Maharashtra Education Society's

Abasaheb Garware College

(Autonomous)

(Affiliated to Savitribai Phule Pune University)

Two Year M. Sc. Degree Program in Mathematics

(Faculty of Science and Technology)

Syllabi under NEP -2020

M. Sc. I (Mathematics)

To be implemented from Academic Year 2023-2024

Title of the Course: M. Sc. (Mathematics)

Preamble:

Taking into consideration the rapid changes in science and technology and new approaches in different areas of Mathematics and related subjects, Board of studies in Mathematics after a thorough discussion with the teachers of Mathematics from Abasaheb Garware College and experts from industry as well as other Academic institutions has prepared the syllabus of M.Sc. I Semester - I and Semester- II (w.e.f. 2023-24) Mathematics course under the NEP-2020. The model curriculum as developed by U.G.C. is used as a guideline for the present syllabus.

Program Outcomes:

1) To maintain 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 frame work, for exchange, mobility and free dialogue across the Indian Mathematicians and associated community.
5) To create an aptitude for Mathematics in those students who show a promise for higher studies and creative work in Mathematics.
6) To create confidence in others, for equipping themselves with that part of Mathematics which is needed for various branches of Sciences or Humanities in which they have aptitude for higher studies and original work.

Eligibility:

Passed B.Sc. [Mathematics] or equivalent course.

Credit Distribution for PG

Year (2Year PG)	Level	Sem (2Year)	Major		RM	OJT/ FP	RP	Cum. Cr.	Degree
			Mandatory	Electives					
I	6.0	Sem I	12-14 (3*4 T+1*2 P)	1*4T	4			22	PG Diploma(after 3 Year Degree)
		Sem II	12-14 (3*4 T +1*2 T)	1*4T		4		22	
Cum. Cr. For PG Diploma			28	8	4	4		44	
Exist option :PG Diploma(40-44 Credits)after three year UG Degree									
II	6.5	Sem III	12-14 (3*4T+1*2 P)	1*4T			4	22	PG Degree after 3 Year UG OR PG Degree after 4 Year UG
		Sem IV	10-12 (3*4T)	1*4T			6	22	
			26	8			10	44	
Total of First and Second Year			54	16	4	4	10	88	
Cum. Cr. For 1 Year PG Degree			22-26	8			10	40-44	
Cum. Cr. For 2 Year PG Degree			46-54	16	4	4	10	80-88	
2 Years-4 Sem.PG Degree(80-88credits)after three Year UG Degree or 1 Year-2 Sem PG Degree(40-44credits)after 4 year UG Degree									
	8.0		Course Work Min.12(3*4)		Training in teaching/ Education /Pedagogy :4		16+Ph.D. Work		Ph.D. in Subject

Structure of the course: M. Sc. Mathematics

Year	Level	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures/ Practical to be conducted
1	6.0	I	Core	MTS-501-MJ	Linear Algebra	Theory	4	60
			Core	MTS-502-MJ	Group Theory	Theory	4	60
			Core	MTS-503-MJ	Advanced Calculus	Theory	4	60
			Core	MTS-504-MJP	Programming with Python	Practical	2	12
			Elective	MTS-510-MJ	Dynamical Systems	Theory (Choose any one)	4	60
				MTS-511-MJ	Number Theory			
				MTS-512-MJ	Combinatorics			
			RM	MTS-541-RM	Research Methodology	Theory	2	30
				MTS-541-RMP		practical	2	12
		II	Core	MTS-551-MJ	Complex Analysis	Theory	4	60
			Core	MTS-552-MJ	Rings and Modules	Theory	4	60
			Core	MTS-553-MJ	General Topology	Theory	4	60
			Core	MTS-554-MJP	Numerical Analysis	Practical	2	12
			Elective	MTS-560-MJ	Graph Theory	Theory (Choose any one)	4	60
				MTS-561-MJ	Classical Mechanics			
				MTS-562-MJ	Coding Theory			
			OJT/FP	MTS-581-OJT	On Job Training or Field Project		4	60

Year	Level	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
2	6.5	III	Core	MTS-601-MJ	Measure and Integration	Theory	4	60
			Core	MTS-602-MJ	Ordinary differential Equations	Theory	4	60
			Core	MTS-603-MJ	Field theory	Theory	4	60
			Core	MTS-604-MJP	Machine learning usingPython	Practical	2	12
			Elective	MTS-610-MJ	Probability and Statistics	Theory (Choose any one)	4	60
				MTS-611-MJ	Algebraic topology			
				MTS-612-MJ	Integral Equations and Calculus of variation			
			RP	MTS-631-RP	Research Project		4	
		IV	Core	MTS-651-MJ	Functional analysis	Theory	4	60
			Core	MTS-652-MJ	Differential Geometry	Theory	4	60
			Core	MTS-653-MJ	Partial Differential Equations	Theory	4	60
			Elective	MTS-660-MJ	Commutative Algebra	Theory (Choose any one)	4	60
				MTS-661-MJ	Representation theory of finite groups			
				MTS-662-MJ	Differential Manifolds			
			RP	MTS-681-RP	Research Project		6	

The study tour is important to learn, network and collaborate with academics, students and industry professionals in Science and Technology, Engineering and Mathematics recruiters. It is also important to know and understand different cultures, easily adapt to new environments, skillfully negotiate business deals.

Therefore, Department of Mathematics should arrange a student's study tour in each Academic year.

SEMESTER-I

Course Code and Title: MTS-501-MJ: LINEAR ALGEBRA

Lectures: 60 (Credits- 4)

Course Outcomes:

1. To learn vector spaces, basis and dimension.
2. Explain the concept of linear transformation and study its applications
3. Students are able to find eigenvalues, eigenvectors, minimal polynomial, diagonalizable matrix.
4. Students learn inner product spaces, self adjoint, normal and unitary operators.

Unit I: Vector Spaces [8 Hours]

1.1 Definition and Examples
1.2 Subspaces
1.3 Basis and Dimension

Unit II: Linear Transformation [12 Hours]

2.1 Linear Transformations
2.2 Quotient Spaces
2.3 Direct sum
2.4 Matrix of linear transformation
2.5 Duality

Unit III: Canonical forms [20 Hours]

3.1 Eigenvalues and eigenvectors
3.2 The Minimal polynomial
3.3 Diagonalizable and Triangulable operators
4.4 The Jordan form

Unit IV: Inner Product spaces [16 Hours]

4.1 Inner products
4.2 Orthogonality
4.3 The Adjoint of a linear transformation
4.4 Unitary Operators
4.5 Self adjoint and normal operators
4.6 Polar and Singular value decompositions

Unit V: Applications of Linear Algebra [4 Hours]

(At least three applications to be taken from Chapter 11 of book 2)

Recommended Book:

1) Vivek Sahai, Vikas Bist, Linear Algebra, Narosa Publication.
   Unit 1: Chapter 2: 1 to 3
   Unit 2: Chapter 2: 4 to 8
   Unit 3: Chapter 3: 1 to 4
   Unit 4: Chapter 4: 1 to 6
2) Elementary Linear Algebra (Applications Version) (11th Edition) – Howard Anton, Chris Rorres. (Wiley)

Reference Books:

1) K. Hoffman, Ray Kunze, Linear Algebra, Prentice Hall of India Private Ltd.
2) P. B. Bhattacharya, S. R. Nagpaul, S. K. Jain, First Course in Linear Algebra, 2nd Edition, New Age International Publishers.
3) S. Kumaresan, Linear Algebra A Geometric Approach, PHI Learning Private Ltd

Course Code and Title: MTS-502-MJ: GROUP THEORY

Lectures: 60 (Credits- 4)

Course Outcomes:

1. Students are able to understand the difference between centralizer, normalizer andstabilizer.
2. To learn group action, conjugation and class equation.
3. To explain Sylow theorem and to apply Sylow theorems for solving problems.
4. Students learn direct and semidirect products and fundamental theorem of finitely generated an abelian groups.
5. To study p-groups, Nilpotent groups and solvable groups.

Unit I: Groups, Subgroups, Quotient groups and Homomorphism [18 Hours]

1.1 Revision Definition and Examples of groups
1.2 Definition and examples of subgroups
1.3 Centralizers and Normalizers, Stabilizers and Kernels
1.4 Cyclic groups
1.5 Definition and examples of quotient groups
1.6 Isomorphism theorems

Unit-II: Group Actions [24 Hours]

2.1 Group actions and permutation representation
2.2 Group acting on themselves by left multiplication and Cayley's Theorem
2.3 Group acting on themselves by conjugation and Class equation
2.4 Automorphisms
2.5 The Sylow Theorems
2.6 The simplicity of A_n

Unit-III: Direct and Semidirect Product and Abelian groups [10 Hours]

3.1 Direct Products
3.2 Fundamental theorem of Finitely generated Abelian groups
3.3 Semidirect Products

Unit-IV: Solvable groups [8 Hours]

4.1 p-groups, Nilpotent groups and solvable groups

Recommended Books:

David S. Dummit, Richard M. Foote, Abstract Algebra, 2nd Edition, John Wiley and Sons (Indian Edition)
Unit 1: Chapter 1: 1.1 to 1.3, Chapter 2: 2.1 to 2.3, Chapter 3: 3.1 to 3.3
Unit 2: Chapter 4: 4.1 to 4.6
Unit 3: Chapter 5: 5.1, 5.2, 5.5
Unit 4: Chapter 6: 6.1

Reference Books:

1. S. Luthar, I. B. S. Passi, Algebra (Vol 1), Groups; Narosa Publication House.
2. 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.

Course Code and Title: MTS-503-MJ: ADVANCED CALCULUS

Lectures: 60 (Credits- 4)

Course Outcomes:

1. To learn directional derivatives.
2. Students are able to find work done using line integral.
3. Understand geometric interpretation of the double integral as a volume.

4. Students learn Green's theorem, Stoke's theorem, surface integral, curl and divergence, divergence theorem.

Unit-I: Differential Calculus of Scalar and Vector Fields [20 Hours]

1.1 Functions from R^n to R^m, Scalar and vector fields, Limits and continuity.

1.2 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 Implicit Function theorem. (Without proof)

1.3 Directional derivatives and continuity, The total derivatives, The gradient of a scalar field, A sufficient condition for differentiability.

1.4 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.

Unit-II: Line Integrals [10 Hours]

2.1 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.

Unit-III: Multiple Integrals [15 Hours]

3.1 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.

3.2 Integrability of continuous functions; Integrability of bounded functions with Discontinuities, Double integrals extended over more general regions, Applications to area and volume, Worked examples.

3.3 Green's theorem in the plane (without proof), Some applications of Green's Theorem, A necessary and sufficient condition for a two-dimensional Vector Field to be a gradient.

3.4 Change of variables in a double integral, special cases of the transformation formula with proof, General case of the transformation formula with proof,

Extensions to higher dimensions, Change of variables in an n-fold integral, Worked examples.

Unit-IV: Surface Integrals [15 Hours]

4.1 Parametric representation of a surface, the fundamental vector product, the fundamental vector product as a normal to the surface, Area of a parametric surface.

4.2 Surface integrals, Change of parametric representation, Other notations for surface integrals

4.3 The theorem of Stokes, Curl and divergence of a vector field, Properties of curl and divergence, the divergence theorem (Gauss' theorem) and applications of divergence theorem.

Recommended Book:

1. Tom M. Apostol, Calculus Volume II (Second Edition) Indian Reprint 2016 (John Wiley & Sons, Inc) ISBN: 978-81-265-1520-2.
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 1: Chapter 8: 8.1, 8.4, 8.6-8.22

Unit 2: Chapter 10: 10.2 to 10.11, 10.14 to 10.16

Unit 3: Chapter 11: 11.2 to 11.15, 11.19 to 11.22, 11.26 to 11.33

Unit 4: 12.1 to 12.15, 12.19, 12.20

Reference Books:

1) Gerald B. Folland, Advanced Calculus, Pearson Edition 2012. 2) A Devinatz, Advanced Calculus (Holt, Reinhart & Winston) 1968.

Course Code and Title: MTS-504-MJP: PROGRAMMING WITH PYTHON

(Credits- 2)

Course Outcomes:

1. Study python on different operating systems, variables, strings and comments.
2. Working with lists and understand difference between lists and dictionaries.
3. Study loops in python.
4. Learn functions, classes, files in python.

Unit I: Getting Started, Variables and Simple Data Types

Setting Up your Programming Environment, Python on different Operating Systems, Troubleshooting, Running Python Programs from a terminal Variables, Strings, Numbers, comments, The Zen of Python

Unit II: **Introducing Lists, Working with Lists**

What is a List? Changing, Adding and Removing Elements, organizing a List, Avoiding Index Errors When Working with Lists, Looping Through an Entire List, Avoiding Indentation Errors, Making Numerical Lists, Working with Part of a List, Tuples, Styling your Code

Unit III: **If Statements, Dictionaries**

Conditional Tests, If Statements, Using if Statements with Lists, Styling your If Statements Working with Dictionaries, Looping through a dictionary, Nesting

Unit IV: User Input and While Loops, Functions

Input( ) Function**,** Introducing while loops, Using a while Loop with Lists and Dictionaries Defining a Function, Passing Arguments, Return Values, Passing a List, Passing an Arbitrary Number of Arguments, Storing Your Function in Modules, Styling Functions.

Unit- V: Classes, Files and Exceptions, Testing Your Code

Creating and Using a Class, Working with Classes and Instances, Inheritance, Importing Classes, The Python Standard Library, Styling Classes Reading from a file, writing to a File, Exceptions, Storing Data Testing a Function, Testing a class

Unit VI: Numpy, Sympy module

Mathematics using Numpy, Sympy module

Recommended Book:

Python Crash Course by Eric Matthes, no starch press, San Francisco
Part I: Chapter 1 to 11

Reference Books:

1. H. Bhasin: Python Basics, MERCURY LEARNING AND INFORMATION Dulles, Virginia Boston, Massachusetts New Delhi
2. Beginning-Python, Second Edition by Magnus Lie Hetland
3. The Complete Reference Python by Martin C. Brown
4. Head First Python by Patrick Barry
5. Learning Python, O‟Reilly by Mark Lutz 5. Python in a Nutshell, O‟Reilly by Alex Martelli

Total 12 practicals based on all of the above topics will be conducted.

Course Code and Title: MTS-510-MJ: DYNAMICAL SYSTEMS

Course Outcomes:

1. To learn one dimensional and two dimensional differential system.
2. To learn qualitative properties of solution of differential system by plotting phase portrait.
3. To learn how to find solution of linear differential system using exponential method.
4. To learn about stability of solutions of differential system.
5. To learn linearization of differential systems and Hartman-Grobman Theorem.
6. To learn about stable, unstable, centre manifolds of an autonomous systems.
7. To learn index theory, Poincare Bendixson theorem, Poincare sphere.
8. To learn about limit cycles of autonomous systems.

Unit I: Introduction [05 Hours]

1.1 Modelling
1.2 What Are Differential Equations?
1.3 One-Dimensional Dynamics
Population Dynamics, Mechanical Systems Oscillating Circuits, Fluid Mixing
1.5 Two-Dimensional Dynamics, Null clines, Phase Curves
1.6 The Lorenz Model
1.7 Quadratic ODEs: The Simplest Chaotic Systems

Unit II: Linear System [13 Hours]

2.1 Matrix ODE's, Eigen values and Eigenvector, Diagonalization
2.2 Two Dimensional Linear System
2.3 Exponential of Operators.
2.4 Fundamental Solution Theorem
2.5 Complex Eigen values
2.6 Multiple Eigen values, Semisimple-Nilpotent Decomposition
The Exponential, Alternatives Method
2.7 Linear Stability
2.8 Nonautonomous Linear System and Floquet Theory

Unit III: Existence and Uniqueness [05 Hours]

3.1 Existence and Uniqueness Theorem
3.2 Dependence on Initial Conditions and Parameters
3.3 Maximal Interval of Existence

Unit IV: Dynamical Systems [15 Hours]

4.1 Definitions
4.2 Flows
4.3 Global Existence of Solutions
4.4 Linearization
4.5 Stability
4.6 Lyapunov Functions
4.7 Topological Conjugacy and Equivalence
4.8 Hartman–Grobman Theorem
4.9 Omega-Limit Sets
4.10 Attractors and Basins
4.11 Stability of Periodic Orbits
4.12 Poincaré Maps

Unit V: Invariant Manifolds [10 Hours]

5.1 Stable and Unstable Sets
5.2 Heteroclinic Orbits
5.3 Stable Manifolds
5.4 Local Stable Manifold Theorem
5.5 Global Stable Manifolds
5.6 Centre Manifolds

Unit VI: The Phase Plane [12 Hours]

6.1 Nonhyperbolic Equilibria in the Plane
6.2 Two Zero Eigen values and Nonhyperbolic Nodes
6.3 Imaginary Eigen values: Topological Centers
6.4 Symmetries and Reversors
6.5 Index Theory
6.6 Poincaré–Bendixson Theorem
6.7 Liénard Systems
6.8 Behavior at Infinity: The Poincaré Sphere

Recommended Book:

James D. Meiss, Differential Dynamical Systems, Society for Industrial and Applied Mathematics Philadelphia Publication

Reference Books:

1) Morris W. Hirsh, Stephen Smale, Robert L. Devaney, Differential Equations, Dynamical Systems and an Introduction to Chaos, Academic Press.

2) Lawrence Perko, Differential Equations and Dynamical Systems, Springer Publication.

Course Code and Title: MTS-511-MJ: NUMBER THEORY

Lectures: 60 (Credits- 4)

Course Outcomes:

1. To introduce number theoretic problems and to different areas of number theory.
2. To understand and apply the fundamental concepts in Number theory
3. To apply skills in calculation and manipulation of problem solving in the following areas: integers, prime numbers, congruences, arithmetic functions, quadratic residues, Diophantine equations.

Unit I: Arithmetical Functions and Dirichlet Multiplication [15 Hours]

1.1 The Mobius function $\mu(n)$
1.2 The Euler Totient function $\phi(n)$ and relation between $\mu(n)$
1.2 The product formula for $\phi(n)$
1.3 The Dirichlet Product of Arithmetical functions
1.3 Dirichlet Inverses and the Mobius Inversion formula
1.4 Mangoldt function
1.5 Multiplicative functions and Dirichlet Multiplication
1.6 Inverse of completely multiplicative functions
1.7 Liouville's function, the divisor functions
1.8 Generalized convolutions
1.9 Bell series of Arithmetical functions

Unit II: Congruences [12 Hours]

2.1 Definition and basic properties of congruences
2.2 Residue Classes and complete residue system
2.3 Linear congruences
2.4 Reduced Residue systems and Euler-Fermat theorem
2.5 Polynomial congruences modulo p, Lagrange's Theorem and its applications
2.6 Simultaneous congruences and Chinese remainder theorem
2.7 Polynomial congruences and Prime power moduli

Unit III: Finite Abelian Groups and Their Characters [12 Hours]

3.1 Characters on finite abelian groups
3.2 The Character group
3.3 The orthogonality relation for characters
3.4 Dirichlet characters
3.5 The sum involving Dirichlet characters

3.6 The nonvanishing of L(1, χ) for real nonprincipal χ

3.7 The Dirichlet's theorem for primes of the form 4n-1 and 4n+1 (without proof)

Unit IV: Quadratic Residues and the Quadratic Reciprocity law [15 Hours]

4.1 Quadratic Residues
4.2 Legendre symbol and its properties
4.3 Evaluation of (-1/p) and (2/p)
4.4 Gauss Lemma
4.5 Quadratic reciprocity law and its applications
4.6 The Jacobi Symbol
4.7 Applications to Diophantine equations

Unit V: Introduction to Algebraic Integers [06 Hours]

5.1 Gaussian integers
5.2 Integrality

Recommended Book:

T. M. Apostol, An Introduction to Analytical Number Theory
Chapters: Chapter 2 (2.1 to 2.17) , Chapter 5 (5.1 to 5.9), Chapter 6 (6.5 to 6.10), Chapter 9 (9.1 to 9.8)
Jurgen Neukirch, Algebraic Number Theory
Chapters: Chapter 1(1.1, 1.2)

Reference Books:

1) Ivan Niven & H.S. Zuckerman, An introduction to number theory
2) David M Burton, Elementary Number Theory
3) K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory

Course Code and Title: MTS-512-MJ: COMBINATORICS

Lectures: 60 (Credits- 4)

Course Outcomes:

1. To learn general counting methods for arrangements and selections.
2. Students will able to use generating functions and recurrence relations to solve problems.
3. Understand inclusion-exclusion with Venn diagrams and inclusion – exclusion formula.
4. To learn restricted positions and Rook polynomials.

Unit I: General Counting Methods for Arrangements and Selections [20 Hours]

Counting principles, arrangements and selections, arrangements and selection with repetition, distributions, binomial identities

Unit II: Generating function [14 Hours]

Generating function models, calculating coefficients of generating functions, Partitions, exponential generating functions, a summation method

Unit III: Recurrence Relations [14 Hours]

Recurrence relation models, Divide and conquer relations, solution of linear homogeneous and Inhomogeneous recurrence relation, solution with generating functions.

Unit IV: Inclusion-exclusion [12 Hours]

Counting with Venn diagrams, inclusion – exclusion formula, restricted positions and Rook polynomials, Derangements, Counting onto functions.

Recommended Book:

Alan Tucker, Applied Combinatorics (fourth edition), John Wiley & sons, New York (1995)

Unit 1: Chapter 5 (sections 1-6)
Unit 2: Chapter 6 (sections 1-5)
Unit 3: Chapter 7 (sections 1-5)
Unit 4: Chapter 8 (sections 1-3)

Reference books:

1. V. Krishnamurthy, Combinatorial, Theory and Applications, East West Press, New Delhi (1989) Scientific (1996)
2. K.D. Joshi: Foundations of discrete mathematics, Wiley
3. Marshall Hall: Combinatorial theory, Wiley

Course Code and Title: MTS-541-RM: RESEARCH METHODOLOGY

Lectures: 30 (Credits- 2)

Course Outcomes

1. To understand the concept, need and importance of Research.
2. To make them aware of the various methods of types of research.
3. To make them aware of the various research tools.
4. To help the learner to realize the research problem and try to find solutions through research

Unit I: Literature Survey [4 Hours]

1.1 Scientific research and literature survey.
1.2 History of Mathematics

Unit II : Introduction of Research [10 Hours]

2.1 Finding and solving research problems.
2.2 Role of a supervisor, survey of a research topic, publishing a paper, reviewing a paper, research grant proposal writing, copyright issues, ethics and plagiarism.

Unit III: Research Tools [8 Hours]

3.1 Research tools. Searching google (query modifiers), MathSciNet, ZMATH, Scopus, ISI Web of Science, Impact factor, h-index, Google Scholar, ORCID, JStor, Online and open access journals, Virtual library of various countries

Unit IV: Scientific Writing [8 Hours]

4.1 Scientific writing and presentation. Writing a research paper, survey article, thesis writing; LaTeX, PSTricks, Beamer, HTML and MathJaX
4.2 Software for Mathematics. Mathematica/MATLAB/Scilab/GAP

Reference:

1. J. Stillwell, Mathematics and its History, Springer International Edition, 4th Indian Reprint, 2005
2. L. Lamport, LaTeX, a Document Preparation System, 2nd ed, Addison-Wesley, 1994.
3. Norman E. Steenrod, Paul R. Halmos, Menahem M. Schiffer, Jean A. How Write Mathematics, American Mathematical Society, 1973.
4. Nicholas J. Higham, Handbook of Writing for the Mathematical Sciences, 2ed, SIAM, 1998.

Course Code and Title: MTS-541-RMP: Research Methodology (Credits- 2)

12 practicals based on Research Methodology theory course.

SEMESTER-II

Course Code and Title: MTS-551-MJ: COMPLEX ANALYSIS

Lectures: 60 (Credits- 4)

Course Outcomes:

1. Students understand the different properties of complex numbers.
2. Study complex integration.
3. Students are able to classify singularities.
4. Students are able to find residues.

Unit I: The Complex Number System. [4 hours]

1.1 The real numbers.
1.2 The field of complex numbers.
1.3 The complex plane.
1.4 The Polar representation and roots of complex numbers.
1.5 Lines and half planes in complex plane.
1.6 The extended plane and its spherical representation.

Unit II: Elementary properties and examples of Analytic Functions: [12 hours]

2.1 Power series
2.2 Analytic functions
2.3 Analytic functions as mappings, Mobius transformations.

Unit III: Complex integration: [22 hours]

3.1 Riemann Stieltjes integrals.
3.2 Power series of analytic functions.
3.3 Zeros of an analytic function.
3.4 The index of a closed curve.
3.5 Cauchy's theorem and Integral formula.
3.6 Homotopic version of Cauchy's theorem and simple connectivity.
3.7 Counting zeros: The Open Mapping theorem.
3.8 Goursat's theorem.

Unit IV: Singularities and The Maximum Modulus Theorem [22 hours]

4.1 Classification of singularities.
4.2 Residues.
4.3 The argument Principle.
4.4 The Maximum Principle
4.5 Schwartz's Lemma

4.6 The Riemann mapping theorem (Without proof)

Recommended Book:

John B. Conway Functions of One Variable, Springer International student edition
Unit I: Chapter 1: 1 to 6
Unit II: Chapter 3: 1 to 3
Unit III: Chapter 4: 1 to 8
Unit IV: Chapter 5: 1 to 3, Chapter 6: 1, 2

Reference Books:

1. S. Ponnusamy, Foundation of Complex Analysis, Narosa Publications. (Second Edition)
2. L.V. Alfors, Complex Analysis, McGraw Hill, 1979.
3. J. W. Brown and R.V. Churchill, Complex Variables and Applications, Indian Edition. (Eighth Edition).

Course Code and Title: MTS-552-MJ: RINGS AND MODULES

Lectures: 60 (Credits - 4)

Course Outcomes:

1. Students understand the different examples of rings
2. Students learn ideals.
3. Students understand domains, PID and UFD.
4. Students learn free module, quotient module, simple module and module over PID.

Unit I: Introduction to Rings [14 hours]

1.1 Basic definitions and examples
1.2 Polynomial Rings, Matrix Rings, Group Rings
1.3 Ring Homomorphism's and Quotient Rings
1.4 Properties of Ideals
1.5 Rings of fractions

Unit II: Euclidean domains, Principal ideal domains and unique factorization domains [12 hours]

2.1 Euclidean domains
2.2 Principal Ideal domains
2.3 Unique factorization domains

Unit III: Polynomial Rings [14 hours]

3.1 Definitions and Basic Properties

3.2 Polynomial Rings over Fields I

3.3 Polynomial Rings that are UFD

3.4 Irreducibility Criterion

3.3 Polynomial Rings over Fields II

Unit IV: Module theory [20 hours]

4.1 Basic definitions and Examples

4.2 Quotient Modules and Module homomorphism's

4.3 Generation of Modules, Direct sums and Free Modules

4.4 The Basic theory of Module over PID

Recommended Book:

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

Unit 1: Chapter 7: 7.1 to 7.5

Unit 2: Chapter 8: 8.1 to 8.3

Unit 3: Chapter 9: 9.1 to 9.5

Unit 4: Chapter 10: 10.1 to 10.3, Chapter 12: 12.1

Reference Books:

1. C. Musili, Rings and Modules, 2nd Revised Edition, Narosa Publishing House.
2. Luther and Passi, Algebra II, Narosa Publishing House.
3. Jain and Bhattacharya, Basic Abstract Algebra, 2nd Edition, Cambridge University Press.
4. Joseph Gallian, Contemporary Algebra, 7th Edition, Narosa Publishing House.

Course Code and Title: MTS-553-MJ: GENERAL TOPOLOGY

Lectures: 60 (Credits- 4)

Course Outcomes:

1. Students study topological spaces.
2. Students study connectedness and compactness of topological spaces.
3. Students study Countability and separation axioms of topological spaces.
4. Understand difference between Metric Spaces and Topological Spaces.

Unit I: Topological Spaces [15 Hours]

1.1 Infinite Sets and Axiom of Choice
1.2 Well Ordered Sets
1.3 Topological Spaces
1.4 Basis for a Topology
1.5 Order Topology
1.6 Product Topology on X× Y
1.7 Subspace Topology

Unit II: Continuous Functions [10 Hours]

2.1 Closed Sets and Limit Points
2.2 Continuous Functions
2.3 The Product Topology, Metric Topology
2.4 Quotient Topology

Unit III: Connected and Compact Spaces [20 Hours]

3.1 Connected spaces
3.2 Connected Subspaces of Real Line
3.3 Components and Local Connectedness
3.4 Compact spaces
3.5 Compact Subspaces of the Real Line
3.6 Limit point compactness
3.7 Local Compactness

Unit IV: Countability and Separation Axioms [15 Hours]

4.1 The Countability Axioms
4.2 The Separation axioms and Normal Spaces
4.3 Urysohn Lemma
4.4 The Urysohn Metrization Theorem (Without proof)
4.5 Tietze Extension Theorem (Without proof)
4.6 Tychonoff's Theorem (Without proof)

Recommended Book:

J. R. Munkres, Topology: A First Course, (Prentice Hall, Second Edition), 2000.
Unit I: Chapter 1: 9, 10, Chapter 2: 12 to 16
Unit II: Chapter 2: 17 to 22
Unit III: Chapter 3: 23 to 29
Unit IV: Chapter 4: 30 to 35, 37

Reference Books:

1. K Janich. Topology. Springer, 1984.
2. M A Armstrong. Basic Topology. Springer, 1983.
3. O Viro, O Ivanov, V Kharlamov, and N Netsvetaev. Elementary Topology: Problem Textbook, AMS Publication, 2008.
4. K. D. Joshi, Introduction to General Topology, John Wiley & Sons.

Course Code and Title: MTS-554-MJP: NUMERICAL ANALYSIS

Lectures: 30 (Credits- 2)

Course Outcomes:

4 To learn different methods to find roots of equations.
5 To learn techniques to solve system of equations.
6 Students learn eigenvalues and eigenvectors.
7 Students are able to find integration of functions and solution of Ordinary Differential Equations.

Unit I: Roundoff and Truncation Errors [5 Hours]

1.1 Errors
1.2 Roundoff errors
1.3 Truncation Errors

Unit II: Root Finding Methods [5 Hours]

2.1 Bracketing Methods: Graphical Methods, Bracketing Methods and Initial Guesses, Bisection, False Position
2.2 Open Methods: Simple Fixed-Point Iteration, Newton- Raphson, Secant Method, Polynomials

Unit III: Eigenvalues [5 Hours]

3.1 The Power Method
3.2 The Inverse Power Method
3.3 Reduction to Symmetric Tridiagonal Form

Unit IV: Interpolation [5 Hours]

4.1 Introduction to Interpolation
4.2 Newton Interpolating polynomial
4.3 Lagrange Interpolating polynomial
4.4 Inverse Interpolation

4.5 Extrapolation and oscillations

Unit V: Regression [7 hours]

5.1 Random numbers and simulation

5.2 Linear least square regression

5.3 Linearization of Nonlinear relationship

5.4 Polynomial regression

5.5 Multiple linear regression

5.6 General linear least squares

5.7 QR factorization and backslash operator

5.8 Nonlinear regression

Unit VI: Fourier Analysis [3 hours]

6.1 Curve fitting with sinusoidal functions

6.2 Continuous Fourier series

6.3 Frequency and time Domain

6.4 Fourier integral and transform

6.5 Discrete Fourier Transform

6.6 The Power spectrum

Recommended Book:

Applied Numerical Methods with MATLAB for Engineers and Scientists, Steven C. Chapra, Tata Mc Graw - Hill Edition, Third Edition.

Reference Books:

1) Brian Bradie**,** A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall 2007
2) K.E. Atkinson, An Introduction to Numerical Analysis, Second Edition, John Wiley & Sons
3) John H. Mathews, Kurtis D. Fink, Numerical Methods Using MATLAB, 4th Edition, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, Delhi 2005
4) Numerical Analysis (9th Edition) - Richard L. Burden and J. Douglas Faires. (Brooks/Cole)
5) S. S. Sastry - Introductory methods of numerical analysis (2012, PHI Learning Pvt. Ltd.)

Total 12 practicals based on all of the above topics will be conducted.

Course Code and Title: MTS-560-MJ: GRAPH THEORY

Lectures: 60 (Credits-4)

Course Outcomes:

1. To understand and apply the fundamental concepts in graph theory
2. Model problems using graphs and to solve these problems algorithmically.
3. Apply theories and concepts to test independent mathematical thinking in problem solving and proof writing.

Unit I: Fundamental concepts **[15 Hours]**

1.1 What is a Graph?
Graphs as Models; Matrices and Isomorphism; Decomposition and Special Graphs; Degree of a vertex; Counting and Bijections

1.2 Paths, Cycles and Trails: Paths, Cycles, Trails: Connection in Graphs; Bipartite Graphs; Eulerian Circuits; Hamiltonian Cycles

1.3 Directed Graphs: Definition and Examples; Vertex Degrees; Eulerian Digraphs

Unit II: Trees and Distances **[16 Hours]**

2.1 Basic Properties: Properties of Trees, Distance in Trees and Graphs

2.2 Spanning Trees and Enumeration: Enumeration of Trees, Spanning Trees in Graphs

2.3 Optimization and Trees: Minimum Spanning Tree, Shortest Paths

Unit III: Matching and Factors **[15 Hours]**

3.1 Matching and Covers:
Maximum Matching's, Hall's Matching Condition, Min-Max Theorem

Unit IV: Connectivity and Paths **[12 Hours]**

4.1 Cuts and Connectivity: Connectivity; Edge-connectivity

4.2 2-connected Graphs

Unit V: Introduction to Four color theorem and Five color theorem, Planarity **[2 Hours]**

Recommended Book:

Douglas B. West, Introduction to Graph Theory 2nd Edn, PHI Learning Pvt. Ltd.

Unit I: Section 1.1, 1.2, 1.3 (Counting and Bijections), Section 7.2 (Hamiltonian Cycles) Section 1.4 (Definitions, Vertex Degrees, Eulerian Digraphs)

Unit II: Section 2.1 (Properties of Trees, Distance in Trees and Graphs), Section 2.2 (Enumeration of Trees, Spanning Trees), Section 2.3 (Minimum Spanning Tree, Shortest Path);

Unit II: Section 3.1 (Maximum Matchings, Hall's Matching Condition, Min-Max Theorem)
Unit II: Section 4.1 (Connectivity, Edge-Connectivity), Section 4.2 (2-connected Graphs)
Unit V: Section 6.1 (Euler's Formula without proof), 6.2 (Kuratowski Theorem without proof), Brooks Theorem (without proof), Chromatic polynomial (computation only), Four color theorem (Idea only).

Reference Books:

1) John Clarke and D.A. Holton, A First Look at Graph Theory, Allied Publisher (1991)
2) Harary, Graph Theory, Narosa Publishers, New Delhi (1989)

Course Code and Title: MTS-561-MJ: CLASSICAL MECHANICS

Lectures: 60 (Credits-4)

Course Outcomes:

1. To learn about Lagrangian and Hamiltonian formulation of equation of motions.
2. To learn Conservation Theorem and Symmetry Properties.
3. Students are able to understood Angular Momentum and Kinetic energy of the motion.
4. To learn Euler's theorem on Motion of a rigid body.

Unit I: Survey of Elementary Principles [15 Hours]

1.1 Mechanics of a Particle
1.2 Mechanics of system of Particles
1.3 Constraints.
1.4 D'Alemberts Principle and Lagrange's Equations
1.5 Velocity dependant potentials and dissipation function
1.6 Simple Applications of Lagrange's Formulation

Unit II: Variational Principle and Lagrange's Equations [15 Hours]

2.1 Hamilton's Principle
2.2 Some techniques of Calculus of variation
2.3 Derivations of Lagrange's Equations from Hamilton's principle
2.4 Extensions of Hamilton's principle to non-holonomic systems
2.5 Advantages of variational Principle Formulation
2.6 Conservation Theorems and Symmetry Properties
2.7 Energy function and the conservation of energy

Unit III: Kinematics of Rigid Body Motion [15 Hours]

3.1 Independent co-ordinates of rigid body

3.2 Orthogonal transformations
3.3 Formal properties of transformation Matrix
3.4 The Euler Angles
3.5 The Cayley Klein Parameters and related quantities
3.6 Euler's theorem on Motion of a rigid body
3.7 Finite Rotations
3.8 Infinitesimal Rotations
3.9 Rate of change of a vector

Unit IV: The Rigid Body Equations of Motion [15 Hours]

4.1 Angular Momentum and Kinetic energy of Motion about a point
4.2 Tensors
4.3 The Inertia Tensor and the Moment of Inertia
4.4 Eigenvalues of the Inertia Tensor and Principal axis Transformations
4.5 Solving Rigid body problems and Euler's Equations of Motion
4.6 Introduction of two body and three body problems.

Recommended Book:

Classical Mechanics (3rd Ed.) by Herbert Goldstein, Charles Poole, John Safko (Pearson Education)
Chapters: Chapter 1, Chapter 2, Chapter 4: 4.1-4.9, Chapter 5: 5.1-5.5

Reference Books:

1) Problems in Classical Mechanics by L. N. Katkar (Narosa Publication)
2) Classical Mechanics by Gupta, Kumar and Sharma (A Pragati Edition).
3) Classical Mechanics by Rana and Joag (McGraw Hill India)

Course Code and Title: MTS-562-MJ: CODING THEORY

Lectures: 60 (Credits- 4)

Course Outcomes:

1. To learn error detection and linear codes.
2. To learn bounds in coding theory, cyclic codes.
3. Students learn decoding and error correction.

Unit I: Error detection [12 Hours]

1.1 Correction and decoding: Communication channels, Maximum likelihood Decoding
1.2 Hamming distance, Nearest neighbor / minimum distance decoding,

Distance of a code

Unit II: Linear codes [18 Hours]

2.1 Vector spaces over finite fields, Linear codes, Hamming weight, Bases of linear codes

2.2 Generator matrix and parity check matrix, Equivalence of linear codes, Encoding With a linear code, Decoding of linear codes

2.3 Cossets, Nearest neighbor decoding for linear codes, Syndrome decoding

Unit III: Bounds in Coding Theory [16 Hours]

3.1 Main coding theory problem, lower bounds, sphere covering bounds, Gilbert Varshamov bound, Hamming Codes

3.2 Hamming bound and perfect codes Singleton bound and MDS codes

Unit IV: Cyclic codes [10 Hours]

4 .1 Definitions, Generator polynomials

4.2 Generator and parity check matrices

4.3 Decoding of cyclic codes, Burst-error-correcting codes

Unit V: Some special cyclic codes: [04 Hours]

5.9 BCH codes, Definitions, Parameters of BCH codes

Recommended Book:

San Ling and Chaoping Xing, Coding Theory- A First Course (Cambridge University Press, 2004) (Sections 2.1, to 2.5); (Sections 3.1. to 3.4 and Sections 4.1, to 4.8); (Sections 5.1, to 5.4), (7.1, to 7.4); (8.1, 8.1.1 and 8.1.2)

Reference Books:

1) Raymond Hill, A First Course in Coding Theory (Oxford)

Course Code and Title:

MTS-581-OJT: ON JOB TRAINING OR FIELD PROJECT (Credits: 4)