DEPARTMENT OF MATHEMATICS
SCHOOL OF MATHEMATICAL SCIENCES
NORTH MAHARASHTRA UNIVERSITY, JALGAON

SYLLABUS FOR

M. Sc. I (Mathematics)
(with Specialization in Computational Mathematics)

WITH EFFECT FROM

ACADEMIC YEAR 2016-2017

DEPARTMENT OF MATHEMATICS
SCHOOL OF MATHEMATICAL SCIENCES
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Syllabus for M.Sc. I Mathematics (with Specialization in Computational Mathematics)
Syllabus Structure

Semester-I

Course Code	Title of the Course	Contact hours/week			Distribution of Marks for Examination					
					Internal		External		Total	
		Th (L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr
MT-101	Real Analysis	04	--	04	40	--	60	--	100	--
MT-102	Topology	04	--	04	40	--	60	--	100	--
MT-103	Linear Algebra	04	--	04	40	--	60	--	100	--
MT-104	Abstract Algebra	04	--	04	40	--	60	--	100	--
MT-105	Programming in C++	04	06	10	--	40	--	60	--	100

Th: Theory **Pr:** Practicals/Project **L:** Lectures

Semester-II

Course Code	Title of the Course	Contact hours / week			Distribution of Marks for Examination					
					Internal		External		Total	
		Th (L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr
MT-201	Complex Analysis	04	--	04	40	--	60	--	100	--
MT-202	Measure and Integration Theory	04	--	04	40	--	60	--	100	--
MT-203	Ordinary Differential Equations	04	--	04	40	--	60	--	100	--
MT-204	Advanced Abstract Algebra	04	--	04	40	--	60	--	100	--
MT-205	Numerical Methods with C++	04	06	10	--	40	--	60	--	100

Th: Theory **Pr:** Practicals/Project **L:** Lectures

MT-101: - Real Analysis

Unit I: The Riemann-Stieltjes Integral

Definition and Existence of the integral, Properties of integral, Integration and differentiation, Integration of vector-valued functions, Rectifiable curves. **{Chapter 6 [1]}** **[10 Lectures]**

Unit II: Sequences and Series of functions

Rearrangement of series, Pointwise and uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Dirichlets test for uniform convergence, The Stone-Weierstrass theorem. **{Chapter 3[1] (3.52 to 3.55), Chapter 7[1] & Chapter 9[2] (9.11)}** **[20 Lectures]**

Unit III: Power Series

Uniqueness theorem for power series, Abel's limit theorem, Taubers first theorem. **{Chapter 8[1] (8.1 to 8.4) & Chapter 9[2] (9.23)}** **[10 Lectures]**

Unit IV: Functions of Several Variables

Linear transformations, Differentiation, The contraction principle, The inverse function theorem, The implicit function theorem. **{Chapter 9[1] }** **[20 Lectures]**

Recommended Text Books:

[1] Walter Rudin: Principles of Mathematical Analysis, McGraw-Hill Book Company, 3rd Edition (2013).

[2] T. M. Apostol: Mathematical Analysis, Narosa Publishing House, 2nd Edition (1977).

Reference Books:

[1] D. Somasundaram, A Second Course in Mathematical Analysis, Alpha Science International Ltd. (2009)

[2] S. C. Malik and Savita Arora: Mathematical Analysis, New Age International Publishers, 4th Edition (2010).

MT- 102: Topology

Unit I. Topological spaces:

Countable and uncountable sets, Topological Spaces, Basis for a Topology, The Order Topology, The Product Topology on $X \times Y$, The Subspace Topology, Closed Sets and Limit Points. . **{Chapter 1 [1] (Art. 7), Chapter 2 [1] (Art. 12-17)}** **[15 Lectures]**

Unit II: Continuous Functions:

Continuous Functions, The Product Topology, The Metric Topology, The Quotient Topology. **{Chapter 2 [1] (Art. 18, 19, 22)}** **[10 Lectures]**

Unit III: Connectedness:

Connected Spaces, Components and Local Connectedness **{Chapter 3 [1] (Art. 23, 25)}** **[10 Lectures]**

Unit IV: Compactness:

Compact Spaces, Compact Subspaces of the Real Line, Limit Point Compactness, Local Compactness **{Chapter 3 [1] (Art. 26-29)}** **[10 Lectures]**

Unit V. Countability and Separation Axioms

The Countability Axioms, The Separation Axioms, Normal Spaces, The Urysohn Lemma, The Urysohn Metrization Theorem, The Tietze Extension Theorem. {**Chapter 4 [1] (Art. 30-35)}** **[15 Lectures]**

Recommended Textbooks:

1. J. R. Munkres, Topology, 2nd edition, Prentice Hall of India (2000).

Reference Books:

1. G. F. Simmons, Introduction to topology & Modern Analysis, McGraw Hill Education, 1st Edition (2004)
2. W. J. Perwin, Foundation of General topology, Academic Press (1964).
3. K. D. Joshi, Introduction to general topology, Wiley Eastern Limited (1984)

MT-103: Linear Algebra

Unit I: Vector Spaces and Modules

Elementary Basic Concepts, Linear Independence and Bases, Dual Spaces, Inner Product Spaces, Modules. {**Chapter 4 [1] (Art. 4.1-4.5)**} **[20 Lectures]**

Unit II: Linear Transformations

The Algebra of Linear Transformations, Characteristics Roots, Matrices, Canonical Forms. . {**Chapter 6 [1] (Art. 6.1-6.7)**} **[25 Lectures]**

Unit II: Determinants and Types of Linear Transformations

Trace and Transpose, determinants, Hermitian, Unitary and Normal Transformations, Real Quadratic Forms. {**Chapter 6 [1] (Art. 6.8-6.11)**}

[15 Lectures]

Recommended Text Books:

[1]. I. N. Herstein, Topics in Algebra**,** 2nd Edition, Wiley Eastern Ltd, New Delhi, (1975).

Reference Books:

[1]. Hoffman, Kenneth and Kunze R, Linear Algebra, Prentice Hill of India Private Limited. (1984).

MT-104: Abstract Algebra

Unit I: Groups:

(Prerequisites: Groups and Subgroups, Homomorphisms and Cosets). Direct Product, Conjugate Classes, Sylow's theorems its applications, p-Sylow subgroups, Normal and subnormal series, Jordan Holder theorem, Solvable groups. **{Chapter 1 [1] (Article 1.10-1.14)}** **[30 Lectures]**

Unit II: Rings:

(Prerequisites: Rings and subrings, Examples of rings, types of rings and characteristic of a ring). Euclidean domain, Principal Ideal Domain, Unique Factorization Domain Polynomial rings, Roots of Polynomials, Factorization of Polynomials. **{Chapter 2 [1] (Article 2.10-16}** **[30 Lectures]**

Recommended Text Books:

[1]. N. S. Gopalakrishnan, University Algebra, Wiley Eastern Ltd (1988).

Reference Books:

[1]. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley Eastern Ltd, New Delhi, (1975).

[2]. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul: Basic Abstract Algebra, 2nd Edition, Cambridge University press, Indian Edition, (1997).

[3]. Dummit and Foote, Abstract Algebra, 3rd Edition, Wiley - Eastern Ltd. (2014).

MT-105: Programming in C++

Unit I: Beginning with C++

What is C++, Its Applications, Advantages, Difference between C and C++, Creating C++ source file, Editing, Compiling, Linking, Debugging. **{Chapter 2 [1] (Article 2.1-2.8)}** **[10 Lectures]**

Unit II: C++ Tokens, Expressions and Control Structure.

Tokens, C++ keywords, Basic Data Types, User-defined Data Types, Derived Data Types, Operators in C++, Reference Variables, Memory management operators, Manipulators, Operator Overloading, Operator Precedence, Control Structure. **{Chapter 3 [1] (Article 3.1-3.25)}** **[15 Lectures]**

Unit III: Functions in C++

Different forms of functions, Function prototyping, Call by Reference, Inline Functions, Function overloading, Friend and virtual functions, Math library functions. **{Chapter 4 [1] (Article 4.1-4.12)}** **[10 Lectures]**

Unit IV: Classes and Objects

C Structure revision, Defining classes, Defining member functions, Declaration of objects to class, Access to member variables from objects, Different forms of member functions dependence on access specifiers (i.e. Private, public, protected), Array of objects, Objects as function arguments, Friendly function, Returning objects, Pointers to members, Local classes. **{Chapter 5 [1] (Article 5.1-5.19)}** **[15 Lectures]**

Unit V: Pointers, Virtual Functions and Polymorphism

Pointers, Pointers to objects, This pointer, Pointers to derived class, Virtual functions, pure virtual functions. **{Chapter 9 [1] (Article 9.1-9.8)}** **[10 Lectures]**

Recommended Text Books:

[1]. E. Balaguruswamy, Object-Oriented Programming with C++, 5th Edition, Tata McGraw Hill, New Delhi (2012).

Reference Books:

[1]. John R. Hubbard, Schaum's Outline of Fundamentals of Computing with C++, Schaum's Outline Series, (2000).

List of C++ Programs for MT-105

1. C++ Program to find perfect number.
2. C++ Program to find prime number in C++.
3. C++ Program to find prime number between a range.
4. Program Take Hours, Minutes, Seconds And Print It In 24 Hours & 12 Hours Format.
5. Program to convert the given temperature from Fahrenheit to degree Celsius.
6. Program to find greatest number between 3 number using if-else-if statements.
7. C++ program to find factorial of number in C++.
8. C++ Program to find table of a given number using for loop.
9. C++ Program to convert decimal number to binary number.
10. C++ Program to find the area and perimeter of rectangle.
11. C++ Program to find the area of triangle.
12. C++ program to calculate area of circle.
13. C++ Program to swap the values of two integers.
14. C++ Program to swap two variables without using third variable or temporary variable.
15. C++ Program to find the last prime number before number entered.
16. C++ Program to find Fibonacci series with simple logic.
17. C++ program to swap two numbers using built in swap function in C++ standard library.
18. Find Palindrome Number in C++.
19. Find Armstrong Number in C++ code with logic explanation and code dry run.
20. Print a right angle triangle using for loop.
21. Find GCD of two numbers.
22. C++ program to reverse a Number.
23. Switch statement example in C++ to calculate grade points when user enter a grade.
24. C++ program to check entered character is small, capital, digit or a special character.
25. Maximum or Largest Number in Array C++ Code.
26. Maximum and Minimum Number in array C++ code array should be initialized randomly.
27. Factorial of a number using recursive function simple example.
28. Add two matrix in C++ code using 2D arrays.
29. Matrix multiplication code in C++ using 2D arrays.
30. Different ways to pass an array to a function.
31. C++ program to convert binary number to decimal number.
32. C++ pointer example pass by reference.
33. Find Transpose of a matrix in C++ Code and check symmetric or not.
34. Count numbers of vowels in string C++ source code.

MT-201: - Complex Analysis

Unit I: Elementary Properties and Examples of Analytic Functions

Power series, Analytic functions, Analytic functions as mappings, Mobius transformations **{Chapter 3 [1], (Art 1-3)}** **[15 Lectures]**

Unit II: Complex Integration

Riemann-Stieltjes integrals, Power series representation of analytic functions, Zeros of an analytic function, The index of a closed curve, Cauchy's Theorem and Integral Formula, Counting zeros; the Open Mapping Theorem, Goursat's Theorem.

{Chapter 4 [1], (Art 1-5, 7-8)} **[25 Lectures]**

Unit-III Singularities

Classification of singularities, Laurent Series Development, Residues, The Argument Principle. **{Chapter 5 [1], (Art 1-3)}** **[15 Lectures]**

Unit-IV: The Maximum Modulus Theorem

The Maximum Principle, Schwarz's Lemma. **{Chapter 6 [1], (Art 1-2)}**

[05 Lectures]

Recommended Text Books:

[1]. J. B. Conwey, Functions of one Complex Variables, 2nd Edition, Springer Verlag, (2002).

Reference Books:

[1]. T. W. Gamelin, Complex Analysis, Springer-Verlag (2006).

[2]. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Edition, McGraw-Hill, Companies, Inc., (2009).

MT-202: Measure and Integration Theory

Unit I: Lebesgue Measure

Algebra of Sets, Lebesgue Outer Measure, The σ-Algebra of Lebesgue Measurable Sets, Outer and Inner Approximation of Lebesgue Measurable Sets, Countable Additivity, Continuity and the Borel-Cantelli Lemma, Non-measurable Sets, The Cantor Set and the Cantor-Lebesgue Function. {**Chapter 2 [1], (Art. 2.1-2.7)}** **[15 Lectures]**

Unit-II: Lebesgue Measurable Functions

Sums, Products, and Compositions, Sequential Pointwise Limits and Simple Approximation, Littlewood's Three Principles, Egoroff's Theorem, and Lusin's Theorem {**Chapter 3 [1], (Art. 3.1-3.3)}** **[10 Lectures]**

Unit-III: Lebesgue Integration

The Riemann Integral, The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure, The Lebesgue Integral of a Measurable Nonnegative Function, The General Lebesgue Integral, Countable Additivity and Continuity of Integration, Uniform Integrability: The Vitali Convergence Theorem. {**Chapter 4 [1], (Art. 4.1-4.6)}**

[15 Lectures]

Unit-IV: Differentiation and Integration

Continuity of Monotone Functions, Differentiability of Monotone Functions: Lebesgue's Theorem, Functions of Bounded Variation: Jordan's Theorem, Absolutely Continuous Functions, Integrating Derivatives: Differentiating Indefinite Integrals, Convex Functions. {**Chapter 6 [1], (Art. 6.1-6.6)}** **[10 Lectures]**

Unit-V: The L^P Spaces

Completeness and Approximation, Normed Linear Spaces, The Inequalities of Young, Holder, and Minkowski, L^P Is Complete: The Riesz-Fischer Theorem. **{Chapter 7 [1], (Art. 7.1-7.3)}** **[10 Lectures]**

Recommended Text Books:

[1]. Royden H. L. and Fitzpatrick P. M, Real Analysis, 4th Edition, PHI Learning (2010).

Reference Books:

[1]. P. K. Jain and V. P. Gupta: Lebesgue Measure and Integration, 3rd Edition, New Age International (P) Ltd., New Delhi, 1986.

[2]. Inder K. Rana, An introduction to Measure & Integration, Narosa Pub. House, Delhi, (1997).

[3]. G. de. Barra, Measure Theory and Integration, Wiley Eastern Limited, (1981).

MT-203: - Ordinary Differential Equations

Unit I: System of Linear Differential Equations:

Systems of first order equations, Model for arms competition between two nations, Existence and uniqueness theorem, Fundamental matrix, Non-homogeneous linear systems, Linear systems with constant coefficients, Linear systems with periodic coefficients. **{Chapter 4 [1], (Art. 4.1-4.8)}** [**15 Lectures**]

Unit II: Existence and Uniqueness of Solutions:

Successive approximations, Picard's theorem, Continuation and dependence on initial conditions, Existence of solutions in the large, Existence and uniqueness of solutions of systems, Fixed point method. **{Chapter 5 [1], (Art. 5.1-5.9)}**
[**15 Lectures**]

Unit III: Boundary Value Problems:

Sturm-Liouville problem, Green's function, Application of boundary value problems (BVP), Picard's theorem. **{Chapter 7 [1], (Art. 7.-7.5)}** [**10 Lectures**]

Unit IV: Oscillations of Second Order Equations:

Fundamental results, Sturm's comparison theorem, Elementary linear oscillations, Comparison theorem of Hille-Winter, Oscillations of $x''+a(t)x=0.$

{Chapter 8 [1], (Art. 8.1-8.5)} [**10 Lectures**]

Unit V: Stability of Linear and Nonlinear Systems:

Elementary critical points, System of equations with constant coefficients, Linear equation with constant coefficients. **{Chapter 9 [1], (Art. 9.1-9.4)}** [**10 Lectures**]

Recommended Text Books:

[1]. S. G. Deo, V. Lakshmikantham and V. Raghavendra, Text Book of Ordinary Differential Equations, Tata Mc-Graw Hill Publishing Company Limited, New Delhi (1997).

Reference Books:

[1]. Earl A. Coddington and Norman Levinson, Theory of Ordinary Differential Equations, McGraw Hill, New York (1972).

[2]. G. F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw- Hill, 1991.

[3]. Shepley L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons Inc., (2004).

MT-204: Advanced Abstract Algebra

Unit I: Field Extensions

Extension Fields, The Transcendence of e, Roots of polynomials, Construction with Straight Edge and Compass, More about roots. {**Chapter 5 [1], Art.1-5)}**

[20 Lectures]

Unit II: Galois Theory

Elements of Galois Theory, Solvability by Radicals, Finite Fields. {**Chapter 5 [1], Art.6-7) and Chapter 7 [1], Art. 1}** **[20 Lectures]**

Unit III: Structure of Finite Fields

Characterization of finite fields, Roots of irreducible polynomials, Traces, Norms and Bases, Roots of unity and cyclotomic polynomials, Representation of elements of finite fields. {**Chapter 2 [2], Art.1-5)}** **[20 Lectures]**

Recommended Text Books:

[1]. I. N. Herstein, Topics in Algebra**,** 2nd Edition, Wiley Eastern Ltd, New Delhi, (1975).

[2]. Rudolf Lidl and Harald Niederreiter: Introduction to Finite Fields and their Applications, Cambridge University Press, Cambridge (1986).

Reference Books:

[1]. N. S. Gopalakrishnan, University Algebra, Wiley Eastern Ltd (1988).

[2]. John B. Fraleigh, A First Course in Abstract Algebra, 3rd Edition, Narosa Publishing House, New Delhi (1998).

MT-205: Numerical Analysis with C++

Unit I: Solution of Algebraic and Transcendental Equations

Bisection Method, Iteration Method, Method of False Position, Newton-Raphson Method, Ramanujan's Method, Muller's Method. {**Chapter 2 [1], Art. 2.1-2.7**}, **[12 Lectures]**

Unit II: Interpolation

Errors in Polynomial Interpolation, Finite Differences, Detection of Errors by use of Difference Tables, Differences of a Polynomial, Newton's formulae for Interpolation, Central Difference, Interpolation with unevenly spaced points, Divided differences. {**Chapter 3 [1], (Art. 3.1-3.7, 3.9, 3.11)**}, **[12 Lectures]**

Unit III: Numerical Differentiation and Integration

Numerical Differentiation, Maximum and Minimum values of a Tabulated Function, Numerical Integration. {**Chapter 5 [1], (Art. 5.1-5.4)**}, **[12 Lectures]**

Unit IV: Matrices and Linear systems of Equations

Basic Definitions, Solution of Linear Systems-Direct Methods, Solution of Linear Systems-Iterative Methods, Eigenvalue Problem. {**Chapter 6 [1], (Art. 6.1-6.5)**}, **[12 Lectures]**

Unit V: Numerical Solutions of Ordinary Differential Equations

Solution by Taylor's Series, Picard's Method of Successive approximations, Euler's Method, Runge-Kutta methods, Predictor Corrector methods. {**Chapter 7 [1], (Art. 7.1-7.6)**}, **[12 Lectures]**

Recommended Text Books:

[1]. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India Private Ltd. (2004).

Reference Books:

[1]. M. K. Jain, S. R. K. Iyenger and R. K. Jain, Numerical Methods for Scientific and Engineering Computations, 6th Edition, New Age International Publication (P) Ltd. (2012).

[2]. Erwin Kreyszig, Advanced Engineering Mathematics, 2nd Edition, John Wiley & Sons, INC. (2005).

List of C++ Programs for MT-205

1. Simple Bisection method
2. Bisection with tests for convergence
3. Recursive solution for Bisection
4. Newton's method
5. Secant Method
6. Polynomial interpolation
7. Estimating Derivatives
8. Regula – Falsi method
9. Muller method
10. Gauss elimination method
11. Gauss-Seidal method
12. Gauss-Jacobi method
13. Power method
14. Euler method
15. Runge-Kutta second order method
16. Runge-Kutta fourth order method
17. Trapezoidal rule
18. Simpson's 1/3rd rule
19. Simpson's 3/8th rule