KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION
(DEEMED TO BE UNIVERSITY)
(Under Section 3 of the UGC Act 1956)
Anand Nagar, Krishnankoil - 626126
Srivilliputtur(via), Virudhunagar(Dt.), Tamil Nadu, INDIA

M.Sc. (Mathematics)

(Master of Science)

CURRICULUM AND SYLLABUS - 2018

DEPARTMENT OF MATHEMATICS
SCHOOL OF ADVANCED SCIENCES

M.Sc. (MATHEMATICS) PROGRAMME

(offered from July 2015 onwards)

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION
(Deemed to be University)
ANAND NAGAR, KRISHNANKOIL – 626 126
DEPARTMENT OF MATHEMATICS

VISION OF THE UNIVERSITY

- To be a Centre of Excellence of International repute in education and research.

MISSION OF THE UNIVERSITY

- To produce technically competent, socially committed technocrats and administrators through quality education and research.

VISION OF THE DEPARTMENT

- To be a global centre of excellence in mathematics for the growth of science and technology.

MISSION OF THE DEPARTMENT

- To provide quality education and research in Mathematics through updated curriculum, effective teaching learning process.
- To inculcate innovative skills, team-work, ethical practices among students so as to meet societal expectations

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DEPARTMENT OF MATHEMATICS

PROGRAMME EDUCATIONAL OBJECTIVES (PEO) FOR M.Sc. (MATHEMATICS)

PEO1: Technical Proficiency:

- Victorious in getting employment in different areas, such as, industries, laboratories, educational, research institutions since the impact of the subject concerned is very wide.

PEO2: Professional Growth:

- Keep on discovering new avenues in the chosen field and exploring areas that remain conducive for research and development.

PEO3: Management Skills:

- Encourage personality development skills like time management, crisis management, stress interviews and working as a team.

PROGRAMME OUTCOMES (PO) FOR M.Sc. MATHEMATICS:

POs describe what students are expected to know or be able to do by the time of graduation. The Program Outcomes of PG in Mathematics are:

At the end of the programme, the students will be able to:

1. Apply knowledge of Mathematics, in all the fields of learning including research and its extensions.
2. Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.
3. To solve one dimensional Wave and Heat equations employing the methods in Partial Differential equations.
4. Utilize Number Theory in the field of Cryptography that helps in hiding information and maintaining secrecy in Military information transmission, computer password and electronic commerce.
5. Facilitate in the study of crystallographic groups in chemistry and Lie symmetry groups in physics.

6. Demonstrate risk assessment in Financial markets, Disease spread in Biology and Punnett squares in Ecology.
7. Identify Simulation of ground freezing and water evaporation, Heat transfer analysis due to solar radiation, Calculation of temperatures and heat flow under steady-state or transient boundary conditions.
8. Explain the knowledge of contemporary issues in the field of Mathematics and applied sciences.
9. Work effectively as an individual, and also as a member or leader in multi-linguistic and multi-disciplinary teams.
10. Adjust themselves completely to the demands of the growing field of Mathematics by life-long learning.
11. Effectively communicate about their field of expertise on their activities, with their peer and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations
12. Crack lectureship and fellowship exams approved by UGC like CSIR – NET and SET.

FIRST YEAR

I Semester

Course Code	Course Name	Course Type	L	T	P	C
MAT18R4021	Groups and Rings	T	5	1	0	4
MAT18R4022	Real Analysis - I	T	5	1	0	4
MAT18R4023	Number Theory	T	5	1	0	4
MAT18R40**	Elective - 1	T	5	1	0	4
MAT18R40**	Elective - 2	T	5	1	0	4
MAT18R4083	Seminar and Comprehensive Viva	Viva	1	0	0	2
		TOTAL	**26**	**5**	**0**	**22**

II Semester

Course Code	Course Name	Course Type	L	T	P	C
MAT18R4024	Linear Algebra	T	5	1	0	4
MAT18R4025	Real Analysis - II	T	5	1	0	4
MAT18R4026	Complex Analysis	T	5	1	0	4

MAT18R40**	Elective - 3	T	5	1	0	4
MAT18R40**	Elective - 4	T	5	1	0	4
MAT18R4084	Seminar and Comprehensive Viva	Viva	1	0	0	2
MAT18R4061	Skill Development Course	TP	-	-	-	2
		TOTAL	**27**	**5**	**1**	**24**

SECOND YEAR

III Semester

Course Code	Course Name	Course Type	L	T	P	C
MAT18R5021	Fields and Lattices	T	5	1	0	4
MAT18R5022	Measure Theory	T	5	1	0	4
MAT18R5023	Topology	T	5	1	0	4
MAT18R50**	Elective – 5 †	T	5	1	0	4
MAT18R50**	Elective – 6 †	T	5	1	0	4
MAT18R5082	Seminar and Comprehensive Viva	Viva	1	0	0	2
MAT18R5041	Research Methodology	T	2	0	0	2

MAT18R5051	Project (Phase-I)	Project	-	-	-	2
	TOTAL		**26**	**5**	**0**	**26**

† If a candidate clears NPTEL / ONLINE course(s) (not studied in the regular programme), then he / she may be exempted from appearing for Elective(s).

IV Semester

Course Code	**Course Name**	**Course Type**	**L**	**T**	**P**	**C**
MAT18R5024	Functional Analysis	T	5	1	0	4
MAT18R5025	Numerical Analysis	TP	3	1	2	4
MAT18R5026	Statistics	T	5	1	0	4
PHY18R5052	Project and Viva Voce (Phase-II)	Project	-	-	-	6
	TOTAL		**13**	**3**	**2**	**18**

ELECTIVES

Electives for Semester I

Course Code	**Course Name**	**Course Type**	**L**	**T**	**P**	**C**
MAT18R4031	Differential Equations	T	5	1	0	4
MAT18R4032	Graph Theory	T	5	1	0	4

MAT18R4033	Coding Theory	T	5	1	0	4
MAT18R4034	Design Theory	T	5	1	0	4

Electives for Semester - II

Course Code	Course Name	Course Type	L	T	P	C
MAT18R4035	Mechanics	T	5	1	0	4
MAT18R4036	Graph Algorithms	T	5	1	0	4
MAT18R4037	Calculus of Variations and Integral Equations	T	5	1	0	4
MAT18R4038	Programming in C++	TP	5	1	0	4

Electives for Semester - III

Course Code	Course Name	Course Type	L	T	P	C
MAT18R5031	Combinatorial Theory	T	5	1	0	4
MAT18R5032	Operations Research	T	5	1	0	4
MAT18R5033	Differential Geometry	T	5	1	0	4
MAT18R5034	Cryptography	T	5	1	0	4

T – Theory, TP – Theroy with practical.

Non-CGPA Courses

(The candidate has to clear any one of the following Items in the Table given below)

Sl. No.	Course Code	Course	Credit
1	XXXX*	NET/SET/GATE etc. coaching classes (spread over a period of first three semesters) Note: Minimum attendance is 80%. Exam will be conducted by the department at the end of the third semester. 30% Weightage for attendance 70 % Weightage for Exam.	2
2	XXXX	Paper presentation in National/International Conferences/Seminars	2
3	XXXX	Participation in workshops (at least 3 days) or participation in Guest Lecture (at least 5 Nos.)	2
4	XXXX	Internship programme at recognized (National / International) Institutions of repute.	2
5	XXXX	Foreign Language/National Language	2

*80% attendance is compulsory in this category even if the student earns Non-CGPA credit under Items 2,3,4 and 5 above.

Consolidated Credits

Semester	Credits
I – Semester	22
II – Semester	24
III – Semester	26
IV – Semester	18
Non-CGPA	2
Total Credits	92

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DEPARTMENT OF MATHEMATICS

Course Name and Course code	**GROUPS AND RINGS/ MAT18R4021**
Programme	**M.Sc. MATHEMATICS**
Semester	**I**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

The objective is to enable the students to understand the basic concepts, such as normal subgroup, group homomorphism, automorphisms of groups, Sylow's theorem. Further the student will understand the basic concepts of ring theory, such as Euclidean rings, Polynomial rings.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Identify the concept of Normal groups and Quotients groups.
2. Analyze Permutation groups and Counting principle.
3. Explain Sylow's theorem and its applications.
4. Provide information on ideals and Quotient rings, Field of Quotient of an integral domain.
5. Concentrate on a particular Euclidean ring and other forms of Polynomial rings.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3					M							
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Normal subgroups and Quotient groups
Normal subgroups and Quotient groups - Homomorphisms - Automorphisms.

Unit II - Permutation groups
Cayley's Theorem - Permutation groups - Another counting Principle.

Unit III - Sylow's Theorem and Direct Products
Sylow's Theorem - Direct products.

Unit IV - Basics of Rings
Ideals and Quotient Rings - More Ideals and Quotient Rings - Field of Quotients of an Integral Domain - Euclidean Rings.

Unit V - Euclidean rings and Polynomial rings
A particular Euclidean Ring - Polynomial Rings - Polynomials Over the Rational Field.

Text Book : I. N. Herstein, Topics in Algebra, Second Edition, Wiley Eastern Edition, New Delhi, 2015.

Contents : Unit I: Chapter 2, Sections 2.6 to 2.8.
Unit II: Chapter 2, Sections 2.9 to 2.11
Unit III: Chapter 2, Sections 2.12 and 2.13
Unit IV: Chapter 3, Sections 3.4 to 3.7
Unit V: Chapter 3, Sections 3.8 to 3.10

References :

1) D. S. Dummit and R. M. Foote, Abstract Algebra, Wiley 2004.
2) Hall, Marshal, Theory of Groups, Macmillan, New York, 1961.
3) John B Fraleigh, A First Course in Abstract Algebra, Pearson Education India, 2003.
4) Jacobson, Nathan, Basic Algebra, Vol.1, Hindustan Publishing Corporation, 1991.

Course Name and Course code	**REAL ANALYSIS – I / MAT18R4022**
Programme	**M.Sc. MATHEMATICS**
Semester	**I**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

The objective is to enable the students to understand the ideas of basic topology, sequences and series, continuity and differentiability.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the concepts of Archimedean property, Perfect sets and Connected sets.
2. Understand the concepts of convergence of sequences and series.
3. Test the convergence of the series.
4. Enumerate the limits of functions, infinite limits and limit at infinity.
5. Understand and analyze the Mean value theorem and Taylor's theorem.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2		M										
CO3								M				
CO4										S		
CO5											M	

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Basic Topology
Real number System as a Complete Ordered Field - Archimedean Property - Supremum and Infimum - Finite, Countable and Uncountable Sets - Metric Spaces - Compact Sets - Perfect Sets and Connected Sets.

Unit II - Sequences and Series
Convergent Sequences - Subsequences - Cauchy Sequenes - Upper and Lower Limits - Some Special Sequences - Series - Series of Nonnegative Terms.

Unit III – Convergence of series
The Number *e* - The Root and Ratio Tests - Power Series- Summation by Parts - Absolute Convergence - Addition and Multiplication of Series - Rearrangements.

Unit IV – Continuity
Limits of Functions - Continuous Functions - Continuity and Compactness - Continuity and Connectedness - Discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity.

Unit V – Differentiability
The Derivative of a Real Function - Mean Value Theorems - The Continuity of Derivatives - L'Hospital'sRule - Derivatives of Higher Order - Taylor's Theorem - Differentiation of vector valued functions.

Text Book: Walter Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill, 2015.

Contents: Chapters 2, 3, 4and 5 Full.

References:
1) Tom M Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, 1985.
2) Tom M Apostol, Calculus Volume I, Second Edition, Wiley Student Edition, New Delhi, 2009.
3) Tom M Apostol, Calculus Volume II, Second Edition, Wiley Student Edition, New Delhi, 2007.
4) Richard R Goldberg, Methods of Real Analysis, Blaisdell Publishing Company, 2009.
5) S. C. Malik and S. Arora, Mathematical Analysis, Second Edition, New Age International, 2016.

Course Name and Course code	**NUMBER THEORY/ MAT18R4023**
Programme	**M.Sc. MATHEMATICS**
Semester	**I**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

The objective is to enable the students to understand the concepts of congruences, quadratic reciprocity and functions of number theory and apply them at appropriate places.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the concepts of divisibility and Primes.
2. Solve congruences.
3. Describe power residue, multiplicative groups.
4. Discuss Quadratic residues and Jocobi symbol.
5. Study greatest integer function and recurrence functions.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3				M								
CO4								S				
CO5											S	

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Divisibility

Divisibility – Division algorithms – Euclidean algorithm – Primes – Euclid's Lemma.

Unit II - Congruences

Congruences - Solutions of Congruences - Congruences of Degree 1 - The Function $\varphi(n)$- Congruences of Higher Degree - Prime Power Moduli.

Unit III - Congruences with Prime Modulus

Prime Modulus - Congruences of Degree Two, Prime Modulus - Power Residues.

Unit IV - Quadratic Reciprocity

Quadratic Residues - Quadratic Reciprocity - The Jacobi Symbol.

Unit V - Some Functions of Number Theory

Greatest Integer Function - Arithmetic Functions - The M*ö*bius Inversion Formula - The Multiplication of Arithmetic Functions - Recurrence Functions.

Text Book :I. Niven and H.S. Zuckerman, An Introduction to the Theory of Numbers, Wiley Eastern Limited, New Delhi, 1976.

Contents : Unit I: Chapter 1, Sections 1.1 to 1.3
Unit II: Chapter 2, Sections 2.1 to 2.6
Unit III: Chapter 2, Sections 2.7 to 2.9
Unit IV: Chapter 3, Sections 3.1 to 3.3
Unit V: Chapter 4, Sections 4.1 to 4.5

References :

1) Tom M. Apostol, Introduction to Analytic Number Theory, Springer Science & Business Media,1998.
2) David M. Burton, Elementary Number Theory, Tata McGraw-Hill Education, 2006.

Course Name and Course code	**DIFFERENTIAL EQUATIONS/ MAT18R4031**
Programme	**M.Sc. MATHEMATICS**
Semester	**I**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to solve linear equations with variable coefficients. Further they will able to solve problems on partial differential equations of first and second order.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Obtain solutions of the Homogenious equation with constant co-efficient and Homogenious equation with analytic co-efficient.
2. Comprehend the Euler equations, the Bessel equation and Regular singular points at infinity.
3. Solve ordinary differential equations with more than two variables.
4. Solve first order partial differential equations using Charpit’s method.
5. Identify the second order equations and solve them using separation of variable method.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3										S		
CO4											M	
CO5												M

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Linear Equations with Variable Co-efficients
Initial value problems for the homogeneous equation - Solutions of the homogeneous equation – The Wronskian and linear independence - Reduction of the order of a homogeneous equation - The nonhomogeneous equation - Homogeneous equations with analytic coefficients - The Legendre equation.

Unit II - Linear Equations with Regular Singular Points
The Euler equation - Second order equations with regular singular points - (an example) - Second order equations with regular singular points - (the general case) - The Bessel equation - Regular singular points at infinity

Unit III - Ordinary Differential Equations in more than two variables
Surfaces and Curves in Three Dimensions - Simultaneous Differential Equations of the First Order and First Degree in Three Variables - Methods of Solution of $dx/P = dy/Q = dz/R$ - Pfaffian Differential Forms and Equations.

Unit IV - Partial Differential Equations of the First order
Origins of First-order Partial Differential Equations - Linear Equations of the First Order - Compatible Systems of First-order Equations - Charpit’s Method - Special Types of First-order Equations.

Unit V - Partial Differential Equations of the second order
The Origin of Second-order Equations - Linear Partial Differential Equations with Constant Coefficients - Equations with Variable Coefficients - Characteristics of Equations in Three Variables - Separation of Variables.

Text Book:
1) Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall

of India Private Ltd., New Delhi, 1991 .
2) Ian N. Sneddon, Elements of Partial Differential Equations, Dover Publications, Inc. Mineola, New York, 2006.

Contents:
Unit I: Chapter 3, Sections 1 to 8. (Text book 1)
Unit II: Chapter 4, Sections 1 to 9 (Except 5 and 6) (Text book 1)
Unit III: Chapter 1, Sections 1, 2, 3, 5 (Text book 2)
Unit IV: Chapter 2, Sections 1, 2, 4, 9, 10, 11 (Text book 2)
Unit V: Chapter 3, Sections 1, 4, 5, 7, 9. (Text book 2)

References :
1) George F Simmons, Differential equations with applications and historical notes, Tata McGrawHill, New Delhi, 1974.
2) M.D. Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd. New Delhi, 2001.

Course Name and Course code	**GRAPH THEORY/ MAT18R4032**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will enable to understand the elementary concepts of graphs such as, trees, connectivity, Eulerian graphs, Hamiltonian graphs, matchings, colorings, planarity.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the concepts namely, cut vertex, bridge, blocks and automorphism group of a graph.
2. Study the properties of trees and connectivity.
3. Identify Eulerian graphs and Hamiltonial graphs.
4. Understand the concepts Planarity including Euler identity.
5. Discuss and identify matchings and colorings in graphs.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2		M										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I : Elementary Concepts of Graphs and Digraphs
Graphs - Degree sequences - Connected graphs and Distance -Digraphs and Multigraphs - Cut vertices - Bridges - Blocks - Automorphism group of a graph.

Unit II : Trees and Connectivity
Properties of Trees - Connectivity - Edge connectivity - Strong Digraphs.

Unit III : Eulerian and Hamiltonian Graphs
Eulerian Graphs and Digraphs - Hamiltonian Graphs and Digraphs.

Unit IV : Planar Graphs
The Euler Identity - Characterization of Planar Graphs (statement only)

Unit V :Matchings and Colorings
Matchings and Independence in Graphs - Vertex Colorings.

Text Book:
G. Chartrand and L. Lesniak, Graphs and Digraphs, Chapman and Hall, CRC, fourth edition, 2005.

Contents : Unit I: Chapter 1 and 2, Sections 1.1 to 1.4 and 2.1 to 2.2
Unit II: Chapter 3 and 5, Sections 3.1, 3.3 and 5.1
Unit III: Chapter 4, Sections 4.1 and 4.2
Unit IV: Chapter 6, Sections 6.1 and 6.2
Unit V: Chapter 8 and 9, Sections 8.1 and 9.1

References :
1) J.A.Bondy and U.S.R. Murty, Graph Theory and Applications, Macmillan, London, 1976.
2) S. Arumugam and S. Ramachandran, Invitation to Graph Theory, Scitech Publication Pvt Ltd,

India, 2006.
3) J.Clark and D.A.Holton , A First look at Graph Theory, Allied Publishers, New Delhi, 1995.
4) R. Balakrishnan and K. Ranganathan, A Text Book of Graph Theory, Springer, Second Edition, 2012.

Course Name and Course code	**CODING THEORY / MAT18R4033**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will enable to understand the basic concepts coding theory such as, Perfect Codes, Hamming Codes, Sphere-Packing Bound, General Facts, Self-Dual Codes, the Golay Codes, Cyclic Codes, Quadratic Residue (*Q.R.*) Codes.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the concept of Maximum-Likelihood Decoding and Syndrome Decoding.
2. Analyze Double Error-Correcting B.C.H. code.
3. Understand Cyclic Codes.
4. Apply Quadratic Residue (*Q.R.*) Codes.
5. Study the concept of Bose-Chaudhuri-Hocquenghem (*B.C.H.*) Codes and Weight distributions.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3				M								
CO4							M				L	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Introductory concepts and Background

Introduction - Basic Definitions - Weight, Minimum Weight and Maximum-Likelihood Decoding - Syndrome Decoding - Perfect Codes, Hamming Codes, Sphere-Packing Bound -General Facts - Self-Dual Codes, the Golay Codes.

Unit II - Double Error-Correcting B.C.H. code and Finite Fields Polynomials

A Finite Field of 16 Elements - The Double-Error-Correcting Bose-Chaudhuri-Hocquenhem (B.C.H.) Code Problems - Groups - The Structure of a Finite Field - Minimal Polynomials - Factoring $x^n - 1$.

Unit III - Cyclic Codes

The Origin and Definition of Cyclic Codes - How to Find Cyclic Codes: The Generator Polynomial - The Generator Polynomial of the Dual Code - Idempotents and Minimal Ideals for Binary Cyclic Codes Problems.

Unit IV - The Group of a code and Quadratic Residue (*Q.R.*) Codes

Some Cyclic Codes We Know - Permutation Groups - The Group of a Code - Definition of Quadratic Residue (*Q.R.*) Codes - Extended Q. R. Codes, Square Root Bound and Groups of *Q.R.* Codes - Permutation Decoding.

Unit V - Bose-Chaudhuri-Hocquenghem (*B.C.H.*) Codes and Weight distributions

Cyclic Codes Given in Terms of Roots - Vandermonde Determinants - Definition and Properties of *B.C.H.* Codes - Preliminary Concepts and a Theorem on Weights in Homogeneous Codes - The MacWilliams Equations - Pless Power Moments - Gleason Polynomials.

Text Book: Vera Pless, Introduction to the Theory of Error-Correcting Codes, John Wiley & Sons, New York, 1982.

Contents: Unit I: Chapters 1 and 2 (Full)

Unit II: Chapters 3 and 4 (Full)

Unit III: Chapters 5 (Full)

Unit IV: Chapter 6 (Full)

Unit V: Chapter 7 and 8 (Full)

References :

1) I.F. Blake and R.C. Mullin, Introduction to Algebraic and Combinatorial Coding Theory, Academic Press, INC, New York, 1977.

2) F.J. MacWilliams and N.J.A. Sloane, The Theory of Error-Correcting Codes, Vols. I and II, North-Holland, Amsterdam, 1977.

Course Name and Course code	**DESIGN THEORY / MAT18R4034**
Programme	**M.Sc. MATHEMATICS**
Semester	**I**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be able to identify and analyze the basic concepts of balanced designs, finite algebra, finite geometrics and Latin squares.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Identify the basic concept of Balanced Designs.
2. AnalyzeFinite algebra, Difference sets and Difference method.
3. Understand Finite Geometrices and Block Designs
4. Apply Hadamard Matrices and find its applications.
5. Understand the concept of Latin Squares

<u>Mapping with Programme Outcomes</u>

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3					M							
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Basic concepts and Balanced Designs

Combinatorial Designs - Some Examples of Designs - Block Designs - System of Distinct Representatives - Pairwise Balanced Designs - Balanced Incomplete Block Designs.

Unit II - Finite algebra, Difference sets and Difference method

Finite Fields - Quadratic Elements - Sums of Squares - Difference sets - Properties of Difference sets - General Methods.

Unit III - Finite Geometrices and Block Designs

Finite affine planes - Construction of finite affine Geometries - Finite pro jective Geometries – Residual and derived designs - Existence theorem.

Unit IV - Hadamard Matrices

Hadamard Matrices and Block Designs - Kronecker Product Constructions - Williamson's Method - Regular Hadamard Matrices

Unit V - Latin Squares

Latin Square and Subsquares - Orthogonality - Idempotent Latin Squares- Transversal Designs – Spouse - Avoiding Mixed - Double Tournaments - Three Orthogonal Latin Squares.

Text Book :W. D. Wallis, Combinatorial Designs, Marcel Dekker, INC, New York, 1988.

Contents : Unit I: Chapters 1 and 2 (Full)
Unit II: Chapters 3 and 4 (Full)
Unit III: Chapters 5 and 6: Section 5.1 to 5.3, 6.1 and 6.2
Unit IV: Chapter 8 (Full)
Unit V: Chapter 10 (Full)

References :

1) M. Hall, Combinatorial Theory, Second Edition, Wiley-Interscience, New York, 1986.

2) D.R. Stinson, Combinatorial Designs: Constructions and Analysis, Springer, 2004.

Course Name and Course code	**LINEAR ALGEBRA - MAT18R4024**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

The objective is to enable the students to understand the concepts of vector spaces, linear transformations and canonical forms, and different types of linear transformations, such as, Hermitian, Unitary, Normal Transformations.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the concepts of Liner independence, bases and Dual spaces.
2. Discuss Algebra of Linear Transformations and Characteristics roots.
3. Study canonical forms and Nilpotent transformations.
4. Analyze Rational canonical forms and Determinants.
5. Understand the Hermitian, Unitary and Normal Transformations.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2		M										
CO3					S							
CO4								M				
CO5												M

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Vector Spaces

Basic concepts - Dual spaces - Inner product spaces.

Unit II - Linear Transformations
Algebra of Linear Transformation - Characteristics Roots - Matrices.

Unit III - Canonical forms
Canonical forms - Triangular forms - Nilpotent Transformation.

Unit IV - Rational Canonical Forms
Rational Canonical forms - Trace and Transpose - Determinants.

Unit V - Types of Linear Transformations
Hermitian, Unitary and Normal Transformation - Real Quadratic forms.

Text Book :

I. N. Herstein, Topics in Algebra, Second Edition, Wiley Eastern Edition, New Delhi, 2015.

Contents : Unit I: Chapter 4: Sections 4.3 and 4.4
Unit II: Chapter 6: Sections 6.1 to 6.3
Unit III: Chapter 6: Sections 6.4 to 6.5
Unit IV: Chapter 6: Sections 6.7 to 6.9
Unit V: Chapter 6: Sections 6.10 and 6.11

References :

1) Paul R. Halmos, Finite Dimensional Vector Spaces, 2nd ed. Princeton, N.J.:D.VanNostrand Company, 2011.
2) K. Hoffmann and R. Kunze, Linear Algebra, 2nd Edition, Pearson Education Taiwan Limited, 2011.

Course Name and Course code	**REAL ANALYSIS – II - MAT18R4025**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

The objective is to enable the students to understand the concepts of Riemann-Stieltjes integral, sequences and series of functions, functions of several variables and integration.

COURSE OUTCOMES:

At the end of the course students will be able to:

1) Understand the concept of Riemann integration and Differentiation.
2) Understand Uniform convergence and continuity.
3) Apply the Stone-Weierstrass theorem.
4) Analyze the concept of functions of several variables.
5) Study the applications of Integration and Differential forms.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2		M										
CO3												
CO4								S		M		
CO5											M	S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - The Riemann - Stieltjes Integral

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

Unit II : Sequences and Series of Functions

Uniform Convergence - Uniform Convergence and Continuity - Uniform Convergence and Integration .

Unit III : Equicontinuity

Uniform Convergence and Differentiation - Equicontinuous Families of Functions - The Stone-Weierstrass Theorem.

Unit IV: Functions of Several Variables

Linear transformations - Differentiation - The Contraction Principle - The Inverse function theorem-The Implicit function theorem.

Unit V: Integration of Differential Forms

Differentiation of Integrals - Integration of Differential forms: Integration - Primitive Mappings-Partitions of unity - Change of Variables.

Text Book:
Walter Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill, 2015.
Contents :
Chapters 6, 7, 9 (9.6 to 9.29, 9.42 and 9.43 only) and Chapter 10 (10.1 to 10.9 only).
References :
1) S. C. Malik and S. Arora, Mathematical Analysis, Second Edition, New Age International, 2009.
2) Tom M Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, 1985.
3) Tom M Apostol, Calculus Volume II, Second Edition, Wiley Student Edition, New Delhi, 2007.

Course Name and Course code	**COMPLEX ANALYSIS - MAT18R4026**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

The objective is to enable the students to understand the concepts of analytic functions, complex integration, residue calculus and power series expansion.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Analyze Analytic functions and exponential functions.
2. Apply Cauchy's theorem for disk.
3. Understand Local properties of Analytic functions.
4. Apply Residue theorem and the argument principle.
5. Differentiate the Taylor's series and the Laurent series.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3										S		
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I : Analytic Functions

Complex Numbers - Spherical representation - Analytic Functions - Polynomials - Power Series – The Exponential and Trigonometric Functions -Conformality - Linear Transformations.

Unit II : Complex Integration

Line Integrals - Rectifiable arcs - Cauchy's Theorem for disk and rectangle - The Index of a point with respect to a closed curve - The Integral formula - Higher derivatives.

Unit III : Local Properties of Analytic Functions

Removable Singularities - Taylor's Theorem - Zeros and poles - The local Mapping - The Maximum Principle - Chains and cycles - Simple Connectivity - Homology - The General statement of Cauchy's Theorem (Without proof).

Unit IV : Residue Calculus

Residue theorem - The argument principle - Evaluation of definite integrals.

Unit V : Power Series Expansions

Weierstrass theorem - Taylor's Series - Laurent series.

Text Book:

Lars V. Ahlfors, Complex Analysis, (3rd edition) McGraw Hill Company, New York, 1979.

Contents : Unit I: : Chapter 1 : Full, Chapter 2 : Sections 1.2, 1.3 and 2.4
: Chapter 2 : Section 3 : Full, Chapter 3 : Section 2 : Full
: Chapter 3 : Section 3 : 3.1, 3.2 and 3.3
Unit II : Chapter 4 : Section 1 : Full, Section 2 : Full
Unit III : Chapter 4 : Section 3 : Full, Section 4 : 4.1 to 4.4
Unit IV: Chapter 4 : Sections 5 : Full
Unit V: Chapter 5 : Section1 : Full

References :

1) S. Ponnusamy and H. Silverman, Complex Variables with Applications, Birkhauser, Boston, 2006.
2) J. B. Conway, Functions of one complex variables Springer - Verlag, International student Edition,Naroser Publishing Co., 1978.

Course Name and Course code	**MECHANICS - MAT18R4035**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

To enable the students to acquire the knowledge of Mechanics. Also to understand the concepts of Lagrange's Equation and Hamiltonion Principle.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand D' Alembert's Principle and simple applications of the Lagrangian Formulation.
2. Derive the Lagrange's Equations from Hamilton's Principle.
3. Study the concept of the Equations of Motion and the Equivalent One-Dimensional Problems.
4. Understand the Kepler Problem and Inverse-Square Law of Force.
5. Distinguish the concept of the Hamilton Equations of Motion and the Principle of Least Action.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Survey of the Elementary Principles

Mechanics of a Particle - Mechanics of a System of Particles - Constraints - D' Alembert's Principle and Lagrange's Equations - Velocity-Dependent Potentials and the Dissipation Function - Simple Applications of the Lagrangian Formulation.

Unit II - Variational Principles and Lagrange's Equations
Hamilton's Principle - Some Techniques of the Calculus of Variations - Derivation of Lagrange's Equations from Hamilton's Pnnciple - Extension of Hamilton's Principle to Nonholonomic Systems .

Unit III - The Central Force Problem
Reduction to the Equivalent One-Body Problem - The Equations of Motion and First Integrals – The Equivalent One-Dimensional Problem, and Classification of Orbits - The Virial Theorem - The Differential Equation for the Orbit, and Integrable Power-Law Potentials - Conditions for Closed Orbits.

Unit IV - The Kepler Problem
The Kepler Problem: Inverse-Square Law of Force - The Motion in Time in the Kepler Problem – The Laplace-Runge-Lenz Vector

Unit V - The Hamilton Equations of Motion
Legendre Transformations and the Hamilton Equations of Motion - Cyclic Coordinates and Conservation Theorems - Derivation of Hamilton's Equations from a Variational Principle - The Principle of Least Action.

Text Book :H. Goldstein, C. Poole and J. Safko, Classical Mechanics, Third Edition, Addison-Wesley,2001.

Contents :
Unit I: Chapter 1: Full
Unit II: Chapter 2: Sections 2.1 to 2.4
Unit III: Chapter 3: Sections 3.1 to 3.5
Unit IV: Chapter 3: Sections 3.7 to 3.9
Unit V: Chapter 8: Sections 8.1, 8.2, 8.5 and 8.6
References :
1) F. Chorlton, Textbook of Dynamics, second edition, Ellis Horwood Series: Mathematics and itsApplications, Halsted Press (John Wiley & Sons, Inc.), New York, 1983.
2) D. T. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
3) John A. Synge and Byron A. Griffith, Principles of Mechanics, McGraw-Hill Book Company, INC, Second Edition, New York, 1949.

Course Name and Course code	**GRAPH ALGORITHMS / MAT18R4036**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be able to understand the effectiveness of solving real world problems using graph algorithms.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Find shortest paths between pairs of vertices of a graph and minimum weight spanning tree of a graph.
2. Find Matchings and Depth-First Search tree.
3. Obtain Strong connectivity of digraphs and testing of planarity of graphs
4. Obtain Flows in Networks.
5. Obtain Connectivity of graphs using Network flows.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3					M							
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:
Unit I - Trees and Branchings

Transitive closure, Shortest paths, Minimum weight spanning tree, Optimum branchings.

Unit II - Matchings and Depth-First Search

Perfect matching, Optimal assignment, and Timetable scheduling, The Chinese Postman problem, Depth- First search.

Unit III - Strong connectivity and Planarity

Biconnectivity - Strong Connectivity - st-Numbering of a Graph - Planarity testing.

Unit IV - Flows in Networks

The Maximum Flow problem, Maximum Flow Minimum Cut theorem, Ford-Fulkerson labeling algorithm, Edmonds and Karp Modification of the labeling algorithm.

Unit V - Connectivity - An Algorithimic Approach

Dinic Maximum Flow algorithm, Maximum Flow in 0-1 networks, Maximum matching in Bipartite Graphs, Menger's Theorem and Connectivity.

Text Book : K. Thulasiraman and M.N.S. Swamy, Graphs: Theory and Algorithms, John Wiley & Sons, Canada, 1992.

Contents:

Unit I: Chapter 11: Sections 11.1 to 11.4
Unit II: Chapter 11: Sections 11.5 to 11.7
Unit III: Chapter 11: Sections 11.8, 11.10, 11.11
Unit IV: Chapter 12: Sections 12.1 to 12.4
Unit V: Chapter 12: Sections 12.5, 12.8, 12.9 and 12.10

References :

1) A. Gibbons, Algorithmic Graph Theory, Cambridge University Press, London, 1985.

2) D. Jungnickel, Graphs, Networks and Algorithms, Springer, 2013.

Course Name and Course code	**CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS / MAT18R4037**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to understand and study the concepts of calculus of variations and integral equations.

COURSE OUTCOMES:

At the end of the course students will be able to:

- Understand Calculus of Variations and its applications.
- Analyze Constraints and Lagrange multipliers.

- Find relations between differential and integral equations
- Study Fredholm equations with separable kernels
- Analyze Hilbert and Schmidt theory

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3				M								
CO4							M				L	
CO5												S

S- Strong; M-Medium; L-Low

Syllabus:

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: Methods of Applied Mathematics by Francis B. Hildebrand (Second Edition), Dover publications, 1952.

Content: Sections 2.1 to 2.11, 3.1 to 3.9 and 3.11.

Reference books:

1. A. M. Wazwaz, A first course in integral equations, World Scientific Publishing Company Pvt. Ltd., 1997.
2. L. Elsgolts, Differential Equations and the Calculus of Variations, University Press of the Pacific, 2003.

Course Name and Course code	**Programming in C++ / MAT18R4038**
Programme	**M.Sc. MATHEMATICS**
Semester	**II**
Course Credit	**4**
Course Type	**Theory with practical**

COURSE OBJECTIVES:

In this course, students will be enable to write simple programs to solve real world problems and problems in Mathematics using the programming language C++.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Identify the basic concepts such as, Tokens, Expressions and Control structures
2. Analyze Classes and Objects.
3. Understand the concepts of Constructors and Destructors
4. Apply the concepts of Extending classes, Pointers, Virtual Functions and Polymorphism.
5. Write programs in C++ to solve problems.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3					M							
CO4								M				
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I

Tokens - data types – declaration of variables – operators - expressions – operator over loading - operator precedence – control structures – functions – call by reference – return by reference – recursion – function over loading.

Practical: related programs using the concepts.

Unit II

Specifying a class - member functions – arrays within a class - arrays of objects - friendly functions – pointers to members.

Practical: related programs using the concepts.

Unit III

Constructors – parameterized constructors – multiple constructors – copy constructor – dynamic constructor – destructor – operator over loading - type conversions.

Practical: related programs using the concepts.

Unit IV

Derived classes – inheritance – constructors in derived classes – pointers – polymorphism.

Practical: related programs using the concepts.

Unit V

Opening and closing a file - file pointers and their manipulators – updating a file: random access.

Practical: related programs using the concepts.

Text Book : E. Balagurusamy, Object Oriented Programming with C++, Sixth Edition, McGraw-Hill Education (India) Private Ltd., 2013.

Contents : Unit I: Chapters 3 and 4
Unit II: Chapter 5
Unit III: Chapters 6 and 7
Unit IV: Chapters 8 and 9
Unit V: Chapter 11

References :

1) Steve Oualline, Practical C++ Programming, O'Reilly Media, 2003.

2) Chuck Easttom, C++ Programming Fundamentals, Charles River Media, 2003.

Course Name and Course code	**FIELDS AND LATTICES - MAT18R5021**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to understand the concepts of field extension, splitting fields, finite fields, partially ordered sets and lattices.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the concepts of Extension fields and Roots of polynomials.
2. Understand the basics of Galois Theory.
3. Know the finite fields and their constructions.
4. Understand Partially ordered sets, Distributivity and Modularity lattices.
5. Understand Boolean Algebras and Modules.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Fields

Extension Fields - Roots of Polynomials - More about roots.

Unit II - Galois Theory

Elements of Galois Theory - Solvability by Radicals.

Unit III - Finite Fields

Finite fields - Wedderburns theorem on finite division rings - A theorem of Frobenius.

Unit IV - Lattices

Partially ordered sets and Lattices - Distributivity and Modularity - The Theorem of Jordan Holder and Dedekind.

Unit V - Boolean Algebra and Modules

Boolean Algebras - Modules.

Text Book :

1) I. N. Herstein, Topics in Algebra, Second Edition, Wiley Eastern Edition, New Delhi, 2015.
2) N. Jacobson, Basic Algebra, Vol.1, Hindustan Publishing Corporation, 1991.

Contents :

Unit I: Chapter 5: Sections 5.1, 5.3 and 5.5 (Refer Book 1)
Unit II: Chapter 5: Sections 5.6 and 5.7 (Refer Book 1)
Unit III: Chapter 7: Sections 7.1 to 7.3 (Refer Book 1)
Unit IV: Chapter 8: Sections 8.1 to 8.3 (Refer Book 2)
Unit V: Chapter 8: Sections 8.5 (Refer Book 2)
Chapter 4 : Section 4.5 (Refer Book 1)

References :

1. D. S. Dummit and R. M. Foote, Abstract Algebra, Wiley 2004.

2. Thomas W. Hungerford, Algebra, Springer Verlag, Indian reprint, 2004.

Course Name and Course code	**MEASURE THEORY – MAT18R5022**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to understand the concepts of measurable sets, measurable functions, measure integrable functions and Differentiability of Monotone Functions.

COURSE OUTCOMES:

At the end of the course students will be able to:

1) Understand measurable sets and Lebesgue measure.
2) Understand the classical theorems, namely, Egoroff's Theorem and Lusin's Theorem.
3) Understand the Lebesgue Integration.
4) Study the Radon-Nikodym theorem and its applications.
5) Understand the concepts of Convergence in Measure and Lebesgue Integrability

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2		M										
CO3												
CO4								S		M		
CO5											M	S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I: Lebesgue Measure

Introduction – Lebesgue Outer Measure – The σ-Algebra of Lebesgue Measurable sets – Outer and Inner Approximation of Lebesgue Measurable sets – Countable Additivity, continuity, and the Borel-Cantelli Lemma – Nonmeasurable sets – The Cantor set and the Cantor-Lebesgue Function.

Unit II: Lebesgue Measurable Functions

Sums, Products, and Compositions – Sequential Pointwise Limits and Simple Approximation - Littlewood's Three Principles, Egoroff's Theorem, and Lusin's Theorem.

Unit III: Lebesgue Integration

The Riemann Integral – The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure – The Lebesgue Integral of a Measurable Nonnegative Function - The General Lebesgue Integral – Countable Additivity and Continuity of Integration – Uniform Integrability: The Vitali Convergence Theorem.

Unit IV: Lebesgue Integration: Further Topics

Uniform Integrability and Tightness: A General Vitali Convergence Theorem – Convergence in Measure - Characterizations of Riemann and Lebesgue Integrability.

Unit V: Differentiation and Integration

Continuity of Monotone Functions – Differentiability of Monotone Functions: Lebesgue's Theorem – Functions of Bounded Variation: Jordan's Theorem – Absolutely Continuous Functions – Integrating Derivatives: Differentiating Indefinite Integrals - Convex Functions.

Text Book: H. L. Royden and P. M. Fitzpatrick, Real Analysis, Fourth Edition, Pearson Prentice-Hall, 2010.

Contents:

Unit I: Chapter 2 (Full)

Unit II: Chapter 3 (Full)

Unit III: Chapter 4 (Full)

Unit IV: Chapter 5 (Full)

Unit V: Chapter 6 (Full)

References :

1) G. Debarra, Measure Theory and Integration, New Age International, 1981.
2) Walter Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill, 2015.

Course Name and Course code	**TOPOLOGY - MAT18R5023**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to learn the concepts of topology such as, product topology, connectedness, compactness, separation axioms, the Uryshon lemma, the Tietze Extension theorem.

COURSE OUTCOMES:

At the end of the course students will be able to:

- Understand the concept of basis for a topology, the order topology, the product topology on $X \times Y$ and the subspace topology.
- Understand the basics of connected spaces, components and Local connectedness.
- Understand the concepts of compactness and limit point compactness.
- Understand the Countability axioms, the Separation axioms and Normal spaces.
- Understand the classical theorems such as, the Uryshon lemma, the Tietze Extension theorem.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I: Topological Spaces and Continuous Functions

Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology - Closed sets and limit points - Continuous functions.

Unit II: The Product Topology

The product topology – connected spaces, connected subspaces of the Real line - components and Local connectedness.

Unit III: Compactness

Compact spaces – compact subspaces of the Real line – limit point compactness.

Unit IV: Countability and Separation Axioms

The Countability axioms – The Separation axioms - Normal spaces.

Unit V: The Uryshon lemma

The Uryshon lemma – The Uryshon Metrization theorem - The Tietze Extension theorem – The Tychonoff theorem (statement only).

Text Book: J. R. Munkres, Topology, Second Edition, Pearson Prentice hall, (2000).

Contents :

Unit I: Sections 12 to 18

Unit II: Sections 19, 23 to 25

Unit III: Sections 26 to 28.

Unit IV: Sections 30 to 32

Unit V: Sections 33, 34, 35

References :

1) George F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Company,1963.
2) J. L. Kelly, General Topology, Springer, 1975.
3) L. A. Steen and J. A. Seebach, Counterexamples in Topology, Springer-Verlag , New York, 1978.
4) S. Willard, General Topology, Addison - Wesley, 1970.

Course Name and Course code	**COMBINATORIAL THEORY / MAT18R5031**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to count objects using permutations and combinations. Also they understand the concepts of generating functions, recurrence relations, the principles of inclusion and exclusion and Polya's Theory of Counting.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the ideas of Permuations and Combinations.
2. Understand the theory generating functions.
3. Understand the concepts of recurrence relations and their applications.
4. Understand the concepts of Permutations with Restrictions on Relative Positions and the Rook Polynomials.
5. Enumerate configuration using Polya's Theory.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Permutations and Combinations

Introduction - The rules of Sum and Product - Permuations - Combinations - Distributions of Distinct objects - Distributions of nondistinct objects.

Unit II - Generating Functions
Introduction - Generating Functions for Combinations - Enumerators for Permutations – Distributions of distinct objects into nondistinct Cells - Partitions of Integers - Elementary Relations.

Unit III - Recurrence Relations
Introduction - Linear Recurrence relations with Constant Coefficients - Solution by the technique of Generating Functions - Recurrence Relations with Two Indices.

Unit IV - The Principle of Inclusion and Exclusion
Introduction - The Principle of Inclusion and Exclusion - The General Formula - Derangements - Permutations with Restrictions on Relative Positions - The Rook Polynomials

Unit V - Polya's Theory of Counting
Introduction - Equivalence Classes under a Permutation Group - Equivalence Classes of Functions -Weights and Inventories of Functions - Polya's Fundamental Theorem - Generalization of Polya's Theorem.

Text Book :C. L. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill Inc., Newyork,1968.

Contents : Unit I: Chapter 1: Sections 1.1 to 1.6
Unit II: Chapter 2: Sections 2.1 to 2.5 and 2.7
Unit III: Chapter 3: Sections 3.1 to 3.5 (Except 3.4)
Unit IV: Chapter 4: Sections 4.1 to 4.6
Unit V: Chapter 5: Sections 5.1 to 5.7 (Except 5.2)

References :
1) J. H. Van Lint and R. M. Wilson, A Course in Combinatorics, Cambridge University Press, 2001.
2) TituAndreescu and ZumingFeng, A Path to Combinatorics, Springer Science & Business Media, 2004.

Course Name and Course code	**OPERATIONS RESEARCH / MAT18R5032**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to understand several concepts of Operations Research such as, several algorithms in network models, Queuing theory, Non-linear programming algorithms, etc.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand several network algorithms, such as minimal spanning algorithms, shortest route algorithms, Dijkstra's algorithms, Floyds algorithm, maximal flow algorithm.
2. Analyze the ideas of CPM and PERT in Network analysis.
3. Comprehend several Queueing system models, namely single server models and multi server models.
4. Understand the ideas of Classical optimization theory.
5. Comprehend several non-linear programming algorithms such as, separable programming algorithm, quadratic programming algorithm, geometric programming algorithm.

<u>Mapping with Programme Outcomes</u>

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

Syllabus:

Unit I:

Network models - minimal spanning algorithms - shortest route algorithms - Dijkstra's Algorithms - Floyds algorithm - maximal flow algorithm.

Unit II:

CPM and PERT - Network representation critical path(CPM) – computations constructions of the time schedule - determination of floats.

Unit III:

Queuing systems - elements of queuing model - role of exponential distribution - pure birth and death models - Generalized Poisson queuing model - Specialised poisson queues - steady - state measure of performance - single server models - (M/M/1):(GD/∞/∞), (M/M/1):(GD/N/∞) - multi server models - $(M/M/c):(GD/\infty/\infty)$.

Unit IV:

Classical optimization theory - unconstrained problems-necessary and sufficient conditions - the Newton Raphson method - constrained algorithms - equality constraints - inequality constraints.

Unit V:

Non-linear programming algorithms - unconstrained algorithms - direct search method - gradient method - constrained algorithms - separable programming - quadratic programming - geometric programming - linear combination method.

Text Book :

Hamdy A.Taha, Operations Research, An Introduction, Printice –Hall, Seventh Edition, 2005.

Contents:

Unit I: Chapter 6 sections 6.1; 6.2; 6.3 - 6.3.1, 6.3.2; 6.4 - 6.4.1, 6.4.2.

Unit II: Chapter 6 sections 6.6 - 6.6.1, 6.6.2, 6.6.3

Unit III: Chapter 17section 17.1 to 17.6.4.

Unit IV: Chapter 20

Unit V: Chapter 21 sections 21.1.1, 21.1.2, 21.2.1, 21.2.2, 21.2.3 and 21.2.5.

Reference Books:

1. B.S. Goel, S.K. Mital, Operations Research,Pragati prakashan, 1996.

2. Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research, Seventh Edition, The McGraw-Hill Companies, 2003.

Course Name and Course code	**DIFFERENTIAL GEOMETRY / MAT18R5033**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to understand several concepts of Differential Geometry such as, space curves, surfaces, geodesics, curvatures, developables, etc.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand the concepts of curvature, surfaces, involutes and evolutes.
2. Study the classical theorem on Differential Geometry, namely fundamental existence theorem for space curves.
3. Comprehend several concepts on Differential Geometry such as, metric, direction coefficients, geodesics.
4. Understand the several concept of curvatures such as, geodesic curvature Gaussian curvatures, constant curvature
5. Understand the ideas of developables associated with space curves and surface curves.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3				M								
CO4							M				L	
CO5												S

S- Strong; M-Medium; L-Low

Syllabus:

Unit I:

Introductory remarks about space curves - Definitions of arc length, tangent, normal and binomial - curvature and torsion of a curve given as the intersection of two surfaces, contact between curves and surfaces, tangent surface, involutes and evolutes.

Unit II:

Intrinsic equations, fundamental existence theorem for space curves, Helices and definition of a surface, curves on a surface, surfaces of revolution, Helicoids.

Unit III:

Metric, direction coefficients, families of curves, isometric correspondence – geodesics, canonical geodesic equations, normal property of geodesics.

Unit IV:

Existence theorems, geodesic parallels, geodesic curvature Gauss-Bonet theorem, Gaussian curvatures - surfaces of constant curvature.

Unit V:

The second fundamental form, principal curvatures, lines of curvature, developables, developables associated with space curves, developables associated with curves on surfaces, minimal surfaces, ruled surfaces.

Text Book:

T.J. Wilmore, An Introduction to Differential Geometry, Oxford University Press,1983.

Contents:

Unit I: Chapter 1 : sections 1 to 7

Unit II: Chapter 1 : sections 8 and 9, Chapter 2 : sections 1 to 4

Unit III: Chapter 2 : sections 5 to 7 and 10 to 12

Unit IV: Chapter 2 : sections 13 to 18

Unit V: Chapter 3 : sections 1 to 8

Reference Books:

1. P.P. Gupta, G.S. Malik, Three dimensional Differential Geometry, Pragati Prakasham, Twelfth edition ,2005.

2. Mittal Agarwal, Krishna's Differential Geometry, Kirshna Prakash, Media private

Limited, New Delhi, 2007.

3. J. A. Thorpe, Elementary topics in Differential Geometry, Springer, 1994.

4. D. Somasudaram, Differential Geometry, Alpha Science International Limited, 2005.

Course Name and Course code	**CRYPTOGRAPHY / MAT18R5033**
Programme	**M.Sc. MATHEMATICS**
Semester	**III**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to understand the concepts of public key Cryptosystem and RSA-Cryptosystem.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand Euler-Fermat Theorem and its applications.
2. Analyze Symmetric and Asymmetric Cryptosystems.
3. Understand the concept of Public Key Encryption.
4. Analyze Message Authentification Code (MAC).
5. Analyze Digital Signatures and its applications.

<u>Mapping with Programme Outcomes</u>

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3				M								
CO4							M				L	
CO5												S

S- Strong; M-Medium; L-Low

Syllabus:

Unit I:

Euclidian Algorithm - Extended Euclidian Algorithm and its efficiency for huge numbers - Factoring in primes - Congruences and Residue Class Rings - Order of group elements - Multiplicative group of residues mod n (large) - Euler-Fermat Theorem - Fast Exponentiation.

Unit II:

Encryption - Symmetric and Asymmetric Cryptosystems - Linear Block Ciphers and its Crypto analysis - Probability and Perfect Secrecy - One-Time-Pad - Prime Number Generation with probabilistic algorithm for huge primes: Fermat Test - Carmichael Numbers - Miller-Rabin-Test.

Unit III:

Public Key Encryption: Idea - Security - RSA-Cryptosystem - Diffie-Hellmann Key Exchange.

Unit IV:

Cryptographic Hash functions - Compression functions: Birthday attack - Message Authentification Code (MAC)

Unit V:

Digital Signatures: Idea, Security, RSA signatures - Elliptic curves over a finite field.

Text Book : Johannes A. Buchmann, Introduction to Cryptography, Second edition, Springer, 2001.

Content:
Unit I: Chapter 1 & 2

Unit II: Chapters 3, 4 & 7
Unit III: Chapter 8
Unit IV: Chapter 11
Unit V: Chapters 12 & 13

Reference Books:

1. X. Wang, G. Xu, M. Wang and X. Meng, Mathematical Foundations of Public key Cryptography, CRC Press, 2015.
2. Richard A. Mollin, An Introduction to Cryptograph, Second Edition, Chapman & Hall, 2006.

Course Name and Course code	**FUNCTIONAL ANALYSIS – MAT18R5024**
Programme	**M.Sc. MATHEMATICS**
Semester	**IV**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be enable to obtain knowledge on Banach spaces, Hilbert spaces, operator theory and finite dimensional spectral theory.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand Continuous linear transformations and the Hahn-Banach theorem.
2. Comprehend the Open Mapping Theorem and Closed Graph Theorem.
3. Construct orthonormal sets and conjugate spaces.
4. Understand the relevance of self-adjoint operators, normal, unitary operators and projections.
5. Comprehend the ideas of determinants and the spectrum of an operator.

<u>Mapping with Programme Outcomes</u>

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										

CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Banach Spaces

The definition and some examples - Continuous linear transformations - The Hahn-Banach theorem

Unit II - The Open Mapping Theorem

The natural imbedding of N in N^{**} - The open mapping theorem - The conjugate of an operator.

Unit III - Hilbert Spaces

The definition and some simple properties - Orthogonal complements - Orthonormal sets - The conjugate space H*.

Unit IV - Operator Theory

The adjoint of an operator - Self-adjoint operators - Normal and unitary operators - Projections.

Unit V - Finite - Dimensional Spectral Theory

Matrices - Determinants and the spectrum of an operator - The spectral theorem - A survey of the situation.

Text Book :

1) George F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 2015.

Contents: Chapters 9, 10 and 11 Full.

References :

1) B. V.Limaye, Functional Analysis, New Age International, 1996.
2) G. Bachman and L. Narici, Functional Analysis, Dover Publications, 2000.
3) A. E. Taylor and D. C. Lay, Introduction to Functional Analysis, John Wiley and Sons, 1980.
4) Walter Rudin, Functional Analysis, Tata McGraw-Hill Education, 2006.

Course Name and Course code	**NUMERICAL ANALYSIS - MAT18R5025**
Programme	**M.Sc. MATHEMATICS**
Semester	**IV**
Course Credit	**4**
Course Type	**Theory with practical**

COURSE OBJECTIVES:

In this course, students will be enable to obtain numerical solutions to problems, such as, finding roots of polynomials, solving ODE's, system of equations by different methods.

COURSE OUTCOMES:

At the end of the course students will be able to:

1) Obtain the roots of Polynomial Equations.
2) Solve system of equations by Direct methods and Iteration methods.
3) Apply Hermite Interpolation, Piecewise and Spline interpolation to solve problems.
4) Obtain numerical solutions to integration problems.
5) Obtain numerical solutions to ODE's.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - Transcedental and Polynomial Equations

Bisection method - Iteration method based on first degree equations: Secant and Regula-Falsi methods – Newton-Raphson method - Iteration method based on second degree equations: Muller method – Chebyshev method – Multipoint iteration methods - Rate of convergence – related programs using MATLAB.

Unit II – System of Linear Algebraic Equations and Eigenvalue Problems

Direct methods – Error Analysis for Direct method - Iteration methods - Eigen values and Eigen vectors – Bounds on Eigen values – related programs using MATLAB.

Unit III - Interpolation

Finite Difference operators - Interpolating Polynomials using finite differences - Hermite Interpolation - Piecewise and Spline interpolation – related programs using MATLAB.

Unit IV - Numerical Differentiations and Integrations

Numerical Differentiation – Optimal choice of step length –Numerical Integration - Method based on interpolation - Method based on undetermined coefficient – related programs using MATLAB.

Unit V - Ordinary Differential Equations: IVP's and BVP's

Difference Equation – Numerical methods – Single step and Multi-step methods – Stability analysis – Initial Value Problem shooting methods – Finite Difference Methods - related programs using MATLAB.

Text Books:

1) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, Fourth Edition, New Age International Publishers , New Delhi, 2003.

Contents : Unit I: Chapter 2: Sections 2.1 to 2.5
Unit II: Chapter 3: Sections 3.1 to 3.6
Unit III: Chapter 4: Sections 4.3 to 4.6
Unit IV: Chapter 5: Sections 5.2, 5.3, 5.6 to 5.8
Unit V: Chapter 6: Sections 6.2 to 6.6, Chapter 7: Sections 7.2 and 7.3

References :

1. C.F. Gerald and P.O. Wheatley , Applied Numerical Methods, Sixth Edition, Pearson Education, 2002.
2. M.K. Jain, Numerical Solution of Differential Equations, Second Edition, Wiley Edition Limited, 1979.
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications, 1991.
4. S.S. Sastry, Introductory Methods of Numerical analysis, Prentice-Hall of India, New Delhi, 1998.

Course Name and Course code	**STATISTICS - MAT18R5026**
Programme	**M.Sc. MATHEMATICS**
Semester	**IV**
Course Credit	**4**
Course Type	**Theory**

COURSE OBJECTIVES:

In this course, students will be able to analyze the concepts of mathematical expectations, marginal and conditional distributions and to introduce MGF techniques.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Understand some special mathematical expectations and Chebyshev's inequality.
2. Understand marginal and conditional distributions, the correlation co-efficient and Stochastic independence.
3. Apply the Trinomial and Multinomial Distributions, The Poisson Distribution and the Gamma and Chi-square distributions to solve problems.
4. Understand the t & F distributions and their applications.
5. Understand MGF Technique and the Central Limit Theorem.

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2		S										
CO3								S				
CO4											M	
CO5												S

S- Strong; M-Medium; L-Low

SYLLABUS:

Unit I - PDF and Some special mathematical expectations

Random variables - The probability density functions - The distribution function - Certain probably models - Mathematical expectation - Some special mathematical expectation - Chebyshev's inequality.

Unit II - Marginal and conditional distributions

Conditional probability - Marginal and conditional distribution - The correlation co-efficient -

Stochastic independence.

Unit III - Distributions
The Binomial, The Trinomial and Multinomial Distributions - The Poisson Distribution - The Gamma and Chi-square distribution - The Normal distribution.

Unit IV - The t & F distributions
Sampling theory - transformations of variables of the discrete type - Transformations of variables of continuous type - The t & F distributions - Distribution of order statistics.

Unit V - MGF Technique and the Central Limit Theorem
The moment generating function technique - The distribution of $\bar{X}$ and $n\,s^2/\sigma^2$ - Limitting distribution - Stochastic convergence - Limiting moment generating function - The central limit theorem.

Text Book :

R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Fourth Edition, Macmillan, 1978.

Contents : Unit I: Chapter 1: Sections 1.5 to 1.11
Unit II: Chapter 2: Sections 2.1 to 2.4
Unit III: Chapter 3: Sections 3.1 to 3.4
Unit IV: Chapter 4: Sections 4.1 to 4.4 and 4.6 to 4.8
Unit V: Chapter 5: Sections 5.1 to 5.4

References :
1) R. Bhattacharya and E. C. Waymire , A Basic Course in Probability Theory, Springer 2007
2) W. Feller, An Introduction to Probability Theory and Its Applications, Vol. 1 Third Edition, Vol. 2, Second Edition, Wiley, New York, 1972.