

Department of Mathematics

Revised M.Phil Syllabus with effect from June 2018 (CBCS)

Preamble

As per the guidelines given by the University Grants Commission and the Tamil Nadu State Council for Higher Education, the M. Phil degree program is designed in such a way to have a foundation in discrete and continuous Mathematics; a Mathematical attitude towards problem formulation and solving; an analytical skill and desire for correctness; an appreciation towards approaching of Mathematical techniques; the programming skill at higher level computer language and research aptitude to Mathematics.

Objectives of the course

- To provide students a firm grip on all the facets of pure and applied mathematics and inculcate the student, an ardor for mathematical knowledge.
- To propel the student towards higher academic ambitions in Advanced Mathematics.
- To develop in the student logical, heuristic, systematic and critical ways of thinking to assist in problem solving in their chosen career.
- To provide the student some inputs in teaching methodology and psychology of teaching.

REGULATIONS

1. ELIGIBILITY FOR ADMISSION:

All candidates should have passed two year PG degree course after three year degree course and higher secondary of 12 years duration or pre-university and 11 year SSLC plus one year or 10+2 pattern.. Candidates who have secured a minimum of 55% in M.Sc., Mathematics are alone eligible to apply. SC/ST candidates should have a minimum of 50% in M.Sc., Mathematics to apply. Candidates who have passed the PG degree examination with less than 17 years of total duration of the course are not eligible for admission to M. Phil degree course.

2. DURATION OF THE PROGRAMME: 1 Year(Full time)

One year M. Phil course is divided into two semesters. In the first semester two core papers are covered. In the second semester, one specialization paper (Internal) is covered along with the submission of dissertation.

3. COURSE OF STUDY

The main subject of study for M. Phil Degree shall consist of the following:

Part - I : Algebra and Analysis

Part - II : Topology and Geometry

4. PASSING MINIMUM

A candidate shall be declared to have passed in each paper / dissertation of the main subject of study wherever prescribed, if she secured NOT LESS THAN 50% of the marks prescribed for the examination.

5. CLASSIFICATION OF SUCCESSFUL CANDIDATES:**Part I & II**

Successful candidates passing the examination and securing the marks (i) 60 percent and above and (ii) 50 percent and above but below 60 percent in the aggregate shall be declared to have passed the examination in the FIRST and SECOND class respectively. All other candidates shall be declared to have failed in the M Phil examination.

PROGRAMME PROFILE –M.Phil MATHEMATICS

SEM	COURSE CODE	PAPER	TITLE OF THE PAPER	CREDITS	HOURS/WK	TOTAL HOURS	CA	SE	TOTAL
I	11M18/ALA	Paper I	Algebra & Analysis	5	6	90	40	60	100
I	11M18/TGY	Paper II	Topology And Geometry	5	6	90	40	60	100
II	11M18/SP/AAL 11M18/SP/FSP 11M18/SP/GRT 11M18/SP/CAN	Paper III	Specialization Paper	5	6	90	40	60	100
II	11M/DIS		Dissertation	21	12		100	100	200

EVALUATION PATTERN FOR CONTINUOUS ASSESSMENT-M.Phil

(a) Assignment/ Seminar (Report to be prepared and presented)	10 marks
(b) Participatory Learning/ Problem Solving/ Group Discussion	10 marks
(c) Test 1 (2 Hours – 50 marks)	10 marks
(d) Test 2 (2 Hours – 50 marks)	10 marks
TOTAL	40 Marks

RUBRICS FOR CONTINUOUS ASSESSMENT

Assignment	Content/originality/Presentation/Schematic Representation and Diagram/Bibliography
Seminar	Organisation/Subject Knowledge/Visual Aids/Confidence level/presentation-Communication and Language
Participation Learning	Answering Questions/Clearing Doubts/Participating in Group Discussions/Regular Attendance/ communication and language

END SEMESTER EVALUATION PATTERN- M.Phil

Knowledge level	Components	Nature of the Question	Maximum Marks	Special Instructions if any
K ₅ , K ₆	Part A	Understanding Description/Problems	5 x 20 =100 Marks	At least 2 questions to be answered out of 4 questions from Part A.
K ₅ , K ₆	Part B	Understanding Description/Problems		At least 2 questions to be answered out of 4 questions from part B.

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SEMESTER I COURSE PROFILE-PROGRAMME OF STUDY

COURSE CODE	Paper	TITLE OF THE PAPER	CREDITS	HOURS /WK	TOTAL HOURS	L-T-P	CA	SA	TOTAL
11M18/ALA	Paper I	Algebra & Analysis	5	6	90	3 - 3 - 0	40	60	100
11M18/TGY	Paper II	Topology And Geometry	5	6	90	3 - 3 - 0	40	60	100
		TOTAL CREDITS	10						

SEMESTER – I ALGEBRA AND ANALYSIS

Paper: I**Course Code : 11M18/ALA****Teaching hours: 90 hours****Credits : 5 L T P : 3 3 0****COURSE OBJECTIVES:**

To enable the students to

- achieve an advanced mastery of representations of associative algebras.
- realise the importance of modules as central objects in algebra and to study some applications.
- gain knowledge of the theory of semi simple algebras
- state the axioms of L_p spaces.
- apply appropriate techniques of integration to product spaces.

COURSE OUTLINE:**UNIT - I: The Associative Algebra**

Chapter 1 (Section 1.1 – 1.7 (Omit section 1.5)) (20 hours)

UNIT- II: Modules

Chapter 2 (Section 2.1 – 2.7) (18 hours)

UNIT- III: The Structure of Semi – simple Algebras

Chapter 3 (Section 3.1 – 3.6) (18 hours)

UNIT- IV: L^p Spaces

Chapter 3 (17 hours)

UNIT- V: Integration on Product Spaces

Chapter 8 (17 hours)

Recommended Textbooks:

1. Richard S. Pierce, Associative Algebras (For Unit I, II, III)
2. Walter Rudin, Real And Complex Analysis (For Units IV and V)

PERIODICALS:

The Mathematics Intelligencer

Mathematics Newsletters

Journal in Algebra and Number Theory

Journal of Algebraic combinatorics

WEBSITES & e-LEARNING SOURCES:

<http://www.mathforum.org>

<http://www.opensource.org>

<https://sites.math.northwestern.edu/~len/d70/chap5.pdf>

<https://www.math.ksu.edu/~nagy/real-an/4-03-lp-spaces.pdf>

https://link.springer.com/chapter/10.1007/978-3-642-88044-5_6

**KEY: STRONGLY CORRELATED-3 MODERATELY CORRELATED-2 WEAKLY
CORRELATED-1 NO CORRELATION-0**

QUESTION PAPER TEMPLATE

Knowledge level	Components	Nature of the Question	Maximum Marks	Special Instructions if any
K ₅ , K ₆	Part A	Understanding Description/Problems	5 x 20 =100 Marks	At least 2 questions to be answered out of 4 questions covering all the Algebra units.
K ₅ , K ₆	Part B	Understanding Description/Problems		At least 2 questions to be answered out of 4 questions covering all the Analysis units.

TOPOLOGY AND GEOMETRY

Paper : II
TOTAL HOURS: 90

COURSE CODE: 11 M18/TGY
Credits: 5 L-T-P : 3 3 0

COURSE OBJECTIVES:

1. To understand various higher level topics in Topology, Geometry, Methods And Psychology of Teaching Mathematics
2. To equip the students in pursuing research in Mathematics
3. To prepare the student for lectureship in Mathematics.
4. To understand and generalize the classical theorems in Calculus.
5. To know the basic notions of homotopy theory.

COURSE OUTLINE:

UNIT – I : The Fundamental Group
Chapter 9 (Section 51 – 52) (20 hours)

UNIT – II : Covering Spaces
Chapter 9 (Section 53 – 54) (19 hours)

UNIT - III: Deformation Retracts and Homotopy Type
Chapter 9 (Sections 58 – 59) (18 hours)

UNIT - IV: Differential Forms in \mathbb{R}^n - Line Integrals
Chapter 1 & Chapter 2 (16 hours)

UNIT - V: Differentiable Manifolds- Integration on Manifold's, Stokes's theorem and Poincare's Lemma.
Chapter 3 & Chapter 4 (17 hours)

BOOKS RECOMMENDED:

1. James R. Munkres, TOPOLOGY, Second Edition, Prentice Hall of India Private Ltd, New Delhi, 2005.
2. Manferdo, P.do Carmo, Differential Forms and Applications, Springer, Berlin, Heidelberg, 1994.

REFERENCE BOOKS:

1. W. S. Massy, A basic course in Algebraic Topology, Springer Verlag, 1991, Indian Reprint, new Delhi, 2001.
2. R. Anant Shastri, Basic Algebraic Topology, Chapman and Hall, 2013.
3. H. Edwin Spanier, Algebraic Topology, Springer, 2008.
4. J. Peter May, A concise Course in Algebraic Topology, The University of Chicago press, London, 1999.
5. J. Vick, Homology theory, Springer Verlag, 1994.

PERIODICALS:

1. Mathematics Newsletter
2. Discrete Mathematical Sciences and Cryptography.
3. Journal of Topology and its Applications
4. Journal of Differential Geometry

WEBSITES & E-LEARNING SOURCES:

1. <http://www.mathforum.org>
2. <http://www.opensource.org>
3. <http://khanacademy.org>
4. <http://in.ixl.com>
5. <http://www.learningwave.com>

QUESTION PAPER TEMPLATE

Knowledge level	Components	Nature of the Question	Maximum Marks	Special Instructions if any
K ₅ , K ₆	Part A	Understanding Description/Problems	5 x 20 =100 Marks	At least 2 questions to be answered out of 4 questions covering all the Topology units.
K ₅ , K ₆	Part B	Understanding Description/Problems		At least 2 questions to be answered out of 4 questions covering all the Geometry units.

SEMESTER II COURSE PROFILE-PROGRAMME OF STUDY

COURSE CODE	TITLE OF THE PAPER	CREDITS	HOURS/WK	TOTAL HOURS	L-T-P	CA	SA	TOTAL
11M18/SP/AAL 11M18/SP/FSP 11M18/SP/GRT 11M18/SP/CAN	Specialization Paper	5	6	90	3 - 3 - 0	40	60	100
11M/DIS	Dissertation	21	12	180		100	100	200
	TOTAL CREDITS	26	18					

SEMESTER – II ADVANCED ALGEBRA

PAPER - III : Specialization Paper
Teaching Hours: 90 hrs

Course Code : 11M18/SP/AAL
Credits: 5 L-T-P : 3 3 0

OBJECTIVES:

To enable students to

- To analyze and understand the concepts of special fields
- To study on representation of one endomorphisms.
- To study and analyze on matrices and linear maps over non-commutative rings
- Analyze and understand theorems on semi simplicity and smith normal form.
- Understand and discuss the algebraic concepts of tensor products.

COURSE OUTLINE:

UNIT 1: SPECIAL FIELDS

Ordered domains- the ordered field \mathbb{Q} -convergence in ordered fields-the real field \mathbb{R} -valuations and p-adic numbers.

Chapter 8 (Sections: 1,2,4,5,10) (18 hrs)

UNIT 2: REPRESENTATION OF ONE ENDOMORPHISM

Representations -decomposition over one endomorphism-the characteristic polynomial.

Chapter 14 (Sections: 1 to 3) (18 hrs)

UNIT 3: SEMI SIMPLICITY

Matrices and linear maps over non-commutative rings-conditions defining semi simplicity-semi simple rings-the Jacobson radical, base change and tensor products.

Chapter 17 (Sections: 1,2,4,6) (18 hrs)

UNIT 4: SMITH NORMAL FORM OVER A PID AND RANK

Preliminaries-row module, column module and rank-smith normal form

Chapter 20 (Sections: 1 to 3) (18 hrs)

UNIT 5: TENSOR PRODUCTS

Categories and functors - tensor products-module structure of tensor products-tensor product of homomorphisms -tensor product of algebras.

Chapter 22 (Sections: 1 to 5) (18 hrs)

RECOMMENDED TEXTS:

1. Algebra (2nd Edition) by Saunders Mac lane and Garrett Birkoff-
UNIT 1 (P.NO. 261-267, 269-274,286-292.)
2. Algebra (3rd Edition) by Serge Lang-
UNITS 2 & 3 (P.NO. 553-570, 641-646, 651-654, 657-659)
3. Basic Abstract Algebra by P.B.BATTACHARYA,S.K.JAIN & S.R.NAGPAUL-
UNITS 4 & 5 (P.NO. 392-401, 426-437)

REFERENCES :

1. Higher Algebra by Hall & Knight
2. Advanced Modern Algebra (second Edition) by Joseph J. Rotman (Indian Edition)
3. Graduate Texts in Mathematics Advanced Linear Algebra (Springer) by Steven Roman.
4. Advanced Algebra by Anthony W. Knapp.
5. A Concise Text on Advanced Linear Algebra by Yisong Yang

JOURNALS

1. Journal of Algebra
2. Journal of Algebra and its Applications
3. Algebra and Logic
4. Advances in Linear Algebra & Matrix Theory

WEBSITES & e-LEARNING SOURCES:

<http://www.math.stonybrook.edu>

<https://www.siam.org>

<https://www.scirp.org>

www.journals4free.com

<http://www.opensource.org>

www.openculture.com

Question Paper Pattern

Knowledge level	Components	Nature of the Question	Maximum Marks
K ₅ , K ₆	Part A	Understanding Description/Problems	5(/8)x 20 =100 Marks

FUZZY THEORY AND APPLICATIONS

PAPER III : SPECIALIZATION PAPER COURSE CODE: 11M18/SP/FTA
Teaching Hours : 90 hours Credits: 5 L-T-P : 3 3 0

OBJECTIVES:

To enable students to

- Understand the concepts of fuzzy sets and its operations.
- Introduce advanced concepts in Fuzzy Mathematics leading to research.
- Know fuzzy numbers and fuzzy relations.
- Understand the application of fuzzy in various Engineering fields.
- Impart knowledge and skills in fuzzy decision making problems.

UNIT I: From Classical (Crisp) Sets to Fuzzy Sets: A Grand Paradigm Shift –

Introduction – Crisp Sets: An Overview – Fuzzy Sets: Basic Types – Fuzzy Sets: Basic Concepts – Characteristics and Significance of the Paradigm Shift.

Fuzzy Sets Versus Crisp Sets: Additional Properties of α – cuts – Representations of Fuzzy Sets – Extension Principle for Fuzzy Sets.

Operations on Fuzzy Sets: Types of Operations – Fuzzy Complements. (17 hrs)

Sections: 1.1 – 1.5, 2.1 – 2.3, 3.1 & 3.2.

UNIT II: Fuzzy Arithmetic: Fuzzy Numbers – Linguistic Variables – Arithmetic

Operations On Intervals – Arithmetic Operations On Fuzzy Numbers – Lattice of Fuzzy Numbers – Fuzzy Equations.

Fuzzy Relations: Crisp Versus Fuzzy Relations – Projections and Cylindric Extensions –

Binary Fuzzy Relations - Binary Relations on a Single Set – Fuzzy Equivalence Relations

Sections: 4.1 – 4.6, 5.1 – 5.5. (17 hrs)

UNIT III: Fuzzy Relations (cont.): Fuzzy Ordering Relations – Fuzzy Morphisms – Sup-i Compositions of Fuzzy Relations – Inf- ω_i Compositions of Fuzzy Relations.

Fuzzy Relation Equations: Solution Method – Fuzzy Relational Equations Based on sup- i compositions – Fuzzy Relational Equations based on inf- ω_i Compositions. (18 hrs)

Sections: 5.7 – 5.10, 6.3 – 6.5.

UNIT IV: Fuzzy Logic: Fuzzy Propositions – Fuzzy Quantifiers – Linguistic Hedges – Inference From Conditional Fuzzy Propositions.

Constructing Fuzzy Sets: Methods of Construction: An Overview – Direct Methods with One Expert – Indirect Method With One Expert.

Fuzzy Systems: Fuzzy Controllers: An Overview – Fuzzy Controllers: An Example. (20 hrs)

Sections: 8.3 – 8.6, 10.2, 10.3, 10.5, 12.2 & 12.3.

UNIT V: Fuzzy Decision Making: General Discussion – Individual Decision Making – Multiperson Decision Making – MultiCriteria Decision Making – MultiStage Decision Making – Fuzzy Ranking Methods – Fuzzy Linear Programming. (18 hrs)

Sections: 15.1 – 15.7.

RECOMMENDED TEXT:

George Klir and Bo Yuan, Fuzzy Sets And Fuzzy Logic – Theory and Applications, 2009, PHI Learning Pvt Ltd, New Delhi.

REFERENCE BOOKS:

1. Ahmad M. Ibrahim, Introduction to Applied Fuzzy Electronics. New Delhi : Prentice Hall India, 1997.
2. Bart.Kosko, Neural Networks and fuzzy systems, New Delhi :Prentice-Hall of India, 2003.
3. George Klir J. and Folger Tina A., Fuzzy Sets, Uncertainty and Information. New Delhi: Prentice Hall India, 2004.
4. Toshiro Terano, Asai Kiyoji, Sugeno Michio, Applied Fuzzy Systems. New York : A.P. Professional, 1994.
5. Zadeh Lotfi A., Fuzzy Sets and Their Applications to Cognitive and Decision Processes, New York, Academic Press, 1975.

PERIODICALS:

Journal of Intelligent & Fuzzy Systems
 International Journal of Fuzzy System and Applications
 International Journal of Fuzzy Computation and Modelling
 The Mathematics Intelligencer
 Mathematics News Letter

WEBSITES AND E-LEARNING SOURCES:

<http://mathforum.org>

<http://www.opensource.org>

<http://www.sjsu.edu/faculty/watkins/fuzzysets.htm>

<https://www.britannica.com/science/fuzzy-logic>

https://www.tutorialspoint.com/fuzzy_logic/fuzzy_logic_decision_making.htm

Question Paper Pattern

Knowledge level	Components	Nature of the Question	
K ₅ , K ₆	Part A	Understanding Description/Problems	

Maximum Marks

$5(8) \times 20 = 100$ Marks

GRAPH THEORY

PAPER III : Specialization Paper

Course Code: 11M18/SP/GRT

Teaching Hours : 90 Hours

Credits: 5 L-T-P : 3 3 0

OBJECTIVES:

This course will enable the students

1. To know about Matchings, Factors and their related theorems
2. To understand Colourings in graphs.
3. To identify independent sets and cliques.
4. To study about directed graphs and its applications.
5. To explore and study more about the nature and properties of Planar graphs and Networks.

COURSE OUTLINE:**UNIT I: Matching and factors:**

Maximum Matching, Hall's matching condition, Min-Max theorems, Tutte's 1-factor theorem

From Book 1: Chapter 3: 3.1, 3.3

(15 hours)

UNIT II: Colouring of graphs:

Definitions and examples, upper bounds, Brook's theorem

Edges and cycles Edge colourings, Hamiltonian cycles

(Necessary and Sufficient conditions) Tait's theorem

From Book 1: Chapter 5 :5.1 , Chapter 7 : Section 7.1, 7.2, 7.3

(20 hours)

UNIT III: Independent Sets and Cliques

Independent sets, Ramsey's theorem, Turan's theorem

From Book 2: Chapter 7 Sections 7.1, 7.2, 7.3 (15 hours)

UNIT IV: Directed Graphs

Directed Graphs, Directed paths, Directed cycles

From Book 2: Chapter 10 Sections 10.1 - 10.4 (20 hours)

UNIT V: Planar graphs:

Drawings in the plane, Dual graphs, Euler's formula,
preparation for Kuratowski's theorem, convex embeddings.

Networks: Flows, cuts, The Max –flow Min-cut theorem.

From Book 1: Chapter 6 Section 6.1, 6.2

From Book 2: Chapter 11 Sections 11.1-11.3 (20 hours)

Recommended Test

Book 1: Graph Theory and its applications - Douglas. B. West

Book 2: Graph Theory and its applications – J. A. Bondy and

U. S. R. Murty

Books for References:

1. Douglas B. West, *Introduction to Graph Theory* –Second edition, PHI learning pvt. ltd, 2011.
2. A. Gibbons, *Algorithmic Graph Theory*, Cambridge University Press, Cambridge, 1989.
3. S.A. Choudum, *A First Course in Graph Theory*, MacMillan India Ltd. 1987.
4. Richard J. Trudeau, *Introduction to Graph Theory* (Dover Books on Mathematics) Paperback – 9 Feb 1994.
5. Gary Chartrand, Ping Zhang, *A First Course in Graph Theory*, Courier Corporation, 2012.

Journals:

1. Discrete Mathematics- Elsevier publications
2. Journal of Graph Theory
3. Electronic journal of Graph Theory and Applications

Websites and e- learning sources

www.graphtheorysoftware.com

<https://www.britannica.com/topic/graph-theory>

<http://www.elsevier.com/mathematics>

<https://onlinelibrary.wiley.com/journal/10970118>

<https://www.ejgta.org>

<http://mathforum.org>

<http://www.opensource.org>

Question Paper Pattern

Knowledge level	Components	Nature of the Question	Maximum Marks
K ₅ , K ₆	Part A	Understanding Description/Problems	5(8) x 20 =100 Marks

COMPLEX ANALYSIS

PAPER III : Specialization Paper
Teaching Hours : 90 hours

COURSE CODE : 11M18/SP/CAN
Credits: 5 L-T-P : 3 3 0

OBJECTIVES:

To enable students to

- Understand the basic concepts of univalent functions.
- Analyse and understand the concepts and theorems on univalent functions.
- Understand the concepts of subordination
- Understand the properties of Extremal functions.
- Equip the students in pursuing research in Mathematics.

COURSE OUTLINE:

UNIT I : ELEMENTARY THEORY OF UNIVALENT FUNCTIONS : Introduction – The Area Theorem – Growth and Distortion theorems – Coefficient estimates – Convex and Starlike functions – Close to convex functions – Starlike functions.

Chapter 2 : 2.1 to 2.7 (15 hrs)

UNIT II : Growth and integral means – Odd univalent functions – Asymptotic Bieberbach Conjecture .

Chapter 2 : 2.10 to 2.12 (15 hrs)

UNIT III : GENERALIZATIONS OF THE AREA PRINCIPLE :

Faber polynomials – Polynomial Area theorem – The Grunsky Inequalities – Inequalities of Goluzin and Lebedev – Unitary matrices – The Fourth Coefficients – Coefficient problem in the class Σ .

Chapter 4 : 4.1 to 4.7 (20 hrs)

UNIT IV : SUBORDINATION :

Basic principles – Coefficient inequalities – Sharpened Forms of the Schwarz Lemma – Majorization – Univalent Subordinate Functions.

Chapter 6 : 6.1 to 6.5 (20 hrs)

UNIT V : GENERAL EXTREMAL PROBLEMS :

Functionals on Linear spaces – Representation of Linear functional – Extreme points and Support points – Properties of Extremal functions – Extreme points of S – Extreme points of Σ .

Chapter 9 : 9.1 to 9.6 (20 hrs)

RECOMMENDED TEXT:

1. Univalent Functions , P.L.Duren, Springer-Verlag, Newyork, (1980).

REFERENCES :

1. Univalent Functions Vol I and Vol II By Goodman . A.W, Mariner Pub Co, 1983
2. Conformal Mapping by Z.Nehari, McGraw-Hill, New York (1952).
3. Handbook of Complex Analysis: Geometric Function theory Vol -1, R.Kuhnau, Elsevier Publications, (2002).
4. Introductory Complex Analysis, Richard A. Silverman, **Dover Publications (15 April 2013)**
5. Univalent Functions and Teichmuller Spaces,Olli Lehto, Springer, (1987).

PERIODICALS:

The Mathematics Intelligencer.

Mathematics Newsletters

Journal of Complex Analysis

Acta Mathemetica

WEBSITES & E-LEARNING SOURCES:

<http://www.mathforum.org>

<http://www.opensource.org>

<https://terrytao.wordpress.com/tag/univalent-functions/>

<https://www.khanacademy.org/>

<https://cuhkmath.wordpress.com/2012/03/04/principle-of-subordination/>

**KEY: STRONGLY CORRELATED-3 MODERATELY CORRELATED-2 WEAKLY
CORRELATED-1 NO CORRELATION-0**

Question Paper Pattern

Knowledge level	Components	Nature of the Question	Maximum Marks
K ₅ , K ₆	Part A	Understanding Description/Problems	5(8) x 20 =100 Marks