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

SL. NO.	COURSE CODE	COURSE TITLE	Hard Core/Soft Core
1	MATH-605	Hydrodynamic Stability	Hard Core
2	MATH-619	Algebra	Hard Core
3	MATH-621	Theory of Graphs	Soft Core
4	MATH-635	Algebraic Theory of Numbers	Soft Core
5	MATH-636	Integrable Systems	Soft Core
6	MATH-637	Lie Groups of Transformations and Differential Equations	Soft Core
7	MATH-638	Homological Algebra	Soft Core
8	MATH-639	Representation and Characters of Finite Groups	Soft Core
9	MATH-602	Topics in Analysis	Soft Core
10	MATH-641	Fuzzy Clustering and its Applications	Soft Core
11	MATH-642	Topics in Graph Theory	Soft Core
12	MATH-643	Algorithmic Graph Theory	Soft Core
13	MATH-644	Product Graphs	Soft Core
14	MATH-645	Computational Method for the PDE	Soft Core
15	MATH-646	Theory of Partitions	Soft Core

M.Phil. Mathematics

HARD CORE COURSE
MATH - 605 HYDRODYNAMIC STABILITY
4 Credits

SYLLABUS

UNIT - I
Theory of Stability – definition of stability and asymptotic – stability – reduction of equilibrium solution – elementary types of rest points – nodes – focus – centre – saddle points.

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

UNIT - III
Rayleigh problem – squire's theorem – Rayleigh's equation – Rayleigh's inflection points theorem – Fjortoft's theorem.

UNIT - IV
Lin's formula, Tollmien's insviscid solutions – Heisenberg's expansions – Reynolds stress – formula for variation of Reynolds stress.

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**
Unit - V: Arnold and Khesin, Topological Methods in Hydrodynamics, Applied Mathematical Sciences 125, Springer, **2009**

***

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:

M.F Atiyah and I.G. Macdonald, Introduction to Commutative Algebra, Addison-Weseley, **1969**

Reference Books:

1. H. Matsumura, Commutative Ring Theory, Cambridge University Press, **1986**
2., I. Kaplansky, Allyn and Bacon, Commuatavie Rings, Springer, **1970**
3. O. Zariski and P. Samuel, Commutative Algebra, New Edition, Springer, **1975**

M.Phil. Mathematics

SOFT CORE COURSE
MATH - 621 THEORY OF GRAPHS
4 Credits

SYLLABUS

UNIT–1
Graphs and Simple graphs-Special graphs (Complete graphs, Complement of graphs) - Graph isomorphism-Sub graphs-ertex 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**
2. M.Behzad and G.Chartrand, Introduction to the Theory of Graphs, **1971**
3. G.Chartrand and L.Lesniak, Graphs and Digraphs, **1979**
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 - Integrally closed rings - Elements algebraic over a field - Algebraic extensions - Conjugate elements - Conjugate fileds - 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 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, Alegbraic 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

1. P. G. Drazin: Solitons, Cambridge University Press, Cambridge, **1983**
2. M. Lakshmanan and S. Rajesekhar: Nonlinear Dynamics – Integrability, Chaos and Patterns, Springe Verlag, Berlin, **2003**
3. G. Bluman and S. Kumei, Symmetries and Differential Equations, Springer-Verlag Berlin**, 1989**
4. Kosmann - Schawarzba , B. Gramaticcos and K. M. Tamizhmani, (Ed.): Integrablity to Nonlinear Sy LNP 49, Springer – Verlag, Berlin, **1997**
5. R. Hirota, Mathematics of Solitons, Direct Method, Iwami, Japan, **1992**
6. D. Takahashi: Discrete and Ultra - discrete Systems, Kyoritsu, Japan, **2003**

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 ofa partial differential equations of first and second order – elementary examples.

Reference book

G. W. Bluman and S. Kumei: Symmetries and Differential Equations, Springer**, 1989**
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

1. Rotman, J, An Introduction to Homologiocal Algebra, Academic Press. Inc. **1979**
2. Gopalakrishnan, N.S:, Commutative Algebra, Oxonian Press Pvt. Ltd., **1984**
3. Dand, S. Dummit and Richard M. Foote, Abstract Algebra, Prentice Hall International Inc**. 2004**

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
Artinian and Notherian rings - Structure theory of ring – Density theorem - Wedderburn-Artin theorem for semi simple rings.

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

1. Charles W. Curtis and Irving Reiner: Representation Theory of Finite Groups and Associative Algebras, Inter Science Publishers, **1962**
   (Chapters 2, 4 and 5).
2. Bruce E. Sagan: The Symmetric Group, Second Edition, Springer International Edition, Springer-Verlag, New York, **2001**
   (Chapters 2 and 3).

Reference books

1. William Fulton and Joe Harris: Representation Theory - A First Course, Springer International Edition, Springer-Verlag, New York, **2004**
2. Jacobson: Basic Algebra II, Hindustan Publishing Corporation (India), **1983**
3. I.N Herstein: Non-Commutative Rings, The Mathematical Association of America, **1968**

M.Phil. Mathematics

SOFT CORE COURSE
MATH - 602 TOPICS IN ANALYSIS
4 Credits

SYLLABUS

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 ┐ is the scalar field r or -Minkowski functional-Sublinear functional and semi nos-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:

1. Robert E.Megginson: An Introduction to Banach space theory, Springer GTM, 183, **1998**
2. John B.Conway: A course in Functional analysis, Springer, **1990**
3. H.H.Schefer: Topological Vector Spaces, Springer-Verlag, **1980**
4. 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 – Verlag, **2001**

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

Properties of Fuzzy sets: Membership function- Fuzzy number – Triangular fuzzy number- Bell shaped Fuzzy number- Trapezoidal fuzzy number – Operation on crisp sets- Properties of crisp sets- Basic Fuzzy set operations – Types of operations on Fuzzy sets – Fuzzy Union – fuzzy Intersection – Fuzzy complements.

Unit -III

Clustering & Data Analysis: Basic concepts of clustering – Types of clustering – Hierarchical clustering and Non Hierarchical clustering - Hard partition –Hard Clustering-K-Means-Hierarchical clustering-Fuzzy Partition-Fuzzy Clustering.

Unit -IV

Formation and Extension of Fuzzy C-Means: Clusters and Prototypes-Parameters of the FCM Algorithm - Number of Clusters. Fuzziness Parameter- Termination Criterion- Initial Partition Matrix-Formation of C-Means-Formation of Fuzzy C-Means-Extensions of the Fuzzy C-Means Algorithm- Distance based Clustering – Center based Clustering - Kernel Based Fuzzy C-Means-Entropy Based Fuzzy C-Means – Regularization term based Fuzzy C-Means – Fuzzy c-shells algorithm– Possibilistic C-means.

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:

1. George Bojadziev and Maria Bojadziev, *Fuzzy Sets, Fuzzy Logic, Applications*, World Scientific Publishing Co.Pte.Ltd, Singapore **(1995)**
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**
2. George Bojadziev and Maria Bojadziev: *Fuzzy Sets, Fuzzy Logic, Applications*, World Scientific Publishing Co.Pte.Ltd, Singapore, **1995**
3. Sadaaki Miyamoto: *Algorithms for Fuzzy Clustering*, Springer – Verlag Berlin Heidelberg **2008**
4. S. N. Sivanandam and S. N. Deepa,*: Principles of Soft Computing*, Wiley India Pvt. Ltd., New Delhi, **2007**

M.Phil. Mathematics

MATH-642: Topics in Graph Theory

4 credit (Soft Core)

Unit –I

Graphs – vertex degrees –Paths –Cycles –connectivity –Trees –Forests –Bipartite graphs – 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

Circulations –Flows and cuts in networks –Group-valued flows –small k-flows –Flow-colouring 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**
2. J.A. Bondy and U.S.R. Murthy: Graph Theory with Applications Springer Publication, **2008**
3. G.Chartrand and P. Zhang: Introduction to Graph Theory, Tata McGraw –Hill Edition **2009**
4. G. Chartrand: Chromatic Graph Theory, Chapman & Hall/CRC, **2009**

M.Phil Mathematics

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

Unit –I
Graphs –Vertex Degrees –Isomorphic Graphs –Subgraphs –Degree sequences –connected Graphs –Cut vertices –Cut edges –Special Graphs –Digraphs.

Unit –II
Algorithmic Complexity –Search Algorithms –Sorting Algorithms –NP completeness –Greedy Algorithms –Representing Graphs in a computer.

Unit –III
Basic Properties of Trees –Rooted Trees –Depth First search –Tools for Finding Blocks –Breadth First search –Minimum spanning Tree Problem.

Unit –IV
Networks –The Max.Flow; Min.Cut Theorem –A Max.Flow; Min.Cut Algorithm –The complexity of the Max Flow; Min.cut Algorithm –Connectivity, (Edge) connectivity –Menger's Theorem.

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

Text Book:
G.Chartrand, and O.R. Oellermann, Applied and Algorithmic Graph Theory, Mc Graw –Hill, Inc., **1993**

Reference Books:
A. Gibbons: Algorithmic Graph Theory, Cambridge Univ., Press, Cambridge, **1985**
H.S. Wilf: Algorithms and Complexity, Prentice –Hall Englewood Cliffs, NJ, **1986**
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**

M.Phil. Mathematics

MATH-644: PRODUCT GRAPHS
4 Credits
SOFT CORE

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 Γ and Γ_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:

1. Wilfried Imrich and Sandi Klavzar, Product graphs: Structure and recognition, John Wiley and sons Publication**, 2000**
2. Douglas B. West, Introduction to graph Theory, Second Edition, Pearson Prentice Hall publication, **2009**

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

Uni t – II: Difference methods in Parabolic PDEs
Introduction, One space dimension, Two space dimensions, variable coefficients problems, spherical and cylindrical coor5dinate 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:

1. Williams F Ames, Numerical Methods in PDE, Academic Press, New York, **1977**
2. Paul Duchateau and David W Zachmann, Partial Differential Equations – Schaum's Outline Series, Mc Graw-Hill, **1986**

M.Phil. Mathematics

MATH-646: Theory of Partitions

4 Credits
SOFT CORE

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

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

1. G. H. Hardy and E.M. Wright- An introduction to Theory of Numbers, Oxford university press, **1979,** 5th edition.
2. I.Niven, H.S. Zukerman and H.L.Montgomery-An Introduction to the Theory of numbers, new York, John Wiley and Sons, Inc**., 2004,** 5th edition
3. G. E. Andrews- The Theory of partitions, Addision Wesley, **1976**
4. Bruce C. Berndt- Ramanujan's Note Books Vol-3, chapter 16, **2001**