Post Graduate Program in Applied Mathematics(M.Sc,)

Course of Study, Schemes of Examinations & Syllabi
(Choice Based Credit System)

PG & Research Department of Mathematics

H.H. The Rajahs' College (Autonomous)

Re-Accredited with B^+ by NAAC

Pudukkottai- 622 001.

2021 – 2022

Post – Graduate Program in Applied Mathematics

Eligibility : An under graduate degree in Mathematics.

Preference : A high first class in Part III of the UG Curriculum.

Structure of the Curriculum

Parts of the Curriculum	No. of courses	Credits
Core	13	65
Elective	3	15
Project	1	05
EDC	1	05
Total	**18**	**90**

Learning Outcomes of Under-Graduate Program in Mathematics

General Outcomes	Specific Outcomes
On successful completion of the programme, the studentwill be 1. equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof. 2. prepare students for pursuing research or careers in industry in mathematical sciences and allied 3. continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences. 4. create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.	After the successful completion of the under-graduate programme in Mathematics, the student is expected to 1. understanding of the fundamental axioms in mathematics and capability of developing ideas based on them. 2. provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains. 3. provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions. 4. strong foundation on algebraic topology and representation theory which have strong links and application in theoretical physics, in particular string theory. 5. nurture problem solving skills, thinking, creativity through assignments, project work. 6. assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc..

M.Sc., Applied Mathematics

Sem.	Sub. Code	Course Title	Ins. Hrs. / Week	Credit	Exam Hrs	Marks		Total
						Int	Ex	
I	21PMAT1	Algebra	7	5	3 Hrs	25	75	100
	21PMAT2	Optimization Techniques	7	5	3 Hrs	25	75	100
	21PMAT3	Ordinary and Partial Differential Equations	7	5	3 Hrs	25	75	100
		Elective – 1	7	5	3 Hrs	25	75	100
II	21PMAT4	Real Analysis	6	5	3 Hrs	25	75	100
	21PMAT5	Graph Theory and Its Applications	6	5	3 Hrs	25	75	100
	21PMAT6	Numerical Analysis	6	5	3 Hrs	25	75	100
		Mathematical Software- I MATLAB- (Objective Type- EDC)	6	5	3 Hrs	25	75	100
		Elective – II	5	5	3 Hrs	25	75	100
III	21PMAT7	Complex analysis	6	5	3 Hrs	25	75	100
	21PMAT8	Applied Probability and Statistics	6	5	3 Hrs	25	75	100
	21PMAT9	Fuzzy Mathematics and Its Applications	6	5	3 Hrs	25	75	100
	21PMAT10	Mathematics Software – II Latex	6	5	3 Hrs	25	75	100
		Elective – III	6	5	3 Hrs	25	75	100
IV	21PMAT11	Discrete Mathematics	6	5	3 Hrs	25	75	100
	21PMAT12	Stochastic Process	6	5	3 Hrs	25	75	100
	21PMAT13	Bio Mathematics	6	5	3 Hrs	25	75	100
		Dissertation	12	5		25	75	100
		Total		90				1800

List of Electives

Course Title

Elective – I (Any one from the list)

- Classical Dynamics
- Differential Geometry
- Analytical Number Theory

Elective – II (Any one from the list)

- Topology
- Fluid Dynamics
- Probability & Queuing Theory

Elective - III (Any one from the list)

- Calculus of Variations & Integral Equations
- Functional Analysis
- Linear Algebra

EDC PAPER : MATLAB (Objective Type)

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
Chapter: 2 - Sections 2.5 - 2.7

Unit-II

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

Unit-III

Another counting principle - Sylow theorem - Direct products – Finite abelian groups
Chapter: 2 - Sections 2.11 - 2.13

Unit – IV

Vector Spaces : Elementary Basic Concepts – Linear Independence and Bases – Dual Spaces – Inner Product Spaces – Modules
Chapter : 4 Sections : 4.1 - 4.5

Unit – V

Linear Transformations: The algebra of Linear Transformations – Characteristic Roots – Martices – Canonical Forms – Nilpotent Transformation – Determinants – Hermitian , Unitary and Normal Transformations-
Chapter 6 : Sections – 6.1 to 6.6, 6.9 & 6.10

Text Book:

I.N.Herstein, "**Topics in Algebra**"- 2nd edition,, Wiley Eastern Ltd., New Delhi, 2017

Reference books:

1. M. Artin: Algebra, Prentice-Hall of India, 2015
2. N.Jacobson: Basic Algebra, Volumes I & II, W.H.Freeman, **2009**
3. S.Lang: Algebra, 3rd edition, Addison-Wesley, **2005**
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian edition, **2009**

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 completion of this course, the learners will

1. be able to understand the structure of finite abelian groups and their non-isomorphic copies.
2. be able to investigate the solvability of polynomials through Galois theory.
3. ability to understand counting principle and finite abelian group
4. facility in working with situations involving linear independence, basis and modules
5. simplify characteristic roots and determinants, hermitiants, unitary and normal transformations

Course Outcome Vs Program 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: 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:

S.S. Rao, Engineering Optimization **,** John Wiley and Sons, New York ,**1996**

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_2iUCG87Bq8RG MTdeFZ iB-87V4i9p1&index=28
3	https://www.youtube.com/watch?v=2aPlzhsEsIw
4	https://www.youtube.com/watch?v=PavZX3hAL6I

COURSE OUTCOMES

Upon completion of the subject, students will be able to

1. Explain the fundamental knowledge of Linear Programming and Dynamic Programming problems.

2. Use classical optimization techniques and numerical methods of optimization.

3. Describe the basics of different evolutionary algorithms.

4. Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas.

5. Explain the fundamental knowledge of Linear Programming and Dynamic Programming problems

Course Outcome Vs Program 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 : 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.

Unit- II

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

Unit- III

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

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.

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.

Text Book:

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

Unit I: 3.15, 3.16, 3.19, 5.26, 5.28
Unit II: 5.29, 6.32 to 6.35.
Unit III: 7.37, 7.38, 11.55 and 11.56

2. I.N. Snedden, "**Elements of Partial Differential Equations**", McGraw Hill, 1985.
Unit IV: 1.3 to 1.6, 2.4
Unit V: 2.5, 2.6, 2.9, 2.10, 2.13

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 outcome

1. Recall the types of general solution of the homogenous equation, power series solution, series solutions of first order equations and Regular singular point.
2. Analyze the legendre polynomials, properties of Legendre polynomial and Bessel Functions
3. Understand and solve the homogeneous equations with constant coefficient and Picard's theorem.
4. Comprehend the Orthogonal trajectories of a system of curves on a surface and solution of Pfaffian differential equations in three variables
5. Find the solution of integral surface passing through a given curve, Charpit's methods and Jacobi's Method.

Course Outcome Vs Program 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

ELECTIVE COURSE I: 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

Upon completion, successful students will be able to:

1. understand important topics of classical dynamics including relativity
2. further develop critical thinking and problem solving skills
3. conduct physics research on a better foundation
4. analyze those principles to the problems arising in practical situations.
5. understand and develop the Hamilton's Principal function and Hamilton Jacobi equation .

Course Outcome Vs Program 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.

MSc APPLIED MATHEMATICS

ELECTIVE COURSE I : DIFFERENTIAL GEOMETRY

OBJECTIVE:

1. This course gives students basic knowledge of classical differential geometry of curves and surfaces such as the catenary, the tractrix, the cycloid and the surfaces of constant Gaussian curvature and minimal surfaces. .

UNIT I: SPACE CURVES

Definition of a space curve – Arc length – Tangent – Normal and binormal – Curvature and torsion – Contact between curves and surfaces – Tangent surface – Involutes and evolutes – Intrinsic equations – Fundamental existence theorem for space curves – Helics.

Chapter 1: Sections 1.1- 1.9

UNIT II: INTRINSIC PROPERTIES OF A SURFACE

Definition of a surface – Curves on a surface – Surface of revolution – Helicoids – Metric – Direction coefficients – Families of curves – Isometric correspondence – Intrinsic properties.

Chapter 2: Sections : 2.1 - 2.9

UNIT III: GEODESICS

Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence theorems – Geodesic parallels – Geodesics curvature- Gauss-Bonnet Theorem – Gaussian curvature – Surface of constant curvature.

Chapter 2 : Sections 2,10 - 2.18

UNIT IV: NON INTRINSIC PROPERTIES OF A SURFACE

The second fundamental form – Principal curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface – Minimal surfaces – Ruled surfaces.

Chapter 3: Sections 3.1 - 3.8

UNIT V: DIFFERENTIAL GEOMETRY OF SURFACES

Compact surfaces whose points are umblics – Hilbert's lemma – Compact surface of constant curvature –Complete surface and their Characterization – Hilbert's Theorem – Conjugate points on geodesics.

Chapter 4: Sections 4.1 - 4.8

REFERENCE BOOKS:

1. T.J. Willmore, *"An Introduction to Differential Geometry"*, Oxford University press, (17th
Impression), New Delhi, 2002. (Indian Print)

Course outcome

At the end of this course the student will able to

1. decribe the concept of space curves,Arc length,Curvature and Torsion, Fundamental existence theorem for space curves.
2. gather the good knowledge about Intrinsic properties of a surface.
3. acquire the best knowledge about Geodesics curve ,properties and its theorems.
4. acquire the knowledge about Non intrinsic properties of a surface.
5. get good idea about differential Geometry of Surfaces, Hilbert's lemma, Complete surface and their Characterization,conjugate points on geodesics.

Course Outcome Vs Program 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 COURSE I : ANALYTICAL NUMBER THEORY

Objective:

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 $\mu(n)$ – The Euler totient function $\varphi(n)$– A relation connecting μ and φ - A product formula for $\varphi(n)$ – The Dirichlet product of arithmetical functions – Dirichlet inverses and the Mobius inversion formula – The Mangoldt function $\Lambda(n)$ – Multiplicative functions – Inverse of a completely multiplicative function.

Chaper 2 : Sections 2.1 - 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 $\sigma\_\alpha(n)$,$\varphi(n)$,$\mu(n)$ and $\Lambda(n)$

Chapter 3 : Sections 3.1 to 3.7; 3.9

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.

Chapter 5 : Sections 5.1 - 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.

Chapter 9 : Sections 9.1 - 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).

Chapter 14 : Sections 14.1 - 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 outcome

1. Find the arithmetical functions and Dirichlet Multiplication.
2. Understand the definitions of the averages of arithmetical function.
3. Analyze the concept of Congruences
4. Determine the quadratic residues and the quadratic reciprocity law
5. Acquire knowledge on partitions

Course Outcome Vs Program 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
CORE COURSE: REAL ANALYSIS

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

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- Summation by parts-Addittion and multiplication of series

Chapter 3

Unit-II

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- III

The Riemann-Stieltjes Integral: Definition and Existence of the Integral - Properties of the Integral - Integration and Differentiation

Chapter 6

Sequence and series of functions – Uniform convergence – Uniform convergence and continuity – Uniform convergence and integrations

Chapter 7

Unit- IV

The Real number system -Axioms for the real numbers- The extended real number system – sequence of real numbers

Chapter 2: 2.1 ,2.3,2.4

The Lebesgue Measure: Introduction – Outer measure – Measurable sets and Lebesgue measure – Measurable functions

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.

Text Book 2 Chapter 4 Section: 4.1 – 4.5

Text Book:

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.**

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 completion of this course, the learner will be able

1. to acquire an understanding of functions of several variables.
2. to apply the techniques used in Real and Complex Analysis in extending the results to 'n' dimensional space
3. to prove the results on mathematical analysis and to formulate precise mathematical arguments.
4. Apply the Riemann Stieltjes integral and bring its properties and rectifiable curves.
5. 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.

Course Outcome Vs Program 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: 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 (with proof) Edge chromatic number - Vizing's theorem (with proof)

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

After learning the course the students should be able to

1. Solve problems using basic graph theory
2. Identify induced subgraphs, cliques, matchings, covers in graphs
3. Determine whether graphs are Hamiltonian and/or Eulerian
4. Solve problems involving vertex and edge connectivity, planarity and crossing numbers
5. Solve problems involving vertex and edge coloring
6. Model real world problems using graph theory

Course Outcome Vs Program 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
CORE COURSE: NUMERICAL ANALYSIS

PREREQUISITE:

Basic Mathematics

OBJECTIVES

Prepare students to impart the knowledge of finding approximate solutions of polynomial, simultaneous algebraic equations, Interpolation, Differentiation and Integration, ODEs by various Numerical techniques. To motivate students how to solve mathematical modelling problems using Numerical analysis.

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 Section: 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 Section: 3.3 to 3.5

UNIT – III: Interpolation and Approximation:

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

Chapter 4 Section: 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

Chapter 5 Section: 5.2 to 5.5

UNIT – V: Ordinary Differential Equations:

Local truncation error – Euler, Backward Euler, Midpoint, Taylor's Method and second order Runge - Kutta method

Chapter 6 Section: 6.2 and 6.3

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.

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

Upon completion of this course the student will be able to

1. Solve Algebraic and Transcendental Equations by applying appropriate methods.
2. Find the approximate factors of degree one and two using appropriate methods.
3. Choose suitable method to find solution to the linear systems.
4. Find the approximate solution to the problems related to Interpolation, Differentiation and Integration.
5. Apply appropriate method to find the approximate solution to the ODE.

Course Outcome Vs Program 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

SEMESTER - II

EDC : MATLAB (Objective Type)

Objectives:

1. Understand the Matlab Desktop, Command window and the Graph Window.
2. Be able to carry out numerical computations and analyses.
3. Understand the mathematical concepts upon which numerical methods rely.

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:

1. 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:

- Understand the basic concepts of starting windows and solve the MATLAB applications.
- Create arrays and solve them in MATLAB.
- Solve problems using M files and apply the same for advanced data objects in MATLAB.
- Understand the importance of MATLAB in differential equations and assess it for plotting graphs using layouts.
- Diagnose various applications of MATLAB in curve fitting, statistics and integration. How to answer the online Multiple Choice Questions.

Course Outcome Vs Program 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.**

M.Sc. APPLIED MATHEMATICS
ELECTIVE COURSE II: TOPOLOGY

Objectives:

- To develop and understand Topological spaces including connectedness and compactness.
- To study the continuous functions on the topological spaces and study their homeomorphisms.
- To study regular second countable spaces which are metrizable.
- To be familiar with compactness.
- To understand countability axioms and normal spaces.

Unit - I: Topological spaces and continuous functions
Topological Spaces – Basis for a Topology – The Order Topology – The Product Topology on XxY – The Sub-space topology – Closed sets and limit points – Continuous functions
Chapter 2: Sec 12 - 18

Unit-II: Metric topology and Connectedness:
The Product topology – The Metric Topology - Connected spaces – Connected Subspaces of the Real line - Components and Local connectedness.
Chapter 2: Sec 19 -21 and **Chapter 3:** Sec 23-25

Unit-III: Compactness:
Compact Spaces – Compact subspaces of the real line – Limit point compactness
Chapter 3: Sec 26- 28

Unit -IV: Countability and Separation axioms:
The countability axioms - The separation axioms – Normal space.
Chapter 3: Sec 30- 32

Unit-V: Complete Metric Spaces
The Urysohn's Lemma – The Urysohn's Metrization theorem - Tietz Extension theorem
Chapter 4: Sec 33 - 35.

Text Book: James R. Munkres,"**Topology**"– second edition, Prentice Hall, New Delhi. (2009)

Reference Book:

1. J. Dugundgi, "**Toplogy"**, Allyn and Bacon, Boston, (1966)
2. Sze-Tsen Hu, Elements of General Topology, Holden-Day Series in Mathematics, 1964.

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:

1. Understanding metric spaces as a motivation to topology
2. Continuous functions and their properties in topological spaces
3. Understanding Basis as a collection of basic open sets
4. Understand compactness and connectedness in topological spaces
5. Understand separation axioms.
6. Problem solving techniques in topology
7. Advance concepts in topology
8. Sufficient conditions for metrizability of a topological space

Course Outcome Vs Program 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 COURSE – II : 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 - 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 - 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 - 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 - 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 - 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 Program 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

MSc APPLIED MATHEMATICS
ELECTIVE COURSE II: PROPBABILITY AND QUEUEING THEORY

Objectives:

To enable the students to acquire the knowledge of Probability and Queueing Theory

To make the students understand various characteristics of discrete and continuous statistical distributions with mathematical techniques

Unit: I PROBABILITY THEORY AND RANDOM VARIABLES

Definition and Laws of Probability-Random variables-need for random variables-types of random variables-Probability distribution Function- Probability Density Function – Expection and Moments- Important Inequalities of Expectation-Generating Functions-Moment Generating Function- Characteristic Function

Chapter : 1. 1.2 to 1.3,Chapter: 2. 2.1 to 2.9, .
P.Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.

Unit :II SOME PROBABILITY DISTRIBUTION FUNCTIONS

Introduction-Binomial Distribution-Negative Binomial Distribution-Geometric Distribution-Poisson Distribution-Gamma Distribution-Exponential Distribution-Weibull Distribution-Uniform Density Function- Normal Density Function.

Chapter :3 . 3.1 to 3.10, .
P**.**Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.

Unit :III TWO DIMENSIONAL RANDOM VARIABLES

Introduction-Joint Probability Distribution – Joint Cumulative Distribution Function – Marginal probability Distribution Function – Joint Probability Density Function – Marginal Probability Density Function – Statistical Properties of jointly Distributed Random Variables –Conditional Probability Distribution Function – Conditional Probability Density Function – Transformations of Random Variables – Central Limit Theorem – Correlation and Regression.

Chapter: 4 . 4.1 to 4.12, .
P.Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.

Unit IV: QUEUEING THEORY

Description of the Queueing Problem-Characteristics of Queueing Problem-Deterministic Queueing Models-poisson process and the Exponential Distribution-Markovian property of the Exponential Distribution-Single-Channel Exponential QUEUEING Models-steady state solution for the M/M/1 Model-Waiting time Distribution-Relation between Expected Queue length and Expected waitng Time-Little's Formula-Finite system Capacity-Queue with Truncation(M/M/1/K)-Transient Behavior-Busy period Analysis.

Chapter 1 : 1.1,1.2, 1.7 - 1.9
Chapter 2: 2.1,2.3 - 2,7)
Donald Gross &Carl m. Harris, Fundamentals of Queueing Theory

Unit V: SIMPLE MARKOVIAN BIRTH-DEATH QUEUEING MODELS

Birth –Death Processes-queue with Parallel Channels(M/M/C)-Queue with Parallel Channels and Truncation (M/M/C/K) –Erlang's Formula (M/M/c/c) –Queue with Unlimited Service (M/M/∞) –Finite state Queues –State Dependent Service- Queue with Impatience.
Chapter 3 : 3.1 - 3.8
Donald Gross &Carl m. Harris, Fundamentals of Queueing Theory

Text Books:

1. P.Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.
2. Donald Gross &Carl m. Harris, Fundamentals of Queueing Theory

Reference:

1. J.L.Devore, Probability and Statistics, 5th Edition, Thomson (2000).
2. R.A.Johnson, Miller & Freund's Probability and Statistics for Engineers, Seventh edition,
Pearson Education, New Delhi (2008).
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand &
Sons, 11th Edition, 2003.

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

At the end of the Course, the Students will able to

1. Describe the concepts of Random variables and Distribution Function with examples.
2. Evaluate Binomial, Poisson distributions, Normal distributions, Gamma and Exponential distribution ,Erlang Distribution,Weibull distribution ,Standard normal Distributions.
3. To describe the concept of queueing Theory, properties of queueing Theory and its Applications.

Course Outcome Vs Program 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: 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.

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(S)
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 completion of this course, the learner will
1. be able to comprehend the local and global properties of analytic functions.
2. know and understand harmonic functions and their basic properties.
3. be able to understand properties of entire functions.
4. Evaluate Chains and Cycles, Simple Connectivity, Homology and Evaluation of Definite Integrals.
5. Analyze Harmonic Functions, Schwarz's Theorem, Weierstrass's Theorem , the Taylor Series ,the and the Laurent Series.

Course Outcome Vs Program 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.

MSc APPLIED MATHEMATICS
CORE COURSE: APPLIED PROPBABILITY AND STATISTICS

Objectives:

To enable the students to acquire the knowledge of Probability and statistics
To make the students understand various characteristics of discrete and continuous statistical distributions with mathematical techniques
Course Outcome : At the end of the Course, the Students will able to
Describe the concepts of Random variables and Distribution Function with examples.
Evaluate Binomial, Poisson distributions, Analyze student's t-test, F-test and Chi-square test.
Analyze Randomized Block Design (RBD) and Latin Square Design (LSD).

Unit: I PROBABILITY THEORY AND RANDOM VARIABLES

Definition and Laws of Probability-Random variables-need for random variables-types of random variables-Probability distribution Function- Probability Density Function – Expection and Moments- Important Inequalities of Expectation-Generating Functions-Moment Generating Function- Characteristic Function

Chapter : 1: 1.2 to 1.3 ,Chapter: 2. 2.1 to 2.9 .
P.Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.

Unit :II SOME PROBABILITY DISTRIBUTION FUNCTIONS

Introduction-Binomial Distribution-Negative Binomial Distribution-Geometric Distribution-Poisson Distribution-Gamma Distribution-Exponential Distribution-Weibull Distribution-Uniform Density Function- Normal Density Function.

Chapter :3 . 3.1 to 3.10 . P.Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.

Unit :III TWO DIMENSIONAL RANDOM VARIABLES

Introduction-Joint Probability Distribution – Joint Cumulative Distribution Function – Marginal probability Distribution Function – Joint Probability Density Function – Marginal Probability Density Function – Statistical Properties of jointly Distributed Random Variables –Conditional Probability Distribution Function – Conditional Probability Density Function – Transformations of Random Variables – Central Limit Theorem – Correlation and Regression.

Chapter: 4 . 4.1 to 4.1. P.Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.

Unit IV: STATISTICAL INFERENCE-TESTS OF HYPOTHESIS

Estimation and procedure of testing of hypothesis - Large sample tests - Small sample tests -student's t-test - Chi-square test - Testing of mean, variance and proportions - independence of attributes and goodness of fit.

Chapter :3 S.P.GUPTA,Statistical methods, Sultan Chand &Sons Educational Publishers, New Delhi.

Unit V: F-TEST AND ANALYSIS OF VARIANCE

The F-Test or the Variance ratio- Test- Applications of F-Test-Analysis of Variance-Assumptions in Analysis of Variance-Technique of Analysis of variance - One way and two way classifications - completely Random Design (CRD)
- Randomized Block Design (RBD) - Latin Square Design (LSD).

Chapters : 5&6 S.P.GUPTA,Statistical methods, Sultan Chand &Sons Educational Publishers, New Delhi.

Text Books:

1. P.Kandasamy,K.Thilagavathi,K.Gunavathi, Probability Statistics and Queueing Theory S.CHAND & Company Ltd Ramnagar, New Delhi.
2. S.P.GUPTA,Statistical methods, Sultan Chand &Sons Educational Publishers, New Delhi.

Reference:

1. J.L.Devore, Probability and Statistics, 5th Edition, Thomson (2000).
2. R.A.Johnson, Miller & Freund's Probability and Statistics for Engineers, Seventh ed, Pearson Education, New Delhi (2008).
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 11th Edition, 2003.

Course Outcomes

At the end of the Course, the Students will able to

1. Describe the concepts of Random variables and Distribution Function with examples.
2. Evaluate Binomial, Poisson distributions, Analyze student's t-test, F-test and Chi-square test.
3. Analyze Randomized Block Design (RBD) and Latin Square Design (LSD).

Course Outcome Vs Program 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.

4.

M.Sc. APPLIED MATHEMATICS
CORE COURSE : FUZZY MATHEMATICSAND ITS APPLICATIONS

Objectives:

- To provide the knowledge of operations on fuzzy sets
- .To introduce the mathematical field on the concept of a fuzzy numbers
- To enable the students to develop fuzzy relations.
- To use direct methods with one expert and multiple experts.
- To know the applications of fuzzy methodology.

UNIT – I: Fuzzy sets: **(14 Hours)**
Basic types – Basic concepts – α-cuts – Additional properties of α-cuts – Extension principle for Fuzzy sets.

UNIT – II: Operations on Fuzzy sets: **(14 Hours)**
Types of operations – Fuzzy complements – t-Norms – Fuzzy Unions - Combinations of operations.

UNIT – III: Fuzzy Arithmetic and Fuzzy Relations **(15 Hours)**
Fuzzy numbers - Arithmetic operations on intervals – Arithmetic operations on Fuzzy numbers - Binary fuzzy relations – Fuzzy equivalence relations – Fuzzy compatibility relations - Fuzzy ordering relations - fuzzy morphisms

UNIT – IV: Constructing Fuzzy Sets and Operations on Fuzzy Sets **(15 Hours)**
General Discussion – Methods of Construction: An Overview – Direct Methods with One Expert – Direct Methods with Multiple Experts – Indirect Methods with one Expert – Indirect Methods with Multiple Experts - Constructions from Sample Data.

UNIT – V: Miscellaneous Applications **(14 Hours)**
Introduction – Medicine – Economics – Fuzzy Systems and Genetic Algorithms – Fuzzy Regression – Interpersonal Communication – Other Applications.

Text Book:

1. George J.Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 1995.

   UNIT I : Chap. 1 Sec. 1.3 to 1.4 and Chap. 2 Sec. 2.1, 2.3
   UNIT II : Chap. 3 Sec. 3.1 to 3.5
   UNIT III: Chap. 4 Sec. 4.1, 4.3 to 4.4 and Chap. 5 Sec: 5.3, 5.5 to 5.8
   UNIT IV: Chap. 10 Sec. 10.1 to 10.7
   UNIT V : Chap. 17 Sec. 17.1 to 17.6

Reference Books:

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited, New Delhi, 1991.

Outcomes:
The learners would have the ability to

1. Discuss the Basic types and operations on fuzzy sets,
2. t- norms and fuzzy arithmetic.
3. Identify fuzzy relations, binary fuzzy relations and fuzzy equivalence relations.
4. Gain the knowledge of constructing fuzzy sets and operations on fuzzy sets.
5. Apply the fuzzy models to natural science and technical fields.

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/

Outcomes:
The learners would have the ability to

6. discuss the Basic types and operations on fuzzy sets,
7. t- norms and fuzzy arithmetic.
8. Identify fuzzy relations, binary fuzzy relations and fuzzy equivalence relations.
9. gain the knowledge of constructing fuzzy sets and operations on fuzzy sets.
10. apply the fuzzy models to natural science and technical fields.

Course Outcome Vs Program 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

CORE COURSE :Mathematical Software: LATEX

PREREQUISITE:

Basic Mathematics and Programming Knowledge

SUBJECT OBJECTIVES:

Prepare students to impart the knowledge of mathematical software and made them to prepare mathematical documents / their projects using this software.

LEARNING OUTCOMES:

Upon completion of this course the student will be able to

6. Understand the mathematical software / tool Latex and its procedures.
7. Understand the Latex environment and its arguments and commands.
8. Prepare a document by applying the commands of Latex.
9. Prepare the text alignments and able to draw tables and boxes by applying Latex commands.
10. Understand mathematical environment and commands to prepare a documents contains mathematical equations and symbols by applying the commands.

Unit I: Introduction:

Just What is LATEX? – Markup Languages - TEX and its offspring, Basics of a LATEX file – TEX Processing Procedure.

Chapter 1: Sections: 1.1-1.3, 1.5 - 1.6.

Unit II: Text, Symbols, Commands:

Command names and arguments – Environments – declarations – Lengths - Special Characters - Exercises.

Chapter 2: Sections: 2.1 – 2.6.

Unit III: Document Layout and Organization:

Document class - Page style - Parts of the document - Table of contents.

Chapter 3: Sections: 3.1 – 3.4, 4.1 – 4.7.

Unit IV: Displayed Text:

Changing font - Centering and indenting – lists - generalized lists - Theorem-like declarations - Tabulator stops – Boxes – Tables - Printing literal text, Footnotes and marginal notes – Comments within text.

Chapter 4: Sections: 4.1 – 4.11.

Unit V: Mathematical Formulas

Mathematical environments - Main elements of math mode - Mathematical symbols - Additional elements - Fine-tuning mathematics - Beyond standard Latex.

Chapter 5: Sections: 5.1 – 5.6.

Text Book:

1. **A guide to LATEX and Electronic Publishing by H. Kopka and P.W. Daly**, Fourth Edition, Addison – Wesley, London, 2003. (https://www2.mps.mpg.de/homes/daly/GTL/gtl_20030512.pdf)

Course Outcomes

On the successful completion of the course, student will be able to:

- understand the basic concepts of starting windows and solve the Latex software
- understand command names and special characters and solve them in Latex.
- document class and table of content
- understand the changing fonts, boxes and comments within text
- diagnose various applications of mathematical environment fine tuning mathematics beyond the standard latex

Course Outcome Vs Program 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
ELECTIVE COURSE III : 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 Program 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
ELECTIVE COURSE III : FUNCTIONAL ANALYSIS

Objectives:

1. This course introduces functional analysis and operator theoretic concepts.
2. This area combines ideas from linear algebra and analysis in order to handle infinite-dimensional vector spaces and linear mappings thereof.
3.This course provides an introduction to the basic concepts which are crucial in the modern study of partial differential equations, Fourier analysis, quantum mechanics, applied probability and many other fields.

UNIT I: BANACH SPACES

Banach spaces - Definition and examples - Continuous Linear Transformations – Hahn Banach Theorem.

Chapter 9: Sections 46 - 48

UNIT II: BANACH SPACES AND HILBERT SPACES

The natural embedding of N in N** - Open mapping theorem - Conjugate of an operator – Hilbert space - Definition and properties.
Chapter 9: Sections 49 - 51; **Chapter 10**: Sections 52.

UNIT III: HILBERT SPACE

Orthogonal complements - Orthonormal sets - Conjugate space H* - Adjoint of an operator.
Chapter 10: Sections 53 - 56

UNIT IV: OPERATIONS ON HILBERT SPACES

Self - adjoint operator - Normal and Unitary Operators – Projections.
Chapter 12: Sections 57 - 59

UNIT V: BANACH ALGEBRAS

Banach Algebras - Definition and examples - Regular and single elements – Topological divisors of zero - spectrum - the formula for the spectral radius - the radical and semi-simplicity.
Chapter 12: Sections 64 - 69

TEXT BOOK(S)

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 outcome

1. understand the concepts of banach spaces and continuous linear transformations
2. describe the concept of definition, properties of a Hilbert space
3. know about the concepts of orthogonal complements and adjoint of an operator
4. Know about the General Preliminaries on self adjoint operator and projections
5. Describe the clear cut idea about the regular and single element and topological divisors of zero

Course Outcome Vs Program 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

ELECTIVE COURSE I : 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 outcome

1. Understand the basic concepts of Vector Spaces and Modules.
2. Explain about the Linear transformations and Invariant subspaces and Matrices.
3. Understand the basic concepts of Reduction to triangular forms, Nilpotent transformations
4. Recognize the concepts of Jordan forms, and transpose and Determinants.
5. Analyze Hermitian, Unitary and Normal transformations

Course Outcome Vs Program 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: DISCRETE MATHEMATICS

PREREQUISITE:

Basic abstract Algebra

SUBJECT OBJECTIVES:

Prepare students to develop mathematical foundations to understand and create mathematical arguments. To motivate students how to solve practical problems using Discrete mathematics.

Unit I: Computability and Formal Languages:

Principle of Inclusion and Exclusion - Mathematical Induction – Proposition – Logical Connectives – Conditional and biconditionals – well-formed formulas – Tautologies – Logical equivalences – Theory of inference for statement calculus – Predicate Calculus – The statement function, variable and quantifiers – Free and Bound variables – Inference theory of Predicate Calculus – Methods of Proof

Chapter 1 Section: 1.5 & 1.7 to 1.19

Unit II: 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 2 Section: 2.1 to 2.5, 2.7 and 2.8

Unit III: Discrete Numeric functions and Generating functions:

Introduction – Manipulation of numeric functions - examples– Generating functions – Definition and Examples.

Chapter 8 Section: 8.1, 8.2, 8.4 and 8.5.

Unit IV: Recurrence Relations and Recursive Algorithms:

Introduction – Recurrence relations – Linear recurrence relation with constant coefficients – Homogenous solutions – Particular solutions – Total solutions

Chapter 9 Section: 9.1 to 9.7

Unit V: Boolean Algebras

Lattices and Algebraic systems – Principle of Duality – Basic Properties of Algebraic systems defined by Lattices – Distributive and Complemented Lattices – Boolean Lattices and Boolean Algebras – Uniqueness of finite Boolean Algebras – Boolean functions and Boolean expressions – Normal forms.

Chapter 11 Section: 11.1 to 11.9

Text Book:

C. L. Liu and D. P. Mohapatra, "**Elements of Discrete Mathematics",** Fourth edition, Tata McGraw-Hill Education Private Limited, New Delhi 2013.

Reference Books:

J.P.Tremblay and R.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

Upon completion of this course the student will be able to

1. Construct mathematical arguments using mathematical induction and Principle of inclusion and exclusion.
2. Understand the types of grammars and Languages in the algorithm-based mathematics.
3. Gather the enumerators for permutation aspects in combinatorial theory and basic ideas of probability.
4. Learn how to work with some of the discrete structures which includes recurrence relations, discrete functions, generating functions and recursive algorithms.
5. Understand how Boolean algebra can be used as a tool and mathematical model in the study of networks.

Course Outcome Vs Program 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
CORE COURSE: STOCHASTIC PROCESSES

Objectives:

- To understand the stochastic models for many real life probabilistic situations.
- To learn the well known about Markov processes Wiener process and Kolmogorov equationmodels 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 IV Section: 4.1 to 4.5

UNIT IV

Markov processes with continuous state space: Introduction – Brownion motion- Wiener process – Differential equations for a Wiener process – Kolmogorov equation – First passage time distribution for Wiener process

Chapter V 5.1 to 5.5

UNIT V

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

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 outcome

At the end of the course the students will able to

1. describe stochastic processes, Markov processes,Poisson processes and iits generalisation.
2. gather the knowledge about Wiener process and its Applications.
3. to acquire the the knowledge about Brownion motion,differential equations for a wiener process,and Kolmogorov equation.
4. to acquire the Knowledge about Renewal processes, Wald's equation, renewal theorems and its Applications.
5. to understand the concept of renewal process and its applications

Course Outcome Vs Program 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: NUMBER THEORY AND CRYPTOGRAPHY

Objectives:

1. This course gives an introduction to mathematical modelling and data analysis for biological and biomedical systems. Examples include: the formation of animal coat patterns, the spread of diseases through the community, the interaction between pathogens and the immune system of the body, the growth of tumours, nerve cell signalling, population dynamics, pharmacokinetics and bacterial growth.
2. The emphasis in this course is on the development of the governing model equations and on computer simulations of the model equations rather than on mathematical methods for solving the model equation

Unit 1:

Micribial population models: Importance of microbial kinetics – Microbial growth in a chemist at – Stability of steady states for chemist at- Growth of microbial populations – Product formation due to microbial action – Competition for a growth – Rate limiting – substrate in a chemostate

Chapter 2 : Sections 2.1 – 2.6

Unit 2:

Models in Genetics : Basic model for inheritance – Further discussion of basic model for inheritance of genetic

Chapter 9 : Sections 9.1 – 9.2

Unit 3:

Models in Genetic: Models of genetic improvement – selection and mutation – models for genetic inbreeding

Chapter 9 : Sections 9.3 – 9.4(Omit 9.4.4)

Unit 4:

Mathematical models in pharamacokinetics : Basic equations and their solutions – solutions for special cases – determination of transfor co-efficients and compartment volumes – mathematical techniques used in compartment analysis – stochastic compartment models

Chapter 10

Unit 5:

Optimization models in biology and medicine: Some simple optimization models – optimization models for blood testing and patient care – models for optimal control of water pollution control – other optimal pollution control models

Chapter 14

Text Book:

1. Mathematical models in Biology and Medicine, By JN Kapur , 1 January 2008

Course outcome

- Understand the foundations of microbial population models
- Be able to perform basic models in genetics
- Be able to read and understand the models in genetics
- Be able to write and understand Mathematical models in pharamacokinetics
- Develop and maintain problem-solving skills in Optimization models in biology and medicine

Course Outcome Vs Program Outcome

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

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