APPENDIX-III

PONDICHERRY UNIVERSITY
DEPARTMENT OF MATHEMATICS

M.Phil. MATHEMATICS PROGRAMME

SYLLABI

WITH EFFECT FROM THE ACADEMIC YEAR

2011 - 2012
M.PHIL MATHEMATICS

Regulations

Eligibility for admission:

A candidate for admission into M.Phil. programme shall have studied M.Sc. Mathematics under 10 + 2 + 3 + 2 pattern of study.

Candidates who have secured 55% of marks or above in Master’s Degree in Mathematics are eligible to apply.

Duration of study:

The course duration shall normally be of one year spread over two semesters. The maximum duration to complete the course shall be 3 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.

Credit Requirements

A candidate of M.Phil. programme has to take 2 hard core courses and sufficient number of soft core courses and carry out a dissertation work.

The Course Work shall be done for a minimum of 18 credits. The Dissertation and Viva-voce carry 15 and 3 credits, respectively
## PONDICHERRY UNIVERSITY
DEPARTMENT OF MATHEMATICS

M.Phil. MATHEMATICS

List of Hard and 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>
<th>Hard Core/Soft Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MATH-605</td>
<td>Hydrodynamic Stability</td>
<td>Hard Core</td>
</tr>
<tr>
<td>2</td>
<td>MATH-619</td>
<td>Algebra</td>
<td>Hard Core</td>
</tr>
<tr>
<td>3</td>
<td>MATH-621</td>
<td>Theory of Graphs</td>
<td>Soft Core</td>
</tr>
<tr>
<td>4</td>
<td>MATH-635</td>
<td>Algebraic Theory of Numbers</td>
<td>Soft Core</td>
</tr>
<tr>
<td>5</td>
<td>MATH-636</td>
<td>Integrable Systems</td>
<td>Soft Core</td>
</tr>
<tr>
<td>6</td>
<td>MATH-637</td>
<td>Lie Groups of Transformations and Differential Equations</td>
<td>Soft Core</td>
</tr>
<tr>
<td>7</td>
<td>MATH-638</td>
<td>Homological Algebra</td>
<td>Soft Core</td>
</tr>
<tr>
<td>8</td>
<td>MATH-639</td>
<td>Representation and Characters of Finite Groups</td>
<td>Soft Core</td>
</tr>
<tr>
<td>9</td>
<td>MATH-602</td>
<td>Topics in Analysis</td>
<td>Soft Core</td>
</tr>
<tr>
<td>10</td>
<td>MATH-641</td>
<td>Fuzzy Clustering and its Applications</td>
<td>Soft Core</td>
</tr>
<tr>
<td>11</td>
<td>MATH-642</td>
<td>Topics in Graph Theory</td>
<td>Soft Core</td>
</tr>
<tr>
<td>12</td>
<td>MATH-643</td>
<td>Algorithmic Graph Theory</td>
<td>Soft Core</td>
</tr>
<tr>
<td>13</td>
<td>MATH-644</td>
<td>Product Graphs</td>
<td>Soft Core</td>
</tr>
<tr>
<td>14</td>
<td>MATH-645</td>
<td>Computational Method for the PDE</td>
<td>Soft Core</td>
</tr>
<tr>
<td>15</td>
<td>MATH-646</td>
<td>Theory of Partitions</td>
<td>Soft Core</td>
</tr>
</tbody>
</table>
UNIT - I

UNIT - II
General theorems of Lyapunov – chetayev’s instability theorem – examples.

UNIT - III

UNIT - IV

UNIT - V
Howard’s theorem – Unbounded flows – asymptotic formula for instability – piece wise linear profiles – Arnold’s theorems.

Text Books:
Units I and II: Elsgolts, Differential Equations and Calculus of Variations, 2003
Units III and IV: Drazin and Reid, Hydrodynamic Stability, 2004

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M.Phil. Mathematics

HARD CORE COURSE
MATH - 619 ALGEBRA
4 Credits

SYLLABUS

UNIT - I

Prime ideals, maximal ideals, Nil radical, Jacobson radical, Operation on ideals, Extension and contraction.

UNIT - II

Operation on sub-modules, Direct sum and product. Finitely generated modules, Exact sequences, Tensor product, Restriction and extension of Scalars.

UNIT - III

Rings and Modules of Fraction and Primary decomposition Local properties Extended and contracted Primary decomposition.

UNIT – IV

Integral dependence and chain conditions.

UNIT - V

Noetherian rings and Artinian rings

Text Book:


Reference Books:

2. I. Kaplansky, Allyn and Bacon, Commutative Rings, Springer, 1970
M.Phil. Mathematics

SOFT CORE COURSE
MATH - 621 THEORY OF GRAPHS
4 Credits

SYLLABUS

UNIT–I
Graphs and Simple graphs-Special graphs (Complete graphs, Complement of graphs) - Graph isomorphism-Sub graphs-vertex degrees Walks, Paths, Cycles-Graph Connection and Components-Bipartite graphs-Trees-Cutedges- Cutvertices-Blocks.

UNIT–II
Matchings - Berge’s Theorem-Hall’s Theorem and its applications-Coverings in graphs-Konig’s Theorem-Perfect Matching-Tutt’s Theorem and its applications.

UNIT–III
Independent sets-Gallai’s Theorem- Ramsay numbers-Ramsay graphs-Erdos and Szekers Theorem.

UNIT–IV
Erdos Theorem- Turan’s Theorem and its applications Chromatic number of graphs-Critical graphs-Brook’s Theorem-Chromatic polynomials.

UNIT–V
Plane and Planar graphs-The Five Colour Theorem and the four colour Theorem statement only-Directed graphs-Directed paths-Tournaments-Directed Hamilton Paths and Cycles.

Text Book:
1. J.A.Bondy and U.S.R.Murthy, Graph Theory with applications, 1976

Reference Books:
1. F.Harary, Graph Theory, 1969
4. D.B.West, Introduction to Graph Theory.
5. K.R.Parthasarathy, Basic Graph Theory, 1994
6. N.Deo, Graph Theory with Applications to Engineering and Computer Science, 1974
7. R.J.Wilson, Introduction to Graph Theory, 1972
8. L.R.Foulds, Graph Theory Applications, 1993
M.Phil. Mathematics

SOFT CORE COURSE
MATH - 635 ALGEBRAIC THEORY OF NUMBERS

4 Credits

SYLLABUS

UNIT - I
Divisibility in principal ideal rings - The Diophantine equation $X^2 + Y^2 = Z^2$ - The diophantine equation $X^4 + Y^4 = Z^4$ - Euler's phi function - Modules over principal ideal rings - Roots of unity a in a field.

UNIT - II
Elements integral over a ring - Integally closed rings - Elements algebraic over a field - Algebraic extensions - Conjugate elements - Conjugate fields - Integers in quadratic fields.

UNIT - III
Noetherian rings and modules - Application of integral elements - Properties of ideals - Dedekind rings.

UNIT - IV
Discrete sub groups of $\mathbb{R}$ - Cononical imbedding of a number field - Finiteness of the ideal class group.

UNIT - V
The unit theorem - Units in imaginary quadratic fields - Units in real quadratic fields.

Reference Book:

P. Samuel, Algebraic Theory of Numbers, Houghton Mifflin Company, Boston, 1970
M.Phil. Mathematics

SOFT CORE COURSE
MATH - 636 INTEGRABLE SYSTEMS
4 Credits

UNIT -I
Introduction to linear and nonlinear waves –Korteweg - de Veries equation - Lax pairs – Conservation laws –Hamiltonian structures

UNIT -II
Hirota’s bilinear method – Korteweg - de Veries and KP equations - Finding three soliton solutions

UNIT -III
Lie symmetry analysis - Heat, Burger’s, Korteweg - de Veries and modified Korteweg – de - Veries equation and similarity reductions

UNIT -IV
Introduction to difference equations-Discrete heat, Burgers’ and Korteweg – de –Veries

UNIT -V
Applications of REDUCE and MAPLE mathematical software to certain problems in integrable systems

Reference books

5. R. Hirota, Mathematics of Solitons, Direct Method, Iwami, Japan, 1992
M.Phil. Mathematics

SOFT CORE COURSE
MATH - 637 LIE GROUPS OF TRANSFORMATIONS AND DIFFERENTIAL EQUATIONS
4 Credits

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.

Reference book
Unit 1: Chapter 2 (omit sections 1-6, 14);
Unit 2: Chapter 3 (omit sections 1-3, 6, 7, 10, 11);
Unit 3: Chapter 4 (omit sections 1, 6-13);
Unit 4: Chapter 5 (omit sections 1, 5-10);
Unit 5: Chapter 6 (omit sections 1, 5-7).
M.Phil. Mathematics

SOFT CORE COURSE
MATH - 638 HOMOLOGICAL ALGEBRA
4 Credits

UNIT - I
Free modules-Projective modules- Injective modules- flat modules.

UNIT - II
Complexes and derived functors.

UNIT - III
Ext and Tor functors

UNIT - IV
Homological dimensions.

UNIT - V
Tensor Algebra, Symmetric Algebra and Exterior Algebra.

Reference books

2. Gopalakrishnan, N.S; Commutative Algebra, Oxonian Press Pvt. Ltd., 1984
M.Phil. Mathematics

SOFT CORE COURSE
MATH – 639 REPRESENTATION AND CHARACTERS OF FINITE GROUPS
4 Credits

UNIT -I
Modules - Tensor products - Restricted and induced modules- Indecomposable modules - Completely reducible module - Schur lemma- Semi simple rings - The Jacobson radical - Group algebras - Maschke's theorem.

UNIT -II

UNIT -III
Linear and matrix representation – Equivalent and irreducible representations - Induced and restricted representation - Tensor product and inner products of representation.

UNIT -IV
Representations of the symmetric groups - Young subgroups -Tableaux - Tabloids - Specht modules - Standard tableaux- Branching rule.

UNIT - V
RSK Algorithm - The Hook length formula - Increasing and decreasing subsequences - Group characters.

Text books


Reference books

UNIT - I
Nets and sequences-characterization of topological properties in terms of nets-Inadequacy of sequences-subnets-unconditionally summable series-examples-Topological Vector Spaces-balanced and absorbing sets-locally convex spaces-The metric space $L_p[0,1]$ for $0 < p < 1$.

UNIT - II
Finite dimensional topological vector spaces-Linear homeomorphism with $k^n$, where $k$ is the scalar field $\mathbb{R}$ or $\mathbb{C}$-Minkowski functional-Sublinear functional and semi norms-bounded and totally bounded sets-Metrizable topological vector spaces-Characterization of normable locally convex spaces

UNIT - III
Continuous linear functionals and dual of locally convex spaces-Mazur’s separation theorem in a topological vector space- First and second separation theorems.

UNIT - IV
Weak topology induced by a subset of the dual-Weak and weak* topologies-weak and weak* convergent sequences-Comparison of weak, weak* and norm topologies-Reflexive spaces-Metrization of weak and weak* topologies on bounded sets-polar sets

UNIT - V
Bipolar theorem-Weak* continuous linear functional on dual normed linear spaces – Goldstein’s theorem- Banach- Alaoglu’s theorem-characterization of reflexive spaces as spaces with weakly compact unit balls-Closed subsapces of reflexive spaces are reflexive.

Reference Books:
M.Phil. Mathematics

MATH-641: Title of Subject: Fuzzy Clustering and Its Applications
Credits: 4

Unit -I
Basic concepts: Basic concepts of interval numbers- Difference between intervals – Two - level intervals valued numbers More general Two -level intervals-General n-level intervals – Infinite level intervals numbers.

Unit-II

Unit -III

Unit -IV

Unit-V
Applications: Fuzzy C-Means in Medical Images – Fuzzy C-Means in Large Medical Data Base and Other real world Data analyzing problems.

Text Books:
2. Frank Hopper, Frank Klawonn, Rudolf Kruse and homas Runkler, Fuzzy Cluster Analysis John Willey & Sons Ltd.

References
1. I S Luthar: “Set, Functions and Numbers”, Narosa Publishing House Pvt. Ltd, 2005
M.Phil. Mathematics
MATH-642: Topics in Graph Theory
4 credit (Soft Core)

Unit –I
Contraction –Minors.

Unit –II
Euler tours – Graphs and linear algebra – 2-connected graphs and subgraphs –The structure of 3-
connected graphs –Menger’s theorem –Mader’s theorem –Edge-disjoint spanning trees.

Unit –III
duality –Tutte’s flow conjectures.

Unit –IV
Turan’s theorem –Ramsey numbers –Generalized Ramsey numbers –Rainbow Ramsey numbers
–Erdos numbers.

Unit –V
Domination numbers and colourings –T-colourings –L(2,1)-colourings –Radio colourings –
Hamiltonian colourings.

References:

1. R.Diestel:– Graph Theory, Springer-verlag, New York, 2000
M.Phil Mathematics

MATH-643: Algorithmic Graph Theory
(4 –credit soft core course)

Unit –I

Unit –II

Unit –III

Unit –IV

Unit –V
Ramsey Numbers –Generalized Ramsey Numbers –Turan’s Theorem.

Text Book:

Reference Books:
J.A. Bondy and U.S.R. Murty: Graph Theory with Applications, North Holland, New York, 1976
S. Even: Graph Algorithms, Computer Science Press, Rockville, MD, 1979
Unit I: Basic concepts
Graphs – Automorphisms and invariants – Hypercubes and isometric subgraphs – Cartesian product – Graph representations and Algorithms.

Unit-II: Hypercubes
The Djokovic Winkler relation – Characterizing and recognizing partial cubes – An Application to chemical graphs – Mulder’s convex expansion – Euler type formulas – Retracts and fixed cubes.

Unit-III: Cartesian Products
Prime factor decompositions – Cartesian products of triangles – Automorphisms – Transitive group action on products – Fixed box theorems.

Unit-IV: Strong and Direct Products
Strong products and retracts – Factoring strong product – Automorphisms of strong products – Direct product in \( \Gamma \) and \( \Gamma_0 \) – Factoring direct products – Recognition of direct and strong products.

Unit-V: Lexicographic products
Basic algebraic properties – Factorizations and nonuniqueness – Automorphisms – Cayley graphs – Recognition complexity.

Books for reference:
M.Phil. Mathematics

MATH-645: COMPUTATIONAL METHODS FOR THE PDE
4 Credits
SOFT CORE

Unit – I: Partial Differential Equations
Introduction, Difference methods, Routh Hurwitz Criterion, Domain of dependence of hyperbolic equations

Unit – II: Difference methods in Parabolic PDEs
Introduction, One space dimension, Two space dimensions, variable coefficients problems, spherical and cylindrical coordinate systems

Unit – III: Difference methods for hyperbolic PDEs
Introduction, One space dimension, Two space dimensions, first order equations, systems of first order equations

Unit – IV: Numerical methods for elliptic PDEs
Difference methods for linear BVPs, General second order linear equations, quasilinear elliptic equations

Unit – V:
Finite element methods and multigrid methods

Text Book:
Computational Methods for PDEs
Unit – I: Sections 1.1 to 1.4
Unit – II: Sections 2.1 to 2.5
Unit – III: Sections 3.1 to 3.5
Unit – IV: Sections 4.1 to 4.5
Unit – V: Sections 4.6 and 4.7

Reference Books:
Unit-I:
Partitions of numbers, The generating functions of \( p(n) \), other generating functions

Unit-II:
Congruence properties of partition functions, Restricted partitions, Gaussian, Frobenius partitions

Unit-III:
q-binomial theorem, Euler’s, Gauss, Heine’s Jacobi’s identities, Product identities

Unit-IV:
Gaussian Polynomials, two theorems of Eulers, Jacobi’s triple product identity and its applications, Ramanujans remarkable 1 psi 1 summation formula proof and its applications,

Unit-V:
Combinatorial proofs of Euler’s identity, Euler’s pentagonal number theorem, Franklin’s combinatorial proof. The Rogers-Ramanujan Identities.

References: