

# **KALASALINGAM UNIVERSITY**

**(KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION)**

**(Under Section 3 of the UGC Act 1956)**

**Anand Nagar, Krishnankoil - 626126  
Srivilliputtur(via), Virudhunagar(Dt.), Tamil Nadu, INDIA**

**M. Sc. (Mathematics)  
CURRICULUM, SYLLABUS – 2018  
(CHOICE BASED CREDIT SYSTEM)**

## SCHEME OF INSTRUCTIONS

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
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
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
MAT18R5024	Functional Analysis	T	5	1	0	4
MAT18R5025	Numerical Analysis	TP	3	1	2	4
MAT18R5026	Statistics	T	5	1	0	4
MAT18R5052	Project and Viva Voce (Phase-II)	Project	-	-	-	6
<b>TOTAL</b>						<b>90</b>

† 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).

**ELECTIVES**

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
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
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 – Theory with practical.

# **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

**KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION**  
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ANAND NAGAR, KRISHNANKOIL – 626 126  
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.

<b>Course Name and Course code</b>	<b>GROUPS AND RINGS/ MAT18R4021</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>I</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

### **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, Marshall, 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.

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<b>Course Name and Course code</b>	<b>REAL ANALYSIS – I / MAT18R4022</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>I</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

### 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 Sequences - 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's Rule - Derivatives of Higher Order - Taylor's Theorem - Differentiation of vectorvalued functions.



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  $\phi(n)$ -  
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 Möbius 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.

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MAT18R4024	LINEAR ALGEBRA	I	Γ	P	C
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### 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 Linear 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.

### 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.VanNostrandCompany, 2011.
- 2) K. Hoffmann and R. Kunze, Linear Algebra, 2nd Edition, Pearson Education Taiwan  
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<b>Course Name and Course code</b>	<b>REAL ANALYSIS – II - MAT18R4025</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>II</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

**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.

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<b>Course Name and Course code</b>	<b>COMPLEX ANALYSIS - MAT18R4026</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>II</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

### **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.

MAT18R4061	Skill Development Course : Latex (For those who have joined in June 2018 and later)	L	T	P	C
		1	0	1	2

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### Course Objective:

To enable the students to acquire knowledge and skills in Latex and to write programmes in Latex

### Course Outcomes:

Upon successful completion of this course, students will be able

1. Understand the basics of latex and advantages of Latex.
2. Use text formatting commands and alignment commands in Latex.
3. Draw figures and create tables.
4. Know the commands related to bibliography
5. Create mathematical equations involving symbols.

**Unit 1 :** Introduction - What is Latex ? – History – More about Latex – Advantages of Latex – Disadvantages of Latex – Simple document : Getting started – A short simple document – Documentclass and font size – Add on packages – Geometry parameters – Title and author(s) – To make an index

– Begin document : No complicating features – some simple rules – spaces overlooked – Indent and noindent – Commands, arguments and curly brackets – comments.

**Unit 2 :** Geometry Parameters – Sectioning into chapters and sections – Quotation marks, new paragraphs and pages – Different fonts and font sizes – Format : Centre, left and right – List of items – Landscape format – Double column entries – Multiple column entries – Mini page – Special characters – Boxes – Rotating – How to type a certificate in latex .

**Unit 3 :** Figures and tables – Figures : Import figures – Reflection of figures – To generate figures by latexcoding. Tables : Simple tables – Multicolumn, Multirow tables – Tables in the landscape format – placing figures and tables side by side.

**Unit 4 :** Cross References and Bibliography : Cross referencing : Pages, equations, figures and tables .Bibliography : A simple case – bibliographic data bases – bibliographic styles – bibtex program.

**Unit 5 :** Mathematical symbols: Special characters – Greek letters - Math mode accents in latex – Some common mathematical symbols – European characters – Transliteration symbols: Sanskrit alphabet. Mathematical expressions and equations : Simple mathematical expressions – Differentiation and Integrations Symbols – Matrices – Boxed equations – Beamer presentation.

### TEXT BOOKS:

1. K.B.M. Nambudiripad, *Latex for Beginners*, Alpha Science International Ltd., 2014.

### REFERENCE BOOKS:



1. Stefankotwitz and Olten, *Latexbeginners guide*, Birmingham: Packtpublishers, 2011.2. GeorgeGratzer, *Practical Latex*, Springer, 2014.

<b>Course Name and Course code</b>	<b>FIELDS AND LATTICES - MAT18R5021</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>III</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

### **COURSE OBJECTIVES:**

In this course, students will be able to understand the concepts of field extension, splittingfields, 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 - Wedderburn's theorem on finite division rings - A theorem of Frobenius.

### Unit IV - Lattices

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

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<b>Course Name and Course code</b>	<b>MEASURE THEORY – MAT18R5022</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>III</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

#### COURSE OBJECTIVES:

In this course, students will be able 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  $\sigma$ -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.

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<b>Course Name and Course code</b>	<b>TOPOLOGY - MAT18R5023</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>III</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

**COURSE OBJECTIVES:**

In this course, students will be able 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
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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.

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<b>Course Name and Course code</b>	<b>FUNCTIONAL ANALYSIS – MAT18R5024</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>IV</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

### **COURSE OBJECTIVES:**

In this course, students will be able 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.

### **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 - 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.

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<b>Course Name and Course code</b>	<b>NUMERICAL ANALYSIS - MAT18R5025</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>IV</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory with practical</b>

#### **COURSE OBJECTIVES:**

In this course, students will be able 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 - Transcendental and Polynomial Equations

Bisection method - Iteration method based on first degree equations: Secant and Regula-Falsimethods – 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 Eigenvectors – Bounds on Eigen values – related programs using MATLAB.

### Unit III - Interpolation

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

### Unit IV - Numerical Differentiations and Integrations

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

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

Difference Equation – Numerical methods – Single step and Multi-step methods – Stabilityanalysis – Initial Value Problem shooting methods – Finite Difference Methods - relatedprograms using MATLAB.

## Text Books:

1) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and EngineeringComputation, 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

MAT18R5026	<b>STATISTICS</b> (M.Sc. Mathematics) (For those who have joined in June 2018 and later)	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>4</b>

Publications, 1991.

4. S.S. Sastry, Introductory Methods of Numerical analysis, Prentice-Hall of India, New Delhi, 1998.

**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.

**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  $n s^2/\sigma^2$ - Limiting 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.

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<b>Course Name and Course code</b>	<b>DIFFERENTIAL EQUATIONS/ MAT18R4031</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>I</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

## COURSE OBJECTIVES:

In this course, students will be able to solve linear equations with variable coefficients. Further they will be 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 Homogeneous equation with constant coefficients and Homogeneous equation with analytic coefficients.
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 variables 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 Coefficients

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, TataMcGrawHill, New Delhi, 1974.
- 2) M.D. Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd. New Delhi, 2001.

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Course Name and Course code	GRAPH THEORY/ MAT18R4032
Programme	M.Sc. MATHEMATICS
	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 Hamiltonian 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 - Cutvertices - 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, SecondEdition, 2012.

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Course Name and Course code	<b>CODING THEORY / MAT18R4033</b>
Programme	<b>M.Sc. MATHEMATICS</b>
	<b>II</b>
Course Credit	<b>4</b>
Course Type	<b>Theory</b>

### 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, theGolay 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-Hocquenghem (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.

**UnitV**

**-Bose-Chaudhuri-**

**Hocquenghem(B.C.H.)CodesandWeightdistributions**

CyclicCodesGiveninTermsofRoots-VandermondeDeterminants-  
DefinitionandPropertiesofB.C.H. Codes-PreliminaryConcepts and  
aTheoremonWeightsinHomogeneous Codes-The  
MacWilliamsEquations-PlessPowerMoments -  
GleasonPolynomials.

**TextBook:**Vera Pless, IntroductiontotheTheory ofError-CorrectingCodes,  
JohnWiley&Sons, NewYork,1982.

**Contents:** Unit I:Chapters1and2 (Full)

- Unit
- II:Chapters3and4(Full)Unit
- III:Chapters5(Full)Unit
- IV:Chapter6(Full)Unit
- V:Chapter7and8(Full)

**References:**

1)

I.F.BlakeandR.C.Mullin,IntroductiontoAlgebraicandCombinatorialCodingTheory,  
Academic Press,INC,NewYork,1977.

2) F.J. MacWilliams and N.J.A. Sloane, The Theory ofError-CorrectingCodes,  
Vols. I and II, North-Holland, Amsterdam,1977.

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<b>Course Name and Course code</b>	<b>DESIGN THEORY / MAT18R4034</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>I</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

**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. Analyze Finite algebra, Difference sets and Difference method.



3. Understand Finite Geometries and Block Designs.  
 4. Apply Hadamard Matrices and find its applications.  
 5. Understand the concept of Latin Squares

**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 - 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 Geometries and Block Designs**

Finite affine planes - Construction of finite affine Geometries - Finite projective 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.



Unit II: Chapters 3 and 4 (Full)

Unit I: Chapters 1 and 2 (Full)

**Contents :**

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.

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<b>Course Name and Course code</b>	<b>MECHANICS - MAT18R4035</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>III</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

**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 Principle - 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 its Applications, 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. Syngé and Byron A. Griffith, Principles of Mechanics, McGraw-Hill Book Company, INC, Second Edition, New York, 1949.

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<b>Course Name and Course code</b>	<b>GRAPH ALGORITHMS / MAT18R4036</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>II</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

### **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 Algorithmic 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.

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Course Name and Course code	<b>CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS /MAT18R4037</b>
Programme	<b>M.Sc. MATHEMATICS</b>
	<b>II</b>
Course Credit	<b>4</b>

<b>Course Type</b>	<b>Theory</b>
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**COURSE OBJECTIVES:**

In this course, students will be enabling 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.

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

**COURSE OBJECTIVES:**

In this course, students will be able 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:**

### **UnitI**

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.

### **UnitII**

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

Practical: related programs using the concepts.

### **UnitIII**

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

Practical: related programs using the concepts.

### **UnitIV**

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

Practical: related programs using the concepts.

### **UnitV**

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





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 - Permutations - 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 non distinct 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., New York, 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) Titu Andreescu and Zuming Feng, A Path to Combinatorics, Springer Science & Business Media, 2004.

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<b>Course Name and Course code</b>	<b>OPERATIONS RESEARCH / MAT18R5032</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>III</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

**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 Queuing system models, namely single server models and multiserver 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.

**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:**

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 constructionsof the time schedule - determination of floats.

**Unit III:**

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

**Unit IV:**

Classical optimization theory - unconstrained problems-necessary and sufficientconditions - 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 :**

HamdyA.Taha, Operations Research, An Introduction, Printice –Hall, SeventhEdition, 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,

6.6.3Unit 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,Pragatiprakashan, 1996.

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

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<b>Course Name and Course code</b>	<b>DIFFERENTIAL GEOMETRY / MAT18R5033</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>III</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

## COURSE OBJECTIVES:

In this course, students will be enabled 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 binormal - 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-Bonnet 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.

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<b>Course Name and Course code</b>	<b>CRYPTOGRAPHY / MAT18R5033</b>
<b>Programme</b>	<b>M.Sc. MATHEMATICS</b>
	<b>III</b>
<b>Course Credit</b>	<b>4</b>
<b>Course Type</b>	<b>Theory</b>

**COURSE OBJECTIVES:**

In this course, students will be able 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 Authentication Code (MAC).

5. Analyze Digital Signatures and its applications.

**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:**

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 Cryptanalysis - 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 Authentication 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.