, Free abelian groups, Algebraic Numbers, Conjugates and Discriminants, Algebraic Integers, Integral Bases, Norms and Traces, Rings of Integers, Quadratic Fields, Cyclotomic Fields. [Chapter1, Sections 1.4 to 1.6; Chapter 2, Sections 2.1 to 2.6; Chapter 3, Sections 3.1 and 3.2 from the text]	
Module 2: Factorization into Irreducibles and Ideals	**25 Hours**
Historical background, Trivial Factorizations, Factorization into Irreducibles, Examples of Nonunique Factorization into Irreducibles, Prime Factorization, Euclidean Domains, Eucidean Quadratic fields Ideals Historical background, Prime Factorization of Ideals, The norm of an ideal [Chapter 4, Sections 4.1 to 4.7, Chapter 5, Sections 5.1 to 5.3.]	
Module 3: Geometric Methods and Kummers Theorem	**25 Hours**
Lattices, The Quotient Torus, Minkowski theorem, The Space Lst, The Class-Group An Existence Theorem, Finiteness of the Class-Group, Factorization of a Rational Prime, Fermats Last Theorem Some history, Elementary Considerations, Kummers Lemma, Kummers Theorem. [Chapter 6, Chapter 7, Section 7.1 Chapter 8, Chapter 9, Sections 9.1 to 9.3, Chapter 10. Section 10.1, Chapter 11: 11.1 to 11.4.]	

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT				
Internal Assessment (5 Weightage) a. Classroom participation (20%): 1 Weightage b. Continuous Assessment Test (40%): 2 Weightage c. Assignment (20%): 1 Weightage d. Seminar/ Viva (20%): 1 Weightage				
External Assessment (30 Weightage) Duration: 3 Hours, No of Questions: 21				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Marks for each question**	**Ceiling of Marks**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE MARK DISTRIBUTION	
Module	**Mark**
Module I	12
Module II	9
Module III	9

REFERENCES:

1. P. Samuel: Theory of Algebraic Numbers, Herman Paris Houghton Mifflin, NY, (1975)
2. S. Lan: Algebraic Number Theory, Addison Wesley Pub Co., Reading, Mass, (1970)
3. bf D. Marcus: Number Fields, Universitext, Springer Verlag, NY, (1976)
4. T.I.FR. Pamphlet No: 4: Algebraic Number Theory (Bombay, 1966)
5. Harvey Cohn: Advanced Number Theory, Dover Publications Inc., NY, (1980).

6. Andre Weil: Basic Number Theory, (3rd Edn.), Springer Verlag, NY, (1974)
7. G.H. Hardy and E.M. Wright: An Introduction to the Theory of Numbers, Oxford University Press.
8. Z.I. Borevich & I.R.Shafarevich: Number Theory, Academic Press, NY 1966.
9. Esmonde & Ram Murth : Problems in Algebraic Number Theory, Springer Verlag 2000.

COURSE CODE –MMT4E07 ELECTIVE COURSE II: ALGEBRAIC TOPOLOGY				
Credit	Hours/week	Marks		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***recall*** relevant concepts and terminology from Algebraic Topology	Remember	PSO2
CO2	***Explain*** how basic geometric structures may be studied by transforming them into algebraic questions.	Understand	PSO3
CO3	***Explain*** basics of homology theory and apply it to get a generalization of Eulers formula to a general polyhedral.	Apply	PSO5
CO4	***Classify*** a group called fundamental group to every topological space.	Analyze	PSO4
CO5	***Evaluate*** the effectiveness of different techniques for computing homology groups in specific examples.	Evaluate	PSO4
CO6	***Create*** new examples of spaces with interesting homology groups.	Create	PSO3

TEXT	**FRED H. CROOM,** BASIC CONCEPTS OF ALGEBRAIC TOPOLOGY, UTM, Springer - Verlag, NY, 1978.

COURSE CONTENT	
Module 1: Simplicial Homology Groups: 12	**30 Hours**
Geometric Complexes and Polyhedra: Introduction. Examples, Geometric Complexes and Polyhedra, Orientation of geometric complexes. Simplicial Homology Groups: Chains, cycles, Boundaries and homology groups, Examples of homology groups; The structure of homology groups; [Chapter 1: Sections 1.1 to 1.4; Chapter 2: Sections 2.1 to 2.3 from the text].	
Module 2: Simplicial Homology Groups (Contd.) and Simplicial Approximation: 12	**30 Hours**
Simplicial Homology Groups (Contd.): The Euler Poincare's Theorem; Pseudomani- folds and the homology groups of Sn. Simplicial Approximation: Introduction, Simplicial approximation, Induced homomorphisms on the Homology groups, The Brouwer fixed point theorem and related results [Chapter 2: Sections 2.4, 2.5; Chapter 3: Sections 3.1 to 3.4 from the text]	
Module 3: The Fundamental Group: 6	**20 Hours**
The Fundamental Group: Introduction, Homotopic Paths and the Fundamental Group, The Covering Homotopy Property for S1, Examples of Fundamental Groups. [Chapter 4: Sections 4.1 to 4.4 from the text]	

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT
Internal Assessment (5 Weightage)
a. Classroom participation (20%): 1 Weightage

b. Test papers I (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage)	*Duration: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Weightage for each question	Total Weightage
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION

Module	Weightage
Module I: Simplicial Homology Groups	12
Module II: Simplicial Homology Groups (Contd.) and Simplicial Approximation	12
Module III: The Fundamental Group	6

REFERENCES:

1. Eilenberg S, Steenrod N: Foundations of Algebraic Topology; Princeton Univ.Press; 1952.
2. S.T. Hu: Homology Theory; Holden-Day; 1965.
3. Massey W.S.: Algebraic Topology : An Introduction; Springer Verlag NY; 1977.
4. C.T.C. Wall: A Geometric Introduction to Topology; Addison-Wesley Pub. Co. Reading Mass; 1972Knut Sydsaeter, Peter Hammond, Arne Strom, Andrés Carvajal ,Essential Mathematics for Economic Analysis. Pearson.
5. Teresa Bradley. and Paul Patton, Essential mathematics for economics and business. New York: Wiley & Sons.
6. Lial, M. L., Hornsby, J., Schneider, D., & Daniels, C. (2016). Precalculus (6th ed.). Pearson.
7. Anton, H., Bivens, I., & Davis, S. (2013). Calculus (10th ed.). Wiley.

COURSE CODE –MMT4E08 ELECTIVE COURSE VIII: COMMUTATIVE ALGEBRA				
Credits	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Basic properties*** of commutative rings, ideals and modules over commutative rings	Understand	PSO2
CO2	***Learn*** uniqueness theorem for a decomposable ideal.	Analyze	PSO3
CO3	***Learn*** integrally closed domain and valuation ring.	Analyze	PSO3
CO4	***Understand*** the basic theory of Noetherian and Artin Rings	Understand	PSO4

TEXT	**ATIYAH M.F., MACKONALD I. G.**, INTRODUCTION TO COMMUTATIVE ALGEBRA, Addison Wesley, NY, 1969.

COURSE CONTENT	
Module 1:	**30 Hours**
Rings and Ideals, Modules [Chapters I and II from the text]	
Module 2:	**25 Hours**
Rings and Modules of Fractions, Primary Decomposition [Chapters III & IV from the text]	

Module 3:	**25 Hours**
Integral Dependence and Valuation, Chain conditions, Noetherian rings, Artinian rings [Chapters V, VI, VII & VIII from the text]	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT				
Internal Assessment (10 Weightage) a. Classroom participation (20%): 1 Weightage b. Test papers I (40%): 2 Weightage c. Assignment (20%): 1 Weightage d. Seminar/ Viva (20%): 1 Weightage				
External Assessment (30 Weightage) *Duration: 3 Hours, No of Questions: 21*				
PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Weightage of Marks**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I	12
Module II	9
Module III	9

REFERENCES:

1. N. Bourbaki: Commutative Algebra; Paris - Hermann; 1961
2. D. Burton: A First Course in Rings and Idials; Addison - Wesley; 1970
3. N. S. Gopalakrishnan: Commutative Algebra; Oxonian Press; 1984
4. T.W. Hungerford: Algebra; Springer Verlag GTM 73(4th Printing); 1987
5. D. G. Northcott: Ideal Theory; Cambridge University Press; 1953.
6. O. Zariski, P. Samuel: Commutative Algebra- Vols. I & II; Van Nostrand, Princeton; 1960

COURSE CODE –MMT4E09

ELECTIVE COURSE IX: DIFFERENTIAL GEOMETRY

Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Recall*** key definitions and concepts in Differential Geometry, such as vector fields, curves, and surfaces.	Remember	PSO2
CO2	***Demonstrate*** an understanding of the relationships between different concepts in Differential Geometry, such as the connections between curvature and geodesics.	Understand	PSO3
CO3	***Apply*** the concepts of Differential Geometry to solve problems in geometry, physics, and engineering.	Apply	PSO5
CO4	***Analyze*** the properties of vector fields, curves and surfaces using the tools of Differential Geometry.	Analyze	PSO4
CO5	***Develop*** a knowledge of the Gauss and Weingarten maps and apply them to describe various properties of surfaces.	Create	PSO3

TEXT	J. A. THORPE: ELEMENTARY TOPICS IN DIFFERENTIAL GEOMETRY

COURSE CONTENT	
Module 1: Level sets and Surfaces	**30 Hours**
Graphs and Level Set, Vector fields, The Tangent Space, Surfaces, Vector Fields on Surfaces, Orientation. The Gauss Map. [Chapters: 1,2,3,4,5,6 from the text.]	
Module 2: Curves in n-surfaces	**35 Hours**
Geodesics, Parallel Transport, The Weingarten Map, Curvature of Plane Curves, Arc Length and Line Integrals. [Chapters: 7,8,9,10,11 from the text].	
Module 3: Curvature of Surfaces and Parametrized Surfaces	**15 Hours**
Curvature of Surfaces, Parametrized Surfaces, Local Equivalence of Surfaces and Parametrized Surfaces. [Chapters 12,14,15 from the text]	

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers I (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage):	*Duration Hours: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Level sets and Surfaces	11
Module II: Curves in n-surfaces	13
Module III: Curvature of Surfaces and Parametrized Surfaces	6

REFERENCES:

1. W.L. Burke: Applied Differential Geometry, Cambridge University Press (1985).
2. M. de Carmo: Differential Geometry of Curves and Surfaces, Prentice Hall Inc Englewood Cliffs NJ (1976).
3. V. Grilleman and A. Pollack: Differential Topology, Prentice Hall Inc Englewood Cliffs NJ (1974).
4. B. O'Neil: Elementary Differential Geometry, Academic Press NY (1966).
5. M. Spivak: A Comprehensive Introduction to Differential, Geometry, (Volumes 1 to 5), Publish or Perish, Boston (1970, 75).
6. R. Millmen and G. Parker: Elements of Differential Geometry, Prentice Hall Inc Englewood Cliffs NJ (1977).
7. Singer and J.A. Thorpe: Lecture Notes on Elementary Topology and Geometry, UTM, Springer Verlag, NY (1967).

COURSE CODE –MMT4E10 ELECTIVE COURSE X: FLUID DYNAMICS				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Analyze*** Equations of Motion	Analyze	PSO3
CO2	***Explain*** the concepts of streaming motions and Aerofoils.	Understand	PSO4
CO3	***Interpret*** Sources and Sinks.	Understand	PSO3
CO4	***Understand*** Stream function and its uses to plot stream lines which represent trajectories of particles in a steady flow.	Understand	PSO6

TEXT	**L.M. MILNE-THOMSON,** THEORETICAL HYDRODYNAMICS, (Fifth Edition) Mac Millan Press, London, 1979

COURSE CONTENT	
Module 1: EQUATIONS OF MOTION AND TWO-DIMENSIONAL MOTION	**25 Hours**
EQUATIONS OF MOTION: Differentiation w.r.t. the time, The equation of continuity Boundary condition (Kinematical and Physical), Rate of change of linear momentum, The equation of motion of an invicid fluid, Conservative forces, Steady motion, The energy equation, Rate of change of circulation, Vortex motion, Permanence of vorticity, Pressure equation, Connectivity, Acyclic and cyclic irrotational motion, Kinetic energy of liquid, Kelvins minimum energy theorem.	

TWO-DIMENSIONAL MOTION: Motion in two- dimensions, Intrinsic expression for the vorticity; The rate of change of vorticity; Intrinsic equations of steady motion; Stream function; Velocity derived from the stream-function; Rankine's method; The stream function of a uniform stream; Vector expression for velocity and vorticity; Equation satisfied by stream function; The pressure equation; Stagnation points; The velocity potential of a liquid; The equation satisfied by the velocity potential. [Chapter III: Sections 3.10, 3.20, 3.30, 3.31, 3.40, 3.41, 3.43, 3.45, 3.50, 3.51, 3.52, 3.53, 3.60, 3.70, 3.71, 3.72, 3.73. Chapter IV: All Sections.]	
Module 2: STREAMING MOTIONS AND AEROFOILS	**25 Hours**
STREAMING MOTIONS: Complex potential; The complex velocity stagnation points, The speed, The equations of the streamlines, The circle theorem, Streaming motion past a circular cylinder; The dividing streamline, The pressure distribution on the cylinder, Cavitation, Rigid boundaries and the circle theorem, The Joukowski transformation, Theorem of Blasius. **AEROFOILS**: Circulation about a circular cylinder, The circulation between concentric cylinders, Streaming and circulation for a circular cylinder, The aerofoil, Further investigations of the Joukowski transformation Geometrical construction for the transformation, The theorem of Kutta and Joukowski. [Chaper VI: Sections 6.0, 6.01, 6.02, 6.03, 6.05, 6.21, 6.22, 6.23, 6.24, 6.25, 6.30, 6.41. Chapter VII: Sections 7.10, 7.11, 7.12, 7.20, 7.30, 7.31, 7.45.]	
Module 3: SOURCES AND SINKS; STOKES' STREAM FUNCTION	**30 Hours**
SOURCES AND SINKS: Two dimensional sources, The complex potential for a simple source, Combination of sources and streams, Source and sink of equal strengths Doublet, Source and equal sink in a stream, The method of images, Effect on a wall of a source parallel to the wall, General method for images in a plane, Image of a doublet in a plane, Sources in conformal transformation Source in an angle between two walls, Source outside a circular cylinder, The force exerted on a circular cylinder by a source.	

STOKES' STREAM FUNCTION: Asymmetrical motions Stokes stream function, Simple source, Uniform stream, Source in a uniform stream, Finite line source, Airship forms, Source and equal sink - Doublet; Rankin's solids. [Chapter VIII. Sections 8.10, 8.12, 8.20, 8.22, 8.23, 8.30, 8.40, 8.41, 8.42, 8.43, 8.50, 8.51, 8.60, 8.61, 8.62. Chapter XVI. Sections 16.0, 16.1, 16.20, 16.22, 16.23, 16.24, 16.25, 16.26, 16.27]

MODE OF TRANSACTION

Lecture Method

Problem Solving Method

Questioning Method

MODE OF ASSESSMENT

Internal Assessment (5 Weightage)

a. Classroom participation (20%): 1 Weightage
b. Test papers I (40%): 2 Weightage
c. Assignment (20%): 1 Weightage
d. Seminar/ Viva (20%): 1 Weightage

External Assessment (30 Weightage): *Duration Hours: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER

Pattern	Total No. of questions	No. of questions to be answered	Marks for each question	Ceiling of Marks
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**

Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: EQUATIONS OF MOTION AND TWO-DIMENSIONAL MOTION	9
Module II: STREAMING MOTIONS AND AEROFOILS	9
Module III: SOURCES AND SINKS; STOKES' STREAM FUNCTION	12

REFERENCES:

1. Von Misesand K. O. Friedrichs: Fluid Dynamics, Springer International Edition. Reprint, (1988)
2. James EA John: Introduction to Fluid Mechanics (2nd Edn.), Prentice Hall of India, Delhi(1983).
3. Chorlten: Text Book of Fluid Dynamics, CBS Publishers, Delhi1985
4. A. R. Patterson: A First Course in Fluid Dynamics, Cambridge University Press 1987

COURSE CODE –MMT4E11 ELECTIVE COURSE XI: GRAPH THEORY				
Credit	Hours/week	Weightage		
		Internal	External	Total
4	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** graph, vertex, path and cycles	Understand	PSO3
CO2	***Explain*** connectivity in communication networks	Understand	PSO4
CO3	***Develop*** matchings and coverings in bipartite graphs	Analyze	PSO3
CO4	***Explain*** chromatic number and related topics	Understand	PSO5
CO5	***Illustrate*** coloring problem and study some special graphs	Understand	PSO6

TEXT	J.A. Bondy and U.S.R.Murty : Graph Theory with applications. Macmillan.

COURSE CONTENT	
Module 1: Basic Concepts of Graphs	**25 Hours**
Basic concepts of Graph. Trees, Cut edges and Bonds, Cut vertices, Cayleys Formula, The Connector Problem, Connectivity, Blocks, Construction of Reliable Communication Networks, Euler Tours, Hamilton Cycles, The Chinese Postman Problem, The Travelling Salesman Problem.	

Chapter 2 Sections 2.1 (Definitions & Statements only), 2.2, 2.3, 2.4, 2.5; Chapter 3 Sections 3.1, 3.2, 3.3; Chapter 4 Sections 4.1 (Definitions & Statements only), 4.2, 4.3, 4.4.	
Module 2: Matchings	**25 Hours**
Matchings, Matchings and Coverings in Bipartite Graphs, Perfect Matchings, The Personnel Assignment Problem, Edge Chromatic Number, Vizings Theorem, The Timetabling Problem, Independent Sets, Ramseys Theorem Chapter 5 - Sections 5.1, 5.2, 5.3, 5.4; Chapter 6 Sections 6.1,6.2,6.3; Chapter 7 Sections 7.1, 7.2	
Module 3: Vertex Colouring	**30 Hours**
Vertex Colouring-Chromatic Number, Brooks Theorem, Chromatic Polynomial, Girth and Chromatic Number, A Storage Problem, Plane and Planar Graphs, Dual Graphs, Eulers Formula, Bridges, Kuratowskis Theorem, The Five-Colour Theorem, Directed Graphs, Directed Paths, Directed Cycles. Chapter 8- Sections 8.1, 8.2, 8.4, 8.5, 8.6; Chapter 9 Sections (9.1,9.2,9.3 Definitions & Statements only), 9.4, 9.5, 9.6; Chapter 10 Sections 10.1, 10.2, 10.3.]	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method** **Flipped Learning**
MODE OF ASSESSMENT
Internal Assessment (5 Weightage) a. Classroom participation (20%): 1 Weightage b. Test papers II (40%): 2 Weightage

c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage):	*Duration Hours: 3, No of Questions: 21*

PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Basic Concepts of Graphs	9
Module II: Matchings	9
Module III: Vertex Colouring	12

REFERENCES:

1. F. Harary : Graph Theory, Narosa publishers, Reprint 2013.
2. Geir Agnarsson, Raymond Greenlaw: Graph Theory Modelling, Applications and Algorithms, Pearson Printice Hall, 2007.
3. John Clark and Derek Allan Holton: A First look at Graph Theory, World Scientific (Singapore) in 1991 and Allied Publishers (India) in 1995
4. R. Balakrishnan & K. Ranganathan: A Text Book of Graph Theory, Springer Verlag, 2nd edition 2012.

COURSE CODE –MMT4E12 ELECTIVE COURSE XII: REPRESENTATION THEORY				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Learn*** the concept of G-Modules and commutant algebra.	Understand and Apply	PSO1, PSO3
CO2	***Learn*** the concepts of orthogonality relations and the finite abelian groups.	Understand and Apply	PSO1, PSO3
CO3	***Learn*** the concepts of induced representations and normal subgroups.	Understand and Apply	PSO1, PSO3

TEXT	**Walter Ledermann,** Introduction to Group Characters (Second Edition).

COURSE CONTENT	
Module 1: Modules and Commutant algebra.	**35 Hours**
Introduction, G- modules, Characters, Reducibility, Permutation Representations, Complete reducibility, Schurs lemma, The commutant(endomorphism) algebra. (Sections: 1.1 to 1.8)	
Module 2: Orthogonality relations and finite abelian groups.	**25 Hours**
Orthogonality relations, the group algebra, the character table, finite abelian groups, the lifting process, linear characters. (Section: 2.1 to 2.6)	

Module 3: Induced representations and normal subgroups.	30 Hours
Induced representations, reciprocity law, the alternating group A5, Normal sub-groups, Transitive groups, the symmetric group, induced characters of Sn. (Sections: 3.1 to 3.4 & 4.1 to 4.3)	

MODE OF TRANSACTION
Lecture Method **Problem Solving Method** **Questioning Method**

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage):	*Duration Hours: 3 Hours, No of Questions: 21*

PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Modules and Commutant algebra.	10
Module II: Orthogonality relations and finite abelian groups.	8
Module III: Induced representations and normal subgroups.	12

REFERENCES:

1. C. W. Kurtis and I. Reiner: Representation Theory of Finite Groups and Asso- ciative Algebras, John Wiley & Sons, New York (1962)
2. Faulton: The Reprsentation Theory of Finite Groups, Lecture Notes in Mathematics, No. 682, Springer 1978.
3. C. Musli: Reprsentations of Finite Groups, Hindustan Book Agency, New Delhi (1993).
4. I. Schur: Theory of Group Characters, Academic Press, London (1977).
5. J.P. Serre: Linear Representation of Finite Groups, Graduate Text in Mathematics, Vol 42, Springer (1977).

COURSE CODE –MMT4E13 ELECTIVE COURSE XIII: WAVELET THEORY				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Learn*** the concept of discrete Fourier Transforms and its basic properties.	Understand	PSO1
CO2	***Learn*** how to construct Wavelets on $\mathbb{Z}N$ and $\mathbb{Z}$.	Create	PSO2
CO3	***Learn*** Wavelets on $\mathbb{R}$ and the construction of MRA.	Create	PSO3

TEXT	**Michael. W. Frazier,** An Introduction to Wavelets through Linear Algebra, Springer, Newyork, 1999

COURSE CONTENT	
Module 1: The discrete Fourier transforms	**25 Hours**
The discrete Fourier transforms: Basic Properties of Discrete Fourier Transforms, Translation invariant Linear Transforms, The Fast Fourier Transforms. Wavelets on ZN. Construction of wavelets on ZN - The First Stage, Construction of Wavelets on ZN: The Iteration Step. [Chapter 2: sections 2.1 to 2.3; Chapter 3: sections 3.1 and 3.2]	

Module 2: Wavelets on Z	**30 Hours**
Wavelets on Z: A2(Z), Complete orthonormal sets in Hilbert spaces, $L2([\pi,\pi))$ and Fourier series, The Fourier Transform and convolution on A2(Z), First stage Wavelets on Z, Implementation and Examples. [Chapter 4: sections 4.1 to 4.6 and 4.7]	
Module 3: Wavelets on R	**25 Hours**
Wavelets on R: L2(R) and approximate identities, The Fourier transform on R, Multiresolution analysis and wavelets, Construction of MRA. [Chapter 5: sections 5.1 to 5.4]	

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage):	*Duration Hours: 3, No of Questions: 21*

PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**8**	**8**	**1**	**8**
Paragraph	**9**	**6**	**2**	**12**
Essay	**4**	**2**	**5**	**10**
			Total	**30**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: The discrete Fourier transforms	10
Module II: Wavelets on Z	10
Module III: Wavelets on R	10

REFERENCES:

1. C.K. Chui: An introduction to wavelets, Academic Press,1992
2. Jaideva. C. Goswami, Andrew K Chan: Fundamentals of Wavelets Theory Algorithms and Applications, John Wiley and Sons, Newyork. , 1999.
3. Yves Nievergelt: Wavelets made easy, Birkhauser, Boston,1999.
4. G. Bachman, L.Narici and E. Beckenstein : Fourier and wavelet analysis, Springer, 2006.

COURSE CODE –MMT4E14 ELECTIVE COURSE XIV: COMPUTER ORIENTED NUMERICAL ANALYSIS				
Credit	Hours/week	Weightage		
		Internal	External	Total
3	5	5	30	35

Course Outcomes

CO No.	Expected Course Outcome Upon completion of this course, students will be able to;	Learning Domain	PSO No
CO1	***Understand*** one of the most popular and robust general purpose programming language Python.	Understand	PSO1
CO2	***Understand*** how scientific programming can be performed using Python using various open-source mathematics libraries and tools available.	Understand	PSO2
CO3	***Solve*** any concrete mathematics or general science problem programmatically using numerical methods.	Analyze	PSO1
CO4	***Apply*** numerical methods to obtain approximate solutions to mathematical problems.	Apply	PSO1
CO5	***Derive*** numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, system of linear equations and the solution of differential equations	Evaluate	PSO5

CO6	***Analyze*** and evaluate the accuracy of common numerical methods.	Analyze	PSO1
CO7	***Implement*** numerical methods in python.	Apply	PSO1
CO8	***Write*** efficient, well-documented python code and present numerical results in an informative way.	Create	PSO6

TEXT 1	A Byte of Python, Swaroop C H
TEXT 2	Numerical Methods, E Balagurusamy, Tata McGraw-Hill Publishing Company Limited, New Delhi.

COURSE CONTENT	
Module 1: Python	**30 Hours**

(Text Book 1, Text Book 2)

A quick review of preliminaries of computers, numerical computing, programming languages, Algorithms, flow charts, computer codes based on **chapter 1, 2** and **3** of Text Book 2

Approximations and errors in computing: Significant Digits, Numerical Errors, Absolute and relative errors, convergence of iterative processes and error estimation. (Sections 4.2, 4.4, 4, 7, 4.11 and 4.12 of Text Book 2)

A quick review of chapters 1, 2 and 3 of Text Book 1

Chapter 4: The Basics: Literal Constants, Numbers, Strings, Variables, Identifier, Data types Chapter 5: Operators, Operator Precedence, Expressions

Chapter 6: Control flow: If, while, for, break, continue statements

Chapter 7: Functions: Defining a function, function parameters, local variables, default arguments, keywords, return statement, Doc-strings

Chapter 8: Modules: using system modules, import statements, creating modules

Chapter 9: Data Structures: Lists, tuples, sequences.

Chapter 10: Writing a python script

Chapter 12: Files: Input and output using file and pickle module

Chapter 13: Exceptions: Errors, Try-except statement, raising exceptions, try-finally statement.	
Module 2: Numerical Method Part I	**25 Hours**
(Text Book 2) **Chapter 6:** Roots of Nonlinear Equations: Evaluation of Polynomials, Bisection method, Newton-Raphson Method. (Sections 6.5, 6.6 and 6.8) **Chapter 7:** Direct Solution of Linear Equations: Solution by elimination, Gauss Elimination method, Gauss Elimination with Pivoting, Triangular Factorisation method (Dolitle Algorithm). (Sections 7.3, 7.4, 7.5 and 7.7) **Chapter 8:** Iterative Solution of Linear Equations: Jacobi Iteration method, Gauss-Seidel method. (Sections 8.2 and 8.3)	
Module 3: Numerical Method Part II	**25 Hours**
(Text Book 2) **Chapter 9:** Curve Fitting-Interpolation: Lagrange Interpolation Polynomial, Newton Interpolation Polynomial, Divided Difference Table, Interpolation with Equidistant points. (Sections 9.4, 9.5, 9.6 and 9.7) **Chapter 11:** Numerical Differentiation: Differentiating Continuous functions, Differentiating Tabulated functions. (Sections 11.2 and 11.3) **Chapter 12:** Numerical Integration: Trapezoidal Rule, Simpson's 1/3 rule. (Sections 12.3 and 12.4) **Chapter 13:** Numerical Solution of Ordinary Differential Equations: Euler's Method, Rung-Kutta method (Order 4) (Sections 13.3 and 13.6). **Chapter 14:** Eigenvalue problems: Polynomial Method, Power method. (Sections 14.5 and 14.6)	
Practical Part:	
The following programs in Python have to be done on a computer and a record of algorithm, Printout of the program and printout of solution as shown by the	

computer for each program should be maintained. These should be bound together and submitted to the examiners at the time of practical examination.

Sample Programs (Recommended)

GCD of two numbers

To Check an integer prime

Evaluation of Totient Function

Writing of Fibonacci sequence

Listing of prime numbers

Average and maximum of a set of numbers

Programs (Compulsory)

Part A

Lagrange Interpolation

Newton's Interpolation

Bisection Method

Newton-Raphson Method

Numerical Differentiation of continuous function

Numerical Differentiation of tabulated function

Trapezoidal rule of Integration

Simpson's rule of Integration

Part B

Euler's method

Runge – Kutta method of order 4

Gauss elimination with pivoting

Runge – Kutta method of order 4

Gauss – Seidal iteration

Eigen value evaluation

Triangular Factorisation

MODE OF TRANSACTION
Lecture Method
Problem Solving Method
Questioning Method
Practicals

MODE OF ASSESSMENT	
Internal Assessment (5 Weightage)	
a. Classroom participation (20%):	1 Weightage
b. Test papers II (40%):	2 Weightage
c. Assignment (20%):	1 Weightage
d. Seminar/ Viva (20%):	1 Weightage
External Assessment (30 Weightage):	*Duration Hours*: $1\frac{1}{2}$, *No of Questions*: *11*

PATTERN OF QUESTION PAPER				
Pattern	**Total No. of questions**	**No. of questions to be answered**	**Weightage for each question**	**Total Weightage**
Short answer	**4**	**4**	**1**	**4**
Paragraph	**5**	**3**	**2**	**6**
Essay	**2**	**1**	**5**	**5**
			Total	**15**

MODULE WISE WEIGHTAGE DISTRIBUTION	
Module	**Weightage**
Module I: Python	8

Module II: Numerical Method Part I	5
Module III: Numerical Method Part II	2

REFERENCES:

1. SD Conte and Carl De Boor: Elementary Numerical Analysis (An algorithmic approach) – 3rd edition, McGraw-Hill, New Delhi
2. K. Sankara Rao: Numerical Methods for Scientists and Engineers – Prentice Hall of India, New Delhi.
3. Carl E Froberg: Introduction to Numerical Analysis, Addison Wesley Pub Co, 2nd Edition
4. Knuth D.E.: The Art of Computer Programming: Fundamental Algorithms (Volume I), Addison Wesley, Narosa Publication, New Delhi.
5. Python Programming, wikibooks contributors
6. Programming Python, Mark Lutz
7. Python 3 Object Oriented Programming, Dusty Philips, PACKT Open-source Publishing
8. Python Programming Fundamentals, Kent D Lee, Springer
9. Learning to Program Using Python, Cody Jackson, Kindle Edition
10. Online reading: http://pythonbooks.revolunet.com/

PROFESSIONAL COMPETENCY COURSE

SEMESTER 2

COURSE CODE –MMT2A02

COMPETENCY COURSE II: TECHNICAL WRITING WITH LATEX (PCC)

Credit	Hours/week	Marks		
		Internal	External	Total
4				

COURSE CONTENT

1. Installation of the software LATEX
2. Understanding LATEX compilation
3. Basic Syntex, Writing equations, Matrix, Tables
4. Page Layout: Titles, Abstract, Chapters, Sections, Equation references, citation.
5. List making environments
6. Table of contents, Generating new commands
7. Figure handling, numbering, List of figures, List of tables, Generating bibliography and index
8. Beamer presentation
9. Pstricks: drawing simple pictures, Function plotting, drawing pictures with nodes
10. Tikz:drawing simple pictures, Function plotting, drawing pictures with nodes

REFERENCES:

1. L. Lamport: A Document Preparation System, User's Guide and Reference Manual, Addison-Wesley, New York, second edition, 1994.
2. M.R.C. van Dongen:LATEX and Friends, Springer-Verlag Berlin Heidelberg 2012.
3. Stefan Kottwitz: LATEX Cookbook, Packt Publishing 2015.
4. David F. Griffths and Desmond J. Higham: Learning LATEX (second edition), Siam 2016.
5. George Gratzer: Practical LATEX, Springer 2015.
6. W. Snow: TEX for the Beginner. Addison-Wesley, Reading, 1992
7. D. E. Knuth:The TEX Book. Addison-Wesley, Reading, second edition, 1986
8. M. Goossens, F. Mittelbach, and A. Samarin:The LATEXCompanion. Addison- Wesley, Reading, MA, second edition, 2000.
9. M. Goossens and S. Rahtz:The LATEXWeb Companion: Integrating TEX, HTML, and XML. Addison-Wesley Series on Tools and Techniques for Computer Typesetting. Addison-Wesley, Reading, MA, 1999.
10. M. Goossens, S. Rahtz and F. Mittelbach: The LATEXGraphics Companion: Illustrating Documents with TEX and PostScript. Addison-Wesley Series on Tools and Techniques for Computer Typesetting. Addison-Wesley, New York, 1997.

COURSE CODE –MMT2A03

COMPETENCY COURSE III: SCIENTIFIC PROGRAMMING WITH SCILAB (PCC)

Credit	Hours/week	Marks		
		Internal	External	Total
4				

COURSE CONTENT

1. Installation of the software Scilab.

2. Basic syntax, Mathematical Operators, Predefined constants, Built in functions.

3. Complex numbers, Polynomials, Vectors, Matrix. Handling these data structures using built in functions
4. Programming

   (a) Functions
   (b) Loops
   (c) Conditional statements
   (d) Handling .sci files

5. Installation of additional packages e.g. "optimization"

6. Graphics handling

   (a) 2D, 3D
   (b) Generating .jpg files
   (c) Function plotting
   (d) Data plotting

7. Applications

(a) Numerical Linear Algebra (Solving linear equations, eigenvalues etc.)
(b) Numerical Analysis: iterative methods
(c) ODE: plotting solution curves

REFERENCES:

1. Claude Gomez, Carey Bunks Jean-Philippe Chancelier Fran ois Delebecque Mauriee Goursat Ramine Nikoukhah Serge Steer: Engineering and Scientific Computing with Scilab, Springer-Science, LLC, 1998.
2. Sandeep Nagar: Introduction to Scilab For Engineers and Scientists, Apress, 2017.

COURSE CODE –MMT2A04 COMPETENCY COURSE IV: SCIENTIFIC PROGRAMMING WITH C++ (PCC)				
Credit	Hours/week	Marks		
		Internal	External	Total
4				

COURSE CONTENT
1. C++ Programming Basics 2. Loops and Decisions 3. Structures 4. Functions 5. Objects and Classes (Sections: A Simple class, C++ Objects as Physical Objects, C++ Objects as data Types and Constructors Only) 6. Arrays: (Sections: Array Fundamentals, Function Declared with array Arguments Only) 7. Algorithms 8. Solutions of Algebraic Equations 9. Interpolation 10. Differentiation, Integration 11. Solutions of Differential equations

REFERENCES:

1. ROBERT LAFORE, OBJECT ORIENTED PROGRAMMING IN C++ (3rd Edn.), Galgotia Publications (Pvt. Ltd.), Ansari Road, New Delhi, 2007.
2. V. RAJARAMAN, COMPUTER ORIENTED NUMERICAL METHODS, Prentice Hall of India, New Delhi.
3. S.D. Conte and Carl De Boor: Elementary Numerical Analysis-an Algorithmic Approach (3rd Edn.); Mc Graw Hill book company, New Delhi, 2007.

4. K. Sankara Rao: Numerical Methods for Scientists and Engineers; Prentice hall of India, New Delhi, 2007.
5. Carl E. Froberg: Introduction to Numerical Analysis (2nd Edn.); Addison Wesley Pub. Co., 1974.
6. A Ralston: A First Course in Numerical Analysis; Mc Graw Hill Book Company, 1978
7. John H Mathews: Numerical Methods for Mathematics, Science and Engg; Prentice Hall of India, New Delhi, 1992.
8. Kunthe D.E: The Art of Computer Programming-VOL I: Fundamental Algorithms; Addison Wesley Narosa, New Delhi, 1997.
9. Herbert Schildt: C++: The Complete Reference (3rd Edn.); Mc Graw-Hill Pub. Co. Ltd., New Delhi, 1982.
10. Yashavant P. Kanetkar: Let Us C++; BPB Publications, New Delhi, 2003.
11. E. Balagurusami: Object Oriented Programming with C++; Tata Mc. Graw - Hill Publishing Co. Ltd., New Delhi, 2013.
12. Schaum Series: Programming in C++; Tata Mc Graw-Hill Publishing Co. Ltd., New Delhi, 2000.