APPENDIX-I

PONDICHERRY UNIVERSITY
DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS PROGRAMME

SYLLABI

WITH EFFECT FROM THE ACADEMIC YEAR

2011 - 2012
M.Sc. MATHEMATICS PROGRAMME

Regulations

Eligibility for admission:
A candidate for admission into M.Sc. programme shall have studied B.Sc. Mathematics under 10 + 2 + 3 pattern of study. Candidates who have secured 55% of marks or above in Bachelor’s Degree in Mathematics are eligible to apply.

Duration of study:
The course duration shall normally be of two years spread over four semesters. The maximum duration to complete the course shall be 4 years.

Medium:
The medium of instruction shall be English.

Passing minimum:
Passing Eligibility and Classification for the award of the Degree are as per the norms of the Choice Based Credit System.

Conditions for Affiliation:
The following are the requirements for the grant of affiliation for M.Sc. Mathematics programme in the institutions affiliated to Pondicherry University:

(i) The institution shall have conducted the B.Sc. Mathematics programme for a minimum period of 6 years.
(ii) Faculty strength for M.Sc. Mathematics programme: 3 regular faculty in the first year. Additional 3 regular faculty in the second year. A total of 6 regular faculty for the whole programme.
(iii) Qualifications for the faculty: The faculty shall possess the qualifications as prescribed by UGC.
(iv) Recruitment of faculty: The recruitment of faculty shall be through a duly constituted Selection Committee with a nominee of the University, by advertisement.
(v) Class rooms: 2 permanent rooms with furniture, platform and black board.
(vi) Faculty room: 1 permanent room with furniture.
(vii) Computers: 3 for the faculty.
(viii) Library:
Books: 10 copies of each prescribed text book; 1 copy of each prescribed reference book; 3 reference books for each hard core subject.
Journals: Minimum 2
Library Room: 1 with furniture for books.
Reading Space for Students

(ix) Computer Lab: required if computer papers are offered as soft core with 1 computer for every 2 students
M.Sc. MATHEMATICS

List of Hard Core Courses offered from the Academic Year 2011-2012

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>Number of Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MATH-411</td>
<td>Advanced Algebra</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>MATH-412</td>
<td>Real Analysis – I</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>MATH-413</td>
<td>Discrete Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>MATH-414</td>
<td>Topology</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>MATH-421</td>
<td>Linear Algebra</td>
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<tr>
<td>6</td>
<td>MATH-422</td>
<td>Lebesgue Measure Theory</td>
<td>4</td>
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<td>7</td>
<td>MATH-423</td>
<td>Complex Analysis</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>MATH-424</td>
<td>Ordinary Differential Equations</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>MATH-425</td>
<td>Real Analysis – II</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>MATH-511</td>
<td>Fluid Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>MATH-512</td>
<td>Differential Geometry</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>MATH-513</td>
<td>Functional Analysis</td>
<td>4</td>
</tr>
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</table>
## M.Sc. MATHEMATICS

List of Soft Core Courses offered from the Academic Year 2011-2012

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MATH-514</td>
<td>Analytical Dynamics</td>
</tr>
<tr>
<td>2</td>
<td>MATH-515</td>
<td>Fuzzy Sets and its Applications</td>
</tr>
<tr>
<td>3</td>
<td>MATH-516</td>
<td>Number Theory</td>
</tr>
<tr>
<td>4</td>
<td>MATH-517</td>
<td>Operations Research</td>
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<tr>
<td>5</td>
<td>MATH-518</td>
<td>Algorithms Using C++</td>
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<tr>
<td>6</td>
<td>MATH-522</td>
<td>Graph Theory with Applications</td>
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<tr>
<td>7</td>
<td>MATH-523</td>
<td>Graph Theory with Algorithms</td>
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<tr>
<td>8</td>
<td>MATH-527</td>
<td>Algebraic Number Theory</td>
</tr>
<tr>
<td>9</td>
<td>MATH-528</td>
<td>Advanced Algebraic Number Theory</td>
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<tr>
<td>10</td>
<td>MATH-529</td>
<td>Theory of Fuzzy Sets</td>
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<tr>
<td>11</td>
<td>MATH-530</td>
<td>Algebraic Coding Theory</td>
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<td>12</td>
<td>MATH-531</td>
<td>Cryptography</td>
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<tr>
<td>13</td>
<td>MATH-532</td>
<td>Automata Theory</td>
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<tr>
<td>14</td>
<td>MATH-533</td>
<td>Advanced Topics in Topology and Analysis</td>
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<td>15</td>
<td>MATH-534</td>
<td>Approximation Theory</td>
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<tr>
<td>16</td>
<td>MATH-536</td>
<td>Difference Equations</td>
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<td>17</td>
<td>MATH-537</td>
<td>Partial Differential Equations</td>
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<td>18</td>
<td>MATH-538</td>
<td>Lie Groups of Transformations and Differential Equations</td>
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<tr>
<td>19</td>
<td>MATH-539</td>
<td>Numerical Analysis for Ordinary Differential Equations</td>
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<td>20</td>
<td>MATH-540</td>
<td>Advanced Fluid Mechanics</td>
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<td>MATH-541</td>
<td>Integral Equations</td>
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<td>22</td>
<td>MATH-542</td>
<td>Advanced Mathematical Analysis</td>
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<td>23</td>
<td>MATH-543</td>
<td>Representation Theory of Compact Groups</td>
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<td>24</td>
<td>MATH-544</td>
<td>Elements of Harmonic Analysis</td>
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<td>25</td>
<td>MATH-545</td>
<td>Linear Lie Groups</td>
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<td>26</td>
<td>MATH-546</td>
<td>Graph Theory</td>
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<td>27</td>
<td>MATH-547</td>
<td>Advanced Functional Analysis</td>
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<tr>
<td>28</td>
<td>MATH-548</td>
<td>Advanced Topics in Discrete Mathematics</td>
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<td>29</td>
<td>MATH-549</td>
<td>Laboratory Practical in Mathematics</td>
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<td>30</td>
<td>MATH-550</td>
<td>Topic in Topology and Analysis</td>
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<td>31</td>
<td>MATH-551</td>
<td>Functional Analysis- II</td>
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<td>32</td>
<td>MATH-552</td>
<td>Operator Theory</td>
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<tr>
<td>33</td>
<td>MATH-554</td>
<td>Non-Commutative Rings and Representations</td>
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<tr>
<td>34</td>
<td>MATH-555</td>
<td>Advanced Complex Analysis</td>
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<tr>
<td>35</td>
<td>MATH-557</td>
<td>Algorithms Using Java</td>
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<td>36</td>
<td>MATH-558</td>
<td>Functional Analysis-III</td>
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<td>37</td>
<td>MATH-559</td>
<td>Mathematica Practical</td>
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<tr>
<td>38</td>
<td>MATH-560</td>
<td>Mathematical Software</td>
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<td>39</td>
<td>MATH-561</td>
<td>Computational Algebra</td>
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<td>MATH-562</td>
<td>Numerical Analysis</td>
</tr>
<tr>
<td>41</td>
<td>MATH-563</td>
<td>Integral Transforms</td>
</tr>
</tbody>
</table>
M.Sc. Mathematics

HARD CORE : MATH-411 ADVANCED ALGEBRA

Unit-I
The class equation of a finite groups - Sylow theorems - Direct products.

Unit-II
Polynomial rings- Polynomials over the rational field – Polynomial rings over Commutative rings.

Unit-III
Field extensions - Algebraic and transcendental extensions, Separable and inseparable extensions – Normal extensions.

Unit-IV
Perfect Fields, Primitive elements, Algebraically closed fields, Galois extensions, Fundamental theorem of Galois Theory.

Unit-V
Solvable groups - Solvability by radicals and insolvability of the general equation of degree 5 - Finite fields.

Treatment and Content as in I.N.Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.

Sections – 2.11, 2.12 and 2.13
Sections – 3.9, 3.10 and 3.11
Sections – 5.1, 5.3 and 5.5
Sections - 5.6
Sections – 5.7 and 7.1

Reference books

M. Sc. Mathematics

Hard Core- 4 credits
MATH-412: Real Analysis - I

Unit-I
Finite, Countable and uncountable sets - Metric Spaces - Compact Sets - Perfect sets - Connected sets - Convergent Sequence - Subsequences - Cauchy Sequences - Upper and lower limits – Some special sequences.

Unit- II

Unit- III
Limits of Functions - Continuous Functions - Continuity and Compactness - Continuity and Connectedness - discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity.

Unit- IV

Unit- V

Text Book:
(Chapters 2-6)

Reference Books:

M.Sc. MATHEMATICS
MATH-413 - DISCRETE MATHEMATICS
(HARD CORE: 4 CREDIT)

Unit-I

Unit-II

Unit-III

Unit-IV

Unit-V
Trees – Cut Edges and Bonds – Cut Vertices – Cayley’s Formula – Connectivity – Blocks – Euler Tours – Hamilton Cycles.

Text Books:
   Chap.-2: Sec.2-1.1, 2-1.2, 2-1.3, 2-1.4, 2-1.6, 2-1.8, 2-1.9, 2-3.1, 2-3.2, 2-3.5, 2-3.8, 2-3.9.
   Chap.-4: Sec.4-1, 4-2, 4-3.
2. Graph Theory with Applications, Bondy J.A. and Murthy U.S.R.,, Mac Comp.
   Chap-1: Sec. (1.1) to (1.7), Chap-2: Sec. (2.1) to (2.4)
   Chap-3: Sec. (3.1) to (3.2), Chap-4: Sec. (4.1) to (4.2)

Reference Books:
7. Harary F. , Graph Theory Addison, Wesley Reading Mass, 1969
8. Wilson R.J., Introduction to Graph Theory, Oliver and Boyd, Edinburgh, 1972
M.Sc. Mathematics

MATH-414 Topology
(Hard Core- 4 Credits)

Unit-I

Unit -II
Topological spaces -- Definitions and examples -- Closure and related concepts – Open bases and open sub bases – Separability and Second Countability - Lindlof’s Theorem

Unit-III
Compactness – Basic Results -- Continuous Maps on Compact sets -- Characterization of Compactness by Basic and Sub basic open Covers – Tychonoff’s Theorem - Generalized Heine – Borel Theorem.

Unit – IV
Compactness for metric spaces – Sequential Compactness -- Lebesgue covering lemma -- Sequential Compactness and Compactness Coincide on Metric Spaces -- T₁ Spaces -- Hausdorff Spaces.

Unite -V
Completely regular spaces and normal spaces – Urysohn’s lemma and Tietze extension theorem-- Connected spaces – Components of a space .

Text book


Chapter 1 – Revision of Sections 1—3 , Section 4—8.
Chapter 2 – Sections 9 -- 12
Chapter 3 – Sections 16, 17 and 18
Chapter 4 – Sections 21 -- 24
Chapter 5 – Sections 26 -- 28
Chapter 6 – Sections 31 and 32

Reference books

3. J.Dugundgi, Toplogy, Allyn and Bacon, Boston, (1966)
M.Sc. Mathematics

HARD CORE : MATH-421 LINEAR ALGEBRA

Unit-I
The Algebra of Linear transformations, characteristic roots, Similarity of linear transformations, Invariant subspaces and Matrices.

Unit-I
Reduction to triangular forms, Nilpotent transformations, Index of nilpotency and Invariant of Nilpotent transformation.

Unit-I
Jordan blocks and Jordan forms, Modules - Cyclic modules - Fundamental theorem on modules over PID.

Unit-I
Rational canonical form, trace, transpose and Determinants.

Unit-I
Hermitian, Unitary and Normal transformations - Real quadratic forms.

I.N.Herstein, Treatment and Contents as in Topics in Algebra, Wiley Eastern Ltd., New Delhi, (1975)

Sections – 6.1,6.2 and 6.3
Sections – 6.4 and 6.5
Sections – 6.6 and 4.5
Sections - 6.7,6.8 and 6.9
Sections – 6.10 and 6.11

Reference books

3. S.Lang, Algebra, 3rd edition, Addison-Wesley, 1993
M.Sc. Mathematics

HARD CORE : MATH-422 LEBESGUE MEASURE THEORY

Unit-I
Ring and algebra of sets- σ-algebras- Examples- Algebras and σ -algebras generated by a class of sets - Borel algebra and Borel sets.
Lebesgue outer measure on R - Countable sub-additivity - Measurable sets – Examples - σ - algebra structure of measurable sets - Countable additivity of Lebesgue measure on R - Cantor set.

Unit-II
Construction of a non-measurable subset of [0, 1] - Measurable functions- Examples and basic properties - Approximation of measurable and bounded measurable functions by simple measurable functions - Approximation by step functions and continuous functions - Egorov’s theorem.

Unit-III

Unit-IV

Unit-V
Absolutely continuous functions - Examples and properties - Absolute continuity of indefinite integral of Lebesgue integrable functions - Differentiation of indefinite integrals - Characterization of absolutely continuous functions as indefinite integrals.

Text books
1. H.L. Royden, Real Analysis, Macmillan Publishing Company, 1988 (Units 1, 2, 4 and 5).

Reference book
M.Sc. Mathematics

HARD CORE : MATH-423 COMPLEX ANALYSIS

Unit-I: Introduction
Algebra of complex numbers, geometric representation of complex numbers, Riemann Sphere and stereographic projection, lines, circles, limit and continuity, Analytic functions, Cauchy-Riemann equations, Harmonic functions, Elementary theory of power series- Sequences, series, uniform convergence of power series, Abel’s limit theorem, Topology of Complex plane

Unit-II: Complex Integration

Unit-III: Calculus of Residues

Unit-IV: Harmonic Functions
Basic properties of harmonic functions - Mean value theorem - Harmonic functions on a disk - Harnack’s inequality - Harnack’s theorem, Poisson’s formula, Schwarz’s Theorem, reflection Principle.

Unit-V: Partial fractions and factorization
Partial fractions, Mittage-Leffer’s theorem Infinite Products, Canonical Products, The Gamma and Beta functions, Sterling’s formula, Entire function-Jenen’s formula. Hadamard’s Theorem

Text book
L.V. Ahlfors, Complex Analysis, McGraw-Hill, Kogakusha, 1979

References
S. Ponnusamy: Foundations of Complex Analysis, Narosa, 1995
M.Sc. Mathematics

HARD CORE : MATH-424 ORDINARY DIFFERENTIAL EQUATIONS

Unit-I
Quilitative properties of Solutions – The Sturm Comparison Theorem –
Eigen values and Eigen functions and Vibrating String.

Unit-II
Series Solutions of First Order Equations – Second Order Linear
Equations – Ordinary points - Regular Singular Points – Gauss Hyper
Geometric Equations.

Unit-III
Legendre Polynomials – Properties of Legendre Polynomials – Bessel
Functions- The Gamma Function - Properties of Bessel Function.

Unit-IV
Linear Systems – Homogeneous Linear System with Constant
Coefficients.

Unit-V
The Existence and Uniqueness of Solutions – The method of
Successive Approximations – Picards’s Theorem.

Text book
G.F.Simmons: Treatment as in Differential Equations with Applications and
Historical Notes, McGraw Hill Book Company, 1972

Sections 22-30, 32-35, 37-38 and 55-56.
M. Sc. Mathematics

Hard Core - 4 credits
MATH-425: Real Analysis – II

Unit-I
Improper Riemann integrals - Functions of Bounded variation - Basic properties - Completeness of Metric Spaces - Nowhere dense sets - Construction of Cantor set-Cantor set is uncountable and nowhere dense- Baire Category Theorem- Sequence and Series of functions - Examples - Uniform convergence.

Unit-II
Uniform convergence and Continuity - Uniform convergence and Integration - Uniform convergence and Differentiation - Double sequences and series - Iterated limits- Equicontinuous Families of Functions - Arzela – Ascoli Theorem

Unit- III

Unit- IV
Functions of Several Variables - Linear Transformation - Differentiation - The Contraction Principle.

Unit- V
The inverse function Theorem - The implicit Function Theorem - The Rank Theorem – Determinants .

Text Book:

Walter Rudin, Principles of Mathematical Analysis, McGraw Hill International Editions (1976) Units 2-5 cover Chapters 7,8 and 9, excluding last two sections of Chapter 9

Reference Books:

M. Sc. Mathematics

HARD CORE: MATH-511  FLUID MECHANICS

Unit-I

Unit-II
Rotations and Vorticity – Kelvin’s Circulation Theorem – Helmboltz’s Theorem.

Unit-III

Unit-IV

Unit-V
Boundary Layers – Prandt Boundary Layer Equations –Steady Boundary Layer Flow on a Flat Plate of Infinite Width.

Text book
M.Sc. Mathematics

HARD CORE : MATH-512 DIFFERENTIAL GEOMETRY

Unit-I
Graphs and level sets - Vector fields - The tangent space

Unit-II
Surfaces - Vector fields on surfaces - Orientation - The Gauss map

Unit-III
Geodesics - Parallel transport

Unit-IV
The Weingantten map - Curvature of plane curves

Unit-V
Arc length and line integrals - Curvature of surfaces

J.A. Thorpe: Treatment as in Elementary Topics in Differential Geometry, Springer, 2004

Chapters 1 to 12.
M. Sc. Mathematics
Hard Core- 4 credits
MATH- 513: Functional Analysis

Unit-I
Normed Linear Spaces – Examples of Sequence and Function Spaces including $c_0$, $l_p$ and $L_p[a,b]$, for $1 \leq p \leq \infty$ - Linear transformations – Continuity – Dual Spaces – Product and Quotient of Normed Linear Spaces – Completeness of Product and Quotient of Normed Linear Spaces – Completeness of the space of all bounded, linear transformations.

Unit-II

Unit-III

Unit-IV

Unit- V
Separable Hilbert spaces and countable orthonormal basis – Linear isometry onto $l_2$ - Example of a non-separable Hilbert space – Uncountable orthonormal basis and definition of convergence of Fourier series – Riesz-Fisher’s theorem- Orthogonal projections – Closed subspaces are Chebychev - Riesz’s representation theorem.

Text book

Reference book

M. Sc. Mathematics

SOFT CORE : MATH-514  ANALYTICAL DYNAMICS

Unit- I
Generalized coordinates-Virtual displacements-D’Alembert’s principle and derivation of the Lagrange equations.

Unit -II
Lagrange equation for non-holonomic constraints-Method of Lagrange multipliers-Velocity dependent potentials-Non-conservative forces and dissipation function- Non-holonomic systems and Lagrange multipliers.

Unit- III
Hamilton’s equation-The Hamilton Principle - Variational – Principle

Unit- IV
Canonical transformations – Hamilton – Jacobi theory.

Unit- V

Text book
Unit I: Sections 14-15(269-309); Unit II: Sections 16-17(314-37); Unit III: Sections 18 (341-364); Unit IV: Sections 19-20(30-399); Unit V: Sections 21-22(419-451).

Reference books
1. H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1985

***
Unit-I  Crisp Sets
Basic Definitions - Operations on crisp sets – Properties of crisp set – Crisp relations- Operations on crisp relations – Properties of Crisp relations – Composition of Crisp relations - Characteristic Function-Exercises

Unit – II  Fuzzy Sets

Unit-III  Fuzzy Relations

Unit-IV  Fuzzy control systems

Unit-V  Applications

Text Books

Reference Books
M. Sc. Mathematics

SOFT CORE : MATH-516  NUMBER THEORY

1. Unit-I
Divisibility : Introduction - Divisibility - Primes.

2 Unit-II
Congruences - Solution of Congruences - Congruences of higher degree -
Prime power moduli - Prime Modulus - Congruences of degree two, prime
modulus - Power residues - Number theory from an algebraic view point
Multiplicative groups, rings and fields.

Unit-III
Quadratic Reciprocity: Quadratic Residues - Quadratic Reciprocity - The Jacobi
Symbol.

Unit-IV
Some functions of Number Theory: Greatest Integer function - Arithmetic function s
- The Moebius Inversion Formula - Multiplication of arithmetic functions –
Recurrence functions.

Unit-V
Some Diophantine Equations: The equation ax+by = c - Positive Solutions - Other
linear equations - The equation $x^2 + y^2 = z^2$ - The Equation $x^4 + y^4 = z^2$ - Sum of
fourth powers - Sum of two squares - The equation $4x^2 + y^2 = n$.

Treatment as in : Ivan Niven and S.Zuckerman, An Introduction to the Theory of Numbers,
John Wiley, New York, 2000

Chapter 1 : Sections 1.1 – 1.3
Chapter 2 : Sections 2.1 - 2.11
Chapter 3 : Sections 3.1 – 3.3
Chapter 4 : Sections 4.1 – 4.5
Chapter 5 : Sections 5.1 - 5.6, 5.10 and 5.11
M. Sc. Mathematics

SOFT CORE : MATH-517 OPERATIONS RESEARCH

Unit-I
Hyperplanes and half-spaces – Supporting and separating hyper planes – Convex functions – Linear programming basic concepts – Convex sets – Linear programming problems – Examples of LPP – Feasible, basic feasible and optimal solutions – Extreme points.

Unit-II
Linear Programming – Graphical Method - Simplex Method.

Unit-III

Unit-IV
Integer Programming – Cutting plane algorithm - Branch and Bound Technique.

Unit-V
Game Theory - Two - Person, Zero - Sum Games - Games with Mixed Strategies - Graphical Solution - Solution by Linear Programming.

Text books

   Chapter 8 – Sections 8.3, 8.4 and Chapter 11– Sections 11.1 to 11.4.

   Chapter 2 – Sections 2.12 to 2.14 and Chapter 4 – Sections 4.3 to 4.4.
M. Sc. Mathematics

SOFT CORE
MATH-518: ALGORITHMS USING C++

Objectives of the Course:
To make the students familiar with certain mathematical algorithms and their implementation through C++ language and equip them well with hands-on experience to acquire skills in solving mathematical problems using computers.

Unit-I   Fundamentals of algorithms
Introduction to algorithms – Steps in the development of algorithms – Examples of algorithms which are significant from computational point of view.

Unit-II  Fundamentals of C++ language
Constants- Variables - Declaration of variables - Type conversions - Relational operators - Decision making, branching and looping. Functions - Simple functions - Passing arguments to functions - Returning values from functions - Reference arguments - Overloaded functions - Inline functions.

Unit-III Defining classes - Creating objects - Constructors - Accessing class members - Member functions - Overloaded constructors - Static class data - Arrays and string functions.

Unit-IV  Operator overloading - Overloading unary and binary operators- Data conversion - Derived class- Class hierarchies – Inheritance - Public and private inheritance – Types of inheritance. Pointers - Pointer to objects - Memory management - New and delete functions.

Unit-V   Applications of C++ in algorithms

Reference books


2. R.G.Dromey: How to solve it by computer Prentice-Hall of India Private Limited, New Delhi, 1999

M. Sc. Mathematics

SOFT CORE : MATH-522  GRAPH THEORY WITH APPLICATIONS

Treatment as in J.A. Bondy and U.S.R. Murthy: Graph Theory with Applications, 1976.

Pre requisites: Graphs and simple graphs - Special graphs (Complete graphs, Complement of graphs and null graphs) - Graph isomorphism – Sub graphs - Vertex degrees - Degree sequences and graphic sequences - walks, paths, Cycles - Graph connection and components - Bipartite graphs and their characterizations.
(Chapter 1. No questions from this chapter)

Unit-I
Connectivity and edge connectivity - Vertex cuts and edge cuts - Whitney's inequality (relating K, K, and d) - Blocks and blocks of graphs - Characterization of 2-connected graphs and blocks - Menger's theorem (without proof).
(Chapter 3 in which Section (3.3) is omitted).

Unit-II
Independent sets and their characterization - Matchings - Vertex as well as edge independence numbers, Covering numbers - Perfect matching – König’s Theorem (without proof) - Galli's theorem - Ramsey numbers - Theorems on the upper bounds and lower bounds for Ramsey numbers - Ramsey graphs - Erdos theorem.
(Chapter 7 - Sections (7.1) and (7.2) only).

Unit-III
Vertex colourings and chromatic numbers of graphs - Critical graphs and their properties - Brook's theorem - Hajo's conjecture and Dirac's theorem.
(Chapter 8 - Sections (8.1), (8.2) and (8.3) only)

Unit-IV
Chromatic polynomials - The five colour theorem - The four colour theorem (without proof) - Edge chromatic number - Vizing's theorem (statement only).
(Chapter 8 - Section (8.4) only; Chapter 9 - Section (9.6) only; Chapter 6 - Sections (6.1) and (6.2) only)

Unit-V
Directed graphs - Directed paths (Roy-Gallai Theorem) - Tournaments - Directed Hamilton paths and cycles (Moon's theorem, Ghouila-Houri theorem).
(Chapter 10 - Sections (10.2) and (10.3) only)

Reference books
1. F. Harary, Graph Theory, Addison –Wesley, 1969
2. G Narasimha Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India Private Limited, New Delhi, 2004
3. I.R.J. Wilson, Introduction to Graph Theory. Logman, 1972
4. L.R. Foulds, Graph Theory Applications, Springer’s, 1993
5. S.A. Choudam, A First Course in Graph Theory, Mac Millan, 1987
M. Sc. Mathematics

SOFT CORE : MATH-523 GRAPH THEORY WITH ALGORITHMS

Unit-I
(Chapters 1 and 2 in which Sections (1.2),(1.6) and (2.3) are omitted).

Unit-II
(Chapter 3).

Unit-III
Cut sets – some properties of a cutest – All cut sets in a graph – Fundamental circuits and cut sets – connectivity and separability – Network flows – (1) Isomorphism – (2) Isomorphism.
(Chapter 4)

Unit-IV
(Chapter 7).

Unit-V
Algorithms – (Input) Computer representation of a graph – the out pat – some basic graph theoretic algorithms: connectedness and components, A spanning tree – A set of fundamental circuits, cut vertices and separability – shortest path algorithms: Shortest path either from a specified vertex to another specified vertex or among all pairs of vertices.
(Chapter 11 in which Sections (11.4) of Algorithm 5, (11.6) of Algorithm 8, (11.7), (11.8), (11.9) and (11.10) are omitted).

Text book
Narsingh Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India Private Limited, New Delhi, 2004

Reference books
1. F. Harary, Graph Theory, Addison Wesley, 1969
4. L.R. Foulds: Graph Theory Applications, Narosa Publishing House, 1993
M. Sc. Mathematics

SOFT CORE : MATH-527 ALGEBRAIC NUMBER THEORY

Unit-I Elementary Number Theory
Integers – Greatest common divisor – Infinitude of primes – Unique factorization in $\mathbb{Z}$ – Fermat’s little theorem – Euler’s $\Phi$ function and Euler’s theorem – Multiplicative property of $\Phi$ function – Applications of unique factorization – The equation $x^2 + y^2 = z^2$ – The equation $x^4 + y^4 = z^2$ – The equation $x^4 - y^4 = z^2$ – Fermat numbers and their properties.

Unit-II Euclidean Rings

Unit-III Algebraic Numbers and Integers
Basic concepts – Algebraic number – Algebraic integer – Minimal polynomial – Countability of algebraic numbers – Liouville’s theorem for $\mathbb{R}$ – Algebraic number fields – Theorem of the primitive element – Liouville’s theorem for $\mathbb{C}$ – Characterization of algebraic integers.

Unit-IV Integral Bases
The norm and the trace – Integral basis for an algebraic number field – Algebraic integers of $\mathbb{Q}(\sqrt{-5})$ – Existence of an integral basis – Discriminant of an algebraic number field – Index – Determination of an integral basis for the ring of integers of a quadratic number field.

Unit-V Dedekind Domains

Text book
J. Esmonde and M. Ram Murty, Problems in Algebraic Number Theory, Graduate Texts in Mathematics, Volume 190, Springer Verlag, New York, 1999
Sections 1.1 and 1.2
Sections 2.1, 2.2 and 2.3
Sections 3.1, 3.2 and 3.3
Sections 4.1, 4.2 and 4.3
Sections 5.1 and 5.2
M. Sc. Mathematics

SOFT CORE : MATH-528 ADVANCED ALGEBRAIC NUMBER THEORY

Unit-I The Ideal Class Group
Euclidean rings – Hurwitz constant – Fractional ideals – Finiteness of the ideal class group – The class number of an algebraic number field – The class number of Q(√-5) – The Diophantine equation \(x^2 + 5 = y^3\).

Unit-II Quadratic Reciprocity

Unit-III The Structure of Units
Discrete subgroup of \(R^m\) – Dirichlet’s unit theorem – Units in real quadratic fields – Pell’s equation.

Unit-IV Higher Reciprocity Laws
Cubic reciprocity – Eisenstein reciprocity.

Unit-V Analytic Methods
The Riemann and Dedekind zeta functions – Zeta functions of quadratic fields – Dirichlet’s hyperbola method.

Text book
J.Esmonde and M.Ram Murty; Problems in Algebraic Number Theory, Graduate Texts in Mathematics, Volume 190, Springer Verlag, New York, 1999
Sections 6.1, 6.2 and 6.3
Sections 7.1, 7.2 and 7.3
Sections 8.1 and 8.2
Sections 9.1 and 9.2
Sections 10.1 and 10.2
M. Sc. Mathematics

SOFT CORE : MATH-529 THEORY OF FUZZY SETS

Unit-I  Fuzzy sets
  Basic definitions – Types of fuzzy sets – Basic concepts – α cuts and their properties –
  Representations of fuzzy sets – first and second decomposition theorems.

Unit-II  Operations on fuzzy sets
  Types of operations – Fuzzy complements – Fuzzy intersections: t norms – Fuzzy
  unions: t conorms – Combinations of operations.

Unit-III  Elements of fuzzy arithmetic
  Fuzzy numbers – Linguistic variables – Arithmetic operations on intervals –
  Arithmetic operations on fuzzy numbers – Fuzzy equations.

Unit-IV  Fuzzy relations
  Crisp and fuzzy relations – Projections and cylindric extensions – Binary fuzzy
  relations – Binary relations on a single set – Fuzzy equivalence relations – Fuzzy
  compatibility relations.

Unit-V  Fuzzy logic
  An overview of classical logic – multi valued logics – Fuzzy propositions – Fuzzy
  quantifiers – Linguistic hedges – Inference from conditional fuzzy propositions.

Text book
  George J. Klir and Bo Yuan: Fuzzy sets and Fuzzy Logic: Theory and Applications,
  Prentice – Hall of India Private Limited, New Delhi, 2000

Reference book
  H.J. Zimmermann: Fuzzy set theory and its Applications,  Allied Publishers Limited,
  New Delhi, 1991
M. Sc. Mathematics

SOFT CORE : MATH-530 ALGEBRAIC CODING THEORY

Unit-I  Error detection, Correction and decoding
Communication channels – Maximum likelihood decoding – Hamming distance –
Nearest neighbourhood minimum distance decoding – Distance of a code.

Unit-II  Linear codes
Linear codes – Self orthogonal codes – Self dual codes – Bases for linear codes –
Generator matrix and parity check matrix – Encoding with a linear code – Decoding
of linear codes – Syndrome decoding.

Unit-III  Bounds in coding theory
Sphere covering bound – Gilbert Varshamov bound – Binary Hamming cores – q-ary
Hamming codes – Golay codes – Singleton bound and MDS codes – Plotkin bound.

Unit-IV  Cyclic codes
Definitions – Generator polynomials – Generator matrix and parity check matrix –
Decoding of Cyclic codes.

Unit-V  Special cyclic codes
BCH codes – Parameters of BCH codes – Decoding of BCH codes – Reed Solomon
codes.

Text book
San Ling and Chaoping Xing; Coding Theory: A first course, Cambridge University
Press, 2004

Reference book
V. Pless: Introduction to the Theory of Error correcting codes, Wiley, New York,
1982
M. Sc. Mathematics

SOFT CORE : MATH-531 CRYPTOGRAPHY

Unit-I Basic concepts
Factoring and primality testing – Perfect numbers – Fermat’s divisibility test – Fermat numbers – Base representation of integers – Computational complexity.

Unit-II Symmetric key crypto systems
An overview of congruences – Block ciphers – The DES key Schedule – The DES Cryptosystem

Unit-III Public key cryptosystems
Exponentiation, discrete logs and protocols – Public key cryptography – RSA system – Rabin system – Elgamal system.

Unit-IV Authentication and knapsack
Digital signatures – Signature schemes related to public key Crypto Systems – Knapsack problem – Merkle Hellman system – Chor Rivest system.

Unit-V Primality testing

Text book

Reference book
M. Sc. Mathematics

SOFT CORE : MATH-532 AUTOMATA THEORY

Unit-I  Introduction to the theory of computation
        Three basic concepts: Languages, Grammars, Automata – Some application.

Unit-II  Finite Automata
        Deterministic finite accepters – Nondeterministic finite accepters – Equivalences of deterministic and nondeterministic finite accepters – Reduction of the number of states in finite automata.

Unit-III  Regular Languages and Regular Grammars
        Regular expression – Connection between regular expression and regular languages - Regular grammars.

Unit-IV  Properties of Regular Languages
        Closure properties of regular languages – Elementary questions about regular languages – Identifying non regular languages.

Unit-V  Context-Free Languages
        Context-free grammars – Parsing and ambiguity – Context – Free Grammars and programming languages.

Treatment as in : Peter Linz, “An Introduction to Formal Languages and Automata”, Jones and Bartlett Publishers, Inc. 2006
M. Sc. Mathematics

SOFT CORE : MATH-533 ADVANCED TOPICS IN TOPOLOGY AND ANALYSIS

Unit-I
Quotient topology and quotient maps - Examples of quotient spaces - Path connectedness - Standard results - Example of a connected but not path connected space- Locally connected spaces.

Unit-II
The Uryshon’s metrization theorem - One point compactification - Stone- Cech compactification - The Arzela - Ascoli theorem.

Unit-III
Local finiteness- Countably locally finite refinement of open coverings of metric spaces – Paracompactness - Standard results - Metric spaces are paracompact.

Unit-IV
Partition of unity - Lp- spaces – Completeness - Dual of Lp[a, b] for 1≤ p < 1.

Unit-V
Extreme points - Caratheodory’s theorem - Krein- Milman theorem - Milman converse theorem - Extreme points of the closed unit ball of c, l∞, C(Q), Q compact, Hausdorff and the dual of C(Q) - Strictly convex spaces - Examples.

Reference books
M. Sc. Mathematics

SOFT CORE : MATH-534 APPROXIMATION THEORY

Unit-I
Interpolation by polynomials - Lagrange interpolation - Vander Monde’s determinant - Bernstein polynomials - Weierstrass approximation theorem.

Unit-II
Stone- Weierstrass theorem (Real and complex versions) - Weierstrass theorem as corollary - Approximation of continuous, periodic functions by trigonometric polynomials - Best approximation in C[a, b] with sup norm - Chebychev’s Alternation theorem - Theorem of de La Vallee Poussin.

Unit-III

Unit-IV
An algorithm of Remes and convergence under Haar condition - Strictly convex and uniformly convex Banach spaces - Approximation in inner product spaces – Approximation from closed, convex subsets - Approximation from subspaces of Hilbert spaces - Uniform convexity and continuity of metric projection.

Unit-V
Approximation from finite dimensional subspaces - Normal equations and Gram’s determinant - approximation in L2[a, b] - Orthogonal polynomials - Legendre and Chebychev polynomials.
Best approximation by subspaces of Banach spaces - Duality formula - Spaces in which all closed subspaces are proximinal or Chebychev-proximinality of weak* closed subspaces - Approximation by closed hyperplanes.

Reference books
5. Ivan Singe: Best approximation in normed linear spaces by elements of linear subspaces, Springer-Verlag, 1970
M. Sc. Mathematics

SOFT CORE : MATH-536 DIFFERENCE EQUATIONS

Unit-I The Difference Calculus

Unit-II First order difference equation

Unit-III Linear Difference equations
Introduction, Linearly Dependent functions. Fundamental Theorem for homogeneous equations.

Unit-IV Inhomogeneous equations
In homogeneous equations. Second order equations. Sturm Liouville Difference equations.

Unit-V Linear Difference equation with constant coefficients
Introduction, Homogeneous equation. Construction of a difference equation having specified solution. Relationship between Linear difference and differential equation.

Text book
M. Sc. Mathematics

Soft Core – MATH-537: Partial Differential Equations

Unit – I: First Order PDEs
Genesis of First order PDE, Linear equations of first Order, Pfaffian Differential equations, Compatible systems, Charpit’s method, Jacobi’s method, Integral surfaces through a given curve, Quasi linear equations

Unit – II: Non-linear first order PDEs.
Cauchy’s method of characteristics, Compatible systems, Special types of first order equations

Unit – III: Second Order PDEs
Genesis of Second order PDEs. Classification of second order pdes, One –dimensional wave equations, Vibrations of a string of Infinite length, semi-infinite length and finite length, Riemann’s Method, Method of separation of variables

Unit – IV: Laplace equations
Boundary value problems, Maximum and minimum principles, Cauchy Problem, Dirichlet problem, Neumann problem, Harnack’s theorem, Green’s function

Unit – V: Heat Conduction Problem in infinite rod case and finite rod case, Duhamel’s Principle, Wave equation, Heat conduction equation, Classification in n-variables, Families of equi potential surfaces, Kelvin’s Inversion Theorem

TEXT BOOK:

REFERENCE BOOKS
2. K. Shankara Rao, Introduction to Partial Differential Equations, PHI Publications, New Delhi, 2005
3. F. John, Partial Differential Equations, Springer Verlag, 1975
M. Sc. Mathematics

**SOFT CORE : MATH-538 LIE GROUPS OF TRANSFORMATIONS AND DIFFERENTIAL EQUATIONS**

**Unit-I**
Introduction–Lie groups of transformation – Infinitesimal transformations.

**Unit-II**
Extended group transformations and infinitesimal transformations (one independent – one dependent and two independent – two dependent).

**Unit-III**
Lie Algebras and Applications.

**Unit-IV**
Invariance of first and second order differential equations.

**Unit-V**
Invariance of a partial differential equations of first and second order – elementary examples.

**Treatment as in** G. W. Blueman and S. Kumei: Symmetries and Differential Equations Springer – Verlag, 1980

1 – Chapter 2 (Sections 2.1 – 2.2);
2 – Chapter 2 (Sections 2.3.1 – 2.3.3);
3 – Chapter 2 (Sections 2.4.1 – 2.4.4);
4 – Chapter 3 (Sections 3.1.1 – 3.3.3);
5 – Chapter 4 (Sections 4.4.1 – 4.2.2).
M. Sc. Mathematics

SOFT CORE : MATH-539 NUMERICAL ANALYSIS FOR ORDINARY DIFFERENTIAL EQUATIONS

Unit-I
Euler's method - trapezoidal rule - theta method.

Unit-II
Adams - Bashforth method - Order and convergence - Backward Differentiation Formula.

Unit-III

Unit-IV

Unit-V
Error Contool - Milne Device - Embedded Runge Kutta method.

Text book
Arieh Iserles, A First Course in the Numerical Analysis of Differential Equations, Cambridge, 2009
M. Sc. Mathematics

SOFT CORE : MATH-540 ADVANCED FLUID MECHANICS

Unit-I

Unit-II

Unit-III

Unit-IV

Unit-V

Text Books
Unit-I
Introduction - classification of integral equation - examples - IVP for ODE.

Unit-II
BVP for ODE - BVP for elliptic PDE - Abel's problem.

Unit-III
Second order ODE and integral equations - Differential equation theory - initial value problems - Boundary value problems - Singular Boundary value problems.

Unit-IV
Integral equations of the second kind - Introduction - Degenerate kernels - a different approach.

Unit-V
Operators - Newmann series.

Book
A practical treatment from spectral theory to applications. - Cambridge: Cambridge University Press, 1996
Unit-I Spaces of functions
Families of functions like periodic functions - Continuous functions, C1- functions, rapidly decreasing functions on Rn which separate points, closed subsets - Partition of unity.

Unit-II
Topology on the spaces functions
Uniform convergence - Uniform convergence on compact on polynomials (with emphasis on power series), Ck-functions, C1-functions on Rn – holomorphic functions on C - Completeness of various spaces of functions under uniform metric, Lp-metric and under uniformly on compact topology.

Unit-III Compact subsets

Unit-IV Fourier analysis
Convolutions - Fourier transform - Approximate identities in L1(Rn) given by classical kernels like Fejer’s kernel.

Unit-V Density
Approximation through convolutions - Density theorems of Weierstrass and Stone, Korovkin – Density of C1c -functions in Lp.

Reference books
1. R. Beals: Advanced mathematical analysis, Springer Verlag, New York, 1973
M. Sc. Mathematics

SOFT CORE : MATH-543 REPRESENTATION THEORY OF COMPACT GROUPS

Unit-I
Locally compact groups - Examples of various matrix groups. - Existence of Haar measure (without proof) - Computation of Haar measure on R, T, SU(2), SO(3) and some simple matrix groups. Convolution - The Banach algebra L1(G).

Unit-II
General properties of representations of a locally compact group - Complete reducibility - Basic operations on representations – Irreducible representations.

Unit-III

Unit-IV
Arzela - Ascoli Theorem - Compact operators - Various forms of Peter- Weyl theorem.

Unit-V
Character of a representation. Schur’s orthogonality relations among characters - Weyl’s charcter formula - Computing all the irreducible representations of SU(2), SO(3).

Reference books

1. T. Brocker and T. Dieck: Representations of compact lie groups, Springer Verlag, 1985
4. B. Vinberg, Linear representations of groups, A series of advanced textbooks in Mathematics, Brikauser Verlag, Berlin - Boston, 1989
M. Sc. Mathematics

SOFT CORE : MATH-544 ELEMENTS OF HARMONIC ANALYSIS

Unit-I
Basic properties of topological groups, subgroups, quotient groups - Examples of various matrix groups.

Unit-II
Connected groups - Existence of Haar measure (without proof) - Computation of Haar measure on R, T, Z and some simple matrix groups - Convolution, the Banach algebra L1(G) and convolution with special emphasis on L1(R), L1(T) and L1(Z).

Unit-III
Fourier transform and its properties - Approximate identities in L1(G).

Unit-IV
The Dual group of a locally compact abelian group - Computation of dual groups for R, T, Z.

5. Unit-V
Classical kernels on R - The Fourier inversion Theorem - Plancherel theorem on R - Plancherel measure on R, T, Z - Discussion on Plancherel theorem on a general locally compact abelian group.

Reference books

3. Y. Katznelson: Introduction to harmonic analysis, J. Wiley and Sons, 1968
M. Sc. Mathematics

SOFT CORE : MATH-545 LINEAR LIE GROUPS

Unit-I
Basic properties of topological groups, subgroups, quotient groups and connected groups.

Unit-II
Linear Lie groups like GL(n,R), GL(n,C), Orthogonal groups, Unitary groups, Motion groups, Heisenberg groups and various properties of them.

Unit-III
Computation of Haar measure for the above groups - The exponential map and the Lie algebras of the above groups.

Unit-IV
Representations of a locally compact group - Adjoint representation - Irreducible representations of SU(2) and SO(3).

Unit-V
Induced representation - Irreducible representations of Motion group M(2) and Heisenberg groups.

Reference books

M. Sc. Mathematics

SOFT CORE : MATH-546  GRAPH THEORY
4 Credits

Unit-I
Vertex cuts – Connectivity – Edge cuts – Edge connectivity – Whitney’s Theorem – Blocks – Cyclic edge connectivity.

Unit-II

Unit-III
Chromatic number of graphs – critical graphs – Brooks theorem – Hajos conjecture – Chromatic polynomials – Girth and chromatic number of graphs.

Unit-IV
Plane and Planar graphs – Dual graphs – Euler’s Formula – Bridges – Kuratowski’s Theorem – Five color Theorem – Four color theorem.

Unit-V

Reference books:
1. R. Balakrishnan and K. Ranganathan, A textbook of Graph Theory, Springer Publication, 2000
M. Sc. Mathematics

SOFT CORE : MATH-547 ADVANCED FUNCTIONAL ANALYSIS

Unit-I
Topological vector spaces-balanced and absorbing sets - Locally convex spaces – Examples- Weak and weak* topologies.

Unit-II

Unit-III
Continuous linear functionals and dual of locally convex spaces - Hahn- Banach separation theorems - Weak topology induced by a subset of the dual polar set – Bipolar theorem.

Unit-IV
Weak* continuous linear functionals on dual normed linear spaces - Goldstein’s theorem - Banach -Alaoglu’s theorem - Characterization of reflexive spaces as spaces with weakly compact unit balls.

Unit-V
Linear operators – Examples - Integral operators - Inverse and adjoint operators - Adjoint operators in Hilbert spaces - Normal and unitary operators.

Reference books

M. Sc. Mathematics

**SOFT CORE : MATH-548 ADVANCED TOPICS IN DISCRETE MATHEMATICS**

**Unit-I**
Applications of Boolean algebra to Switching Theory using AND, OR and NOT gates - The Karnaugh Method.

**Unit-II**
Definition of (undirected) graphs - Paths - Circuits and Cycles - Subgraphs and induced subgraphs - Degree of a vertex - Connectivity - Complete graphs bipartite graphs - Matrix representations of graphs - Weighted graphs - Dijkstra's Algorithm.

**Unit-III**
Trees and their properties- Spanning trees - Minimal spanning trees - Kruskal's Algorithm – Euler graphs and paths - Euler's theorem on the existence of Euler paths and circuits.

**Unit-IV**
Fundamental cycles - Cutsets - Fundamental cutsets - Plane and planar graphs - Dual graphs - Euler's formula for connected plane graphs - Kuratowski's theorem (statement only) and its applications.

**Unit-V**

**Reference books**

6. N. Deo: Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India, 2004
M. Sc. Mathematics

SOFT CORE : MATH-549 LABORATORY PRACTICAL IN MATHEMATICS

Objective of the Course:

To introduce to the students certain important software packages in Mathematics and train them for practical applications so as to augment the skills of the students.

Course contents: Any five units from the following topics:
Kash
Latex
Maple
Mathematica
Mathcad
Mathlab
Octave
Pari
Reduce
Scilab

Methodology of teaching:
(i) Lectures
(ii) Computer Practicals
(iii) Assignments

Methodology of evaluation: Practicals

Reference books

M. Sc. Mathematics

SOFT CORE: MATH 550 TOPICS IN TOPOLOGY AND ANALYSIS

**Unit-I**  Connected topological spaces
Connected topological spaces- Path connectedness- Components-Example of a connected but not path connected space- Locally connected spaces- Continuous images of connected, path connected and locally connected spaces

**Unit-II**  Locally compact spaces and Completely regular spaces
Locally compact spaces-One point compactification -Completely regular spaces- Imbedding theorem for completely regular spaces-The Uryshon's metrization theorem

**Unit-III**  Stone- Cech compactification
Stone- Cech compactification- equicontinuity- Arzela- Ascoli theorem- Stone-Weierstrass theorem

**Unit-IV**  Interpolation
Lagrange interpolation-Bernstein polynomials- Monotone operator theorem- Weierstrass theorem

**Unit-V**  Completeness
Completeness of Lp[a; b]-Product measures- Fubini’s theorem

**Reference books**

1. James R Munkres: Topology, Prentice Hall, **2000**
2. Walter Rudin,: Real and Complex Analysis, Mc Graw-Hill Pupblizhing Co. Ltd., New Delhi, 10th Reprint, **1986**
3. H.L.Royden: Real Analysis, Macmillan Publishing Company, **1988**
M. Sc. Mathematics

**SOFT CORE: MATH 551 FUNCTIONAL ANALYSIS - II**

**Unit-I** Normed linear spaces
Separation theorem and strict separation theorem in normed linear spaces-Applications-Weak and weak* topologies on normed linear spaces, both finite and infinite dimensional

**Unit-II** Weak and weak* topologies
Conditions for metrizability of weak and weak* topologies on bounded sets-Weak and weak* continuous linear functionals-Separation theorem for spaces with weak or weak* topologies

**Unit-III** Dual-polar set
Weak topology induced by a subset of the dual-polar set - Bipolar theorem - Goldstein's theorem- Banach -Alaoglu's theorem- Reflexivity and weak convergence.

**Unit-IV** Operators - I
Linear operators-Examples-Integral operators- Inverse and adjoint operators- Range and null spaces- Adjoint operators in Hilbert spaces- Normal and unitary Operators

**Unit-V** Operators - II
Compact operators on Banach spaces- Definition, examples and basic properties- Hilbert Schmidt operators

**Reference books**

SOFT CORE: MATH 552 OPERATOR THEORY

Unit-I

Unit-II

Unit-III

Unit-IV

Unit-V
Compact operators – Examples and properties – Spectral theorem for compact operators – Hilbert – Schmidt operators.

Reference books

M. Sc. Mathematics

SOFT CORE: MATH - 554 NON-COMMUTATIVE RINGS AND REPRESENTATIONS

Unit-I Modules
Modules - Artinian and Notherian modules - Tensor products - Restricted and induced modules - Indecomposable modules – Completely reducible module - Schur Lemma.

Unit-II Radical
Semi simple rings - The radical of a rings - The Jacobson radical – Group algebras - Maschke's Theorem.

Unit-III Structure theory

Unit-IV Representations - I
Representations - linear representation - Matrix representation - Equivalent representation - Invariant subspaces - Irreducible representations

Unit-V Representations - II
Direct sum of representations - Induced representation – restricted representation - tensor product of representations - Inner products of representation.

Text book

Reference books
SOFT CORE: MATH-555: ADVANCED COMPLEX ANALYSIS

Unit-I
The space of continuous functions - Spaces of analytic functions - Spaces of meromorphic functions - The Riemann Mapping Theorem.

Unit-II
Weierstrass factorization theorem - Factorization of sine function - The gamma function - The Reimann zeta function.

Unit-III
Schwarz Reflection Principle - Analytic continuation along a path - Monmodromy theorem.

Unit-IV
Subharmonic and superharmonic functions - The Dirichlet problem - Green’s function.

Unit-V
Jensen’s formula - The genus and order of an entire function.

Text book

Reference Book:
L.V. Ahlfers, Complex Analysis, Mc-Grow Hill, Kogakush, 1979
M. Sc. Mathematics

SOFT CORE: MATH-557 ALGORITHMS WITH JAVA

Unit-I

Unit-II
JAVA: Data types – Constants, variables – Declaration of variables – Scope of variables-Types casting –operator expressions- Decision making , branching and looping , creating arrays, variable size arrays, Strings.

Unit-III
Defining classes-Creating objects-Accessing class members – Methods overloading, Creating inheritance – Abstract methods and classes.

Unit-IV
Multi threading programming – creating threads, Extending the thread class – Starting , Stopping and blocking threads-Managing errors and exceptions-Types of errors exceptions-Catch statements-Throwing customized Exceptions.

Unit-V
Applet programming-Building Applet codes-Adding Applet to HTML file – passing parameters to Applet.

Text Books

Reference Books
M. Sc. Mathematics

MATH-558: FUNCTIONAL ANALYSIS – III  
(Soft Core - 4 Credits)

Unit-I
Nets and sequences-convergence of nets-unconditional summability of series in Banach Space- 
Review of Hilbert spaces – sesquilinear forms-adjoint and self-adjoint operators in Hilbert 
spaces.

Unit-II
Normal and unitary operators – weak topology – strong and weak convergence of operators – 
orthogonal direct sums.

Unit-III
Compact operators of Banach spaces-integral operators – adjoint operator – Fredholm 
alternative.

Unit-IV
Invertible operators – eigenvalues and sepectrum related results – spectrum of a compact 
operator – self adjoint operators.

Unit-V
Compact operators of Hilbert spaces – Numerical range – spectral theorem for compact, self 
adjoint operators.

Text Books:
   (For units 1 and 2)

2. M.Fabian, P.Habala, P.Hajek, V.M. Santalucia, J.Pelant and V.Zizler: Functional Analysis 
   and Infinite dimensional geometry CMS books in Mathematics, Springer, 2001 
   (For units 3-5)
M. Sc. Mathematics
Math-559 Mathematica Practical
Soft Core

Unit-I
Basic concepts: Constants- Built-In Functions. Basic Arithmetic Operations Strings-
Assignment, Replacement, and Logical relations - Loops.

Unit-II
Two dimensional graphics and Three dimensional Graphics: Plotting Functions of
Single variables and Two Variables - Graphic commands.

Unit-III
Lists: Generating Lists- List Manipulation - Set Theory - Tables and Matrices.
Equations- Algebra and Trigonometry- Polynomials.

Unit-IV
Differential Calculus - Integral Calculus - Multivariable Calculus

Unit-V
Ordinary Differential Equations - Linear Algebra.

Reference:
2. Bruce F. Torrence and Eve A. Torrence, A Students Introductions to Mathematica,
Cambridge University Press, 2009
M. Sc. Mathematics

SOFT CORE: MATH -560 - Mathematical Softwares
(Credits: 4)

Unit-I:

Unit-II:

Unit-III:
Starting with MATLAB- Variables Vectors, Matrices – Creating Array in MATLAB – Menu, Workspace, working Directory, Command window, Diary, Printing- Built_in function, User defined functions, Script M-files- Complex Arithmatic, Figen values and Eigen vectors – Two and three dimensional Plots.

Unit-IV:
Getting around with maple – Maple input and output - Programming in Maple.

Unit-V:
Maple: Abstract Algebra – Linear algebra – Calculus on Numbers – Variables- Complex Arithmatic, Eigen values and Eigen vectors – Two and three dimensional Plots.

Text Books:
M. Sc. Mathematics

MATH-561: Computational Algebra
(Soft core)

Unit- I
Fundamental Algorithms: Representation, Addition and Multiplication of Numbers and Polynomials - Division with Remainder- Euclidean Domain - The Extended Euclidean Algorithm

Unit- II
Modular Arithmetic - Modular Inverses via Euclid - Repeated Squaring - Modular Inverses via Euclid

Unit-III
Modular Algorithms and Interpolation: Change or Representation - Evaluation and Interpolation - The Chinese Remainder Algorithm

Unit- IV

Unit - V
Factoring Polynomial over Finite Fields: - Factorization of Polynomials - Distinct-Degree Factorization - Equal-Degree Factorization - Squarefree Factorization - Factoring in \[\mathbb{F}[x]\] and \[\mathbb{Q}[x]\] - A Factoring Algorithm.

Reference:
1. Joachim von zur Gathen and J{"u}rgen Gerhard: Modern Computer Algebra, Cambridge University Press, 1999
M. Sc. Mathematics  
Soft Core- MATH-562: Numerical Analysis

Unit-I: Nonlinear Equations in One Variable:  
Fixed point iterative method – convergence Criterion -Aitken’s Δ2- process - Sturm sequence  
method to identify the number of real roots – Newton - Raphson’s methods convergence  
criterion Ramanujan’s Method - Bairstow’s Method.

Unit-II: Linear and Nonlinear system of Equations:  
Gauss Eliminations with Pivotal Strategy Jacobi and Gauss Seidel Iterative Methods with  
convergence criterion. LU - decomposition methods – (Crout’s, Choleky and DeLittle methods)  
– consistency and ill conditioned system of equations - Tri-diagonal system of equations –  
Thomas Algorithm. Iterative methods for Nonlinear system of equations, Newton Raphson,  
Quasi Newton and Over Relaxation methods for Nonlinear system of Equations.

Unit-III: Interpolation:  
Lagrange, Hermite, Cubic-spline’s (Natural, Not a Knot and Clamped)- with uniqueness and  
error term, for polynomial interpolation. Bivariate interpolation. Orthogonal polynomials  
Grams Schmidt Orthogoralization procedure and least square, Chebyshev and Rational  
function approximation.

Unit -IV: Numerical Integration:  
Gaussian quadrature, Gauss-Legendre, Gauss-Chebeshev formulas, Gauss Leguree, Gauss  
Hermite and Spline intergation – Integration over rectangular and general quadrilateral areas and  
multiple integration with variable limits.

Unit-V: Numerical solution of ordinary differential equations:  
Initial value problems- Picard’s and Taylor series methods – Euler’s Method- Higher order  
Taylor methods - Modified Euler’s method - Runge Kutta methods of second and fourth order –  
Multistep method - The Adams - Moulton method - stability - (Convergence and Truncation  
error for the above methods). Boundary - Value problems – Second order finite difference and  
cubic spline methods.

TEXT BOOKS
2. C.F. Gerald and P.O. Wheatley : Applied Numerical Methods, Low- priced edition,  
Pearson Education Asia, Sixth Edition, 2002
Edition, 1979

REFERENCE BOOKS
M.Sc. Mathematics

MATH-563: INTEGRAL TRANSFORMS
SOFTWARE COURSE-4 CREDITS

SYLLABUS

Unit- I

Unit- II

Unit- III

Unit-IV
Fourier Transform, Exponential, Sine and Cosine Transforms, Important Properties, Spectral Analysis.

Unit- V

TEXT BOOK