MUSLIM ARTS COLLEGE

(Accredited by NAAC with B+ grade & Affiliated to ManonmaniamSundaranar University, Tirunelveli; Recognized US 2(f) 12 (B) of UGC Act.)

Thiruvithancode, Kanyakumari District, Tamil Nadu - 629174.

DEPARTMENT OF MATHEMATICS

CBCS SYLLABUS

Learning Outcome-based Curriculum Framework for

MATHEMATICS (MSc)

Applicable for students admitted from June 2026 as per the Resolutions of the Academic Council Meeting held on 01.06.2026

Vision

- To be a leading centre of excellence in mathematical education, research, inspiring innovation and critical thinking.

Mission

- To provide a rigorous, comprehensive education in both pure and applied mathematics.
- To advance mathematical knowledge through innovative research, promoting logical reasoning and equipping students with the tools to tackle real world challenges.
- To create an inclusive and collaborative environment that nurtures curiosity, creativity and lifelong learning.

Academic and Professional Attributes of the Graduates

Graduates of the **M.Sc. Mathematics** programme will possess the following academic and professional attributes:

1. **Advanced Mathematical Knowledge**
   Demonstrate in-depth knowledge of pure and applied mathematics, including algebra, analysis, topology, differential equations, numerical methods, statistics, and mathematical modelling.
2. **Analytical and Logical Thinking**
   Apply logical reasoning, critical thinking, and mathematical analysis to solve complex theoretical and practical problems with precision.
3. **Research Competence**
   Conduct independent and collaborative research by formulating mathematical problems, developing proofs, analysing data, and interpreting results using appropriate methodologies.
4. **Computational and Technological Skills**
   Utilize modern mathematical software, programming tools, computational techniques, and digital technologies for modelling, simulation, and problem-solving.
5. **Problem-Solving Ability**
   Design innovative mathematical models and apply quantitative techniques to address scientific, industrial, financial, engineering, and societal challenges.
6. **Communication Skills**
   Communicate mathematical concepts, research findings, and technical information effectively through oral presentations, academic writing, and digital platforms.
7. **Professional Ethics and Integrity**
   Uphold ethical values, academic honesty, professionalism, and social responsibility in research, teaching, and professional practice.
8. **Leadership and Teamwork**
   Demonstrate leadership, collaboration, interpersonal skills, and the ability to work effectively in multidisciplinary and multicultural environments.
9. **Lifelong Learning**
   Engage in continuous learning and professional development to adapt to emerging trends in mathematics, data science, artificial intelligence, and related disciplines.
10. **Global and Societal Perspective**
    Recognize the role of mathematics in scientific advancement, technological innovation, sustainable development, and informed decision-making at local, national, and global levels.
11. **Innovation and Creativity**
    Develop creative approaches to mathematical investigation, interdisciplinary applications, and emerging research areas through innovation and critical inquiry.

12. **Career Readiness**
    Be well prepared for careers in higher education, research institutions, data science, analytics, finance, actuarial science, software development, government services, and other mathematics-related professions, as well as for doctoral studies and competitive examinations.

Programme Educational Objectives

PEO No.	Programme Educational Objectives	Mapping with Mission
PEO1	To provide graduates with advanced knowledge of pure and applied mathematics, enabling them to apply mathematical theories, techniques, and computational methods to solve complex scientific and real-world problems.	**M1, M2**
PEO2	To develop analytical thinking, logical reasoning, mathematical modelling, and research competencies for higher studies, innovation, and interdisciplinary applications.	**M2, M3**
PEO3	To equip graduates with computational skills and proficiency in modern mathematical software, programming, and emerging technologies for academic, industrial, and research applications.	**M1, M2**
PEO4	To cultivate professional ethics, leadership, teamwork, effective communication, and social responsibility while promoting excellence in teaching, research, and professional practice.	**M3**
PEO5	To prepare graduates for successful careers in higher education, research institutions, data science, finance, actuarial science, information technology, government services, and other mathematics-related professions.	**M2, M3**
PEO6	To encourage lifelong learning, innovation, creativity, and continuous professional development for adapting to emerging trends in mathematics, science, and technology.	**M3**

Programme Outcomes (POs)

PO No.	Programme Outcomes	Mapping with PEOs
PO1: Advanced Mathematical Knowledge	Demonstrate comprehensive knowledge of advanced concepts in pure and applied mathematics, including algebra, analysis, topology, differential equations, numerical methods, probability, statistics, and mathematical modelling.	**PEO1, PEO2**
PO2: Critical Thinking and Problem Solving	Apply logical reasoning, analytical thinking, abstraction, and mathematical techniques to solve complex theoretical, computational, and real-world problems.	**PEO1, PEO2**
PO3: Research and Innovation	Conduct independent and collaborative research by formulating mathematical problems, developing proofs, applying research methodologies, interpreting results, and contributing to mathematical knowledge.	**PEO2, PEO6**
PO4: Computational and Digital	Utilize modern mathematical software, programming languages, computational tools, artificial	**PEO3, PEO5**

Competence	intelligence, data analytics, and emerging technologies for mathematical modelling and problem solving.	
PO5: Mathematical Modelling and Applications	Apply mathematical models and quantitative techniques to solve interdisciplinary problems in science, engineering, finance, economics, data science, and other applied domains.	**PEO1, PEO5**
PO6: Communication and Professional Skills	Communicate mathematical ideas, research findings, and technical information effectively through academic writing, presentations, publications, and digital platforms while working collaboratively in multidisciplinary environments.	**PEO4, PEO5**
PO7: Ethics, Leadership and Social Responsibility	Demonstrate professional ethics, leadership qualities, teamwork, social responsibility, and respect for diversity while applying mathematical knowledge for societal development and sustainable solutions.	**PEO4, PEO6**
PO8: Lifelong Learning and Professional Development	Engage in lifelong learning, self-directed study, higher education, competitive examinations, entrepreneurship, and continuous professional development to adapt to advances in mathematics and allied disciplines.	**PEO5, PEO6**

Programme Specific Outcomes (PSOs)

PSO No.	Programme Specific Outcomes	Mapping with POs
PSO1	Demonstrate advanced knowledge and conceptual understanding of pure and applied mathematics, including algebra, analysis, topology, differential equations, numerical methods, probability, statistics, and mathematical modelling for solving complex mathematical problems.	**PO1, PO2, PO5**
PSO2	Apply advanced mathematical theories, computational techniques, programming skills, mathematical software, and digital tools to investigate, analyse, model, and solve interdisciplinary problems in science, engineering, finance, and data analytics.	**PO2, PO4, PO5**
PSO3	Conduct independent and collaborative research by formulating mathematical problems, developing rigorous proofs, analysing data, interpreting results, and contributing to innovation and knowledge creation through research publications and projects.	**PO2, PO3, PO6**
PSO4	Demonstrate professional competence, effective communication, leadership, ethical values, teamwork, and lifelong learning while adapting to emerging technologies and interdisciplinary research in mathematics and allied fields.	**PO6, PO7, PO8**
PSO5	Exhibit career readiness for higher education, research institutions, academia, information technology, data science, actuarial science, banking, finance, government services, and other mathematics-related professions through analytical, computational, and professional competencies.	**PO3, PO4, PO5, PO8**

Mapping of Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

PSOs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
PSO1	3	3	2	2	3	2	2	2
PSO2	3	3	2	3	3	2	2	2
PSO3	2	3	3	3	2	3	2	2
PSO4	2	2	3	3	2	3	3	3
PSO5	2	3	3	3	3	3	2	3
Weightage	**13**	**14**	**13**	**14**	**13**	**13**	**11**	**12**
Weighted Percentage of Programme Contribution	**2.6**	**2.8**	**2.6**	**2.8**	**2.6**	**2.6**	**2.2**	**2.4**

•3 – High Correlation •2 – Moderate Correlation •1 – Low Correlation

COURSES OFFERED

SEMESTER I

Category	Course Code	Title of the course	Credit	Hours/per week
Core I	NMMA11	Group Theory	5	6
Core II	NMMA12	Real Analysis – I	5	6
Core III	NMMA13	Ordinary Differential Equations	4	6
Elective I	NEMA11	Graph Theory and Applications	3	6
Elective II	NEMA12	Analytic Number Theory	3	6
Total			**23**	**30**

SEMESTER I

CORE MI- GROUP THEORY

Subject Code	Category	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
NMMA11	**Core**	Y	-	-	-	4	4	25	75	100

Learning Objectives

After completing this course, students will be able to:

1. To develop an advanced understanding of the structure and properties of groups, normal subgroups, quotient groups, and homomorphisms.
2. To explain automorphisms, Cayley's Theorem, and solvable groups as fundamental concepts in abstract algebra.
3. To familiarize students with permutation groups, counting principles, and their significance in algebraic structures.
4. To provide a rigorous understanding of Sylow's Theorems and their applications in the classification of finite groups.
5. To enable students to analyze direct products and the structure theorem of finite abelian groups for advanced mathematical research and applications.

Course Outcomes

CO No.	Course Outcomes	BT Level
CO1	Analyze normal subgroups, quotient groups, homomorphisms, and counting principles to investigate algebraic structures.	**K4**
CO2	Examine automorphisms, Cayley's Theorem, and solvable groups to establish structural properties of finite groups.	**K4**
CO3	Apply concepts of permutation groups and counting principles to solve advanced problems in abstract algebra.	**K3**
CO4	Evaluate Sylow's Theorems and their applications in determining the structure and classification of finite groups.	**K5**
CO5	Develop mathematical proofs involving direct products, finite abelian groups, and related algebraic concepts for research and higher studies.	**K6**

Bloom's Taxonomy Levels

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create

Course Content

Unit	Contents	No. of Hours
I	**A Counting Principle** – Counting Principle – Normal Subgroups – Quotient Groups – Group Homomorphisms – Properties and Applications. *(Sections 2.5–2.7)*	**15**
II	**Automorphisms and Solvable Groups** – Automorphisms – Inner and Outer Automorphisms – Cayley's Theorem – Solvable Groups. *(Sections 2.8–2.9)*	**15**
III	**Permutation Groups** – Permutation Groups – Cycles and Cycle Decomposition – Even and Odd Permutations – Alternating Groups – Another Counting Principle. *(Sections 2.10–2.11)*	**15**

IV	**Sylow's Theorems** – Sylow p-Subgroups – First, Second and Third Sylow Theorems – Applications of Sylow's Theorems to Finite Groups. *(Section 2.12)*	**15**
V	**Direct Products and Finite Abelian Groups** – External and Internal Direct Products – Structure of Finite Abelian Groups – Fundamental Theorem of Finite Abelian Groups – Applications. *(Sections 2.13–2.14)*	**1**

Sl. No.	Text
1	Contemporary Abstract Algebra. 10th ed., Cengage Learning, 2024. *(Sections 2.5–2.14)*
	Topics in Algebra. 2nd ed., Wiley India, 2006.

Sl. No.	Reference
1	Abstract Algebra. 3rd ed., John Wiley & Sons, 2004.
2	A First Course in Abstract Algebra. 7th ed., Pearson Education, 2003.
3	Algebra. 2nd ed., Pearson, 2011.
4	Algebra. 3rd ed., Springer, 2002.

Sl. No.	Web Resource
1	MIT OpenCourseWare – Abstract Algebra
2	Abstract Algebra: Theory and Applications (Thomas W. Judson)
3	American Mathematical Society (AMS)
4	OpenStax Educational Resources

MappingwithProgrammeOutcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	3	2	2	2
CO2	3	3	3	2	2	2	2	2
CO3	3	3	2	3	3	2	2	2
CO4	3	3	3	2	3	3	2	2
CO5	3	3	3	3	3	3	3	3
Weightage	**15**	**15**	**13**	**12**	**14**	**12**	**11**	**11**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.6**	**2.4**	**2.8**	**2.4**	**2.2**	**2.2**

MappingwithProgrammeSpecificOutcomes

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	3	2	2
CO3	3	3	3	2	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	**15**	**15**	**14**	**12**	**13**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.4**	**2.6**

3 – Strong, 2 – Medium , 1 – Low

SEMESTER I

CORE II M2 - REAL ANALYSIS – I

Subject Code	Category	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
NMMA12	**Core**	Y	-	-	-	4	4	25	75	100

Learning Objectives

The course aims to:

1. To develop a rigorous understanding of functions of bounded variation, monotonic functions, and their analytical properties.
2. To provide comprehensive knowledge of the theory and applications of the Riemann–Stieltjes integral and its fundamental theorems.
3. To strengthen students' understanding of infinite series, infinite products, power series, and convergence tests in mathematical analysis.
4. To familiarize students with sequences and series of functions, including pointwise and uniform convergence, and their applications.
5. To cultivate analytical reasoning and proof-writing skills required for advanced studies and research in real analysis.

Course Outcomes (COs)

CO No.	Course Outcomes	BT Level
CO1	Analyze functions of bounded variation, monotone functions, and convergence properties of infinite series using advanced analytical techniques.	**K4**
CO2	Apply the theory of the Riemann–Stieltjes integral and its fundamental properties to solve advanced integration problems.	**K3**
CO3	Evaluate the convergence of infinite series, infinite products, double series, and power series using appropriate mathematical tests and theorems.	**K5**
CO4	Analyzepointwise and uniform convergence of sequences and series of functions and examine their relationship with continuity, integration, and differentiation.	**K4**
CO5	Develop rigorous mathematical proofs involving advanced concepts in real analysis and apply them in higher mathematical research and interdisciplinary applications.	**K6**

Bloom's Taxonomy Levels

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create

Course Content

Unit	Contents	No. of Hours
I	**Functions of Bounded Variation:** Introduction – Properties of Monotonic Functions – Functions of Bounded Variation – Total Variation – Additive Property of Total Variation – Total Variation on ([a,x]) as a Function of (x) – Functions of Bounded Variation Expressed as the Difference of Two Increasing Functions – Continuous Functions of Bounded Variation. **Infinite Series:** Absolute and Conditional Convergence – Dirichlet's Test – Abel's Test – Rearrangement of Series – Riemann's Theorem on Conditionally Convergent Series. *(Chapter 6: Sections 6.1–6.8; Chapter 8: Sections 8.8, 8.15, 8.17, 8.18)*	**15**

II	**The Riemann–Stieltjes Integral:** Introduction – Notation – Definition of the Riemann–Stieltjes Integral – Linear Properties – Integration by Parts – Change of Variable in a Riemann–Stieltjes Integral – Monotonically Increasing Integrators – Upper and Lower Integrals – Additive and Linearity Properties of Upper and Lower Integrals – Riemann's Condition – Comparison Theorems. *(Chapter 7: Sections 7.1–7.6, 7.11–7.14)*	**15**
III	**Advanced Theory of the Riemann–Stieltjes Integral:** Integrators of Bounded Variation – Sufficient and Necessary Conditions for the Existence of Riemann–Stieltjes Integrals – Mean Value Theorems – Integrals as a Function of the Interval – Second Fundamental Theorem of Integral Calculus – Change of Variable – Second Mean Value Theorem for the Riemann Integral – Riemann–Stieltjes Integrals Depending on a Parameter. *(Chapter 7: Sections 7.15–7.23)*	**15**
IV	**Infinite Series and Infinite Products:** Double Sequences – Double Series – Rearrangement Theorem for Double Series – Sufficient Condition for Equality of Iterated Series – Multiplication of Series – CesàroSummability – Infinite Products. **Power Series:** Multiplication of Power Series – Taylor Series Generated by a Function – Bernstein's Theorem. *(Chapter 8: Sections 8.20–8.26; Chapter 9: Sections 9.14, 9.15, 9.19, 9.20)*	**15**
V	**Sequences of Functions:**Pointwise Convergence – Sequences of Real-Valued Functions – Uniform Convergence and Continuity – Cauchy Criterion for Uniform Convergence – Uniform Convergence of Infinite Series of Functions – Riemann–Stieltjes Integration – Non-uniform Convergence and Term-by-Term Integration – Uniform Convergence and Differentiation – Sufficient Conditions for Uniform Convergence of a Series – Mean Convergence. *(Chapter 9: Sections 9.1–9.6, 9.9–9.11)*	**15**

S. No.	**Text Book**
1	Richard R. Goldberg. **Methods of Real Analysis.** Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. *(Prescribed Text)*
2	Walter Rudin. **Principles of Mathematical Analysis.** 3rd Edition, McGraw-Hill Education.
3	Tom M. Apostol. **Mathematical Analysis.** 2nd Edition, Addison-Wesley Publishing Company.
4	Robert G. Bartle & Donald R. Sherbert. **Introduction to Real Analysis.** 4th Edition, Wiley India.
5	S. C. Malik &SavitaArora. **Mathematical Analysis.** New Age International Publishers.

S. No.	**Reference Book**
1	Kenneth A. Ross. **Elementary Analysis: The Theory of Calculus.** Springer.
2	H. L. Royden& P. M. Fitzpatrick. **Real Analysis.** 4th Edition, Pearson Education.
3	Charles C. Pugh. **Real Mathematical Analysis.** Springer.
4	Terence Tao. **Analysis I.** 3rd Edition, Hindustan Book Agency / Springer.
5	G. F. Simmons. **Introduction to Topology and Modern Analysis.** McGraw-Hill Education.

S. No.	Web Resource
1	NPTEL – Real Analysis Courses – https://nptel.ac.in
2	MIT OpenCourseWare – Real Analysis – https://ocw.mit.edu
3	Paul's Online Math Notes – https://tutorial.math.lamar.edu
4	LibreTexts – Mathematics – https://math.libretexts.org
5	American Mathematical Society (AMS) – https://www.ams.org

MappingwithProgrammeOutcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	3	2	2	2
CO2	3	3	3	3	3	2	2	2
CO3	3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	2	2
CO5	3	3	3	3	3	3	3	3
Weightage	**15**	**15**	**14**	**14**	**15**	**13**	**11**	**11**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.8**	**3.0**	**2.6**	**2.2**	**2.2**

MappingwithProgrammeSpecificOutcomes

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	3	2	2
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	**15**	**15**	**14**	**13**	**12**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.6**	**2.4**

SEMESTER I

CORE III M3 - ORDINARY DIFFERENTIAL EQUATIONS

Subject Code	Category	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
NMMA13	**Core**	Y	-	-	-	4	4	25	75	100

Learning Objectives

The course aims to:

1. To develop a comprehensive understanding of higher-order linear ordinary differential equations with constant and variable coefficients.
2. To provide rigorous knowledge of existence and uniqueness theorems for ordinary differential equations and their theoretical foundations.
3. To familiarize students with analytical techniques for solving homogeneous and non-homogeneous differential equations using advanced methods.
4. To introduce special differential equations, including Legendre and Bessel equations, and their applications in mathematics and physical sciences.
5. To enhance analytical reasoning, proof-writing, and problem-solving skills required for advanced research and interdisciplinary applications of differential equations.

Course Outcomes (COs)

CO No.	Course Outcomes	BT Level
CO1	Analyze higher-order linear differential equations with constant coefficients and apply appropriate analytical techniques to obtain their solutions.	**K4**
CO2	Apply advanced methods to solve homogeneous and non-homogeneous ordinary differential equations involving constant coefficient operators and annihilator techniques.	**K3**
CO3	Examine linear differential equations with variable coefficients, including Legendre equations, using existence, uniqueness, and reduction of order theorems.	**K4**
CO4	Evaluate differential equations with regular singular points and construct series solutions involving Euler and Bessel equations.	**K5**
CO5	Develop rigorous mathematical arguments involving existence and uniqueness theorems, exact equations, and successive approximation methods for first-order differential equations.	**K6**

Bloom's Taxonomy Levels

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create

Course Content

Unit	Contents	No. of Hours
I	**Linear Equations with Constant Coefficients:** Second Order Homogeneous Linear Equations – Initial Value Problems – Linear Dependence and Independence of Solutions – Wronskian and Abel's Formula – Non-homogeneous Second Order Linear Equations. *(Chapter 2: Sections 1–6)*	**15**
II	**Higher Order Linear Equations:** Homogeneous and Non-homogeneous Linear Differential Equations of Order *n* – Initial Value Problems – Annihilator Method for Solving Non-homogeneous Equations – Algebra of Constant Coefficient Differential Operators. *(Chapter 2: Sections 7–12)*	**15**
III	**Linear Equations with Variable Coefficients:** Initial Value Problems –	**15**

	Existence and Uniqueness Theorems – Solutions of Non-homogeneous Equations – Wronskian and Linear Dependence – Reduction of Order – Homogeneous Equations with Analytic Coefficients – Legendre Equation. *(Chapter 3: Sections 1–8)*	
IV	**Linear Equations with Regular Singular Points:** Euler Equation – Second Order Linear Equations with Regular Singular Points – Series Solutions – Bessel Functions and Their Properties – Applications. *(Chapter 4: Sections 1–4, 7 & 8)*	**15**
V	**Existence and Uniqueness of First Order Differential Equations:** Variable Separable Equations – Exact Differential Equations – Method of Successive Approximations (Picard's Method) – Lipschitz Condition – Convergence of Successive Approximations – Existence and Uniqueness Theorem. *(Chapter 5: Sections 1–6)*	**15**

S. No.	Text Book
1	Earl A. Coddington. **An Introduction to Ordinary Differential Equations.** Prentice Hall of India / Dover Publications. *(Prescribed Text)*
2	Shepley L. Ross. **Differential Equations.** 3rd Edition, Wiley India.
3	George F. Simmons. **Differential Equations with Applications and Historical Notes.** 3rd Edition, CRC Press / McGraw-Hill.
4	William E. Boyce & Richard C. DiPrima. **Elementary Differential Equations and Boundary Value Problems.** 11th Edition, Wiley.
5	Dennis G. Zill. **A First Course in Differential Equations with Modeling Applications.**Cengage Learning.

S. No.	Reference Book
1	Morris Tenenbaum& Harry Pollard. **Ordinary Differential Equations.** Dover Publications.
2	Martin Braun. **Differential Equations and Their Applications.** Springer.
3	E. L. Ince. **Ordinary Differential Equations.** Dover Publications.
4	H. T. H. Piaggio. **An Elementary Treatise on Differential Equations and Their Applications.** CBS Publishers & Distributors.
5	Ravi P. Agarwal&DonalO'Regan. **Ordinary and Partial Differential Equations.** Springer.

S. No.	Web Resource
1	NPTEL – Differential Equations – https://nptel.ac.in
2	MIT OpenCourseWare – Differential Equations – https://ocw.mit.edu
3	Paul's Online Math Notes – Differential Equations – https://tutorial.math.lamar.edu
4	LibreTexts – Differential Equations – https://math.libretexts.org
5	Wolfram MathWorld – Differential Equations – https://mathworld.wolfram.com

MappingwithProgrammeOutcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	3	2	2	2
CO2	3	3	3	3	3	2	2	2
CO3	3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	2	2
CO5	3	3	3	3	3	3	3	3
Weightage	**15**	**15**	**14**	**14**	**15**	**13**	**11**	**11**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.8**	**3.0**	**2.6**	**2.2**	**2.2**

MappingwithProgrammeSpecificOutcomes

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	3	2	2
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	**15**	**15**	**14**	**13**	**12**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.6**	**2.4**

SEMESTER I

Elective I - GRAPH THEORY AND APPLICATIONS

Subject Code	Category	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
NEMA11	**Elective I**	Y	-	-	-	4	4	25	75	100

Learning Objectives

The course aims to:

1. To introduce the fundamental concepts, structures, and operations of graph theory.
2. To develop analytical skills in studying graph connectivity, trees, spanning trees, and graph algorithms.
3. To provide knowledge of independent sets, matchings, factors, and bipartite graph theory.
4. To familiarize students with Eulerian graphs, Hamiltonian graphs, graph coloring, and their theoretical foundations.
5. To enable students to apply graph theoretic concepts in optimization, computer science, communication networks, operations research, and related fields.

Course Outcomes

CO No.	Course Outcomes	BT Level
CO1	Analyze graph structures, subgraphs, graph operations, graph products, paths, connectivity, and automorphisms using graph theoretic concepts.	**K4**
CO2	Apply concepts of connectivity, vertex cuts, edge cuts, blocks, trees, spanning trees, and Cayley's formula to solve graph-related problems.	**K3**
CO3	Evaluate independent sets, matchings, factors, bipartite graphs, and perfect matchings for solving optimization and combinatorial problems.	**K5**
CO4	AnalyzeEulerian graphs, Hamiltonian graphs, graph coloring, critical graphs, and Brooks' Theorem in theoretical and practical applications.	**K4**
CO5	Design mathematical models using graph theory to solve real-world problems in computer science, communication networks, transportation, scheduling, and operations research.	**K6**

Bloom's Taxonomy Levels

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create

Course Content

Unit	Contents	No. of Hours
I	**Basic Results in Graph Theory:**Subgraphs – Degrees of Vertices – Paths and Connectedness – Automorphisms of Simple Graphs – Line Graphs – Operations on Graphs – Graph Products. *(Chapter 1: Sections 1.1–1.9)*	**12**
II	**Connectivity:** Vertex Cuts and Edge Cuts – Connectivity and Edge Connectivity – Blocks – Properties and Applications of Connectivity. *(Chapter 3: Sections 3.1–3.4)*	**12**
III	**Trees:** Definition – Characterization and Properties of Trees – Centres and Centroids – Counting the Number of Spanning Trees – Cayley's Formula and Applications. *(Chapter 4: Sections 4.1–4.5)*	**12**

IV	**Independent Sets and Matchings:** Vertex Independent Sets and Vertex Coverings – Edge Independent Sets – Matchings and Factors – Matchings in Bipartite Graphs – Perfect Matchings – Tutte Matrix. *(Chapter 5: Sections 5.1–5.6)*	**12**
V	**Eulerian and Hamiltonian Graphs:**Eulerian Graphs – Hamiltonian Graphs – Hamilton's "Around the World" Game. **Graph Colourings:** Vertex Colourings – Applications of Graph Colourings – Critical Graphs – Brooks' Theorem. *(Chapter 6: Sections 6.1–6.3; Chapter 7: Sections 7.1–7.3 (up to Brooks' Theorem))*	**12**

S. No.	**Text Book**
1	R.Balakrishnan and K.Ranganathan, *TextBook of Graph Theory*, Springer Publications, 2012
2	Frank Harary. **Graph Theory.**Narosa Publishing House / Addison-Wesley. *(Prescribed Text)*
3	J. A. Bondy& U. S. R. Murty. **Graph Theory with Applications.** Macmillan Press / Elsevier.
4	NarsinghDeo. **Graph Theory with Applications to Engineering and Computer Science.** Prentice Hall of India.
5	Gary Chartrand& Ping Zhang. **Introduction to Graph Theory.** McGraw-Hill Education.
	Douglas B. West. **Introduction to Graph Theory.** 2nd Edition, Pearson Education.

S. No.	**Reference Book**
1	ReinhardDiestel. **Graph Theory.** 5th Edition, Springer.
2	Robin J. Wilson. **Introduction to Graph Theory.** 5th Edition, Pearson Education.
3	C. L. Liu & D. P. Mohapatra. **Elements of Discrete Mathematics.** McGraw-Hill Education.
4	Kenneth H. Rosen. **Discrete Mathematics and Its Applications.** McGraw-Hill Education.
5	BelaBollobás. **Modern Graph Theory.** Springer.

S. No.	**Web Resource**
1	NPTEL – Graph Theory – https://nptel.ac.in
2	MIT OpenCourseWare – Mathematics – https://ocw.mit.edu
3	Graph Theory Notes – Discrete Mathematics – https://mathworld.wolfram.com
4	LibreTexts – Discrete Mathematics – https://math.libretexts.org
5	Electronic Journal of Graph Theory and Applications – https://ejgta.org

MappingwithProgrammeOutcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	2	2
CO2	3	3	3	3	3	2	2	2
CO3	3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	2	2
CO5	3	3	3	3	3	3	3	3
Weightage	**15**	**15**	**14**	**15**	**15**	**13**	**11**	**11**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**3.0**	**3.0**	**2.6**	**2.2**	**2.2**

MappingwithProgrammeSpecificOutcomes

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	3	2	2
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	**15**	**15**	**14**	**13**	**12**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.6**	**2.4**

SEMESTER I

Elective- II ANALYTIC NUMBER THEORY

Subject Code	Category	L	T	P	S	Credits	Inst. Hours	Marks		
								CIA	External	Total
NEMA12	**Elective**	Y	-	-	-	4	4	25	75	100

Learning Objectives

The course aims to:

1. To develop an advanced understanding of the fundamental concepts and techniques of analytic number theory.
2. To explain arithmetic and multiplicative functions together with their algebraic and analytical properties.
3. To familiarize students with Dirichlet multiplication, Möbius inversion, and related number-theoretic techniques.
4. To provide knowledge of average orders of arithmetic functions and asymptotic methods.
5. To introduce Chebyshev's functions and the Prime Number Theorem with emphasis on their significance in modern number theory.

Course Outcomes

CO No.	Course Outcomes	BT Level
CO1	Analyze the Fundamental Theorem of Arithmetic and its applications in advanced number theory.	**K4**
CO2	Apply arithmetic functions and their properties to solve problems in analytic number theory.	**K3**
CO3	Evaluate multiplicative functions, Dirichlet multiplication, and Möbius inversion in theoretical investigations.	**K5**
CO4	Analyze average orders and asymptotic behaviour of arithmetic functions using appropriate mathematical techniques.	**K4**
CO5	Develop rigorous mathematical arguments involving Chebyshev's functions and the Prime Number Theorem for advanced study and research.	**K6**

Bloom's Taxonomy Levels

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyse, K5 – Evaluate, K6 – Create

Course Content

Unit	Contents	No. of Hours
I	**The Fundamental Theorem of Arithmetic:** Divisibility – Prime Numbers – Fundamental Theorem of Arithmetic – Greatest Common Divisor – Least Common Multiple – Euclidean Algorithm – Unique Factorization – Applications. *(Chapter 1: Sections 1.1–1.8; Exercise Problems: Chapter 1: 1–11)*	**18**
II	**Arithmetic Functions:** Introduction to Arithmetic Functions – Euler's Phi Function – Divisor Functions – Möbius Function – Properties and Applications of Arithmetic Functions. *(Chapter 2: Sections 2.1–2.8; Exercise Problems: Chapter 2: 1–6)*	**18**

III	**Multiplicative Functions and Dirichlet Multiplication:** Multiplicative and Completely Multiplicative Functions – Dirichlet Multiplication – Inverse Functions – Möbius Inversion Formula – Applications of Dirichlet Convolution. *(Chapter 2: Sections 2.9–2.14; Exercise Problems: Chapter 2: 21–23, 25, 26)*	**18**
IV	**Averages of Arithmetical Functions:**Summatory Functions – Average Order of Arithmetic Functions – Asymptotic Formulae – Distribution of Arithmetic Functions – Applications. *(Chapter 3: Sections 3.1–3.9; Exercise Problems: Chapter 3: 1–4)*	**18**
V	**Partial Sums of Dirichlet Products and Prime Number Theorem:** Partial Sums of Dirichlet Products – Chebyshev's Functions – Equivalent Forms of the Prime Number Theorem – Applications in Analytic Number Theory. *(Chapter 3: Sections 3.10–3.11; Chapter 4: Sections 4.1–4.4; Exercise Problems: Chapter 4: 3, 4, 5, 8)*	**18**

S. No.	Text Book
1	Tom M. Apostol. **Introduction to Analytic Number Theory.** Springer (Undergraduate Texts in Mathematics). *(Prescribed Text)*
2	Ivan Niven, Herbert S. Zuckerman & Hugh L. Montgomery. **An Introduction to the Theory of Numbers.** 5th Edition, Wiley India.
3	Gareth A. Jones & J. Mary Jones. **Elementary Number Theory.** Springer.
4	David M. Burton. **Elementary Number Theory.** 7th Edition, McGraw-Hill Education.
5	Kenneth H. Rosen. **Elementary Number Theory and Its Applications.** 6th Edition, Pearson Education.

S. No.	Reference Book
1	G. H. Hardy & E. M. Wright. **An Introduction to the Theory of Numbers.** 6th Edition, Oxford University Press.
2	Hugh L. Montgomery & Robert C. Vaughan. **Multiplicative Number Theory I: Classical Theory.** Cambridge University Press.
3	Thomas Koshy. **Elementary Number Theory with Applications.** 2nd Edition, Academic Press (Elsevier).
4	Paulo Ribenboim. **The Little Book of Bigger Primes.** 2nd Edition, Springer.
5	Neal Koblitz. **A Course in Number Theory and Cryptography.** 2nd Edition, Springer.

S. No.	Web Resource
1	NPTEL – Number Theory – https://nptel.ac.in
2	MIT OpenCourseWare – Number Theory – https://ocw.mit.edu
3	American Mathematical Society (AMS) – https://www.ams.org
4	Wolfram MathWorld – Number Theory – https://mathworld.wolfram.com
5	Springer Mathematics – https://link.springer.com

MappingwithProgrammeOutcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	3	2	2	2
CO2	3	3	3	2	3	2	2	2
CO3	3	3	3	3	3	3	2	2
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	3
Weightage	**15**	**15**	**14**	**13**	**15**	**13**	**11**	**12**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.6**	**3.0**	**2.6**	**2.2**	**2.4**

MappingwithProgrammeSpecificOutcomes

CO / PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	3	2	2
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	**15**	**15**	**14**	**13**	**12**
Weighted Percentage of Course Contribution	**3.0**	**3.0**	**2.8**	**2.6**	**2.4**