



# SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|--------------|--------------------------|----------------------|----------------|
|             |              |              | L-P-T                    |                      |                |
| DSC         | P2S02NCMTH01 | Topology     | 4-0-1                    | 120                  | 04             |

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply concepts of topological spaces, bases, and subbases to construct and compare different topologies.

CLO2: Analyse subspace, product, box, and metric topologies and evaluate their structural differences through examples.

CLO3: Analyse neighbourhoods, closure, interior, boundary, limit points, and density to study set-theoretic properties in topological spaces.

CLO4: Apply continuity concepts and the Pasting Lemma to analyse functions and evaluate homeomorphisms with examples.

CLO5: Differentiate and evaluate spaces using countability and separation axioms ( $T_0$ – $T_4$ ) and related theorems.

CLO6: Classify spaces based on compactness and connectedness, applying key results such as compactness under continuity and product compactness

| Unit | Course Content                                                                                                                                                                                                                                                                                                                                                    | Learning Pedagogies                                                                                          | CLO(s)       |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------|
| I    | Topological spaces: definition and examples, basis, examples of topologies given by basis, subbasis, closed sets.<br>Techniques of creating topologies: the subspace topology, the product topology on $X \times Y$ , subbasis and basis for the product topology on arbitrary product, definition of the box topology on arbitrary product, the metric topology. | Seminars, Problem-Based Learning, Inquiry-Based Learning, Collaborative Learning, ICT-Enabled Learning       | CLO1<br>CLO2 |
| II   | Neighborhood of a point, closure of a set, interior of a set, limit points of a set (i.e., derived set), dense set, boundary of a set.<br>Continuous functions, intrinsic continuity of certain canonical functions, Pasting lemma, homeomorphisms, properties of homeomorphisms, examples and non-examples of homeomorphism.                                     | Seminars, Problem-Based Learning, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning      | CLO3<br>CLO4 |
| III  | Countability Axioms: first countable spaces, second countable spaces, separable spaces.<br>Separation Axioms: $T_0$ -spaces, $T_1$ -spaces, $T_2$ -spaces, $T_3$ -spaces and regular spaces, $T_4$ -spaces and normal spaces, Urysohn's lemma (statement only), Tietze extension theorem (statement only).                                                        | Seminars, Problem-Based Learning, Inquiry-Based Learning, Research-Oriented Learning, Collaborative Learning | CLO5         |



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## M.Sc. Mathematics Semester-II

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                    |      |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------|
| IV | Compactness: compact spaces, compact subspaces, finite intersection property, compact subspaces of the real line, compactness and continuity, compactness of a finite product, Tychonoff's theorem (statement only), classifying spaces by compactness, definition and examples of Lindelöf spaces – a countability axiom. Connectedness: connected spaces, totally disconnected spaces, connected subspaces of the real line, components, path-connectedness, classifying spaces by connectedness. | Seminars, Problem-Based Learning, Research-Oriented Learning, Micro-Projects, ICT-Enabled Learning | CLO6 |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------|

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20 Marks)

- (i) Assignment (5 marks)
- (ii) Seminar (5 marks)
- (iii) Quizzes (5 marks)
- (iv) Attendance (5 marks)

##### b. Internal Summative Assessment (30 Marks)

- (i) Mid-term test (30 Marks)

#### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|-------------------------------------------------------|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)                                          | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CLO1, CLO2  | 15                   | 2                                                     | 4                 | 7                                | 13          |
| II   | CLO3, CLO4  | 15                   | 2                                                     | 4                 | 7                                | 13          |
| III  | CLO5        | 15                   | 2                                                     | 3                 | 7                                | 12          |
| IV   | CLO6        | 15                   | 2                                                     | 3                 | 7                                | 12          |
|      |             | 60 (4Hr/week)        | 8                                                     | 14                | 28                               | 50          |

### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |



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## M.Sc. Mathematics Semester-II

### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 3    | 3    | 2    | 1    | 2    | 1    | 1    | 1    | 1     |
| CLO2 | 3    | 3    | 3    | 2    | 1    | 2    | 1    | 1    | 1    | 1     |
| CLO3 | 3    | 3    | 3    | 2    | 1    | 3    | 1    | 1    | 1    | 1     |
| CLO4 | 3    | 3    | 3    | 2    | 1    | 2    | 1    | 1    | 1    | 2     |
| CLO5 | 3    | 3    | 2    | 2    | 1    | 3    | 1    | 1    | 2    | 2     |
| CLO6 | 3    | 3    | 3    | 3    | 1    | 3    | 1    | 1    | 2    | 2     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

### • Suggested Learning Materials Books:

| Sr. No. | Title                                           | Author(s)                      | Edition/Year | Publisher                       |
|---------|-------------------------------------------------|--------------------------------|--------------|---------------------------------|
| 1       | General Topology for Beginners                  | Jay Mehta                      | 2025         | Cambridge University Press      |
| 2       | Topology: A Core Course                         | Vikram Aithal and S. Kumaresan | 2023         | Techno World                    |
| 3       | Topology: A First Course                        | James R. Munkres               | 2003         | Prentice Hall of India Pvt. Ltd |
| 4       | General Topology                                | S. Willard                     | 2004         | Dover Publication               |
| 5       | General Topology, Graduate Texts in Mathematics | J. Kelley                      | 1975         | Springer-Verlag                 |
| 6       | Introduction to Topology and Modern Analysis    | G. F. Simmons                  | 1963         | McGraw-Hill Co.                 |

### • Online Resources (Open Source)

| Sr. No. | Description of Resource(s)                                                                                                                              | Weblink                                                                                                                                                                                                 |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Dinesh Karia, <i>Point Set Topology An Experience of a Teacher</i> , Open Mathematics Notes Series of the American Mathematical Society, November 2020. | <a href="https://www.ams.org/open-math-notes/omn-view-listing?listingId=110864">https://www.ams.org/open-math-notes/omn-view-listing?listingId=110864</a>                                               |
| 2       | "Topology" – YouTube video playlist by S. Kumaresan                                                                                                     | <a href="https://youtube.com/playlist?list=PLDzvuf9Uf4FNo3wbYrSEilPptlXvzx6Ch&amp;si=cyesgZMWzKLEB-CW">https://youtube.com/playlist?list=PLDzvuf9Uf4FNo3wbYrSEilPptlXvzx6Ch&amp;si=cyesgZMWzKLEB-CW</a> |
| 3.      | Essentials of Topology (IIT Dhanbad) NPTEL course by Prof. S. P. Tiwari                                                                                 | <a href="https://onlinecourses.nptel.ac.in/noc25_ma60/preview">https://onlinecourses.nptel.ac.in/noc25_ma60/preview</a>                                                                                 |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title                | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|-----------------------------|--------------------------|----------------------|----------------|
|             |              |                             | L-P-T                    |                      |                |
| DSC         | P2S02NCMTH02 | Lebesgue Integration Theory | 4-0-1                    | 120                  | 04             |

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply the concepts of algebra and  $\sigma$ -algebra of sets, Borel sets, and the structure of open sets in  $\mathbb{R}$  to analyze measurable set constructions.

CLO2: Analyze Lebesgue outer measure and Lebesgue measurable sets, and evaluate their properties including the existence of non-measurable sets.

CLO3: Apply the theory of Lebesgue measurable functions, including simple functions, approximation theorems, and key results such as Egoroff's Theorem and Lusin's Theorem.

CLO4: Evaluate Lebesgue integration for simple, bounded, and non-negative measurable functions, and apply fundamental convergence theorems such as Fatou's Lemma and Monotone Convergence Theorem.

CLO5: Analyze advanced integration results including Dominated Convergence Theorem, countable additivity, and continuity properties of the Lebesgue integral.

CLO6: Apply the concepts of bounded variation and absolute continuity to establish the Fundamental Theorem of Lebesgue Integration and compare Lebesgue and Riemann integrals.

| Unit | Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                           | Learning Pedagogies                                                                       | CLO(s)        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------|
| I    | <b>Lebesgue Measurable Sets</b><br>Algebra and $\sigma$ -algebra of sets;<br>Borel $\sigma$ -algebra and Borel sets in $\mathbb{R}$ ;<br>Structure theorem for open subsets of $\mathbb{R}$ ;<br>$G_\delta$ -sets and $F_\sigma$ -sets;<br>Lebesgue outer measure in $\mathbb{R}$ ;<br>Lebesgue measurable sets and Lebesgue measure on $\mathbb{R}$ ;<br>Basic results on Lebesgue measure;<br>Non-Borel sets and Non-measurable sets in $\mathbb{R}$ ; | Seminars,<br>Problem-Based Learning,<br>Collaborative Learning,<br>Inquiry-Based Learning | CLO1          |
| II   | <b>Lebesgue Measurable Functions</b><br>Simple function and its canonical form;<br>Lebesgue measurable functions;<br>Results on Lebesgue measurable functions;<br>Relation between continuous and Lebesgue measurable functions; Continuity and Lebesgue measurability of monotone functions; Littlewood's three principles;<br>Egoroff's Theorem; Simple Approximation Theorem;<br>Lusin's Theorem;                                                     | Seminars,<br>Problem-Based Learning,<br>Collaborative Learning,<br>Inquiry-Based Learning | CLO2,<br>CLO3 |



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## M.Sc. Mathematics Semester-II

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                               |               |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---------------|
| III | <b>Lebesgue Integration</b><br>Lebesgue integral of measurable simple functions and results;<br>Lebesgue integral of bounded measurable functions over a measurable set $E$ of finite measure and results;<br>Bounded Convergence Theorem;<br>Lebesgue integral of non-negative measurable functions;<br>Fatou's Lemma; Monotone Convergence Theorem;<br>Lebesgue integral of measurable functions $f : E \rightarrow [-\infty, +\infty]$ ;<br>Lebesgue Dominated Convergence Theorem;<br>Countable additivity and continuity of integration; | Seminars,<br>Problem-Based Learning,<br>Collaborative Learning,<br>ICT-Enabled Learning       | CLO4,<br>CLO5 |
| IV  | <b>Differentiation and Lebesgue Integral</b><br>Functions of bounded variation and results;<br>Jordan's Lemma on functions of bounded variation;<br>Absolutely continuous functions and results;<br>Properties of indefinite integrals of Lebesgue integral functions;<br>Relation between indefinite integral and absolute continuity;<br>Fundamental theorem of Lebesgue integral;<br>Characterization of Riemann integral and Lebesgue integral;<br>Comparison of Riemann integral and Lebesgue integral.                                  | Seminars,<br>Problem-Based Learning,<br>Collaborative Learning,<br>Research-Oriented Learning | CLO6          |

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20 Marks)

- (i) Assignment (5 marks)
- (ii) Seminar (5 marks)
- (iii) Quizzes (5 marks)
- (iv) Attendance (5 marks)

##### b. Internal Summative Assessment (30 Marks)

- (i) Mid-term test (30 Marks)



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## M.Sc. Mathematics Semester-II

### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|-------------------------------------------------------|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)                                          | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CLO1        | 15                   | 2                                                     | 4                 | 7                                | 13          |
| II   | CLO2, CLO3  | 15                   | 2                                                     | 4                 | 7                                | 13          |
| III  | CLO4, CLO5  | 15                   | 2                                                     | 3                 | 7                                | 12          |
| IV   | CLO6        | 15                   | 2                                                     | 3                 | 7                                | 12          |
|      |             | 60 (4Hr/week)        | 8                                                     | 14                | 28                               | 50          |

#### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |

### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 3    | 2    | –    | –    | 1    | 1    | –    | 1    | –     |
| CLO2 | 3    | 3    | 3    | –    | –    | 2    | 1    | –    | 1    | –     |
| CLO3 | 3    | 3    | 3    | –    | 2    | 2    | 1    | 1    | –    | –     |
| CLO4 | 3    | 3    | 3    | –    | 2    | 3    | 1    | –    | 1    | –     |
| CLO5 | 3    | 3    | 3    | –    | 2    | 3    | 1    | –    | 1    | –     |
| CLO6 | 3    | 3    | 3    | 2    | 2    | 3    | 1    | –    | 1    | 1     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
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## M.Sc. Mathematics Semester-II

### • Suggested Learning Materials Books:

| Sr. No. | Title                                      | Author(s)                          | Edition/Year                 | Publisher                           |
|---------|--------------------------------------------|------------------------------------|------------------------------|-------------------------------------|
| 1       | Real Analysis                              | Royden H. L. and Fitzpatrick P. M. | 4 <sup>th</sup> Edition 2010 | Pearson                             |
| 2       | An Introduction to Measure and Integration | Rana I. K.                         | 1997                         | Narosa Publication House, New Delhi |
| 3       | Introduction to Measure Theory             | G. de Berra                        | 1974                         | van-Nordstrand                      |

### • Online Resources (Open Source)

| Sr. No. | Description of Resource(s)                     | Weblink                                                                                                   |
|---------|------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| 1       | MathOnline – Measure & Lebesgue Integral Notes | <a href="https://mathonline.wikidot.com/measure-theory">https://mathonline.wikidot.com/measure-theory</a> |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title     | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|------------------|--------------------------|----------------------|----------------|
|             |              |                  | L-P-T                    |                      |                |
| DSC         | P2S02NCMTH03 | Rings and Fields | 4-0-1                    | 120                  | 04             |

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply concepts of rings, ideals, divisibility, GCD, and prime elements in algebraic structures.

CLO2: Analyze factorization in integral domains, including Gaussian integers and the Unique Factorization Theorem.

CLO3: Apply polynomial ring theory, division algorithm, and standard irreducibility criteria.

CLO4: Analyze field extensions, including algebraic elements, degree, and splitting fields.

CLO5: Evaluate automorphisms of fields and determine fixed fields and the automorphism group  $G(K, F)$ .

CLO6: Apply Galois theory to study normal extensions, Galois groups, and solvability of polynomials.

| Unit | Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                            | Learning Pedagogies                                                                                    | CLO(s)     |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------|
| I    | <b>Euclidean Rings and Factorization</b><br>Recall rings and ideals, Euclidean rings, Principal ideal rings, Divisibility ( $a b$ ), Greatest Common Divisor (GCD), Units and associates, Prime and relatively prime elements, Unique Factorization theorem, Ring of Gaussian integers $\mathbb{Z}[i]$ , Fermat's theorem.                                                                                                                                | Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning                       | CLO1, CLO2 |
| II   | <b>Polynomial Rings and Irreducibility</b><br>Polynomial rings, The division algorithm for polynomials, Irreducible polynomials, Polynomials over the rational field, Primitive polynomials, content of polynomial, monic polynomial, Gauss's Lemma, Eisenstein Criterion, Polynomial rings over commutative rings, Unique factorization domain, Reducibility tests (polynomials of degree 2 and 3), Mod $p$ irreducibility test, Cyclotomic polynomials. | Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning                       | CLO3       |
| III  | <b>Field Extensions</b><br>Extension fields, Degree of an extension, Finite extensions, Algebraic and transcendental elements, Degree of algebraic elements, Algebraic extension, Algebraic complex numbers, Roots of polynomials, Splitting fields, More about roots, Derivative of polynomial, Simple extensions.                                                                                                                                       | Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning, ICT-Enabled Learning | CLO4       |



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## M.Sc. Mathematics Semester-II

|    |                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                         |               |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------|
| IV | <b>Galois Theory</b><br>Automorphisms of fields, Fixed field of a group of automorphisms, Automorphism group $G(K,F)$ , Field of rational functions in $n$ variables over a field, Elementary symmetric functions, Field of symmetric rational functions over a field, Normal extensions, Galois group $G(K,F)$ , Fundamental Theorem of Galois Theory, Radical extensions, Solvable groups, Abel's Theorem. | Seminars,<br>Problem-Based Learning,<br>Collaborative Learning,<br>ICT-Enabled Learning | CLO5,<br>CLO6 |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------|

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20 Marks)

- (i) Assignment (5 marks)
- (ii) Seminar (5 marks)
- (iii) Quizzes (5 marks)
- (iv) Attendance (5 marks)

##### b. Internal Summative Assessment (30 Marks)

- (i) Mid-term test (30 Marks)

#### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|-------------------------------------------------------|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)                                          | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CLO1, CLO2  | 15                   | 2                                                     | 4                 | 7                                | 13          |
| II   | CLO3        | 15                   | 2                                                     | 4                 | 7                                | 13          |
| III  | CLO4        | 15                   | 2                                                     | 3                 | 7                                | 12          |
| IV   | CLO5, CLO6  | 15                   | 2                                                     | 3                 | 7                                | 12          |
|      |             | <b>60 (4Hr/week)</b> | <b>8</b>                                              | <b>14</b>         | <b>28</b>                        | <b>50</b>   |

### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |



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## M.Sc. Mathematics Semester-II

### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 2    | 2    | –    | –    | –    | –    | –    | –    | –     |
| CLO2 | 3    | 3    | 2    | –    | –    | –    | –    | –    | –    | –     |
| CLO3 | 3    | 2    | 3    | –    | 1    | –    | –    | –    | –    | –     |
| CLO4 | 3    | 3    | 2    | –    | –    | 2    | –    | –    | –    | –     |
| CLO5 | 3    | 3    | 2    | –    | –    | 2    | 2    | –    | –    | –     |
| CLO6 | 3    | 3    | 3    | –    | –    | 2    | 2    | –    | –    | –     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

### • Suggested Learning Materials Books:

| Sr. No. | Title                              | Author(s)                       | Edition/Year                    | Publisher          |
|---------|------------------------------------|---------------------------------|---------------------------------|--------------------|
| 1       | Topics in Algebra                  | I. N. Herstein                  | 2 <sup>nd</sup> Edition<br>2006 | John Wiley & Sons  |
| 2       | Contemporary Abstract Algebra      | J. A. Gallian                   | 8 <sup>th</sup> Edition<br>2013 | Books/Cole Cengage |
| 3       | Abstract Algebra                   | D. S. Dummit<br>and R. M. Foote | 3 <sup>rd</sup> Edition<br>2004 | John Wiley & Sons  |
| 4       | A First Course in Abstract Algebra | J. B. Fraleigh                  | 7 <sup>th</sup> Edition<br>2003 | Addison Wesley     |

### • Online Resources (Open Source)

| Sr. No. | Description of Resource(s)                                             | Weblink                                                                                   |
|---------|------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| 1       | NPTEL course on <i>Introduction to Rings and Fields</i> video lectures | <a href="https://nptel.ac.in/courses/111106131">https://nptel.ac.in/courses/111106131</a> |
| 2       | NPTEL course on <i>Galois Theory</i> video lectures.                   | <a href="https://nptel.ac.in/courses/111101117">https://nptel.ac.in/courses/111101117</a> |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title                    | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|---------------------------------|--------------------------|----------------------|----------------|
|             |              |                                 | L-P-T                    |                      |                |
| DSE         | P2S02NEMTH01 | Ordinary Differential Equations | 4-0-1                    | 120                  | 04             |

**Note:** This course is same as the “PS1EMTHCW01 Ordinary Differential Equations” offered in Semester I. The students who have studied “PS1EMTHCW01 Ordinary Differential Equations” in Semester I shall not be offered this course.

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Analyse linear independence of solutions using the Wronskian.

CLO2: Identify and solve Pfaffian differential equations using homogeneous and Natani's methods.

CLO3: Classify singularities of second-order linear differential equations.

CLO4: Construct series solutions near regular singular points.

CLO5: Explain the existence and uniqueness of solutions using Picard's theorem.

CLO6: Analyse critical points of autonomous systems.

| Unit | Course Content                                                                                                                                                                                                                                                                                                                                                                     | Learning Pedagogies                                                                                        | CLO(s)     |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------|
| I    | Review of fundamentals of ordinary differential equations, The Wronskian and linear independence of solution, The method of undetermined coefficients, The method of Variation of Parameters. Pfaffian differential equation: homogeneous method and Natani's method.                                                                                                              | Seminars, Problem-Based Learning, Inquiry-Based Learning, ICT-Enabled Learning, Collaborative Learning     | CLO1, CLO2 |
| II   | Interval of convergence of Power series, real valued analytic function, second order linear homogeneous differential equation: classification of singularities, series solution near ordinary point, Legendre's differential equation, Legendre polynomial and its properties, Rodrigue's formula, Fourier-Legendre's expansion theorem, and its examples.                         | Seminars, Problem-Based Learning, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning    | CLO3       |
| III  | Series solution near regular singular point: Frobenius Theorem (statement only), the point at infinity, Bessel's differential equation, Bessel's function of first kind and its properties, Fourier-Bessel's expansion theorem, and its examples.                                                                                                                                  | Seminars, Micro-Projects, Research-Oriented Learning, ICT-Enabled Learning, Reflective Practices           | CLO4       |
| IV   | Picard's Method of successive Approximations, Existence and uniqueness of solution of initial value problems of first order equation: Picard's theorem (statement only). System of first order equation: Homogeneous Linear system with constant coefficients, Critical points of an autonomous system and classification, Stability of linear systems with constant coefficients. | Seminars, Problem-Based Learning, Research-Oriented Learning, Inquiry-Based Learning, ICT-Enabled Learning | CLO5, CLO6 |



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## M.Sc. Mathematics Semester-II

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20 Marks)

- (i) Assignment (5 marks)
- (ii) Seminar (5 marks)
- (iii) Quizzes (5 marks)
- (iv) Attendance (5 marks)

##### b. Internal Summative Assessment (30 Marks)

- (i) Mid-term test (30 Marks)

#### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|-------------------------------------------------------|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)                                          | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CLO1, CLO2  | 15                   | 1                                                     | 2                 | 9                                | 12          |
| II   | CLO3        | 15                   | 1                                                     | 2                 | 9                                | 12          |
| III  | CLO4        | 15                   | 1                                                     | 3                 | 9                                | 13          |
| IV   | CLO5, CLO6  | 15                   | 1                                                     | 3                 | 9                                | 13          |
|      |             | 60 (4Hrs/week)       | 4                                                     | 10                | 36                               | 50          |

### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |

#### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 3    | 2    | -    | -    | 2    | 1    | -    | 1    | -     |
| CLO2 | 3    | 2    | 3    | 1    | -    | 2    | 1    | -    | -    | 1     |
| CLO3 | 3    | 3    | 2    | -    | -    | 2    | 1    | -    | -    | -     |
| CLO4 | 3    | 2    | 3    | 1    | -    | 2    | 1    | 2    | -    | 1     |
| CLO5 | 3    | 3    | 2    | -    | 1    | 2    | 1    | -    | 1    | -     |
| CLO6 | 3    | 2    | 3    | 2    | -    | 3    | 1    | -    | -    | 2     |



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### M.Sc. Mathematics Semester-II

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

- Suggested Learning Materials Books:**

| Sr. No. | Title                                                         | Author(s)          | Edition/Year                  | Publisher               |
|---------|---------------------------------------------------------------|--------------------|-------------------------------|-------------------------|
| 1       | Differential Equations with Applications and Historical Notes | G. F. Simmons      | 2 <sup>nd</sup> Edition 1991  | McGrow Hill             |
| 2       | An Introduction to Ordinary Differential Equations            | E. A. Coddington   | 1989                          | Dover Publications Inc. |
| 3       | Introduction to Ordinary Differential Equations               | Rabenstein A. L    | 2 <sup>nd</sup> Edition 1972  | Academic Press          |
| 4       | Advanced Differential Equations                               | Raisinghania M. D. | 19 <sup>th</sup> Edition 2018 | S. Chand                |
| 5       | Elements of Partial Differential Equations                    | Sneddon I. N.      | 1957                          | McGraw-Hill Publ. Co.   |

- Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)                                         | Weblink                                                                                   |
|---------|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| 1       | NPTEL course on “Ordinary Differential Equations”                  | <a href="https://nptel.ac.in/courses/111104031">https://nptel.ac.in/courses/111104031</a> |
| 2       | NPTEL course on “Ordinary Differential Equations and Applications” | <a href="https://nptel.ac.in/courses/111108081">https://nptel.ac.in/courses/111108081</a> |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title                   | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|--------------------------------|--------------------------|----------------------|----------------|
|             |              |                                | L-P-T                    |                      |                |
| DSE         | P2S02NEMTH02 | Partial Differential Equations | 4-0-1                    | 120                  | 04             |

**Note:** This course is same as the “PS1EMTHCW02 Partial Differential Equations” offered in Semester I. The students who have studied “PS1EMTHCW02 Partial Differential Equations” in Semester I shall not be offered this course.

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply Lagrange's, Charpit's, and Jacobi's methods to solve first-order partial differential equations.

CLO2: Analyse and solve Cauchy problems and compatible systems of first-order partial differential equations.

CLO3: Solve linear partial differential equations using operator methods  $F(D, D')$  for both homogeneous and non-homogeneous cases.

CLO4: Classify second-order partial differential equations and transform them into canonical forms for solution.

CLO5: Apply separation of variables to solve Laplace, Heat, and Wave equations in Cartesian and polar coordinates.

CLO6: Analyse and solve boundary value problems using Dirichlet and Neumann conditions, including uniqueness theorems and Poisson integral formula.

| Unit | Course Content                                                                                                                                                                                                                                                                                                                                                           | Learning Pedagogies                                                            | CLO(s)     |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------|
| I    | Solution of first order partial differential equation using Lagrange's method, non-linear first order partial differential equations: compatible system of first order partial differential equations, solution by Charpit's method and Jacobi's method, Cauchy problem for first order equation.                                                                        | Seminars, Problem-Based Learning, ICT-Enabled Learning, Collaborative Learning | CLO1, CLO2 |
| II   | Linear partial differential equations with constant coefficients $F(D, D')z = f(x, y)$ , where $f(x, y)$ is of the form $\varphi(ax + by)$ , $F(D, D')$ is homogeneous and non-homogeneous, general method. Second order partial differential equations with variable coefficients: $F(xD, yD')z = f(x, y)$ .                                                            | Seminars, Problem-Based Learning, Case-Based Learning, ICT-Enabled Learning    | CLO3       |
| III  | Classification of second order partial differential equations and canonical form, nonlinear second order partial differential equations: Monge's method, special case and general case. Method of separation of variable: solution of three special equations – Laplace, Heat and Wave equations, solution of these equations in cartesian and polar coordinate systems. | Seminars, Micro-Projects, ICT-Enabled Learning, Reflective Practices           | CLO4, CLO5 |



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## M.Sc. Mathematics Semester-II

|     |                                                                                                                                                                                                                                                                                                      |                                                            |      |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|------|
| LIV | Boundary Value Problems (BVP): Maximum and minimum principles, Uniqueness theorem of Dirichlet problem, the Dirichlet interior problem for a circle, Poisson integral formula, the Dirichlet exterior problem for a circle, the Dirichlet problem for a rectangle, the Neumann problem for a circle. | Seminars, Research-Oriented Learning, ICT-Enabled Learning | CLO6 |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|------|

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20 Marks)

- (i) Assignment (5 marks)
- (ii) Seminar (5 marks)
- (iii) Quizzes (5 marks)
- (iv) Attendance (5 marks)

##### b. Internal Summative Assessment (30 Marks)

- (i) Mid-term tests (30 Marks)

#### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned COs | Total Learning Hours  | Approximate weightage (Marks) to Learning levels (BT) |                   |                                 | Total Marks |
|------|-------------|-----------------------|-------------------------------------------------------|-------------------|---------------------------------|-------------|
|      |             |                       | Remember (R)                                          | Understanding (U) | Application/Analyse & above (A) |             |
| I    | CLO1, CLO2  | 15                    | 1                                                     | 3                 | 9                               | 13          |
| II   | CLO3        | 15                    | 1                                                     | 3                 | 9                               | 13          |
| III  | CLO4, CLO5  | 15                    | 1                                                     | 2                 | 9                               | 12          |
| IV   | CLO6        | 15                    | 1                                                     | 2                 | 9                               | 12          |
|      |             | <b>60 (4Hrs/week)</b> | 4                                                     | 10                | 36                              | 50          |

### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |



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## M.Sc. Mathematics Semester-II

### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 2    | 3    | 1    | 1    | 2    | 1    | –    | 1    | 1     |
| CLO2 | 3    | 3    | 3    | 1    | 1    | 2    | 1    | –    | 1    | 1     |
| CLO3 | 3    | 2    | 3    | 2    | 2    | 2    | 1    | –    | 1    | 2     |
| CLO4 | 3    | 3    | 2    | 2    | 1    | 2    | 1    | –    | 1    | 1     |
| CLO5 | 3    | 2    | 3    | 3    | 2    | 2    | 1    | 1    | 1    | 2     |
| CLO6 | 3    | 3    | 3    | 3    | 1    | 3    | 2    | 2    | 1    | 2     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

### • Suggested Learning Materials Books:

| Sr. No. | Title                                               | Author(s)                        | Publisher                    | Edition/Year                 |
|---------|-----------------------------------------------------|----------------------------------|------------------------------|------------------------------|
| 1       | Elementary Course in Partial Differential Equations | Amarnath T                       | 2 <sup>nd</sup> Edition 2003 | Narosa Pub. House, New Delhi |
| 2       | Elements of Partial Differential Equations          | Sneddon I. N.                    | 1957                         | McGraw- Hill Pub. Co.        |
| 3       | Partial Differential Equations                      | Phoolan Prasad, Ravindran Renuka | 2022                         | New Age Int. Pub.            |
| 4       | Advanced Differential Equations                     | Raisinghania M. D.               | 1995                         | S. Chand & Co.               |

### • Online Resources (Open Source)

| Sr. No. | Description of Resource(s)                       | Weblink                                                                                   |
|---------|--------------------------------------------------|-------------------------------------------------------------------------------------------|
| 1       | NPTEL course on “Partial Differential Equations” | <a href="https://nptel.ac.in/courses/111101153">https://nptel.ac.in/courses/111101153</a> |
| 2       | NPTEL course on “Partial Differential Equations” | <a href="https://nptel.ac.in/courses/111103021">https://nptel.ac.in/courses/111103021</a> |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title   | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|----------------|--------------------------|----------------------|----------------|
|             |              |                | L-P-T                    |                      |                |
| DSE         | P2S02NEMTH03 | Graph Theory I | 4-0-1                    | 120                  | 04             |

**Note:** This course is same as the “PS1EMTHCW03 Graph Theory I” offered in Semester I. The students who have studied “PS1EMTHCW03 Graph Theory I” in Semester I shall not be offered this course.

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Understand and apply fundamental concepts of graph theory, including connected graphs, trees, distance, diameter, Euler graphs, and graph isomorphism.

CLO2: Analyze graph coloring concepts such as chromatic number, chromatic partitions, uniquely colorable graphs, and compute chromatic polynomials, including understanding the significance of the Four-Color Problem.

CLO3: Apply matching theory concepts to solve problems involving maximum matching, Hall's condition, vertex cover, edge cover, independence number, and dominating sets.

CLO4: Evaluate connectivity properties of graphs, including vertex and edge connectivity, and determine conditions for the existence of Hamiltonian cycles.

CLO5: Interpret and analyze directed graphs, including their structure, connectivity, directed trees, and spanning in-trees and out-trees.

CLO6: Apply matrix representations (incidence, adjacency, and circuit matrices) of directed graphs and analyze Euler digraphs, fundamental circuits, and their applications.

| Unit | Course Content                                                                                                                                                                                                                                                                                                 | Learning Pedagogies                                                                                          | CLO(s)        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|---------------|
| I    | Review of basic facts about graphs: connected graph, tree, distance and diameter, Euler graph, isomorphic graphs. Chromatic number, chromatic partitioning, uniquely colorable graphs, chromatic polynomial, Four-color Problem.                                                                               | Seminars, Problem-Based Learning, Collaborative Learning, ICT-Enabled Learning, Inquiry-Based Learning       | CLO1<br>CLO2  |
| II   | Matching and covers: maximum matching, Hall's matching condition, min-max theorems, independence number, vertex cover, edge cover, dominating set.                                                                                                                                                             | Seminars, Problem-Based Learning, Micro-Projects, Research-Oriented Learning, Collaborative Learning         | CLO3          |
| III  | Cuts and Connectivity: Vertex connectivity and edge connectivity. Hamiltonian cycles: necessary conditions, sufficient conditions. Directed Graphs: Definitions and examples, some special types of digraphs, directed path and connectedness, trees with directed edges, spanning out-tree, spanning in-tree. | Seminars, Problem-Based Learning, Collaborative Learning, Flipped Classroom Approach, Inquiry-Based Learning | CLO4,<br>CLO5 |
| IV   | Directed graphs (conti.): Euler digraph and its application, relation of spanning out-tree and spanning in-tree with Euler digraph, Incidence matrix A, Circuit matrix B and Adjacency matrix X of digraphs, Fundamental circuits and fundamental circuit matrix in digraphs.                                  | Seminars, Research-Oriented Learning, ICT-Enabled Learning, Micro-Projects, Self-Directed Learning           | CLO5,<br>CLO6 |



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## M.Sc. Mathematics Semester-II

### Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20 Marks)

- (i) Assignment (5 marks)
- (ii) Seminar (5 marks)
- (iii) Quizzes (5 marks)
- (iv) Attendance (5 marks)

##### b. Internal Summative Assessment (30 Marks)

- (i) Mid-term test (30 Marks)

#### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|-------------------------------------------------------|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)                                          | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CLO1, CLO2  | 15                   | 1                                                     | 3                 | 9                                | 13          |
| II   | CLO3        | 15                   | 1                                                     | 3                 | 9                                | 13          |
| III  | CLO4, CLO5  | 15                   | 1                                                     | 2                 | 9                                | 12          |
| IV   | CLO5, CLO6  | 15                   | 1                                                     | 2                 | 9                                | 12          |
|      |             | 60 (4Hrs/week)       | 4                                                     | 10                | 36                               | 50          |

### Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |

#### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 2    | 2    | –    | –    | 1    | 1    | –    | 1    | 1     |
| CLO2 | 3    | 3    | 2    | –    | –    | 2    | 1    | –    | 1    | 1     |
| CLO3 | 3    | 3    | 2    | –    | 1    | 2    | 1    | 1    | 1    | –     |
| CLO4 | 3    | 3    | 3    | 1    | –    | 2    | 2    | –    | 1    | 1     |
| CLO5 | 3    | 3    | 2    | –    | –    | 2    | 1    | –    | 1    | –     |
| CLO6 | 3    | 3    | 3    | 1    | –    | 3    | 1    | 1    | 1    | 1     |



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### M.Sc. Mathematics Semester-II

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

#### • Suggested Learning Materials Books:

| Sr. No. | Title                                                              | Author(s)                   | Edition/Year                 | Publisher                                   |
|---------|--------------------------------------------------------------------|-----------------------------|------------------------------|---------------------------------------------|
| 1       | Graph Theory with applications to Engineering and Computer Science | Narsingh Deo                | 1974                         | Prentice-Hall of India Pvt. Ltd., New Delhi |
| 2       | Introduction to Graph Theory                                       | Douglas B. West             | 2 <sup>nd</sup> Edition 2007 | Pearson Education, Inc.                     |
| 3       | A first look at graph theory                                       | John Clark and D. A. Holton | 1991                         | Allied Publishing Ltd.                      |
| 4       | Introduction to graph theory                                       | Robin J. Wilson             | 4 <sup>th</sup> Edition 1996 | Addison Wesley Longman limited              |

#### • Online Resources (Open Source)

| Sr. No. | Description of Resource(s)                                     | Weblink                                                                                                                                                               |
|---------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Introduction to Graph Theory Course by Dr. Prashantkumar Patel | <a href="https://youtu.be/SZ2zOZu-eoA?si=UgBOLg-4rKaV0dfX">https://youtu.be/SZ2zOZu-eoA?si=UgBOLg-4rKaV0dfX</a>                                                       |
| 2       | Lecture notes on Graph theory-I by Dr. Prashantkumar Patel     | <a href="https://sites.google.com/view/prashantkumarpatel/downloads/graph-theory-msc">https://sites.google.com/view/prashantkumarpatel/downloads/graph-theory-msc</a> |
| 3       | NPTEL course on “Graph Theory”                                 | <a href="https://nptel.ac.in/courses/111106050">https://nptel.ac.in/courses/111106050</a>                                                                             |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title  | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|---------------|--------------------------|----------------------|----------------|
|             |              |               | L-P-T                    |                      |                |
| DSE         | P2S02NEMTH04 | Number Theory | 4-0-1                    | 120                  | 04             |

**Note:** This course is same as the “PS1EMTHCW04 Number Theory” offered in Semester I. The students who have studied “PS1EMTHCW04 Number Theory” in Semester I shall not be offered this course.

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply fundamental concepts such as division algorithm, GCD, and Euclidean algorithm to solve number-theoretic problems.

CLO2: Analyze and solve linear Diophantine equations and understand prime factorization using the Fundamental Theorem of Arithmetic.

CLO3: Apply congruence relations, Chinese Remainder Theorem, and Fermat’s theorem to solve modular arithmetic problems.

CLO4: Investigate arithmetic functions such as divisor functions, Möbius function, and Euler’s phi-function and their properties.

CLO5: Analyze advanced concepts like primitive roots, quadratic residues, Legendre symbol, and quadratic reciprocity.

CLO6: Formulate mathematical arguments and solve problems using rigorous proofs and computational techniques in number theory.

| Unit | Course Content                                                                                                                                                                                                   | Learning Pedagogies                                                                                        | CLO(s)           |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------|
| I    | The division algorithm, the greatest common divisor, the Euclidean algorithm, the Diophantine equation $ax + by = c$ , the fundamental theorem of arithmetic, the sieve of Eratosthenes, the Goldbach conjecture | Seminars, Problem-Based Learning, Inquiry-Based Learning, ICT-Enabled Learning, Collaborative Learning     | CLO1, CLO2, CLO6 |
| II   | Basic properties of congruence, binary and decimal representation of integers, linear congruences and the Chinese remainder theorem, Fermat’s little theorem and pseudoprimes, Wilson’s theorem.                 | Seminars, Problem-Based Learning, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning    | CLO3, CLO6       |
| III  | The sum and number of divisors, the Möbius inversion formula, the greatest integer function, an application to the calendar, Euler’s phi-function, Euler’s theorem, some properties of the phi-function.         | Seminars, Micro-Projects, Research-Oriented Learning, ICT-Enabled Learning, Reflective Practices           | CLO4, CLO6       |
| IV   | The order of an integer modulo $n$ , primitive roots for primes, Euler’s criterion, Legendre’s symbol and its properties, Quadratic reciprocity.                                                                 | Seminars, Problem-Based Learning, Research-Oriented Learning, Inquiry-Based Learning, ICT-Enabled Learning | CLO5, CLO6       |



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## M.Sc. Mathematics Semester-II

### Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20 Marks)

- (i) Assignment (5 marks)
- (ii) Seminar (5 marks)
- (iii) Quizzes (5 marks)
- (iv) Attendance (5 marks)

##### b. Internal Summative Assessment (30 Marks)

- (i) Mid-term test (30 Marks)

#### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned COs      | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|------------------|----------------------|-------------------------------------------------------|-------------------|----------------------------------|-------------|
|      |                  |                      | Remember (R)                                          | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CLO1, CLO2, CLO6 | 15                   | 2                                                     | 4                 | 7                                | 13          |
| II   | CLO3, CLO6       | 15                   | 2                                                     | 4                 | 7                                | 13          |
| III  | CLO4, CLO6       | 15                   | 2                                                     | 3                 | 7                                | 12          |
| IV   | CLO5, CLO6       | 15                   | 2                                                     | 3                 | 7                                | 12          |
|      |                  | 60 (4Hr/week)        | 8                                                     | 14                | 28                               | 50          |

### Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |

#### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 2    | 3    | 1    | 2    | 2    | 1    | 1    | 1    | 1     |
| CLO2 | 3    | 3    | 3    | 1    | 2    | 2    | 1    | 1    | 1    | 1     |
| CLO3 | 3    | 2    | 3    | 2    | 2    | 2    | 1    | 1    | 1    | 2     |
| CLO4 | 3    | 3    | 2    | 2    | 2    | 3    | 1    | 1    | 2    | 2     |
| CLO5 | 3    | 3    | 2    | 2    | 2    | 3    | 1    | 1    | 2    | 2     |
| CLO6 | 3    | 3    | 3    | 2    | 2    | 3    | 2    | 2    | 2    | 2     |



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### M.Sc. Mathematics Semester-II

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

- Suggested Learning Materials Books:**

| Sr No | Title                                    | Author(s)                                              | Edition/Year                    | Publisher               |
|-------|------------------------------------------|--------------------------------------------------------|---------------------------------|-------------------------|
| 1     | Elementary Number Theory                 | Burton David M.                                        | 7 <sup>th</sup> Edition<br>2011 | McGraw Hill Education   |
| 2     | An Introduction to Theory of Numbers     | Hardy G. H. and<br>Wright E. M.                        | 6 <sup>th</sup> Edition<br>2008 | Oxford University Press |
| 3     | An Introduction to the Theory of Numbers | Nivan Ivan,<br>Zuckerman H. S. and<br>Montgomery H. L. | 5 <sup>th</sup> Edition<br>1991 | John Wiley & Sons Inc.  |
| 4     | Introduction to Analytic Number Theory   | Apostol Tom M.                                         | 2010                            | Springer                |

- Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)                                                  | Weblink                                                                                                                                                             |
|---------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | MIT Lecture Notes & Assignments                                             | <a href="https://ocw.mit.edu/courses/18-781-theory-of-numbers-spring-2012/download/">https://ocw.mit.edu/courses/18-781-theory-of-numbers-spring-2012/download/</a> |
| 2       | A Basic Course in Number Theory (IIT Bombay – NPTEL) by Prof. Shripad Garge | <a href="https://onlinecourses.nptel.ac.in/noc24_ma89/preview">https://onlinecourses.nptel.ac.in/noc24_ma89/preview</a>                                             |
| 3       | Number Theory (IIT Guwahati – NPTEL Archive Course) by Prof. Anupam Saikia  | <a href="https://nptel.ac.in/courses/111103020">https://nptel.ac.in/courses/111103020</a>                                                                           |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title                     | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|----------------------------------|--------------------------|----------------------|----------------|
|             |              |                                  | L-P-T                    |                      |                |
| DSE         | P2S02NEMTH05 | Mathematical Classical Mechanics | 4-0-1                    | 120                  | 04             |

**Note:** This course is same as the “PS1EMTHCW05 Mathematical Classical Mechanics” offered in Semester I. The students who have studied “PS1EMTHCW05 Mathematical Classical Mechanics” in Semester I shall not be offered this course.

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

- CLO1: Interpret constraints, generalized coordinates, and configuration space, and apply the principles of virtual work and D'Alembert's principle to formulate equations of motion for constrained systems.
- CLO2: Derive and apply Lagrange's Equations of Motion (LEOM) for conservative, non-conservative, and mixed systems using the Lagrange's equations and solve relevant physical problems.
- CLO3: Apply Hamilton's Principle to derive equations of motion and analyze classical problems such as the Brachistochrone problem.
- CLO4: Construct the Hamiltonian for dynamical systems and use Hamilton's equations of motion to describe system evolution in phase space, including conservation laws.
- CLO5: Analyze dynamical systems using canonical transformations, generating functions, compute Poisson brackets and Lagrange brackets to obtain equations of motion and formal solutions.
- CLO6: Analyze small oscillations using normal coordinates and eigenvalue methods, extend Lagrangian and Hamiltonian formulations from discrete to continuous systems.

| Unit | Course Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Learning Pedagogies                                                                | CLO(s)     |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------|
| I    | Constraints, Types of constraints, Generalized co-ordinates, Configuration space, Principle of virtual work, Lagrange's equations of Motion (LEOM) using D'Alembert's principle, LEOM for conservative system, LEOM for non-conservative system, LEOM for partly conservative and partly non-conservative system, appropriate examples.                                                                                                                                                                                                           | Seminars, Problem-Based Learning, Inquiry-Based Learning, Collaborative Learning   | CLO1, CLO2 |
| II   | Euler-Lagrange equations in various forms (without derivation), Hamilton variational principle, Brachistochrone problem, Derivation of LEOM from Hamilton's principle, generalized momentum, cyclic coordinates, energy function, conservation of linear momentum and angular momentum in Lagrangian formalism, Conservation of total energy, Hamiltonian for a dynamical system, Hamilton's equations of motion (HEOM), phase space, Hamilton's modified principle, derivation of HEOM from Hamilton's modified principle, appropriate examples. | Seminars, Research-Oriented Learning, Problem-Based Learning, ICT-Enabled Learning | CLO3, CLO4 |



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## M.Sc. Mathematics Semester-II

|     |                                                                                                                                                                                                                                                                                                                         |                                                                                                    |      |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------|
| III | Canonical transformations, generating functions, symplectic condition, infinitesimal canonical transformations, examples, Poisson bracket, Lagrange bracket, formal solution of equations of motion in terms of Poisson brackets, appropriate examples.                                                                 | Seminars, Inquiry-Based Learning, Problem-Based Learning, Collaborative Learning                   | CLO5 |
| IV  | Lagrangian for small oscillations, eigenvalue equation and the principal axis transformation, frequencies of free vibration and normal coordinates, free vibrations of a linear triatomic molecule, Transition from a discrete to a continuous system, the Lagrangian and Hamiltonian formulation for continuous system | Seminars, Problem-Based Learning, Mini Research Tasks, ICT-Enabled Learning, Experiential Learning | CLO6 |

### (A) Internal Assessment

#### a. Internal Formative assessment (20 Marks)

- Assignment (5 marks)
- Seminar (5 marks)
- Quizzes (5 marks)
- Attendance (5 marks)

#### b. Internal Summative Assessment (30 Marks)

- Mid-term test (30 Marks)

### (B) Weightage of Learning Efforts for External Assessment (50 Marks)

| Unit | Aligned CLOs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                     | Total Marks |
|------|--------------|----------------------|-------------------------------------------------------|-------------------|---------------------|-------------|
|      |              |                      | Remember (R)                                          | Understanding (U) | Analyse & above (A) |             |
| I    | CLO1, CLO2   | 15                   | 2                                                     | 3                 | 8                   | 13          |
| II   | CLO3, CLO4   | 15                   | 2                                                     | 3                 | 8                   | 13          |
| III  | CLO5         | 15                   | 1                                                     | 2                 | 9                   | 12          |
| IV   | CLO6         | 15                   | 1                                                     | 2                 | 9                   | 12          |
|      |              | <b>60 (4Hr/week)</b> | <b>6</b>                                              | <b>10</b>         | <b>34</b>           | <b>50</b>   |

### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |



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## M.Sc. Mathematics Semester-II

### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 3    | 2    | 2    | 1    | 2    | 1    | 1    | 1    | 1     |
| CLO2 | 3    | 3    | 3    | 2    | 2    | 2    | 1    | 1    | 1    | 2     |
| CLO3 | 3    | 3    | 2    | 2    | 1    | 2    | 1    | 1    | 1    | 2     |
| CLO4 | 3    | 3    | 3    | 2    | 2    | 2    | 1    | 1    | 1    | 2     |
| CLO5 | 3    | 3    | 3    | 2    | 2    | 3    | 2    | 1    | 1    | 2     |
| CLO6 | 3    | 3    | 3    | 3    | 2    | 3    | 2    | 1    | 1    | 3     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

### • Suggested Learning Materials Books:

| Sr. No. | Title                                       | Author(s)                                             | Edition/Year                    | Publisher                 |
|---------|---------------------------------------------|-------------------------------------------------------|---------------------------------|---------------------------|
| 1       | Classical Mechanics                         | Herbert Goldstein, Charles P. Poole and John L. Safko | 3 <sup>rd</sup> Edition<br>2011 | Pearson Education, Inc.   |
| 2       | Mathematical Methods of Classical Mechanics | V. I. Arnold                                          | 2 <sup>nd</sup> Edition<br>1997 | Springer-Verlag           |
| 3       | Mechanics and Relativity                    | Vidwan Singh Soni                                     | 2 <sup>nd</sup> Edition<br>2011 | PHI Learning Pvt. Ltd.    |
| 4       | Classical Mechanics                         | J. C. Upadhyay                                        | 2 <sup>nd</sup> Edition<br>2014 | Himalaya Publishing House |
| 5       | Classical Mechanics                         | Yeshwant R. Waghmare                                  | 1990                            | PHI Pvt. Ltd.             |

### • Online Resources (Open Source):

| Sr. No. | Description of Resource(s)          | Weblink                                                                                   |
|---------|-------------------------------------|-------------------------------------------------------------------------------------------|
| 1       | NPTEL Course on Classical Mechanics | <a href="https://nptel.ac.in/courses/115105098">https://nptel.ac.in/courses/115105098</a> |
| 2       | NPTEL Course on Classical Mechanics | <a href="https://nptel.ac.in/courses/115106123">https://nptel.ac.in/courses/115106123</a> |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title        | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|---------------------|--------------------------|----------------------|----------------|
|             |              |                     | L-P-T                    |                      |                |
| DSE         | P2S02NEMTH21 | Riemann Integration | 2-0-1                    | 60                   | 02             |

**Note:** This course is same as the “PS1EMTHCW21 Riemann Integration” offered in Semester I. The students who have studied “PS1EMTHCW21 Riemann Integration” in Semester I shall not be offered this course.

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply the definition of Riemann integral, partitions, and refinement of partitions to determine the integrability of real-valued functions on closed intervals.

CLO2: Analyze conditions for Riemann integrability using Darboux's Theorem and evaluate the algebra of integrable functions (sum, product, quotient, and modulus).

CLO3: Apply the concept of Riemann sums and interpret definite integrals as limits of sums for various classes of functions.

CLO4: Analyze the relationship between integration and differentiation, including the concept of primitives and the conditions under which functions are integrable.

CLO5: Apply the Fundamental Theorem of Integral Calculus to evaluate definite integrals and solve problems involving accumulation and rate of change.

| Unit | Course Content                                                                                                                                                                                                                                    | Learning Pedagogies                                                            | CLO(s)           |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------|
| I    | Riemann Integrals: Definitions and Existence, Inequalities for Integrals, Refinement of Partitions, Darboux's Theorem for Integrals, Conditions for Integrability, Integrability of the Sum, Difference, Product, Quotient and Modulus functions. | Seminars, Problem-Based Learning, Inquiry-Based Learning, ICT-Enabled Learning | CLO1, CLO2, CLO3 |
| II   | Integral as the limit of sums (Riemann Sums), Some Integrable functions, Integration and Differentiation, The Primitive, The Fundamental Theorem of Integral Calculus.                                                                            | Seminars, Problem-Based Learning, Self-Directed Learning, ICT-Enabled Learning | CLO3, CLO4, CLO5 |



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## M.Sc. Mathematics Semester-II

### Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (15 Marks)

- (i) Quizzes (5 marks)
- (ii) Seminar (5 marks)
- (iii) Attendance (5 marks)

##### b. Internal Summative Assessment (15 Marks)

- (i) Mid-term test (15 Marks)

#### (B) Weightage of Learning Efforts for External Assessment (25 Marks)

| Unit | Aligned COs      | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                   | Total Marks |
|------|------------------|----------------------|-------------------------------------------------------|-------------------|-----------------------------------|-------------|
|      |                  |                      | Remember (R)                                          | Understanding (U) | Application / Analyse & above (A) |             |
| I    | CLO1, CLO2, CLO3 | 15                   | 1                                                     | 3                 | 9                                 | 13          |
| II   | CLO3, CLO4, CLO5 | 15                   | 1                                                     | 2                 | 9                                 | 12          |
|      |                  | 30 (4Hr/week)        | 2                                                     | 5                 | 18                                | 25          |

### Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |

#### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 3    | 3    | 1    | 1    | 2    | 2    | -    | 1    | -     |
| CLO2 | 1    | 3    | 3    | 1    | 1    | 3    | 2    | -    | 1    | -     |
| CLO3 | 3    | 2    | 3    | 1    | 3    | 2    | 2    | -    | 2    | 1     |
| CLO4 | 1    | 3    | 3    | 3    | 1    | 3    | 2    | -    | 2    | 2     |
| CLO5 | 3    | 2    | 3    | 3    | 3    | 2    | 3    | 2    | 2    | 3     |
| CLO6 | 3    | 3    | 3    | 1    | 1    | 2    | 2    | -    | 1    | -     |



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### M.Sc. Mathematics Semester-II

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

- Suggested Learning Materials Books:**

| Sr. No. | Title                                  | Author(s)                       | Edition/Year                    | Publisher                                |
|---------|----------------------------------------|---------------------------------|---------------------------------|------------------------------------------|
| 1       | A course in Calculus and Real Analysis | S. R. Ghorpade and B. V. Limaye | 2006                            | Springer                                 |
| 2       | Real Analysis                          | Dipak Chatterjee                | 2 <sup>nd</sup> Edition<br>2012 | Prentice-Hall India Pvt. Ltd., New Delhi |
| 3       | Principles of Real Analysis            | S. C. Malik                     | 5 <sup>th</sup> Edition<br>2021 | New Age International, New Delhi         |

- Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)                     | Weblink                                                                                                                                                       |
|---------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | MIT Open Courseware – Single Variable Calculus | <a href="https://ocw.mit.edu/courses/18-01sc-single-variable-calculus-fall-2010/">https://ocw.mit.edu/courses/18-01sc-single-variable-calculus-fall-2010/</a> |



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## M.Sc. Mathematics Semester-II

| Course Type | Course Code  | Course Title                         | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|--------------------------------------|--------------------------|----------------------|----------------|
|             |              |                                      | L-P-T                    |                      |                |
| DSE         | P2S02NEMTH22 | History of Indian Mathematicians - I | 2-0-1                    | 60                   | 02             |

**Note:** This course is same as the “PS1EMTHCW22 History of Indian Mathematicians - I” offered in Semester I. The students who have studied “PS1EMTHCW22 History of Indian Mathematicians - I” in Semester I shall not be offered this course.

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

- CLO1: Describe the life and major contributions of key Indian mathematicians such as Aryabhata, Bhaskara II, and Srinivasa Ramanujan across different periods.
- CLO2: Explain fundamental mathematical ideas developed by ancient Indian scholars including Mahaviracharya and Sridharacharya in arithmetic, algebra, and geometry.
- CLO3: Analyze the development of mathematical thought from ancient to early modern India, with special reference to the Kerala School of Mathematics and Astronomy.
- CLO4: Apply selected concepts such as infinite series and algebraic techniques introduced by mathematicians like Madhava of Sangamagrama and Bhaskara II to solve problems.
- CLO5: Evaluate and present the significance and global impact of contributions made by mathematicians such as Srinivasa Ramanujan and Bharati Krishna Tirtha in a structured format.

| Unit | Course Content                                                                                                                                                                                                                                                                                           | Learning Pedagogies                                                            | CLO(s)           |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------|
| I    | Work and Life of Ancient Indian Mathematicians: <ul style="list-style-type: none"> <li>Aryabhata (476-550 CE)</li> <li>Varahmihir (505-587 CE)</li> <li>Bhaskara I (600-680 CE)</li> <li>Mahaviracharya (800–870 CE)</li> <li>Sridharacharya (850–950 CE)</li> <li>Bhaskara II (1114-1185 CE)</li> </ul> | Seminars, Inquiry-Based Learning, Collaborative Learning, ICT-Enabled Learning | CLO1, CLO2       |
| II   | Work and Life of Medieval Indian Mathematicians: <ul style="list-style-type: none"> <li>Kerala School of Mathematics</li> <li>Madhava of Sangamagrama (1340–1425 CE)</li> <li>Parameshvara (c. 1360–1455 CE)</li> <li>Damodara (15<sup>th</sup> century)</li> </ul>                                      | Seminars, Problem-Based Learning, ICT-Enabled Learning, Collaborative Learning | CLO3, CLO4, CLO5 |

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (15 Marks)

- (i) Quizzes (5 marks)
- (ii) Seminar (5 marks)
- (iii) Attendance (5 Marks)



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## M.Sc. Mathematics Semester-II

### b. Internal Summative Assessment (10 Marks)

(i) Mid-term test (10 Marks)

### (B) Weightage of Learning Efforts for External Assessment (25 Marks)

| Unit | Aligned CLOs     | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                     | Total Marks |
|------|------------------|----------------------|-------------------------------------------------------|-------------------|---------------------|-------------|
|      |                  |                      | Remember (R)                                          | Understanding (U) | Analyse & above (A) |             |
| I    | CLO1, CLO2       | 30                   | 2                                                     | 3                 | 8                   | 13          |
| II   | CLO3, CLO4, CLO5 | 30                   | 2                                                     | 3                 | 7                   | 12          |
|      |                  | 60 (4Hrs/week)       | 4                                                     | 6                 | 15                  | 25          |

### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 1    | 1    | -    | -    | -    | 1    | 3    | 1    | 2    | 1     |
| CLO2 | 2    | 2    | -    | -    | -    | 2    | 3    | 1    | 2    | 1     |
| CLO3 | -    | 3    | 2    | -    | -    | 1    | 3    | 1    | 2    | 1     |
| CLO4 | 3    | 2    | 3    | 2    | 1    | 2    | 3    | 1    | 2    | 2     |
| CLO5 | -    | 1    | -    | -    | -    | 2    | 3    | 2    | 2    | 1     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component                                               | Weightage (%) |
|---------|--------------------------------|---------------------------------------------------------|---------------|
| 1       | Continuous Internal Evaluation | Mid-term Test, Assignment, Seminar, Quizzes, Attendance | 50            |
| 2       | End-Semester Examination       | Written Exam                                            | 50            |



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### M.Sc. Mathematics Semester-II

- Suggested Learning Materials Books:**

| Sr No | Title                                                                         | Author(s)                           | Edition/Year                 | Publisher                       |
|-------|-------------------------------------------------------------------------------|-------------------------------------|------------------------------|---------------------------------|
| 1     | Mathematics in India                                                          | Kim Plofker                         | 2009                         | Princeton University Press      |
| 2     | A passage to infinity: Medieval Indian mathematics from Kerala and its impact | G. G. Joseph                        | 2009                         | SAGE Publications               |
| 3     | The crest of the peacock: Non-European roots of mathematics                   | G. G. Joseph                        | 3 <sup>rd</sup> Edition 2011 | Princeton University Press      |
| 4     | The man who knew infinity: A life of the genius Ramanujan                     | R. Kanigel                          | 1991                         | Washington Square Press         |
| 5     | Geometry in ancient and medieval India                                        | T. A. Sarasvati Amma                | 1999                         | Motilal Banarsidass             |
| 6     | Āryabhaṭīya of Āryabhaṭa                                                      | K. S. Shukla & K. V. Sarma (Trans.) | 1976                         | Indian National Science Academy |
| 7     | Vedic mathematics                                                             | B. K. Tirthaji                      | 1965                         | Motilal Banarsidass             |
| 8     | Chalk and duster                                                              | P. C. Vaidya                        | 1999                         | Gujarat University              |

- Online Resources (Open Source):**

| Sr. No. | Description of Resource(s)                                               | Weblink                                                                                   |
|---------|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| 1       | NPTEL Course on Mathematics in India - From Vedic Period to Modern Times | <a href="https://nptel.ac.in/courses/111101080">https://nptel.ac.in/courses/111101080</a> |