ETHIRAJ COLLEGE FOR WOMEN
(AUTONOMOUS)

CHENNAI-600 008

COLLEGE WITH POTENTIAL FOR EXCELLENCE

DEPARTMENT OF MATHEMATICS

M.PHIL

SYLLABUS

Choice Based Credit System
Outcome Based Education

(Offered from the academic year 2018-19)

CONTENTS

Department of Mathematics

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

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 EDUCATIONAL OBJECTIVES (PEOs)

On obtaining a research degree the scholar will be able to:

PEO 1 - Demonstrate advanced domain knowledge competencies and display high order discerning and synthesizing capabilities to address local, regional and national concerns through innovative well researched solutions.

PEO2 - Continue to serve the community of professionals and experts as both independent and team player with a strong grounding in ethics, inclusivity, gender parity and environmental sustainability.

PROGRAMME OUTCOMES (POs)

On completion of the Programme, the learner will be able :

PO1 - To acquire advanced conceptual knowledge and comprehensive understanding of the fundamental principles in respective discipline.

PO2- To apply knowledge and critically evaluate the concepts and scientific developments to take up any challenge.

PO3 - To visualize and work on laboratory multidisciplinary tasks related to current research in the fields of Mathematical, Physical and Life sciences

PO4-To acquire research based knowledge and design methods to conduct investigations of complex problems in research/ Industrial field and achieve employability / self employment.

PO5- To communicate effectively ideas verbally in English, leading to Entrepreneurship ventures such as consultancy and training.

PO6-Employ innovative and environment friendly methods, novel ideas to solve complex and challenging societal and environmental issues.

PROGRAMME SPECIFIC OUTCOME (PSOs)

On completion of the M.Phil Mathematics the student will be able

PSO 1: To develop research level thinking in the field of pure and applied mathematics.

PSO 2: To develop abstract mathematical thinking.

PSO 3: To assimilate mathematics independently and solve advanced mathematical problems.

PSO-4 : To write research articles in mathematics and to publish it in reputed journals.

PSO-5 : To develop and enhance teaching skills in mathematics.

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 CONTINIOUS 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 CONTINIOUS 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 2questions to be answered outof 4 questions from Part A.
K_5, K_6	Part B	Understanding Description/Problems		Atleast 2 questions to be aa nswered out of 4 questions fr om 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 hoursCredits : 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 appropriatetechniques 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

Course Outcomes:

Upon successful completion of Optimization Techniques, Students will be able to:

CO NUMBER.	CO Statement
CO 1	Integrate knowledge at the forefront of associative algebra which forms the basics of higher mathematics.
CO 2	Investigate the properties of modules and appreciate its important results.
CO 3	Learn about semi simple algebras and be familiar with examples.
CO 4	Define the L p spaces and determine whether functions are in L p
CO 5	Evaluate problems in product spaces using the powerful concept of integration.

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	3	3	3	3	3
CO 2	3	2	2	3	3
CO 3	3	3	3	3	3
CO 4	3	2	2	3	2
CO 5	3	2	2	3	2
Average	**3**	**2.4**	**2.4**	**3**	**2.6**

KEY:STRONGLY CORRELATED-3 **M**ODERATELY CORRELATED-2 **W**EAKLY CORRELATED-1 **N**O CORRELATION-0

Teaching Methodology

Lecture (chalk and talk),

Problem Solving,

Discussion and Interactive session,

Assignment,

Seminar.

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 2questions to be answered outof 4 questions covering all the Algebra units.
K_5, K_6	Part B	Understanding Description/Problems		Atleast 2 questions to be nswered out of 4 questions overing allthe Analysis units.

TOPOLOGY ANDGEOMETRY

Paper : IICOURSE CODE:11M18/TGY
TOTALHOURS:90Credits:5 L-T-P: 3 30

COURSE OBJECTIVES:

1. To understand various higher level topics in Topology,Geometry, Methods And Psychology of TeachingMathematics
2. To equip the students in pursuing research inMathematics
3. To prepare the student for lectureship inMathematics.
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
Chapter9 (Section 51–52) (20 hours)

UNIT – II : Covering Spaces
Chapter9 (Section 53– 54) (19 hours)

UNIT - III: Deformation Retracts and Homotopy Type
Chapter9 (Sections 58– 59) (18 hours)

UNIT - IV: Differential Forms in R^n - Line Integrals
Chapter 1 &Chapter2 (16 hours)

UNIT - V: Differentiable Manifolds- Integration on Manifold's, Stokes's theorem and Poincare's Lemma.
Chapter 3 &Chapter4 (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 Toplogy, 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. MathematicsNewsletter
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

COURSE OUTCOME:

Upon successful completion of Optimization Techniques, Students will be able to:

CO NUMBER	CO STATEMENT
CO 1	Construct the fundamental group of a topological space.
CO 2	Understands the connection between covering spaces and fundamental group.
CO 3	Work with cell complexes and the basic notions of homotopy theory.
CO 4	Solve the calculations with differential forms and characterize the exterior Derivative.
CO 5	Know Stroke's theorem and understand how this generalizes classical theorems in Calculus.

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO /PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	2	3	2	2	3
CO 2	3	3	3	2	3
CO 3	3	3	3	2	3
CO 4	3	3	3	2	3
CO 5	3	3	3	2	3
AVERAGE	2.8	3	2.8	2	3

KEY:STRONGLY CORRELATED-3 **M**ODERATELY CORRELATED-2 **W**EAKLY CORRELATED-1 **N**O CORRELATION-0

TEACHING METHODOLOGY

1. Problem Solving-Group Discussion
2. Quiz-Seminar
3. Peer Learning

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 2questions to be answered outof 4 questions covering all the Topology units.
K_5, K_6	Part B	Understanding Description/Problems		At least 2questions to be answered outof 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 Course Code:11M18/SP/AAL
Teaching Hours:90 hrsCredits:5 L-T-P: 3 30

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 discusss the algebraic concepts of tensor products.

COURSE OUTLINE:

UNIT 1: SPECIAL FIELDS

Ordered domains-the ordered field Q-convergence in ordered fields-the real field 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

Course Outcomes:

Upon completion this course will enable the students to

CO Number	CO statement
CO 1	Analysis of the study of ordered Domains and convergence in ordered Fields.
CO 2	Study of representations related to one endomorphism.
CO 3	Prepares to the study of semi simplicity.
CO 4	Study and Evaluate Smith Normal form over PID
CO 5	Study of Tensor products

MAPPING – COURSE OUTCOMES WITH PROGRAMME SPECIFIC OUTCOMES

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	2	2	1	1	1
CO 2	2	2	1	1	1
CO 3	2	2	1	1	1
CO 4	2	2	1	1	1
CO 5	2	2	1	1	1
Average	**2**	**2**	**1**	**1**	**1**

KEY:STRONGLY CORRELATED-3 **M**ODERATELY CORRELATED-2 **W**EAKLY CORRELATED-1 **N**O CORRELATION-0

Teaching Methodology

Problem Solving,

Discussions and Interactive Sessions,

Assignments,

Seminars.

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 30

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, NeuralNetworks 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,AsaiKiyoji, SugenoMichio, Applied Fuzzy Systems.New York : A.P. Professional, 1994.
5. ZadehLotfi 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

Course Outcomes:

Upon completion of this course the student will be able to

CO Number	CO statement
CO 1	Effectively use fuzzy operations.
CO 2	Recognize fuzzy numbers as a foundation of fuzzy sets and fuzzy Mathematics.
CO 3	Represent the strength of association between elements of the two sets.
CO 4	Predict non linear trends.
CO 5	Identify the formulation and solutions of design problems that are developed using fuzzy theory.

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	3	2	3	1	3
CO 2	2	1	3	2	2
CO 3	2	2	1	2	3
CO 4	1	1	1	1	2
CO 5	1	1	3	1	2
Average	**1.8**	**1.4**	**2.2**	**1.4**	**2.4**

KEY:STRONGLY CORRELATED-3 **M**ODERATELY CORRELATED-2 **W**EAKLY CORRELATED-1 **N**O CORRELATION-0

Teaching Methodology

Lecture (chalk and talk),

Problem Solving,

Discussion and Interactive session,

Assignment,

Seminar.

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

GRAPH THEORY

PAPER III : Specialization Paper Course Code: 11M18/SP/GRT
Teaching Hours : 90 Hours Credits:5 L-T-P: 3 30

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,Tuttes' 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:Chapter10 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: Chapter11 Sections 11.1-11.3 (20 hours)

Recommended Test

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

Book 2: Graph Theory and its applications – J. A. Bondy and U. S. R.Murty

Books for References:

1. Doughlas B. West,*Introduction to Graph Theory* –Second edition, PHI learning pvt. ltd, 2011.
2. A.Gibbons,*Algorithmic Graph Theory*,CambridgeUniversity 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

Course Outcomes: Upon completion of Graph Theory, this course will enable the students

CO No.	CO Statement	Knowledge Level
CO 1	To analyze the concept Matchings and factors.	K_5, K_6
CO 2	To examine and identify the chromatic number of various graphs.	K_5, K_6
CO 3	To apply the analytical techniques and theoretical knowledge in solving many real life problems. To prove theorems related to independent sets and Cliques.	K_5, K_6
CO 4	To solve and analyze the properties and theorems related to Directed graphs.	K_5, K_6
CO 5	To apply Euler's formula and Four Colour Conjecture in various problems and in many practical situations. To analyse about network and related problems.	K_5, K_6

Mapping of CO with PSO

CO / PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	2	1	2	3	1
CO 2	2	1	2	3	1
CO 3	2	1	2	3	1
CO 4	2	1	2	3	1
CO 5	2	1	2	3	1
Average	**2**	**1**	**2**	**3**	**1**

KEY:STRONGLY CORRELATED-3 **M**ODERATELY CORRELATED-2 **W**EAKLY CORRELATED-1 **N**O CORRELATION-0

TEACHING METHODOLOGY:

Problem Solving

Group Discussion- Seminar - Peer Learning.

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 COURSE CODE: 11M18/SP/CAN
Teaching Hours : 90 hours Credits:5 L-T-P: 3 30

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.

REFERENCES :

1. Univalent Functions Vol I and Vol II By Goodman . A.W,Mariner Pub Co, 1983
2. Conformal Mappingby 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/

Course Outcomes:

Upon completion of Complex Analysis, this course will enable the students to

CO Number	CO statement
CO 1	Compare the starlike and convex functions
CO 2	Apply the concepts of odd univalent functions
CO 3	Analyse the concepts of Faber polynomial and Grunsky inequalites
CO 4	Discuss the basic principle of subordination and Schwarz lemma.
CO 5	Discuss the properties of Extremal functions and compute general extremal problems

MAPPING – COURSE OUTCOME WITH PROGRAMME SPECIFIC OUTCOME

CO / PSO	PSO 1	PSO 2	PSO3	PS04	PSO5
CO 1	2	2	3	3	2
CO 2	3	2	3	3	2
CO 3	3	3	2	2	3
CO 4	2	2	2	2	3
CO 5	3	3	3	3	2
Average	**2.6**	**2.4**	**2.6**	**2.6**	**2.4**

KEY:STRONGLY CORRELATED-3 **M**ODERATELY CORRELATED-2 **W**EAKLY CORRELATED-1 **N**O CORRELATION-0

Teaching Methodology

Lecture (chalk and talk),

Problem Solving,

Discussion and Interactive session,

Assignment,

Seminar.

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