M. C. E. Society's

Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1

(Autonomous) Affiliated to SavitribaiPhule Pune University

NAAC accredited 'A' Grade

Two Year M.Sc. Degree Program in Mathematics
(Faculty of Science & Technology)

Syllabus for

M.Sc.-I (Mathematics)

Choice Based Credit System Syllabus
To be implemented from the academic year 2021-2022

Title of the Course: M.Sc (Mathematics)

Aims and Objectives of the Course

Sr. No.	Objectives
1.	To maintain an updated curriculum.
2.	To take care of fast development in the knowledge of mathematics
3.	To enhance the quality and standards of Mathematics Education.
4.	To provide a broad common framework, for exchange, mobility, and free dialogue across theIndian Mathematical and associated community.

Expected Course Specific Learning Outcome

Sr. No.	Objectives
1.	Students will have an aptitude to Study higher Mathematics and creative work in Mathematics.
2.	Students will equipped themselves with that part of Mathematics which is needed for various branches of Sciences or Humanities in which they have an aptitude for higher studies and original work.

Structure of M.Sc-I Mathematics Course

Sr. No.	Courses		Continuous Internal Evaluation (CIE) (Internal Marks)	End Semester Exam (External Marks)	Total Marks	Credits
	Semester-I	Semester-II				
1.	21SMMT111: LinearAlgebra	21SMMT121: Complex Analysis	50	50	100	04
2.	21SMMT112: Real Analysis	21SMMT122: General Topology	50	50	100	04

3.	21SMMT113: GroupTheory	21SMMT123: Ring Theory	50	50	100	04
4.	21SMMT114: Advanced Calculus	21SMMT124: Advanced Numerical Analysis	50	50	100	04
5.	21SMMT115: Ordinary Differential Equations	21SMMT125: Partial Differential Equations	50	50	100	04
Extra credit course						
6.	21PGHUR11M: Human Rights	21PGCYS12M: Cyber Security	75		75	03

Structure of M.Sc-II Mathematics Course

Sr. No.	**Courses**		**Continuous Internal Evaluation (CIE) (Internal Marks)**	**End Semester Exam (External Marks)**	**Total Marks**	**Credits**
	Semester-III	**Semester-IV**				
Compulsory Courses						
1.	21SMMT231: Functional Analysis	21SMMT241: Fourier Series and Boundary Value Problems	50	50	100	04
2.	21SMMT232 : Field Theory	21SMMT242: Differential Geometry	50	50	100	04
3.	21SMMT233T: Programming with Python (Theory)	21SMMT243T: Introduction to Data Science (Theory)	25	25	50	02

4.	21SMMT233P: Programming with Python (Practical)	21SMMT243P: Introduction to Data Science (Practical)	25	25	50	02
Optional Courses (Any two of six courses)						
5.	21SMMT234A: Discrete Mathematics	21SMMT244A: Number Theory	50	50	100	04
6.	21SMMT234B: Mechanics	21SMMT244B: Algebraic Topology	50	50	100	04
7.	21SMMT234C: Advanced Complex Analysis	21SMMT244C: Representation Theory of Finite Groups	50	50	100	04
8.	21SMMT234D: Integral Equations	21SMMT244D: Coding Theory	50	50	100	04
9.	21SMMT234E: Differential Manifolds	21SMMT244E: Probability and Statistics	50	50	100	04
10.	21SMMT234F: Students can choose one course from Swayam /NPTEL / E-Pathashala etc, if interested	21SMMT244F: Students can choose one course from Swayam / NPTEL /E-Pathashala etc, if interested	50	50	100	04
Extra Credit Courses						

11.	21PGHPE23M: Human Values & Professional Ethics	21DSDLT24M: Introduction to LaTeX	75		75	03

For Continuous Internal Evaluation (CIE), evaluation of theory courses will be done continuously throughout the semester. CIE will be of 50% marks for CGPA papers.

CIE for 4 credits theory paper: It will be divided as follows:

SR. NO.	COMPONENTS		MARKS
1.	CIE I	Mid Semester examination	15
2.	CIE II	Two Class Test of 15 marks each (Best of 2)	15
3.	CIE III	One Presentation/Seminar/ MCQ Test	10
4.	CIE IV	Class Assignments / One group discussion / Open Book Test	10
		TOTAL	**50**

CIE for 4 credits Practical paper: It will be divided as follows:

SR. NO.	COMPONENTS		MARKS
1.	CIE I	Mock Practical Examination	30
2.	CIE II	Viva Voce	10
3.	CIE III	Journal / project report/ dissertation report completion and certification on time.	05
4.	CIE IV	Attendance	05
		TOTAL	**50**

Above components will also be followed for 2 credit theory and practical papers

Syllabus:

Course/ Paper Title	**Linear Algebra**
Course Code	**21SMMT111**
Semester	**I**
No. of Credits	**04**

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Vector Spaces:**	**16**
	1. Definition and examples. 2. Subspaces. 3. Basis and dimension. 4. Linear transformations. 5. Quotient spaces. 6. Direct sum. 7. The matrix of a linear transformation. 8. Duality	1 1 2 2 2 3 3 2
Unit II	**Canonical Forms:**	**16**
	1. Eigenvalues and eigenvectors. 2. The minimal polynomial. 3. Diagonalizable and triangulable operators. 4. The Jordan form. 5. The rational form.	3 3 4 3 3
Unit III	**Inner Product Spaces:**	**16**
	1. Inner products. 2. Orthogonality. 3. The adjoint of a linear transformation.	2 2 3

	4. Unitary operators. 5. Self-adjoint and normal operators. 6. Polar and singular value decompositions.	3 3 3
Unit IV	**Bilinear Forms:**	**12**
	1. Definition and examples. 2. The matrix of a bilinear form. 3. Orthogonality. 4. Classification of bilinear forms.	1 3 4 4

Textbook:

Vivek Sahai, Vikas Bist, Linear Algebra, Narosa Publishing House.

ISBN 978-88-7319-392-7.

Unit I: Chapter 2.

Unit II: Chapter 3.

Unit III: Chapter 4.

Unit IV: Chapter 5.

References:

1. Books:

1. P. B. Bhattacharya, S. R. Nagpaul, S. K. Jain, First Course in Linear Algebra, 2nd Edition, New Age International Publishers.

2. S. Kumaresan, Linear Algebra A Geometric Approach, PHI Learning Private Ltd.

3. Charles W. Curtis, Linear Algebra An Introductory Approach, Springer.

4. Michael Artin, Algebra, Pearson India Education Services Pvt. Limited.

2. Website:

1. http://math.mit.edu/~gs/linearalgebra/

2. MIT 18.06 Linear Algebra, Spring 2005. Instructor: Gilbert Strang

https://www.youtube.com/results?search_query=linear+algebra+gilbert+strang+

Course/ Paper Title	Real Analysis
Course Code	**21SMMT112**
Semester	**I**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**The Real Numbers: Sets, Sequences, and Functions:**	**10**
	1. Countable and Uncountable Sets. 2. Open Sets; Closed Sets; and Borel Sets of Real Numbers. 3. Sequences of Real Numbers. 4. Continuous Real-Valued Functions of a Real Variable.	2 3 2 3
Unit II	**Lebesgue Measure:**	**20**
	1. Introduction. 2. Lebesgue Outer Measure. 3. The σ- Algebra of Lebesgue Measurable Sets. 4. Outer and Inner Approximation of Lebesgue Measurable Sets. 5. Countable Additivity; Continuity; Borel-Cantelli Lemma. 6. Non-measurable Set. 7. Cantor Set and the Cantor-Lebesgue Function.	1 3 3 3 4 3 3
Unit III	**Lebesgue Measurable Functions:**	**10**
	1. Sums; Products and Compositions. 2. Sequential Pointwise Limits and Simple Approximation. 3. Littlewood's Three Principles; Egoroff's Theorem; and Lusin's Theorem.	2 4 4

Unit IV	**Lebesgue Integration:**	**20**
	1. The Riemann Integral. 2. The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite measure. 3. The Lebesgue Integral of a Measurable Nonnegative Function. 4. The General Lebesgue Integral. 5. Countable Additivity and Connuity of Integration. 6. Uniform Integrability: The Vitali Convergence Theorem.	2 4 4 3 3 4

Textbook:

H. L. Royden, P. M Fitzpatrick, Real Analysis, Fourth Edition, PHI.

Unit I: Chapter 1: Sec. 1.3 - 1.6.

Unit II: Chapter 2: Sec. 2.1 - 2.7.

Unit III: Chapter 3: Sec. 3.1 - 3.3.

Unit IV: Chapter 4: Sec. 4.1 - 4.6.

Reference:

1. Books:

1. N. L. Carothers, Real Analysis, Cambridge University Press, ISBN: 9781139643160.
2. Elias M. Stein and Rami Shakarchi, Real Analysis: Measure Theory, Integration, and Hilbert Spaces, Princeton University Press.

2. Website:

1. Measure Theory Instructor: Prof. Inder Kumar Rana IIT Bombay.

https://www.youtube.com/results?search_query=measure+therory+inder+kumar+rana

Course/ Paper Title	**Group Theory**
Course Code	**21SMMT113:**
Semester	**I**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Groups, Subgroups, and Cyclic Groups:**	**08**
	1. Definition and Examples of Groups; Properties of Groups; Order of a finite group; Order of an element in a group; Subgroups;Subgroup Tests. 2. Cyclic Groups; Properties of Cyclic Groups; Classification of Subgroups of Cyclic Groups	4 4
Unit II	**Permutation Groups- Isomorphism:**	**12**
	1. Permutations Groups; Definition and notation; Cycles; Properties of Permutations; Even and odd permutations; Alternating Group of degree n. 2. Isomorphism of Group; Properties of Isomorphisms; Cayley's Theorem; Automorphisms	6 6
Unit III	**Cosets, Lagrange's Theorem,** **External Direct Product:**	**12**
	1. Cosets; Lagrange's Theorem and consequences; Stabilizer and orbit;Orbit stabilizer theorem. 2. External Direct Products; Properties of External Direct Products;Group of units modulo n as an external direct product.	6 6
Unit IV	**Normal Subgroups, Homomorphisms:**	**12**
	1. Normal Subgroups; Factor Groups; Application of Factor Groups;Internal Direct Products. 2. Group Homomorphisms; Definition and examples; Properties of Homomorphisms;First Isomorphism Theorem.	6 6
Unit V	**Sylow Theorems:**	**12**
	1. Fundamental Theorem of Finite Abelian Groups; Isomorphism Classesof Abelian Groups; Proof of the Fundamental Theorem.	6

	2. Conjugacy Classes; Class Equation; The Sylow Theorems; Applications of Sylow's Theorems.	6
Unit VI	**Group Actions:**	**04**
	1. Group Actions; Definition and examples; Permutation representation associated with a given action; Faithful action; Kernel; Left regular action.	4

Textbooks:

1. Joseph Gallian, Contemporary Abstract Algebra, 9th Edition, Cengage Learning India Pvt. Ltd. ISBN-10 9353502527

Unit I: Chapters: 2, 3, 4.

Unit II: Chapters: 5 (except last article: A check Digit Scheme based on D_5), 6.

Unit III: Chapters: 7 (except: Rotations of a cube and Soccer Ball and subsequent Article),
8 (except: Applications).

Unit IV: Chapters: 9, 10.

Unit V: Chapters: 11, 24.

2. David S. Dummit, Richard M. Foote, Abstract Algebra, 2nd Edition, John Wiley and Sons (Indian Edition)

Unit VI: Chapter: 1 only Article 1.7.

Reference:

1. Books:

1. I. S. Luthar, I. B. S. Passi, Algebra (Vol 1), Groups; Narosa Publication House.
2. I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd.
3. M. Artin, Algebra, Prentice Hall.
4. N. S. Gopalkrishnan, University Algebra, Wiley Eastern Ltd.
5. J. B. Fraleigh, A First Course in Abstract Algebra, 7th Edition, Pearson Edition Ltd.
6. P.B.Bhattacharya, S.K. Jain, S.R. Nagpaul, Basic Abstract Algebra Second Edition, Cambridge University Press.

2. Website:

1. Introduction to Abstract Group Theory - Krishna Hanumanthu | CMI - NPTEL
https://www.youtube.com/results?search_query=introduction+to+abstract+group+theory+krishna+hanumanthu

Course/ Paper Title	**Advanced Calculus**
Course Code	**21SMMT114**
Semester	**I**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Differential Calculus of Scalar and Vector Fields:**	**20**
	1. Functions from R^n to R^m. Scalar and vector fields; Open balls and open sets; Limits and continuity.	4
	2. The derivative of a scalar field with respect to a vector; Directional derivatives and partial derivatives; Partial derivatives of higher order; Inverse function theorem and ImplicitFunction theorem. (Statement only without proof)	6
	3. Directional derivatives and continuity; The total derivatives; The gradient of a scalar field; A sufficient condition for differentiability.	4
	4. A chain rule for derivatives of scalar fields; Applications to geometry. Level sets. Tangent planes; Derivatives of vector fields; Differentiability implies continuity; The chain rule for derivatives of vector fields; Matrix form of the chain rule.	6
Unit II	**Line Integrals:**	**10**
	1. Paths and line integrals; Other notations for line integrals; Basic properties of line integrals.	2
	2. The concept of work as a line integral; Line integrals with respect to arc length; Further applications of line integrals.	2
	3. Open connected sets. Independence of the path; The first and second fundamental theorem of calculus for line integrals; Necessary and sufficient conditions for a vector field to be a gradient; Necessary conditions for a vector field to be a gradient.	6
Unit III	**Multiple Integrals:**	**15**

	1. Partitions of rectangles. Step functions; The double integral of a step function; The definition of the double integral of a function defined and bounded on a rectangle; Upper and lower double integrals; Evaluation of double integral by repeated one-dimensional integration; Geometric interpretation of the double integral as a volume; Worked examples. 2. Integrability of continuous functions; Integrability of bounded functions with discontinuities ; Double integrals extended over more general regions; Applications to area and volume;Worked examples. 3. Green's theorem in the plane; Some applications of Green's theorem; A necessary andsufficient condition for a two dimensional vector field to be a gradient. 4. Change of variables in a double integral; Special cases of the transformation formula withproof; General case of the transformation formula with proof; Extensions to higher dimensions; Change of variables in an n-fold integral; Worked examples.	3 2 5 5
Unit IV	**Surface Integrals:**	**15**
	1. Parametric representation of a surface; The fundamental vector product; The fundamentalvector product as a normal to the surface; Area of a parametric surface. 2. Surface integrals; Change of parametric representation; Other notations for surface integrals. 3. The theorem of Stokes; Curl and divergence of a vector field; Properties of curl and divergence;the divergence theorem (Gauss' theorem) and applications of the divergence theorem.	5 5 5

Textbooks:

1.Tom M. Apostol, Calculus Volume II (Second Edition) Indian Reprint 2016 (John Wiley & Sons, Inc) ISBN: 978-81-265-1520-2.

Unit I: Chapter 8: Sections 8.1 to 8.22.

Unit II: Chapter 10: Sections 10.1 to 10.11, 10.14 to 10.16.

Unit III: Chapter 11: Sections 11.1 to 11.15; 11.19 to 11.22, 11.26 to 11.34.

Unit IV: Chapter 12: Sections 12.1 to 12.15, 12.19 and 12.21.

2. For " Inverse Function Theorem" and "Implicit Function Theorem", use

Tom M. Apostol, Mathematical Analysis 2nd Edition Narosa Publication 20th Reprint 2002. ISBN 978-81-85015-66-8.

Unit I: Chapter 13: Sections 13.3, 13.4.

Reference:

1. Books:

1. Gerald B. Folland, Advanced Calculus, Pearson Edn 2012.

2. A Devinatz, Advanced Calculus, Holt, Rnehart and Winston Inc., New York, 1968.

2. Website

1. Multivariable Calculus Intructor: Dr. S.K.Gupta IIT Roorkee

https://www.youtube.com/results?search_query=multi+variable+calculus+nptel

Course/ Paper Title	**Ordinary Differential Equations**
Course Code	**21SMMT115**
Semester	**I**
No. of Credits	**04**

Unit No.	Title with Contents	No. of Lectures
Unit I	**Linear Equations of the First Order**	**04**
	1. Linear equations of the first order. 2. The equation $y' + ay = 0$. 3. The equation $y' + ay = b(x)$. 4. The general linear equations of first order.	1 1 1 1
Unit II	**Linear Equations with Constant Coefficients:**	**12**
	1. Introduction 2. Second order homogeneous equation. 3. Initial value problems for second order equations.	1 1 1

	4. Linear dependence and independence.2 5. A formula for the Wronskian. 6. The non-homogeneous equation of order two. 7. The homogeneous equation of order n. 8. The non-homogeneous equation of order n. 9. Algebra of constant coefficient operators.	1 1 1 2 2 2
Unit III	**Linear Equations with Variable Coefficients:**	**12**
	1. Introduction. 2. Initial value problems for the homogeneous equation. 3. Solutions of the homogeneous equation. 4. The Wronskian and linear independence. 5. Reduction of the order of a homogeneous equation. 6. The non-homogeneous equation. 7. Homogeneous equations with analytic coefficient. 8. The Legendre equation.	1 1 1 1 2 2 2 2
Unit IV	**Linear Equations with Regular Singular Points:**	**12**
	1. Introduction. 2. Euler equation. 3. Second order equation with regular singular points- an example. 4. The Bessel equation. 5. Regular singular point at infinity.	2 2 2 3 3
Unit V	**Existence and uniqueness of solutions to first order equations:**	**10**
	1. Introduction. 2. Equations with variables separated. 3. Exact equations. 4. The method of successive approximations. 5. The Lipschitz condition. 6. Approximation to, and uniqueness of, solutions.	1 1 2 2 2 2

Unit VI	**Existence and Uniqueness of solutions to Systems and n-th Order Equations:**	**10**
	1. System as vector equations. 2. Existence and uniqueness of solutions to systems. 3. Existence and uniqueness for linear systems.	2 4 4

Textbook:

E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall.
Unit I: Chapter 1: Sections 4, 5, 6, 7.
Unit II: Chapter 2: Sections 1, 2, 3, 4, 5, 6, 7, 10, 12.
Unit III: Chapter 3: Sections 1, 2, 3, 4, 5, 6, 7, 8.
Unit IV: Chapter 4: Sections 1, 2, 3, 4, 6, 7, 8, 9.
Unit V: Chapter 5: Sections 1, 2, 3, 4, 5, 8.
Unit VI: Chapter 6: Sections 5, 6, 7.

Reference:

1. Books:

1. G. F. Simmons, S. G. Krantz, Differential Equations (Tata McGraw-Hill).

2. Lawrence Perko, Differential Equations and Dynamical Systems Third Edition, Springer.

2. Website:

http://gibbs.if.usp.br/~marchett/fismat2/linear-ode_coddington-carlson.pdf

Course/ Paper Title	**Complex Analysis**
Course Code	**21SMMT121**
Semester	**II**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**The Complex Number System:**	**04**

	1. The field of Complex numbers. 2. The complex plane. 3. Polar representation and roots of complex numbers. 4. The extended plane and its spherical representation.	1 1 1 1
Unit II	**Elementary Properties and Examples of Analytic Functions:**	**12**
	1. Power series. 2. Analytic functions. 3 Analytic functions as mappings, Möbius transformations	4 4 4
Unit III	**Complex Integration:**	**12**
	1. Riemann-Stieltjes integrals (without proof). 2. Power series representation of analytic functions. 3. Zeros of an analytic function. 4. The index of a closed curve.	3 3 3 3
Unit IV	**Cauchy's Theorem:**	**12**
	1. Cauchy's Theorem and Integral Formula. 2. The homotopic version of Cauchy's Theorem and simple connectivity (without proof ofTheorem 6.7). 3. Counting Zeros; the Open Mapping Theorem. 4. Goursat's Theorem.	3 3 3 3
Unit V	**Singularities:**	**12**
	1. Classification of singularities. 2. Residues. 3. The Argument Principle.	4 4 4
Unit VI	**The Maximum Modulus Theorem:**	**08**
	1. The Maximum Principle. 2. Schwarz's Lemma.	4 4

Textbook:

John B. Conway, Functions of One Complex Variable, 2nd Edition, Springer International Student Edition, Narosa Publishing House, 16th Reprint, 2002.

Unit I: Chapter 1: Sec. 2, 3, 4, 6.

Unit II: Chapter 3: Sec. 1, 2, 3.

Unit III: Chapter 4: Sec. 1, 2, 3, 4.

Unit IV: Chapter 4: Sec. 5, 6, 7, 8.

Unit V: Chapter 5: Sec. 1, 2, 3.

Unit VI: Chapter 6: Sec. 1, 2.

Reference:

1. Books:

1. Reinhold Remmert, Theory of Complex Functions, Springe, ISBN 9780387971957

2. Serge Lang, Complex Analysis, Fourth Edition, Springer, ISBN 9780387985923

3. Lars V. Ahlfors, Complex Analysis, Third Edition, McGraw-Hill, ISBN 0070850089

4. S. Ponnusamy , Herb Silverman, Complex Variables with Applications, Birkhauser Publications.

2. Website:

Complex Analysis - Pranav Haridas | Kerala School of Mathematics - NPTEL

https://www.youtube.com/results?search_query=complex+analysis+professor+pranav+haridas

Course/ Paper Title	**General Topology**
Course Code	**21SMMT122**
Semester	**II**
No. of Credits	**04**

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Prerequisites:**	**10**
	1. Cartesian Products.	1
	2. Finite Sets.	2
	3. Countable and Uncountable Sets.	3
	4. Infinite Sets and The Axiom of Choice.	2
	5. Well-Ordered Sets.	2

Unit II	**Topological Spaces and Continuous Functions:**	**20**
	1. Topological Spaces.	2
	2. Basis for a Topology.	2
	3. The Order Topology.	2
	4. The Product Topology on X x Y.	2
	5. The Subspace Topology.	2
	6. Closed Sets and Limit Points.	2
	7. Continuous Functions.	2
	8. The Product Topology.	2
	9. The Metric Topology.	2
	10. The Quotient Topology	2
Unit III	**Connectedness and Compactness:**	**15**
	1. Connected Spaces.	2
	2. Connected Subspaces of the Real Line.	2
	3. Components and Local Connectedness.	3
	4. Compact Spaces.	2
	5. Compact Subspaces of the Real Line.	2
	6. Limit Point Compactness.	2
	7. Local Compactness.	2
Unit IV	**Countability and Separation Axioms:**	**15**
	1. The Countability Axioms.	2
	2. The Separation Axioms.	3
	3. Normal Spaces.	2
	4. The Urysohn Lemma (only statement).	2
	5. The Urysohn Metrization Theorem (only statement).	2
	6. The Tietze Extension Theorem (only statement).	2
	7. The Tychonoff's Theorem (only statement).	2

Textbook:

J. R. Munkres, Topology, A First Course, (Prentice Hall, Second Edition), 2000.

Unit I: Chapter 1: Sec. 5 to 7, Sec. 9, 10.

Unit II: Chapter 2: Sec.12 to 22.

Unit III: Chapter 3: Sec. 23 to 29.

Unit IV: Chapter 4: Sec. 30 to 35, Chapter 5: Sec. 37.

Reference:

1. Books:

1. K. Janich, Topology, Springer, 1984.

2. M. A. Armstrong, Basic Topology, Springer, 1983.

3. K. D. Joshi, Introduction to General Topology, John Wiley &Sons.

2. Website:

Topology by Prof. P. Veeramani, Department of Mathematics, IIT Madras

https://www.youtube.com/results?search_query=general+topology+ntptl

Course/ Paper Title	**Rings and Modules**
Course Code	**21SMMT124**
Semester	**II**
No. of Credits	**04**

Unit No	**Title with Contents**	**No. of Lectures**
Unit I	**Rings:**	**16**
	1. Terminologies.	1
	2. Rings of Continuous Functions.	1
	3. Matrix Rings.	1
	4. Polynomial Rings.	1
	5. Power Series Rings.	1
	6. Laurent Rings.	1
	7. Boolean Rings.	2
	8. Some Special Rings.	2
	9. Direct Products.	2
	10. Several Variables.	2

	11. Opposite Rings.	1
	12. Characteristic of a Ring.	1
Unit II	**Ideals:**	**12**
	1. Definitions.	1
	2. Maximal Ideals.	1
	3. Generators.	1
	4. Basic Properties of Ideals.	1
	5. Algebra of Ideals.	2
	6. Quotient Rings.	2
	7. Ideals in Quotient Rings.	2
	8. Local Rings	2
Unit III	**Homomorphisms of Rings:**	**10**
	1. Definitions and Basic Properties.	2
	2. Fundamental Theorems.	2
	3. Endomorphism Rings.	2
	4. Field of fractions.	2
	5. Prime fields.	2
Unit IV	**Factorization in Domains:**	**12**
	1. Division in Domains.	2
	2. Euclidean Domains.	2
	3. Principal Ideal Domains.	2
	4. Factorisation Domains.	2
	5. Unique Factorisation Domains.	2
	6. Eisenstein’s Criterion.	2
Unit 5	**Modules:**	**10**
	1. Definitions and Examples.	1
	2. Direct Sums.	1
	3. Free Modules.	1

	4. Quotient Modules. 5. Homomorphisms. 6. Simple Modules. 7. Modules over P I D’s.	1 2 2 2

Textbook:

C. Musili, Rings and Modules, 2nd Revised Edition, Narosa Publishing House.

Unit I: Chapter 1.

Unit II: Chapter 2.

Unit III: Chapter 3.

Unit IV: Chapter 4.

Unit V: Chapter 5(except 5.4 and 5.5).

Reference:

1 Books:

1. Dummit and Foote, Abstract Algebra, Second Edition (Wiley India).
2. Luther and Passi, Algebra Vol. 2: Rings, Narosa Publishing House.
3. Jain and Bhattacharya, Basic Abstract Algebra, 2^{nd} Edition, Cambridge University Press.
4. Joseph Gallian, Contemporary Algebra, 7^{th} Edition, Narosa Publishing House.

2. Website:

Introduction to Rings and Fields - Krishna Hanumanthu | CMI - NPTEL

https://www.youtube.com/results?search_query=introduction+to+ring+theory+nptel

Course/ Paper Title	**Advanced Numerical Analysis**
Course Code	**21SMMT124:**
Semester	**II**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Root Finding Methods:**	**08**
	1. Convergence; Floating Point Number Systems; Floating Point Arithmetic. 2. Fixed Point Interaction Schemes; Newton’s Method; Secant Method; AcceleratingConvergence	3 5
Unit II	**System of Equations:**	**14**
	1. Gaussian Elimination; Pivoting Strategies. 2. Error Estimates and Condition Number; LU decomposition; Direct Factorization. 3. Iterative Techniques for Linear Systems: Basic Concepts and Methods. 4. Nonlinear Systems of Equations.	3 4 4 3
Unit III	**Eigenvalues and Eigenvectors:**	**05**
	1. The Power Method. 2. The Inverse Power Method. 3. Reduction to Symmetric Tridiagonal Form. 4. Eigenvalues of Symmetric Tridiagonal Matrices.	2 1 1 1
Unit IV	**Interpolation (and Curve Fitting):**	**09**
	1. Lagrange Form of Interpolating Polynomial. 2. Neville’s Algorithm. 3. The Newton Form of Interpolating Polynomial. 4. Optimal Points for Interpolation. 5. Piecewise Linear Interpolation. 6. Cubic Spline Interpolation.	1 1 1 2 2 2
Unit V	**Differentiation and Integration:**	**12**
	1. Numerical Differentiation, Part II. 2. Numerical Integration – The Basics and Newton-Cotes Quadrature; Composite Newton-Cotes Quadrature.	6 6

Unit VI	**Initial Value Problems of Ordinary Differential Equations:**	**12**
	1. Euler's Method; Higher-Order One-Step Methods: Taylor Methods. 2. Runge-Kutta Methods. 3. Multistep Methods (Adams-Bashforth Methods, The Two Step Adams-Bashforth Method, Milnes's Method). 4. Convergence and Stability Analysis.	3 3 3 3

Textbook:

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall 2007, ISBN 978-81-317-0942-9.

Unit I: Chapter 1: Sec. 1.2, 1.3, 1.4, Chapter 2: Sec. 2.3, 2.4, 2.5, 2.6.

Unit II: Chapter 3: Sec.3.1, 3.2, 3.4, 3.5, 3.6, 3.8, 3.10.

Unit III: Chapter 4: Sec. 4.1, 4.2, 4.4, 4.5.

Unit IV: Chapter 5: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6.

Unit V: Chapter 6: Sec. 6.2, 6.4, 6.5.

Unit VI: Chapter 7: Sec. 7.2, 7.3, 7.4, 7.5 (Adams-Bashforth Methods, Example 7.16 and Example 7.17), 7.6.

2. John H. Mathews, Kurtis D. Fink, Numerical Methods Using Matlab, 4th Edition, Pearson Education (Singapore) Pte. Ltd., Indian Branch, Delhi 2005.

(SciLab commands similar to MatLab commands can be used for problems)

Reference:

1. Books:

1. K .E. Atkinson, An Introduction to Numerical Analysis, Second Edition, John Wiley & Sons.
2. J. L. Buchaman, P. R. Turner, Numerical Methods and Analysis, McGraw Hill, 1992.
3. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific & Engineering Computation, 5th Edition, New Age International Publication.
4. Numerical Method Kit: For matlab, Scilab and Octave Users by Rohan Verma University of Delhi Independently published in 2020.
5. G Shanker Rao, Numerical Analysis, New Age International, 2006.
6. S.S.Sastry, Sastry Introductory Methods of Numerical Analysis Fifth Edition, PHI Learning Private Limited.

2. Website:

Numerical Analysis Instructor: Prof Usha Department Of Mathematics IIT Madras

https://www.youtube.com/results?search_query=numerical+analysis+nptel

Course/ Paper Title	**Partial Differential Equations**
Course Code	**21SMMT125**
Semester	**II**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**First Order P.D.E.:**	**25**
	1. Genesis of First Order P.D. E. 2. Classification of Integral. 3. Linear Equations of First the First Order. 4. Pfaffian Differential Equations. 5. Compatible Systems. 6. Charpit's Method. 7. Jacobi's Method. 8. Integral Surfaces Through a Given Curve. 9. Quasi-Linear Equations. 10. Non-Linear First Order P.D.E	1 3 3 4 2 3 3 3 1 2
Unit II	**Second Order P.D.E.:**	**35**
	1. Genesis of Second Order P.D. E. 2. Classification of Second Order P. D. E. 3. One Dimensional Wave Equation. i. Vibrations of an Infinite String. ii. Vibrations of a Semi-infinite String. iii. Vibrations of a String of Finite Length.	2 3 5

	iv. Vibrations of a String of Finite Length (Method of Separation of Variables). 4. Laplace’s Equation. i. Boundary Value Problems. ii. Maximum and Minimum Principles. iii. The Cauchy Problem. iv. The Dirichlet Problem for the Upper Half Plane. v. The Neumann Problem for the Upper Half Plane. vi. The Dirichlet Problem for a Circle. vii. The Dirichlet Exterior Problem for a Circle. viii. The Neumann Problem for a Circle. ix. The Dirichlet Problem for a Rectangle. x. Harnack's Theorem. 5. Heat Conduction Problem. i. Heat Conduction - Infinite Rod Case. ii. Heat Conduction - Finite Rod Case. 6. Duhamel's Principle. i. Wave Equation. ii. Heat Conduction Equation. 7. Classification in the Case of n-Variables. 8. Families of Equipotential Surfaces. 9. Kelvin's Inversion Theorem.	8 4 4 3 3 3

Textbook:

T. Amarnath : An Elementary Course in Partial Differential Equations (2nd edition) (Narosa Publishing House Pvt. Ltd.).

Unit I: Chapter 1: Sec. 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11.

Unit II: Chapter 2: Sec. 2.1, 2.2, 2.3(2.3.1, 2.3.2, 2.3.3, 2.3.5), 2.4(2.4.1 - 2.4.10), 2.5(2.5.1, 2.5.2), 2.6(2.6.1, 2.6.2), 2.7, 2.8, 2.9.

Reference:

1. Books:

1. K. Sankara Rao: Introduction to partial differential equation, third edition.

2. W. E. Williams: Partial Differential equations (Clarendon press-oxford).

3. E. T. Copson : Partial differential equations (Cambridge university press).

4. I.N. Sneddon: Elements of partial differential equations (Mc-Graw Hill Book Company).

2. Website:

Partial Differential Equations Instructor: Prof. Sirshendu De IIT Khargpur

https://www.youtube.com/results?search_query=partial+differential+equations+nptel