DEPARTMENT OF MATHEMATICS

PG SYLLABUS

Effective from the Academic Year 2018 - 2019

H.H. The Rajah's College

(Autonomous)

Accredited at B+ by NAAC

Pudukkottai

Sem.	Course	Course Title	Ins. Hrs. / Week	Credit	Exam Hrs	Marks		Total
						Int	Ex	
I	CC I	Algebra	7	5	3 Hrs	25	75	100
I	CCII	Real Analysis – I	7	5	3 Hrs	25	75	100
I	CCIII	Ordinary and Partial Differential equations	7	5	3 Hrs	25	75	100
I	ECI	Elective I - Graph Theory	7	5	3 Hrs	25	75	100
II	CCIV	Linear Algebra	6	5	3 Hrs	25	75	100
II	CCV	Real Analysis – II	6	5	3 Hrs	25	75	100
II	CCVI	Optimization Techniques	6	5	3 Hrs	25	75	100
II	EC II	Elective II - Topology	6	5	3 Hrs	25	75	100
II	EDC – I	MAT LAB (Objective Type)	5	5	3 Hrs	25	75	100
III	CCVII	Complex analysis	6	5	3 Hrs	25	75	100
III	CCVIII	Functional Analysis	6	5	3 Hrs	25	75	100
III	CCIX	Mathematical Statistics	6	5	3 Hrs	25	75	100
III	CC X	Numerical Analysis	6	5	3 Hrs	25	75	100
III	EC III	Elective – III – Fuzzy Mathematics	6	5	3 Hrs	25	75	100
IV	CCXI	Classical Dynamics	6	5	3 Hrs	25	75	100
IV	CCXII	Stochastic Process	6	5	3 Hrs	25	75	100
IV	CCXIII	Discrete Mathematics	6	5	3 Hrs	25	75	100
IV	CCXIV	Dissertation	12	5		25	75	100
		Total		90				1800

List of Electives

Course Title

Elective – I (Any one from the list)

- Graph Thoery
- Analytic Number theory

Elective – II (Any one from the list)

- Topology
- Calculus of Variations and Integral Equations

Elective - III (Any one from the list)

- Fuzzy Mathematics
- Fluid Dynamics

EDC PAPER : MATLAB (Objective Type)

Program Educational Objectives (PEOs)	
PEO1	Provide a strong foundation in different areas of Mathematics, so that the studentscan compete with their contemporaries and excel in the various careers in Mathematics.
PEO2	Motivate and prepare the students to pursue higher studies and research, thuscontributing to the ever-increasing academic demands of the country.
PEO3	Enrich the students with strong communication and interpersonal skills, broad knowledge and an understanding of multicultural and global perspectives, to workeffectively in multidisciplinary teams, both as leaders and team members.
PEO4	Facilitate integral development of the personality of the student to deal with ethicaland professional issues, and also to develop ability for independent and lifelong learning.

Program Specific Outcomes (PSOs)	
After the successful completion of **M. Sc. Applied Mathematics** program, the students are expectedto	
PSO1	Communicate concepts of Mathematics and its applications.
PSO2	Acquire analytical and logical thinking through various mathematical tools andtechniques.
PSO3	Investigate real life problems and learn to solve them through formulatingmathematical models.
PSO4	Attain in-depth knowledge to pursue higher studies and ability to conductresearch. Work as mathematical professional.
PSO5	Achieve targets of successfully clearing various examinations/interviews for placements in teaching, banks, industries and various otherorganizations/services.

Program Outcomes (POs)	
On successful completion of the M. Sc. Applied Mathematics program, the students will be able to	
PO1	Demonstrate in-depth knowledge of Mathematics, both in theory and application.
PO2	Attain the ability to identify, formulate and solve challenging problems inMathematics.
PO3	Know the various specialised areas of advanced mathematics and itsapplications.
PO4	Analyze complex problems in Mathematics and propose solutions using research-based knowledge.
PO5	Obtain the accurate solutions for the community oriented problems via variousmathematical models.
PO6	Work individually or as a team member or leader in uniform and multidisciplinarysettings.
PO7	Crack lectureship and fellowship exams affirmed by UGC like CSIR-NET andSET.

QUESTION PAPER PATTERN

CHOICE BASED CREDIT CUM SEMESTER PATTERN
(Effective from the academic year 2018-19 onwards)

M.Sc.Applied Mathematics

External Pattern **Duration of Examination: 3 Hours**

Part – A **Answer ALL the Questions** **10 x 2 = 20 marks**	**Part – B** **Answer ALL the Questions** **Internal Choice Type** **5 x 5 = 25 marks**	**Part – C** **Answer any THREE Questions** **3 x 10 = 30 marks**
Questions	**Questions**	**Questions**
1 – 2 – Unit I	11(a) or 11(b) – Unit I	16 – Unit I
3 – 4 – Unit II	12(a) or 12(b) – Unit II	17 – Unit II
5 – 6 – Unit III	13(a) or 13(b) – Unit III	18 – Unit III
7 – 8 – Unit IV	14(a) or 14(b) – Unit IV	19 – Unit IV
9 – 10 – Unit V	15(a) or 15(b) – Unit V	20 – Unit V

Internal Pattern

1. Internal Test – 1 - 50 marks
2. Internal Test – 2 - 75 marks

3. Assignment – 1 - 10 marks
4. Assignment – 2 - 10 marks
5. Seminar - 5 marks

Total **- 150 marks***

***Total marks to be converted into 25 marks**

M. Sc. Applied Mathematics
CORE COURSE: ALGEBRA

Objectives:

- To give foundation in group theory.
- To train the students in problem-solving as a preparatory to NET/SET.

Unit-I

Group Theory:A counting Principle – Normal subgroups and Quotient groups – Homomorphism. –
Chapter: 2Sections – 2.5 to 2.7

Unit-II

Automorphisms – Cayley's theorem – permutation groups.
Chapter: 2Sections – 2.8 to 2.10

Unit-III

Another counting principle - Sylow theorem - Direct products.
Chapter: 2 Sections – 2.11 to 2.13

Unit-IV

Ring theory: Definition and examples of rings - some special classes of rings– Homomorphism - ideal and quotient rings.
Chapter: 3 Sections – 3.1 to 3.4

Unit-V

More ideals and quotient rings - the field of quotients of an integral domain - Euclidean Ring –Particular Euclidean Ring - Polynomial rings - Polynomials over the rational field – Polynomial rings over Commutative rings.
Chapter: 3 Sections – 3.5 to 3.11

Text Book:

I.N.Herstein, "**Topics in Algebra**", Wiley Eastern Ltd., New Delhi, 1975.

Reference books:

1. M. Artin: Algebra, Prentice-Hall of India, **1991**
2. N.Jacobson: Basic Algebra, Volumes I & II, W.H.Freeman, **1980**
3. S.Lang: Algebra, 3rd edition, Addison-Wesley, **1993**
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian edition, **1997**

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
https://nptel.ac.in/content/storage2/111/106/111106113/MP4/mod08lec44.mp4
https://nptel.ac.in/content/storage2/111/106/111106113/MP4/mod08lec45.mp4
https://nptel.ac.in/content/storage2/111/106/111106131/MP4/mod08lec39.mp4
https://nptel.ac.in/content/storage2/111/106/111106131/MP4/mod08lec42.mp4

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Concept of group action and theorems about group actions.
CO2	Solving problems using the powerful concept of group action. Facility in understanding the structure of a problem where the problem involves a permutation group - e.g. nature of the roots of a polynomial equation.
CO3	Ability to understand a large class of commutative rings by regarding them as quotients of polynomial rings by suitable ideals.
CO4	Facility in working with situations involving commutative rings, in particular monogenic algebras of matrices.
CO5	To simplify algebraic expressions, using the commutative, associative and Distributive properties.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**6**	**3**	**3**	**3**	**6**	**9**	**3**
CO2	**9**	**9**	**6**	**3**	**3**	**9**	**3**
CO3	**6**	**3**	**9**	**6**	**9**	**6**	**6**
CO4	**6**	**3**	**9**	**9**	**9**	**6**	**6**
CO5	**3**	**6**	**6**	**9**	**6**	**3**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M.Sc. Applied Mathematics
CORE COURSE: REAL ANALYSIS - I

Objectives:

- To give the students a thorough knowledge of the various aspects of Real line and

Metric Spaces which is imperative for any advanced learning in Pure Mathematics.

- To train the students in problem-solving as a preparatory to NET/SET

Unit-I

Basic Topology: Finite, Countable and uncountable sets - Metric Spaces - Compact Sets - Perfect sets - Connected sets.

Chapter 2

Unit- II

Numerical Sequence and series: Convergent Sequence - Subsequences - Cauchy Sequences - Upper and lower limits – Some special sequences - Series of non- negative terms - The Number e – The Root and Ratio Tests - Power Series.

Chapter 3

Unit- III

Continuity: Limits of functions - Continuous Functions - Continuity and Compactness - Continuity and Connectedness - Discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity.

Chapter 4

Unit- IV

Differentiation: The Derivative of a Real Function - Mean Value Theorems – The Continuity of Derivatives - L'Hospital's Rule - Derivatives of Higher Order - Taylor's Theorem - Derivatives of vector – valued Functions.

Chapter 5

Unit- V

The Riemann-Stieltjes Integral: Definition and Existence of the Integral - Properties of the Integral - Integration and Differentiation - Integration of Vector- valued functions - Rectifiable Curves.

Chapter 6

Text Book:

Walter Rudin, "**Principles of Mathematical Analysis**" McGraw Hill International Editions, Mathematics series, Third Edition **(1964).**

Reference Books:

1. Patrick M. Fitzpatrick, —Advanced Calculus, AMS, Pure and Applied Undergraduate Texts, Indian Edition, **2006**

2. Apostol, Mathematical Analysis, Narosa Publishing House, Indian edition, **1974**

	Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]
1	https://www.youtube.com/watch?v=DO0Dzz07DNI
2	https://nptel.ac.in/courses/111/101/111101100/
3	https://www.youtube.com/watch?v=Y5yEMXZnzYw
4	https://youtu.be/msIZz8ydzcM

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	be able to understand the real number system as a perfect set
CO2	be able to understand the Cauchy sequence, the Root and Ratio Tests.
CO3	continuity of functions and prove how the continuity of functions preserve the properties like the connectedness, compactness etc. and nature of the limit functions.
CO4	be able to analyze the differentiability of various functions and use the differentiability of functions to understand their behavior in the neighborhood of limit points.
CO5	Apply the Riemann Stieltjes integral and bring its properties and rectifiablecurves.

Course Outcome Vs Programme Outcome

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**3**	**9**	**9**	**6**	**9**	**6**	**9**
CO2	**9**	**6**	**6**	**3**	**9**	**9**	**9**
CO3	**3**	**6**	**9**	**3**	**6**	**6**	**6**
CO4	**3**	**6**	**9**	**3**	**6**	**9**	**9**
CO5	**6**	**3**	**9**	**6**	**9**	**3**	**6**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc. Applied Mathematics

CORE COURSE: ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Objectives :

- To give an in-depth knowledge of solving differential equations that we encounter frequently in various walks of life.
- To introduce existence and uniqueness theorems in Differential equations.

Ordinary Differential Equations:

Unit-I

The general solution of the homogenous equation – Use of known solution to find another – The method of variation of parameter – power series solution – series solutions of first order equations – Regular singular point.

Chapter: 3.15, 3.16, 3.19, 5.26, 5.28

Unit- II

Regular singular point(continued) - Legendre polynomials – Properties of Legendre polynomial – Bessel Functions – The Gamma functions – Properties of Bessel function.

Chapter: 5.29, 6.32 to 6.35

Unit- III

Linear system – Homogeneous equations with constant coefficient - The method of successive approximations – Picard's theorem.

Chapter: 7.37, 7.38, 11.55 and 11.56

Partial Differential Equations

Objectives:

- To give an in-depth knowledge of solving partial differential equations that we encounter frequently in various walks of life.
- To introduce existence and uniqueness theorems in Differential equations.

Unit- IV

Methods of solution of $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ – Orthogonal trajectories of a system of curves on a surface – Pfaffian differential forms and equations – solution of Pfaffian differential equations in three variables – Linear equations of the first order.

Chapter: 1.3 to 1.6, 2.4

Unit- V

Integral surface passing through a given curve – surface orthogonal to a given system of surfaces – compatibility system of first order partial differential equations – Charpit's methods – Jacobi's Method.

Chapter: 2.5, 2.6, 2.9, 2.10, 2.13

Text Books:

1.G.F. Simmons, "**Differential Equations with Applications and Historical Notes"** , TMH, New Delhi, 1984.

2. I.N. Snedden, "**Elements of Partial Differential Equations**", McGraw Hill, 1985.

Reference Books:

1. S.G.Deo, V. Lakshmikantham and V. Raghavendra, **"Ordinary Differential Equations"**, Secind edition, Tata McGraw-Hill publishing company Ltd, Delhi, 2004.
2. Clive R.Chester, "**Techniques in Partial Differential Equations**", McGraw-Hill, 1970.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/104/111104031/#
2	https://nptel.ac.in/courses/122/107/122107037/
3	https://www.youtube.com/watch?v=bPPWp65qpIA
4	When do PDE NOT have solutions? https://www.youtube.com/watch?v=BmTFbUAOeec&list=PLGCj8f6sgswntUil8yzohR_qa zOfYZCg_&index=49

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Recall the types of general solution of the homogenous equation, power series solution, series solutions of first order equations and Regular singular point.
CO2	Analyze the legendre polynomials, properties of Legendre polynomial and Bessel Functions
CO3	Understand and solve the homogeneous equations with constant coefficient and Picard's theorem.
CO4	Comprehend the Orthogonal trajectories of a system of curves on a surface and solution of Pfaffian differential equations in three variables
CO5	Find the solution of integral surface passing through a given curve, Charpit's methods and Jacobi's Method.

Course Outcome Vs Programme Outcome

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**9**	**9**	**6**	**6**	**9**	**3**	**9**
CO2	**6**	**9**	**9**	**6**	**9**	**9**	**9**
CO3	**3**	**6**	**9**	**9**	**9**	**9**	**9**
CO4	**6**	**9**	**3**	**6**	**9**	**6**	**9**
CO5	**3**	**6**	**9**	**9**	**9**	**6**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M.Sc. Applied Mathematics
CORE COURSE: LINEAR ALGEBRA

Objectives:

- To give the students a thorough knowledge of the various aspects of Linear Algebra.
- To train the students in problem-solving as a preparatory to NET/SET

Unit-I

Vector Spaces and Modules: Vector Spaces – Linear Independence and bases – Dual spaces – Inner product Spaces, Modules.

Chapter 4 Sections: 4.1, 4.2, 4.3, 4.4 and 4.5

Unit-II

Linear Transformations: The Algebra of Linear transformations, characteristic roots, Similarity of linear transformations, Invariant subspaces and Matrices.

Chapter 6 Sections: 6.1, 6.2 and 6.3

Unit-III

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

Chapter 6 Sections: 6.4 and 6.5

Unit-IV

Jordan forms, rational canonical form, trace, transpose and Determinants.

Chapter 6 Sections: 6.6, 6.7, 6.8 and 6.9

Unit-V

Hermitian, Unitary and Normal transformations - Real quadratic forms.

Chapter 6 Sections: 6.10 and 6.11

Text Book:

I.N.Herstein, **"Topics in Algebra"**, Wiley Eastern Ltd., New Delhi, **(1975)**

Reference books:

1. M.Artin, Algebra, Prentice-Hall of India, **1991**
2. N.Jacobson, Basic Algebra, Volumes I & II, W.H.Freeman, **1980**
3. S.Lang, Algebra, 3rd edition, Addison-Wesley, **1993**
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd Edition) Cambridge University Press, Indian edition, **1997**

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.khanacademy.org/math/linear-algebra/vectors-and-spaces
2	https://nptel.ac.in/courses/111/106/111106051/

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Understand the basic concepts of Vector Spaces and Modules.
CO2	Explain about the Linear transformations and Invariant subspaces and Matrices.
CO3	Understand the basic concepts of Reduction to triangular forms, Nilpotent transformations.
CO4	Recognize the concepts of Jordan forms, and transpose and Determinants.
CO5	Analyze Hermitian, Unitary and Normal transformations

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**9**	**9**	**6**	**3**	**6**	**9**	**9**
CO2	**6**	**9**	**9**	**6**	**3**	**9**	**9**
CO3	**9**	**9**	**6**	**3**	**6**	**9**	**9**
CO4	**3**	**6**	**3**	**9**	**6**	**9**	**6**
CO5	**6**	**9**	**9**	**6**	**3**	**9**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc. Applied Mathematics

CORE COURSE: REAL ANALYSIS – II

Objectives:

- To give the students a thorough knowledge of the various aspects of Real Line and Metric spaces in general which are imperative for any advanced learning.
- To introduce a complete Topological approach in all aspects of Analysis and make them to solve problems.

Unit-I

Sequence and Series of functions: Uniform convergence - Uniform convergence and Continuity - Uniform convergence and Integration - Uniform convergence and Differentiation.

Text Book 1Chapter 7Pages: 143 - 153

Unit-II

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

Text Book 1 Chapter 9 Pages: 204 - 220

Unit- III

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

Text Book 1 Chapter 9 Pages: 221– 234

Unit- IV

The Lebesgue Measure: Introduction – Outer measure – Measurable sets and Lebesgue measure – Measurable functions – Littlewood's three principles.

Text Book 2 Chapter 3 Section: 3.1 – 3.3, 3.5 and 3.6

Unit- V

The Lebesgue Integration: The Riemann integral – The Lebesgue integral of a bounded function over a set of finite measure – The integral of a nonnegative function – The general Lebesgue integral – Convergence in measure.

Text Book 2 Chapter 4 Section: 4.1 – 4.5

Text Books:

1.Walter Rudin, Principles of Mathematical Analysis, McGraw Hill International Editions (1976)

2. Real Analysis – H.L. Royden (3rd Edition), Macmillan Publishing Company, (1988).

Reference Books:

1. Patrick M. Fitzpatrick, —Advanced Calculus, Amer. Math. Soc. Pine and Applied Undergraduate Texts, Indian Edition, **2006**
2. Apostol, Mathematical Analysis, Narosa Publishing House, Indian edition, **1974.**

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1	https://www.youtube.com/watch?v=DO0Dzz07DNI
2	https://nptel.ac.in/courses/111/101/111101100/
3	https://www.youtube.com/watch?v=Y5yEMXZnzYw
4	https://youtu.be/msIZz8ydzcM

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	To acquire an understanding of Uniform convergence, Uniform convergence and Integration
CO2	Explain about Linear Transformation - Differentiation - The Contraction Principle.
CO3	Understand the basic concepts of the inverse function Theorem, The Rank Theorem and Determinants.
CO4	Recognize the concepts of the Lebesgue Measure
CO5	Analyze the Lebesgue Integration

Course Outcome Vs Programme Outcome

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**3**	**9**	**9**	**6**	**9**	**6**	**9**
CO2	**9**	**6**	**6**	**3**	**9**	**9**	**9**
CO3	**3**	**6**	**9**	**3**	**6**	**6**	**6**
CO4	**3**	**6**	**9**	**3**	**6**	**9**	**9**
CO5	**6**	**3**	**9**	**6**	**9**	**3**	**6**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc. Applied Mathematics
CORE COURSE: OPTIMIZATION TECHNIQUES

Objectives:

- To expose the students to the new technique of optimization.
- To highlight some of the Applications of the optimization techniques.

UNIT- I

Introduction: Concept as optimization – statement of the problem – classical optimization – classical treatment as inequality constraints.
Chapter 1 Sections: 1.1 to 1.4

UNIT -II

Nonlinear Programming: Kuhn Tucker necessary condition – Quadratic Programming and Duality.
Chapter 2 Sections: 2.1, 2.2 2.5 to 2.7

UNIT- III

Search method for unconstrained optimization: Gride Search- Hooke and Jeeves Method – Fibbonacci series.
Chapter 3Sections: 3.1 to 3.3, 3.6

UNIT- IV

Gradient method for unconstrained optimization: The Newton-Raphson method – The Davident – Fletcher power method – The complementary DFF formula
Chapter 4 Sections: 4.1 to 4.5

UNIT- V

Dynamic Programming: The Allocation Problem – Oriented and Non-Network – The Farmer's problem – Scheduling problem.
Chapter 6 Sections: 6.1 to 6.6.

Text book:

G.R. Walsh, "**Method of Optimization**",John Wiley and Sons, New York 1975.

Reference Books:

1. HamdyA.Taha, "**Operations Research An Introduction**", Ninth edition, Dorling Kindersley(India) Pvt.Ltd. 2012.
2. Fredericks. Hiller, G.J.Libeberman,"**Operations Research**", second edition, CBS Publishers & distributers.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=WmeUT0jQdwc
2	https://www.youtube.com/watch?v=FTEMe5oUrds&list=PLLy_2iUCG87Bq8RGMTdeFZ iB-87V4i9p1&index=28
3	https://www.youtube.com/watch?v=2aPlzhsEsIw
4	https://www.youtube.com/watch?v=PavZX3hAL6I

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Explain the concept as optimization and classical treatment as inequality constraints.
CO2	Solving Nonlinear Programming problems.
CO3	Apply the Gride Search- Hooke and Jeeves Method.
CO4	Understanding the Newton-Raphson method and the complementary DFF formula.
CO5	Solving the Allocation Problem and Oriented and Non-Network problem.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**6**	**3**	**9**	**6**	**6**	**9**	**9**
CO2	**9**	**6**	**9**	**9**	**9**	**9**	**6**
CO3	**9**	**6**	**9**	**9**	**9**	**9**	**6**
CO4	**6**	**3**	**9**	**6**	**6**	**9**	**9**
CO5	**9**	**6**	**9**	**9**	**9**	**9**	**6**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M.Sc. Applied Mathematics

CORE COURSE: COMPLEX ANALYSIS

Objectives:

- To learn the various intrinsic concepts and the theory of Complex Analysis.
- To study the concept of Analyticity, Complex Integration and Infinite Products in depth.

UNIT I : Elementary Point Set Topology: Sets and Elements – Metric Spaces – Connectedness – Compactness – Continuous Functions – Topological Spaces; Conformality: Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area; Linear Transformations: The Linear Group – The Cross Ratio – Symmetry .

Chapter 3: 1.1-1.6, 2.1-2.4,3.1-3.3

UNIT II: Fundamental theorems in complex integration: Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk; Cauchy's Integral Formula: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.

Chapter 4: 1.1-1.5, 2.1-2.3

UNIT III: Local Properties of Analytic Functions - Removable Singularities - Taylor's Theorem – Integral representation of the nth term - Zeros and Poles – Algebraic order of f(z) – Essential Singularity - The Local Mapping – The Open Mapping Theorem - The Maximum Principle.

Chapter 4: 3.1, 3.2, 3.3,3.4

UNIT IV: The General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions; The Calculus of Residues: The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals

Chapter 4: 4.1-4.7, 5.1-5.3

UNIT V: Harmonic Functions: Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle; Power series expansions-Weierstrass's Theorem – The Taylor Series – The Laurent Series.

Chapter 4: 6.1-6.5, and Chapter 5: 1.1-1.3

TEXT BOOK:

Lars V. Ahlfors, **Complex Analysis**, Third Ed. McGraw-Hill Book Company, Tokyo, 1979.

REFERENCE(S)

[1] Serge Lang, Complex Analysis, Addisn Wesley, 1977.
[2] S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, New Delhi, 1997.
[3] V. Karunakaran, Complex Analysis.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/103/111103070/
2	https://nptel.ac.in/courses/111/106/111106084/
3	https://youtu.be/sJcpfmF5oHo

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Represent Elementary Point Set Topology, Cauchy's Theorem for a Rectangle and Linear Transformations.
CO2	Define and analyze Fundamental theorems in complex integration and Cauchy's Integral Formula.
CO3	Understand about the Local Properties of Analytic Functions, The Open Mapping Theorem and the Maximum Principle.
CO4	Evaluate Chains and Cycles, Simple Connectivity, Homology and Evaluation of Definite Integrals.
CO5	Analyze Harmonic Functions, Schwarz's Theorem, Weierstrass's Theorem , the Taylor Series ,the and the Laurent Series.

Course Outcome Vs Programme Outcome

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**9**	**9**	**6**	**3**	**3**	**6**	**6**
CO2	**6**	**9**	**6**	**3**	**6**	**6**	**6**
CO3	**6**	**9**	**6**	**9**	**6**	**6**	**9**
CO4	**6**	**9**	**9**	**9**	**6**	**9**	**9**
CO5	**9**	**6**	**9**	**9**	**6**	**9**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc.Applied Mathematics
CORE COURSE: FUNCTIONAL ANALYSIS

Objectives:

- To study the three structure theorems of Functional Analysis viz., HahnBanach theorem, Open mapping theorem and Uniform boundedness principle.
- To introduce Hilbert spaces and operator theory leading to the spectral theory of operators on a Hilbert space.

UNIT I : Algebraic Systems: Groups – Rings – The structure of rings – Linear spaces – The dimension of a linear space – Linear transformations – Algebras – Banach Spaces : The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem- The natural imbedding of N in N** - The open mapping theorem – The conjugate of an operator.**Chapters 8 and 9**

UNIT II : Hilbert Spaces: The definition and some simple properties – Orthogonal complements – Orthonormal sets - The conjugate space H* - The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections. **Chapter 10**

UNIT III : Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator – The spectral theorem – A survey of the situation.

Chapter 11

UNIT IV : General Preliminaries on Banach Algebras: The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius – The radical and semi-simplicity.

Chapter 12

UNIT V : The Structure of Commutative Banach Algebras : The Gelfand mapping – Applications of the formula r(x) = lim || xn ||1/n - Involutions in Banach Algebras – The Gelfand-Neumark theorem. **Chapter 13**

TEXT BOOK:

Introduction to Topology and Modern Analysis, G.F.Simmons, McGraw-Hill International Ed. 1963.

REFERENCE(S):

[1] Walter Rudin, Functional Analysis, TMH Edition, 1974.
[2] B.V. Limaye, Functional Analysis, Wiley Eastern Limited, Bombay, Second Print, 1985.
[3] K. Yosida, Functional Analysis, Springer-Verlag, 1974.
[4] Laurent Schwarz, Functional Analysis, Courant Institute of Mathematical Sciences, New York University, 1964.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/105/111105037/
2	https://ocw.mit.edu/courses/mathematics/18-102-introduction-to-functional-analysis-spring- 2009/lecture-notes/

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Understand the concepts of Algebraic systems, definition of Banach space and examples, The Hahn Banach Theorem, The natural imbedding of N in N^{**} , the open mapping theorem and the conjugate of an operator.
CO2	Describe the concept of definition, properties of a Hilbert space, The conjugate space, The adjoint of an operator, self adjoint operators, Normal and unitary operators and Projections.
CO3	Know about the concepts of Finite-Dimensional Spectral Theory of Matrices and Determinants and the spectrum of an operator and the spectral theorem.
CO4	Know about the General Preliminaries on Banach Algebras, The definition and some examples, Regular and singular elements, Topological divisors of zero, The spectrum, The formula for the spectral radius , The radical and semi-simplicity.
CO5	Describe the clear cut idea about the Structure of Commutative Banach Algebras, The Gelfand mapping,Applications of the formula r(x) = lim || xn ||1/n Involutions in Banach Algebras, The Gelfand-Neumark theorem .

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**9**	**9**	**9**	**6**	**6**	**6**	**9**
CO2	**9**	**9**	**6**	**6**	**3**	**9**	**9**
CO3	**5**	**6**	**3**	**9**	**9**	**9**	**9**
CO4	**9**	**6**	**9**	**3**	**3**	**9**	**9**
CO5	**9**	**9**	**9**	**3**	**6**	**9**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc. Applied Mathematics
CORE COURSE: MATHEMATICAL STATISTICS

Objectives:

1. To understand the concepts of various discrete and continuous probability distributions

2. To apply these techniques to real life problems.

Unit I:

Some special distributions: The Binomial and related distributions – The Poisson distribution – The Gamma and Chi-Square Distributions – The Normal distribution- The Bivariate normal distribution.

Chapter: 3, 4 (except 4.5 and 4.10)

Unit II:

Distributions of functions of random variables - Sampling theory – Transformations of variables of the discrete type – Transformations of variables of the continuous type – The β, t and F distributions- Distributions of order statistics- The moment generating function technique.

Chapter: 5(Sections 5.3 and 5.4 only)

The distributions of $\bar{X}$ and nS^2/σ^2 - Expectations of functions of random variables – Limiting distributions: Limiting moment generating functions – The Central limit theorem.

Chapter: 6(except 6.4 and 6.5)

Unit-IV:

Introduction to statistical inference: Point Estimation – Confidence intervals for means – Confidence intervals for differences of means - χ^2 – test – More about estimation - Bayesian Estimation.

Chapter: 8 (Section 8.1 only)

Unit-V:

Theory of statistical tests: Certain best tests - Uniformly most powerful tests-Likelihood ratio test.

Chapter: 9(Sections 9.1 to 9.3).

Text Book:

Robert V. Hogg and Allen T. Craig, "**Introduction to Mathematical Statistics**" (Fifth Edition).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/104/111104032/#
2	https://nptel.ac.in/courses/111/105/111105090/

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Remembering the understanding the basic concepts of distributions.
CO2	Applying the concepts and methods to find the distributions of functions and the moment generating function technique.
CO3	Study distributions and the Central limit theorem.
CO4	Analyze and study the theory of estimation and confidence interval of means.
CO5	Understand the statistical tests such as likelihood ratio test

Course Outcome Vs Programme Outcome

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**9**	**6**	**6**	**3**	**3**	**6**	**9**
CO2	**6**	**9**	**6**	**3**	**9**	**9**	**6**
CO3	**9**	**6**	**9**	**6**	**6**	**9**	**9**
CO4	**6**	**6**	**9**	**6**	**6**	**9**	**6**
CO5	**6**	**6**	**3**	**6**	**9**	**6**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc. Applied Mathematics
Core Course :NUMERICAL ANALYSIS

Objectives:

1. To develop Numerical computational skills.
2. To practice their applications.

UNIT – I

Transcendental and polynomial equations: Rate of convergence of iterative methods – Methods for finding complex roots – Polynomial equations – Birge-Vieta method, Bairstow's method, Graeffe's root squaring method.

Chapter 2 – 2.5 to 2.8

UNIT – II

System of Linear Algebraic equations and Eigen Value Problems: Error Analysis of direct and iteration methods – Finding eigen values and eigen vectors – Jacobi and Power methods.

Chapter 3 – 3.3, 3.4, 3.5

UNIT – III

Interpolation and Approximation : - Hermite Interpolations – Piecewise and Spline Interpolation – Bivariate Interpolation- Approximation – Least square approximation and best approximations.

Chapter 4 – 4.5 to 4.9

UNIT - IV

Differentiation and Integration: - Numerical Differentiation - Optimum choice of Step-length – Extrapolation methods – Partial Differentiation – Methods based on undetermined coefficients – Gauss methods.

Chapter 5 – 5.2, 5.3, 5.4, 5.5, 5.8

UNIT – V

Ordinary differential equations: Local truncation error – Euler, Backward Euler, Midpoint, Taylor's Method and second order Runge-Kutta method– Stability analysis.

Chapter 6 – 6.2, 6.3, 6.6

TEXT BOOK:

M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, III Edn. Wiley Eastern Ltd., 1993.

REFERENCES:

1 Kendall E. Atkinson, An Introduction to Numerical Analysis, II Edn., John Wiley & Sons, 1988.

2 M.K. Jain, Numerical Solution of Differential Equations, II Edn., New Age International Pvt Ltd., 1983.

3 Samuel. D. Conte, Carl. De Boor, Elementary Numerical Analysis, McGraw-Hill International Edn., 1983.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/107/111107105/
2	https://freevideolectures.com/course/3504/numerical-methods-of-ordinary-and-partial/1
3	https://www.classcentral.com/course/swayam-numerical-methods-for-engineers-14213

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Solve Algebraic and Transcendental Equations by applying appropriate methods.
CO2	Learn to find the eigen values and eigen vectors using appropriate methods.
CO3	Choose suitable method to find solution to the problems related to Interpolation.
CO4	Find the Differentiation and Integration of the given function using appropriate method.
CO5	Apply appropriate method to find the approximate solution to the ODE.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**9**	6	**3**	**9**	**9**	**6**	**3**
CO2	**9**	6	**3**	**9**	**9**	**6**	**3**
CO3	**9**	**6**	**3**	**9**	**9**	**6**	**3**
CO4	**9**	**9**	**9**	**9**	**6**	**9**	**9**
CO5	**9**	**9**	**9**	**9**	**6**	**9**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc. Applied Mathematics
CORE COURSE: CLASSICAL DYNAMICS

Objectives:

- To give a detailed knowledge about the mechanical system of particles.
- To study the applications of Lagrange's equations and Hamilton's equations as well as the theory of Hamilton-Jacobi Theory

UNIT I

Introductory concepts: The mechanical system - Generalized Coordinates - constraints - virtual work - Energy and momentum.
Chapter 1: Sections 1.1 to 1.5

UNIT II

Lagrange's equation: Derivation and examples - Integrals of the Motion.
Chapter 2: Sections 2.1 to 2.3

UNIT III

Special Applications of Lagrange's Equations: Rayleigh's dissipation function - impulsive motion - velocity dependent potentials.
Chapter 3: Sections 3.1 - 3.2 and 3.4

UNIT IV

Hamilton's equations: Hamilton's principle - Hamilton's equations - Other variational principles.
Chapter 4: Sections 4.1 to 4.3

UNIT V

Hamilton - Jacobi Theory: Hamilton's Principal Function – The Hamilton - Jacobi equation.
Chapter 5: Sections 5.1 to 5.3

Text Book:

1. Donald T. Greenwood, Classical Dynamics, PHI Pvt. Ltd., New Delhi, 1985.

Reference Books:

1. H. Goldstein, Classical Mechanics, (2nd Edition), Narosa Publishing House, New Delhi, 1998.
2. Narayan Chandra Rana&PromodSharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://math.ucr.edu/home/baez/classical/texfiles/2005/book/classical.pdf.
2	https://nptel.ac.in/courses/115/103/115103115/
4	https://www.youtube.com/watch?v=G6OX1NpToaw

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	understand the basic concepts of the mechanical system, generalized coordinates,work, energy and momentum.
CO2	solve and analyze the Lagrange's equations and integrals of motion with examples.
CO3	Analyze the Special Applications of Lagrange's Equations
CO4	understand the Hamilton's Principle and other variational principles and gain abilityto analyze those principles to the problems arising in practical situations.
CO5	understand and develop the Hamilton's Principal function and Hamilton Jacobi equation .

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**9**	**6**	**9**	**6**	**9**	**6**	**9**
CO2	**6**	**9**	**6**	**9**	**9**	**3**	**6**
CO3	**9**	**9**	**6**	**9**	**9**	**3**	**9**
CO4	**9**	**9**	**6**	**9**	**9**	**6**	**6**
CO5	**9**	**9**	**6**	**9**	**9**	**6**	**6**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.

M. Sc. Applied Mathematics
CORE COURSE: STOCHASTIC PROCESSES

Objectives:

- To understand the stochastic models for many real life probabilistic situations.
- To learn the well known models like birth-death and queueing to reorient their knowledge of stochastic analysis.

UNIT I

Stochastic Processes: Some notions – Specification of Stochastic processes – Stationary processes – Markov Chains – Definitions and examples – Higher Transition probabilities – Generalization of Independent Bernoulli trails – Sequence of chain –Dependent trains.
Chapter II Section: 2.1 to 2.3, Chapter III Section: 3.1 to 3.3

UNIT II

Markov chains: Classification of states and chains – determination of Higher transition probabilities – stability of a Markov system – Reducible chains – Markov chains with continuous state space.
Chapter III Section: 3.4 to 3.6, 3.8, 3.9 and 3.11

UNIT III

Markov processes with Discrete state space: Poisson processes and their extensions – Poisson process and related distribution – Generalization of Poisson process- Birth and Death process – Markov processes with discrete state space (continuous time Markov Chains).
Chapter IVI Section: 4.1 to 4.5

UNIT IV

Renewal processes and theory: Renewal process – Renewal processes in continuous time – Renewal equation – stopping time – Wald's equation – Renewal theorems.
Chapter VI Section: 6.1 to 6.5

UNIT V

Stochastic processes in Queuing: Queuing system – General concepts – the queuing model M/M/1 – Steady state behaviour – transient behaviour of M/M/1 Model – Non-Markovian models - the model GI/M/1.
Chapter X Section: 10.1 to 10.3, 10.7 and 10.8

Text Book:

J. Medhi, Stochastic Processes, Wiley Eastern, 1982.

Reference Books:

1. Samuel Karlin, Howard M. Taylor, A first course in stochastic processes, 2nd edition, Academic Press, 1975.
2. Narayan Bhat , Elements of Applied Stochastic Processes, 2nd edn, John Wiley, 1984.
3. S.K. Srinivasan and K.Mehata, Stochastic Processes, Tata McGraw Hill, 1976.
4. N.U. Prabhu, Stochastic Processes. Macmillan, 1965.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/102/111102014/#
2	https://nptel.ac.in/courses/111/102/111102014/#
3	https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2145&context=gradreports

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Understand the definitions and examples of Stochastic Processes, Stationary Processes, Markov chain, Higher transition Probabilities, Bernoulli trails and dependent trains.
CO2	Know the concepts of Markov chain, Classifiction of states and chain, Stability of a Markov system, Markov chain with continuous state space and Determination of higher transition Probabilities.
CO3	Describe the concept of Markov Processes with discrete state space.
CO4	Describe the concepts of Renewal Processes and theory, Stopping time, Wald's equation and Renewal theorems.
CO5	Gather the clear cut idea about the Stochastic Processes in Queuing system like the general concepts the queuing model, Steady state behavior, transient behavior, Non-Markovian models and the model GI/M/1.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**6**	**9**	**6**	**9**	**6**	**9**	**9**
CO2	**9**	**6**	**3**	**6**	**3**	**6**	**3**
CO3	**9**	**9**	**6**	**6**	**6**	**6**	**9**
CO4	**6**	**6**	**9**	**9**	**9**	**9**	**6**
CO5	**6**	**6**	**6**	**9**	**6**	**6**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M. Sc.Applied Mathematics
CORE COURSE :DISCRETE MATHEMATICS

Objectives:

1. To develop knowledge on various relations
2. To familiarize the application through various statistical methods.

Unit I:

Computability and Formal Languages: ordered sets, Languages – Phrase – Structure grammars – Types of grammars and Language.

Chapter 2 Section: 2.3 to 2.6

Unit II:

Finite state machine: Introduction – Finite state machine as models of physical systems – Equivalent machine – Finite state machines as language recognizers – Finite state languages and type-3 languages.

Chapter7 Section: 7.1 to 7.6

Unit III:

Permutations, combinations and discrete probability: Introduction – The rules of sum and product of permutations – combinations – Generation of permutations and combinations – Discrete probability – Conditional probability.

Chapter 3 Section: 2.3 to 2.6

Unit IV:

Discrete Numeric function and generating functions: Introduction – Manipulation of numeric functions – Generating functions.

Chapter 9 Section: 9.1 to 9.2 and 9.4

Unit V:

Recurrence relations and Recursive algorithm: Introduction – Recurrence relations – Linear recurrence relation with constant coefficients – Homogenous solutions – Particular solutions – Total solution.

Chapter 10 Section: 10.1 to10.6

Text Book:

C. L. Liu, "**Elements of Discrete Mathematics"**, second edition, McGraw-Hills, New York 1987.

Reference Book:

J.P.TrembelayR.Manohar, "**Discrete Mathematics with Applications to Computer Science"**, Tata McGraw-Hill, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://youtu.be/oaOm2pnKkyY
2	https://www.classcentral.com/course/swayam-discrete-mathematics-5217
3	https://onlinecourses.nptel.ac.in/noc21_cs80/preview

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Understand the types of grammars and Languages in the algorithm-based mathematics.
CO2	Understand the concept of machine language using finite state machine and establish the relation with the grammars and languages.
CO3	Gather the enumerators for permutation aspects in combinatorial theory and basic ideas of probability.
CO4	Learn how to work with some of the discrete structures which includes numeric functions, generating functions.
CO5	Learn how to work with some of the discrete structures which includes recurrence relations, and their solving technics.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**9**	**3**	**6**	**6**	**6**	**3**	**6**
CO2	**9**	**6**	**6**	**3**	**3**	**3**	**3**
CO3	**3**	**6**	**6**	**9**	**3**	**3**	**3**
CO4	**6**	**6**	**3**	**3**	**6**	**3**	**3**
CO5	**6**	**6**	**6**	**3**	**3**	**9**	**3**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M. Sc. Applied Mathematics
Elective I : GRAPH THEORY WITH APPLICATIONS

Objectives :

- To give a rigorous introduction to the basic concepts of Graph Theory.
- To give applications of Graph Theory in other disciplines.

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:Independent sets and their characterization - Matchings - Vertex as well as edge independence numbers, Covering numbers - Perfect matching – Konig'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 – Sections7.1 and 7.2.

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

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; Chapter 9 - Section 9.6; Chapter 6 - Sections 6.1 and 6.2.

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

Text Book:

J.A. Bondy and U.S.R. Murthy, "**Graph Theory with Applications**", 1976

Reference books:

1. F. Harary, Graph Theory, Addison –Wesley, **1969**
2. G NarasingaDeo, Graph Theory with Applications to Engineering and Computer

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/106/111106050/
2	https://nptel.ac.in/courses/106/108/106108054/

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Understand the basic concepts of graphs , vertex cuts and edge cuts and connected graphs and blocks.
CO2	Analyze Independent sets, Theorems on the upper bounds and lower bounds for Ramsey numbers - Ramsey graphs - Erdos theorem.
CO3	Acquire knowledge in vertex colourings and chromatic numbers of graphs and Hajo's conjecture and Dirac's theorem.
CO4	Apply Chromatic number and Chromatic polynomials.
CO5	Determining the directed graphs and Directed Hamilton paths and cycle

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**6**	**6**	**3**	**6**	**6**	**6**
CO2	**6**	**9**	**9**	**6**	**6**	**3**	**3**
CO3	**9**	**9**	**9**	**6**	**3**	**3**	**3**
CO4	**3**	**6**	**9**	**9**	**6**	**3**	**6**
CO5	**6**	**3**	**9**	**6**	**6**	**6**	**6**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M. Sc. Applied Mathematics
Elective I : ANALYTICAL NUMBER THEORY

Objectives:

1. To introduce some importance tools in number theory.
2. To learn about number theoretical functions.

Unit I:

Arithmetical Functions and Dirichlet Multiplication: The Mobius function μ(n) – The Euler totient function φ(n)– A relation connecting μ and φ - A product formula for φ(n) – The Dirichlet product of arithmetical functions – Dirichletinverses and the Mobius inversion formula – The Mangoldt function Λ(n) – Multiplicative functions – Inverse of a completely multiplicative function.

Sections: 2.1 to 2.11

Unit II:

Averages of Arithmetical Function: The big oh notation – asymptotic equality of functions – Euler's summation formula – elementary asymptotic formulas – Average order of d(n), of divisor function σ_α (n),φ(n),μ(n) and Λ(n)

Sections: 3.1 to 3.7

Unit III:

Congruences: Basic properties – Residue classes and complete residue systems – linear congruences – Reduced residue systems and Euler Fermat theorem – Polynomial congruences modulo p –Lagrange's theorem – Applications – Simultaneous linear congruences – The Chinese remainder theorem – Polynomial congruences with prime power moduli.

Sections: 3.9; 5.1 to 5.9

Unit IV:

Quadratic Residues & the Quadratic Reciprocity Law: Quadratic Residues – Legendre's symbol and its properties – Evaluation of (-1|p) and (2|p) – Gauss' lemma – The Quadratic Reciprocity law – Applications – The Jacobi symbol.

Sections: 9.1 to 9.7

Unit V:

Partitions: Geometric representation of partitions – Generating functions for partitions – Euler's pentagonal- number theorem – Euler's recursion formula for p(n).

Sections: 14.1 to 14.4; 14.6

Text Book:

Tom M. Apostol, Introduction to Analytic Number Theory, Springer International Student Edition, Narosa Publishing House, New Delhi.

Reference Books:

1. Ivan Niven, Herbert S.Zuckermann, An Introduction to the Theory of Numbers, Wiley Eastern University Edition, V Edition, 1989.
2. W.J.Leveque, Topics in Number Theory, Addison Wesley.

3. Bressoud, D., Wagon, S., A Course in Computational Number Theory, Key College Publishing, 2000.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https:// freevideolectures.com/course/3027/cryptography-and-network-security
2	https://www.youtube.com/watch?v=SCvtxjpVQms&t=3321s (NPTEL)
3	https://www.youtube.com/watch?v=Oyw5OmOd9B8&list=PLLtQL9wSL16iRzTi2aKPiH O1f1UjTTkJD (Mathpod)

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Find the arithmetical functions and Dirichlet Multiplication.
CO2	Understand the definitions of the averages of arithmetical function.
CO3	Analyze the concept of Congruences.
CO4	Determine the quadratic residues and the quadratic reciprocity law.
CO5	Acquire knowledge on partitions.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**9**	**6**	**6**	**3**	**6**	**6**	**6**
CO2	**6**	**9**	**3**	**6**	**6**	**9**	**6**
CO3	**3**	**6**	**9**	**6**	**9**	**9**	**6**
CO4	**3**	**6**	**6**	**3**	**3**	**6**	**6**
CO5	**9**	**6**	**6**	**3**	**6**	**9**	**6**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M.Sc. Applied Mathematics

Elective II: TOPOLOGY

Objectives:

- To study the concepts concerned with properties that are preserved under continuous deformations of objects.
- To train the students to develop analytical thinking and the study of continuity and connectivity.

Unit - I:
Topological spaces and continuous functions: Topological Spaces – Bases for a Topology – The Order Topology – The Product Topology on XxY – The Sub-space topology – Closed sets and limit points – Continuous functions – The Product topology – The metric Topology.
Chapter 2 Section: 12 to 20

Unit-II:
Connectedness and Compactness: Connected spaces – Connected sets in the real line – Components and Local connectedness.
Chapter 3 Section: 23 to 25

Unit-III:
Compact Spaces – Compact sets in the real line – Limit point compactness – Local compactness – Complete metric spaces – Compactness in metric spaces.
Chapter 3 Section: 26 to 29 and Chapter 5 Section: 43 and 45

Unit -IV:
Countability and Separation axioms: The countability axioms - The separation axioms – Normal space.
Chapter 4 Section: 30 to 32

Unit-V:
The Urysohn's Lemma – The Urysohn'sMetrization theorem (statement only) - The Tychonoff theorem.
Chapter 4 Section: 33, 34 and 37

Text Book: James R. Munkres,"**Topology**"– second edition, Prentice Hall, New Delhi (2003).

Reference Book:

J. Dugundgi, "**Toplogy"**, Allyn and Bacon, Boston, (1966)

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/content/storage2/courses/111106054/Topology%20complete%20course.p df
2	https://www.youtube.com/watch?v=Oe3Qjk3t0go&lc=UghijV07WCAwpHgCoAEC
3	https://www.youtube.com/watch?v=2OMPmrHEO2M

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Study Continuous functions and their properties in topological spaces
CO2	Understand compactness and connectedness in topological spaces
CO3	Understand separation axioms.
CO4	Problem solving techniques in topology
CO5	Sufficient conditions for metrizability of a topological space

Course Outcome Vs Programme Outcome

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**3**	**6**	**9**	**3**	**6**	**6**	**9**
CO2	**9**	**6**	**6**	**3**	**3**	**9**	**9**
CO3	**9**	**6**	**9**	**3**	**6**	**9**	**9**
CO4	**9**	**9**	**9**	**6**	**3**	**9**	**9**
CO5	**9**	**6**	**9**	**6**	**6**	**9**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M. Sc. Applied Mathematics
Elective II : CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Objective:

1. To introduce the idea connected to the concepts of calculus and Integral Equations
2. To learn more about Linear Equation and Hilbert – Schmidt Theory.

Unit I:
Calculus of Variations and Applications: Maxima and Minima - The Simplest case-Illustrative examples-Natural boundary conditions and transition conditions – The variational notation-The more general case.

Unit II:
Constraints and Lagrange multipliers-Variable end points - Sturm- Liouville problems-Hamilton's principle-Lagrange's equations

Unit III:
Integral Equations: Introduction – Relations between differential and integral equations – The Green's function – Alternative definition of the Green's function.

Unit IV:
Linear equation in cause and effect: The influence function – Fredholm equations with separable kernels – Illustrative example.

Unit V:
Hilbert – Schmidt theory – Iterative methods for solving equations of the second kind – Fredholm theory.

Text Book:

Method of Applied Mathematics by Francis B. Hilderbrand (Second edition) sections 2.1 to 2.11, 3.1 to 3.9 and 3.11

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://youtu.be/GiPOQC5nYMs
2	https://youtu.be/WPlBrzjI1KI

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Understand and apply calculus of variations
CO2	Recognize and solve Constraints , Lagrange multipliers and Liouville problems and Hamilton's principle
CO3	Understand Integral Equations and alternative definition of the Green's function.
CO4	Understand the Linear equation in cause and effect.
CO5	Demonstrate and apply the Hilbert , Schmidt theory and Iterative methods.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**6**	**6**	**3**	**6**	**6**	**6**	**6**
CO2	**6**	**6**	**3**	**6**	**6**	**3**	**9**
CO3	**3**	**6**	**6**	**6**	**3**	**3**	**9**
CO4	**3**	**6**	**6**	**3**	**6**	**3**	**6**
CO5	**6**	**6**	**6**	**9**	**6**	**6**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M. Sc. Applied Mathematics

Soft Core: FUZZY MATHEMATICS

Objectives:

- To make the students understand the nuances of Fuzzy Analysis.
- To make them understand the applications of these techniques in computer.

UNIT – I

Fuzzy sets: Basic types – Basic concepts – α-cuts – Additional properties of α-cuts – Extension principle for Fuzzy sets.

Chapter 1 Section 1.3, 1.4 and Chapter 2 Section 2.1, 2.3

UNIT – II

Operations on Fuzzy sets: Types of operations – Fuzzy complements – t-Norms – Fuzzy Unions.

Chapter 3 Section 3.1 to 3.4

UNIT – III

Combinations of operations -Fuzzy Arithmetic **– Fuzzy Arithmetic**: Fuzzy numbers.

Chapter 3 Section 3.5 to 3.6 and Chapter 4 Section: 4.1

UNIT – IV

Fuzzy Arithmetic: Arithmetic operations on intervals – Arithmetic operations on Fuzzy numbers - **Fuzzy relations**: Binary fuzzy relations – Fuzzy equivalence relations – Fuzzy compatibility relations.

Chapter 4 Section 4.3 to 4.4 and Chapter 5 Section: 5.3, 5.5, 5.6.

UNIT - V

Fuzzy ordering relations – fuzzy morphisms

Chapter 5 Section 5.7 to 5.8.

Text Book:

1. George J.Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 2004.

Reference Books:

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited, New Delhi, 1991.
2. G.J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 1995.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://giocher.wordpress.com/chapter-2-par-2-2-fuzzy-relations-and-the-extension- principle/
2	https://nptel.ac.in/courses/108/104/108104157/

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Discuss the Basic types and operations on fuzzy sets,
CO2	Study Fuzzy complements and t- norms and fuzzy arithmetic.
CO3	Understand the Combinations of operationsand fuzzy arithmetic.
CO4	Identify fuzzy relations, binary fuzzy relations and fuzzy equivalence relations.
CO5	Gain the knowledge of fuzzy morphisms

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**6**	**9**	**3**	**6**	**3**	**9**
CO2	**6**	**9**	**6**	**9**	**6**	**9**	**9**
CO3	**9**	**9**	**3**	**6**	**6**	**9**	**3**
CO4	**9**	**9**	**3**	**6**	**6**	**9**	**3**
CO5	**6**	**9**	**6**	**9**	**6**	**9**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M. Sc. Applied Mathematics
Soft Core: FLUID DYNAMICS

Objectives:

- To give the students an introduction to the behaviour of fluids in motion.
- To give the students a feel of the applications of Complex Analysis in the analysis of the flow of liquids.

UNIT I

Real Fluids and Ideal Fluids - Velocity of a Fluid at a point - Streamlines and Path lines; Steady and Unsteady Flows - The Velocity potential – The Vorticity vector - Local and Particle Rates of Change – The Equation of continuity - Worked examples - Acceleration of a Fluid – Conditions at a rigid boundary - General analysis of fluid motion - Pressure at a point in a Fluid at Rest - Pressure at a point in Moving Fluid - Conditions at a Boundary of Two Inviscid Immiscible Fluids -Euler's equations of motion - Bernoulli's equation - worked examples.

Chapter 2 and Chapter 3: Sections 3.1 to 3.6

UNIT II

Discussion of a case of steady motion under conservative body forces – Some potential theorems-Some Flows Involving Axial Symmetry - Some special two- Dimensional Flows - Impulsive Motion. Some three-dimensional Flows: Introduction - Sources, Sinks and Doublets - Images in a Rigid Infinite Plane - Axi-Symmetric Flows; Stokes stream function

Chapter 3: Sections 3.7 to 3.11 and Chapter 4: Sections 4.1, 4.2, 4.3, 4.5

UNIT III

Some Two-Dimensional Flows: Meaning of a Two-Dimensional Flow - Use of cylindrical Polar coordinates – The stream function – The Complex Potential for Two- Dimensional, Irrotational, Incompressible Flow - complex velocity potentials for Standard Two-Dimensional Flows - Some worked examples – The Milne-Thomson circle theorem and applications – The Theorem of Blasius

Chapter5 : Sections: 5.1 to 5.9 except 5.7

UNIT IV

The use of conformal Transformation and Hydrodynamical Aspects - Vortex rows. Viscous flow: Stress components in a Real fluid - relations between Cartesian components of stress - Translational Motion of Fluid Element - The Rate of Strain Quadric and Principal Stresses -

Chapter 5: Section 5.10 , 5.12 and Chapter 8: Sections 8.1 to 8.4

UNIT V

Some Further properties of the Rate of Strain Quadric - Stress Analysis in Fluid Motion - Relations Between stress and rate of strain - The coefficient of viscosity and Laminar Flow - The Navier - Stokes equations of Motion of a Viscous Fluid .

Chapter 8: Sections 8.5 to 8.9

TEXT BOOK

1. Content and Treatment as in Text Book of Fluid Dynamics by F. Chorlton (CBS publishers& Distributors, New Delhi-110 002) 1985.

REFERENCES

1. J.F. Wendt, J.D. Anderson, G.Degrez and E. Dick, Computational Fluid Dynamics : An Introduction, Springer-Verlag, 1996.
2. J.D. Anderson, Computational Fluid Dynamics, The Basics with Applications, McGraw Hill, 1995.
3. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1984.
4. A.J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics, Springer-Verlag, New York, 1993.
5. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Pvt Limited, New Delhi, 1976.
6. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/112/106/112106200/
2	https://nptel.ac.in/courses/112/105/112105171/

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Recall the basic concepts of Real Fluids and Ideal Fluids, the Equation of continuity and Euler's equations of motion.
CO2	Discussion of a case of steady motion under conservative body forces and Axi-Symmetric Flows; Stokes stream function
CO3	Analyze and understand the concepts of some two-dimensional flows.
CO4	Analyze the viscous flow.
CO5	Analyze and apply the properties of the Rate of Strain Quadric and The Navier - Stokes equations of Motion of a Viscous Fluid .

Course Outcome Vs Programme Outcome

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	**6**	**9**	**6**	**6**	**6**	**3**	**3**
CO2	**6**	**9**	**6**	**6**	**9**	**6**	**9**
CO3	**3**	**6**	**6**	**6**	**9**	**6**	**9**
CO4	**6**	**6**	**9**	**9**	**6**	**6**	**9**
CO5	**3**	**6**	**9**	**6**	**6**	**6**	**9**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation

M. Sc. Applied Mathematics

EDC : MATLAB (Objective Type)

1. To understand MATLAB platform.
2. To initiate the capability on creation and maintenance of websites.

Unit – I

Introduction: Basics of MATLAB -MATLAB windows – on line help - Input – Output, File types – Platform dependence – General commands.

Chapter 1 Section: 1.6

Unit – II

Interactive Computation: Matrices and Vectors – Matrix and Array operations – Character Strings – A special note on array operators – command line functions - Using Built-in Functions and On-line Help – Saving and loading data – Plotting simple graphs.

Chapter 3 Section: 3.1 to 3.8

Unit – III

Programming in MATLAB: Scripts and Functions – Script files – Functions files- Language specific features – Advanced Data objects.

Chapter 4 Section: 4.1 to 4.4

Unit – IV

Applications: Linear Algebra – Curve fitting and Interpolation – Data analysis and Statistics – Numerical Integration – Ordinary differential equations – Nonlinear Algebraic Equations.

Chapter 5 Section: 5.1 to 5.6

Unit – V

Graphics: Basic 2-D Plots – Using subplot to Layout multiple graphs - 3 – D Plots – Handle Graphics – Saving and printing Graphs – Errors.

Chapter 6 Section: 6.1 to 6.6 and 7

Text Book:

RUDRA PRATAP, **Getting Started with MATLAB** – A Quick Introduction for Scientistsand Engineers, Oxford University Press, 2003.

Reference Books:

1. William John Palm, Introduction to Matlab 7 for Engineers, McGraw-Hill Professional, 2005.
2. Dolores M. Etter, David C. Kuncicky , Introduction to MATLAB 7, Prentice Hall, 2004.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/103/106/103106118/
2	http://web4.cs.ucl.ac.uk/teaching/3085/archive/2010/matlab_tutorial/matlab_booklet.pdf
3	https://www.youtube.com/watch?v=zJm8VHg4TbQ

Course Outcomes:	
On the successful completion of the course, student will be able to:	
CO1	Understand the basic concepts of starting windows and solve the MATLAB applications.
CO2	Create arrays and solve them in MATLAB.
CO3	Solve problems using M files and apply the same for advanced data objects in MATLAB.
CO4	Understand the importance of MATLAB in differential equations and assess it for plotting graphs using layouts.
CO5	Diagnose various applications of MATLAB in curve fitting, statistics and Integration. How to answer the online Multiple Choice Questions.

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**9**	**6**	**9**	**3**	**9**	**6**	**9**
CO2	**6**	**9**	**6**	**6**	**6**	**9**	**6**
CO3	**6**	**6**	**9**	**9**	**9**	**9**	**6**
CO4	**9**	**6**	**6**	**3**	**6**	**6**	**9**
CO5	**9**	**6**	**6**	**9**	**6**	**9**	**6**

Level of correlation: 9 – High; 6 – Medium; 3 – Low; and 0- no correlation.