GOVERNMENT ARTS COLLEGE (AUTONOMOUS) SALEM-7

Reaccredited with B Grade by NAAC

(Affiliated to Periyar University)

M.Sc. MATHEMATICS

Regulations and Syllabus

(Effective from the Academic Year 2021-2022)

VISION

The Department of Mathematics aims at holistic development through academic excellence, employability, acquisition of analytical skills and higher research.

MISSION

- To motivate the students in upgrading their interest in contemporary mathematical techniques.
- To strengthen the students analytical abilities in the field of mathematics.
- To learn new mathematics of their own.
- To provide students in General Education mathematics courses with substantive skills in quantitative and abstract reasoning and in the use of mathematics as a computational and analytical tool.
- To ignite a passion for learning and teaching at high levels

M.Sc. MATHEMATICS

PROGRAMME SPECIFIC OUTCOMES:

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

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

PO 1 : Demonstrate in-depth knowledge of Mathematics, both in theory and application.

PO 2 : Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.

PO 3 : Havestrong foundation in core areas of Mathematics and able to communicate Mathematics effectively .

PO 4 : Solve one dimensional Wave and Heat equations employing the methods in Partial Differential equations.

PO 5 : Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modeling to complex activities with an understanding of the limitations.

PO 6 : Present papers in seminars and conferences in order to defend their mathematical skills on various topics in the curriculum.

PO 7 : Provide knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in other scientific and engineering domains.

PO 8 : Equip the student with skills to analyze problems, formulate hypothesis, evaluate and validate results, so as to draw reasonable conclusions thereof.

PO 9 : Recognise the need to engage in lifelong learning through continuous education and research leading to higher degrees like Ph.D,D.Sc etc.

PO 10 : Present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematics.

Government Arts College (Autonomous), Salem-7

Curriculum Abstract of M.ScMathematics

Category	No. of Courses	Total Credits
Core Theory Courses	15	75
Core Practical Courses	01	03
Major Based Elective Courses	02	10
Research Acumen Courses	03	Nil
Interdisciplinary Course	01	02
Project Work	01	10
UGC-NET COMPONENTS OF CORE COURSES	04	Nil
TOTAL	27	100

Total No. of Courses : 27

Total Marks : 2600

Total Credits : 100

Signature of Board Chairman

GOVERNMENT ARTS COLLEGE(AUTONOMOUS), SALEM - 7
PG MATHEMATICS

For the candidates admitted from the academic year 2021-2022

S. No	Course Code	Title of the Course	Hours to be handled	Credits	Marks		
					I.A.	S.E.	Max
SEMESTER I							
1	21PMT01	Core Course – I : Abstract Algebra	6	5	25	75	100
2	21PMT02	Core Course – II : Real Analysis	6	5	25	75	100
3	21PMT03	Core Course – III : Ordinary Differential Equation	6	5	25	75	100
4	21PMT04	Core Course – IV : Classical Mechanics	6	5	25	75	100
5	21PMTM1	Calculus of Variation and Integral Equations	4	5	25	75	100
	21PMTM2	Mathematical Methods					
6	21RAC01	Research Acumen Course 1: Intellectual Property Rights	2	*			100
7		**UGC-NET components of Core Courses in Semester-I ****			50		50
Total Credits and Marks			**30**	**25**			**650**
SEMESTER II							
1	21PMT05	Core Course – V : Complex Analysis	6	5	25	75	100
2	21PMT06	Core Course – VI : Partial Differential Equations	6	5	25	75	100
3	21PMT07	Core Course – VII : Measure Theory and Integration	6	5	25	75	100
4	21PMT08	Core Course – VIII : Optimization Techniques	6	5	25	75	100
5	21PMTM3	Differential Geometry	4	5	25	75	100
	21PMTM4	Commutative Algebra					
6	21RAC02	Research Acumen Course II: Research Writing	2	*			100
7		**UGC-NET components of Core Courses in Semester-II ****			50		50
Total Credits and Marks			**30**	**25**			**650**
Cum - Total				**50**			**1300**

S. No.	Course Code	Title of the Course	Hours to be handled	Credits	Marks		
					I.A.	S.E.	Max
SEMESTER III							
1	21PMT09	Core Course – IX: General Topology	6	5	25	75	100
2	21PMT10	Core Course – X : Probability Theory	6	5	25	75	100
3	21PMT11	Core Course – XI : Graph Theory	6	5	25	75	100
4	21PMT12	Core Course – XII : Programming in R	6	5	25	75	100
5	21PECMT	Interdisciplinary Course : Mathematical Economics	2	2	25	75	100
6	21PMTPR	Project Work (to be continued in Semester IV)	4	--			
7		**UGC-NET components of Core Courses in Semester-III ****			50		50
Total Credits and Marks			**30**	**22**			**550**
Cum - Total				**72**			**1850**
SEMESTER IV							
1	21PMT13	Core Course – XIII : Functional Analysis	6	5	25	75	100
2	21PMT14	Core Course – XIV : Fuzzy Sets and Fuzzy Logic	6	5	25	75	100
4	21PMT15	Core Course – XVI : Number Theory	6	5	25	75	100
5	21PMTP1	Core Practical-I : R Programming	4	3	40	60	100
6	21RAC03	Research Acumen Course : Research and Publication Ethics	2	*			100
7	21PMTPR	Project Work	6	10	50	150	200
8		**UGC-NET components of Core Courses in Semester-IV ****			50		50
Total Credits and Marks			**30**	**28**	**--**	**--**	**750**
Grand Total of Credits and Marks				**100**			**2600**

*- Non Credit Course

**-Self Study

Enrollment in a minimum of one PG Non-Engineering MOOC Courses relevant to their subject offered through SWAYAM platform is mandatory. The students can enroll after getting permission from the Head of the Department. The students must obtain 40% marks in internal assessment. Besides, a student who wishes to get course completion certificate must necessarily enroll and pass in the examination conducted through SWAYAM platform.

SEMESTER - I

SEMESTER I

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT01	ABSTRACT ALGEBRA	**75**	**15**	**-**	**5**

OBJECTIVE

This course aims to provide an extended study to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called Direct-Product, Finite-Abelian Groups, Extension Fields and some related structures. Abstract algebra gives student a good mathematical maturity and enables to build mathematical thinking and skill.

LEARNING OUTCOMES

Students should achieve mastery of the topics listed below.

- This means that they should know all relevant definitions, correct statements of the major theorems (including their hypotheses and limitations), and examples and non-examples of the various concepts.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to these concepts, and by proving simple (but non-trivial) theorems about the below concepts, related to, but not identical to, statements proven by the text or instructor.

SYLLABUS

UNITI

Another Counting Principle – Sylow's Theorem – Direct product

Chapter -2, Sec: 2.11, 2.12 and 2.13

UNITII

Finite Abelian Groups – Polynomial Rings – Polynomial over the Rational Field – Modules

Chapter - 2, Sec: 2.14, Chapter -3, Sec: 3.9, 3.10, Chapter - 4, Sec: 4.5

UNITIII

Extension Fields – Roots of Polynomials

Chapter – 5, Sec: 5.1 and 5.3

UNITIV

The elements of Galois Theory – Solvability by Radicals – Galois Groups over the Rationals

Chapter -5, Sec: 5.6, 5.7 and 5.8

UNITV

Finite fields – Wedderburn's Theorem on Finite Division Rings – A Theorem of Frobenius

Chapter -7, Sec: 7.1, 7.2 and 7.3

TEXTBOOKS

I.N.Herstein, Topics in Algebra, Second edition, John Wiley Sons, New York, 2003

REFERENCE BOOKS

1. S.Lang, Algebra, Third edition, Addition-Wesley,Mass,1993

2. John B.Fraleigh, A first course in Abstract Algebra, Addition-Wesley,Mass,1982

3. M.Artin, Algebra, Prentice- Hall of India, NewDelhi.1991

WEBRESOURCES

1. en.wikipedia.org/wiki/

2. mathworld.wolfram.com

3. wiki.answers.comandothers

ASSIGNMENTS

Three Assignments can be given from the following topics

- Finite Abelian Groups
- Extension Fields
- Finite Fields

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

Sylow's Theorem and Galois Theory

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Know all relevant definitions, correct statements of the major theorems (including their hypotheses and limitations)	Understand
CO2	Provide the examples and non-examples of the various concepts.	Apply
CO3	Demonstrate their mastery by solving non-trivial problems related to theseconcepts	Apply
CO4	Proving simple (but non-trivial) theorems about the concepts, related to, but not identical to, statements proven by the text or instructor.	Apply
CO5	Differentiate the Structures with their properties and applications	Analyze

MAPPING WITHPROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	S	-	-	M	M	S	-	L
CO2	S	S	S	-	-	M	M	S	-	L
CO3	S	S	S	-	-	M	M	S	-	L
CO4	S	S	S	-	-	M	M	S	-	L
CO5	S	S	S	-	-	M	M	S	-	L

S- Strong; M-Medium; L-Low

SEMESTER I

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT02	REAL ANALYSIS	75	15	-	5

OBJECTIVES

Modern mathematics and physics rely on our ability to be able to solve equations, if not in explicit exact forms, then at least in being able to establish the existence of solutions. To do this it requires the knowledge of so-called "analysis", which in many respects is just Calculus in very general settings. The foundations for this work are commenced in Real Analysis the objective of the course is to develop the student mind in a systematic and rigorous manner in the context of real-valued functions of a real variable.

LEARNING OUTCOMES

At the end of this course, students should:

- understand the axiomatic foundation of the real number system, in particular understand the concepts of limits, continuity, compactness, differentiability, and integrability, rigorously defined;
- be able to use results and techniques involving these concepts to solve a variety of problems.
- have attained an advanced level of competency in developing their own mathematical arguments and communicating them to others in writing.

SYLLABUS

UNIT I : Riemann–Stieltjesintegral

The Riemann – Stieltjes integral - Definition and Existence of the integral – Properties of the integral integration and Differentiation- Integration of Vector valued Functions – Rectifiablecurves.

Chapter 6: Page No: 120 – 142

UNIT II : Sequences and seriesofFunctions

Sequences and Series of Functions – Discussion of main problem – Uniform Convergence - Uniform Convergence and Continuity - Uniform Convergence and Integration.

Chapter 7: Page No : 143-151

UNIT III : Sequences and seriesofFunctions

Uniform convergence and Differentiation - Equi-continuous families of functions – Stone Weierstrass Theorem.

Chapter 7: Page No:152-171

UNIT IV : Sequences andseriesof functions(contd.)

Some special Functions – Power series – The exponential and Logarithmic functions –The trigonometric functions.

Chapter 8: Page No: 172-184

UNIT V: SOMESPECIALFUNCTIONS

The algebra of completeness of the complex field – Fourier series – The Gamma function.

Chapter 8: Page No: 184 – 195

TEXT BOOKS

1. Walter Rudin- Principles of Mathematical Analysis, third edition, Me Graw Hill Book Co., kogakusha,1976.

REFERENCE BOOKS

1. T.M Apostol, Mathematical Analysis,Narosa publ. House,NewDelhi,1985.
2. H.L.Royde, Real Analysis, Macmillan Publ. Co..Fourthedition,NewYork 1993.
3. V.Ganapathy Iyer, Mathematical analysis, Tata McGraw Hill, NewDelhi1970.

WEB RESOURCES

1. *en.wikipedia.org/wiki/*
2. *mathworld.wolfram.com*
3. *wiki.answers.com*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Riemann-Stieltjes integral
- Sequences and Series
- Some Special Functions

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Mean Value Theorem
- Uniform convergence

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Identity the logic behind the execution of the Riemann Stieltjes integral ,Existence of the integral, Properties of the integral, identity the Rectifiable curves.	Knowledge
CO2	Analyze the field of sequences and series of functions, uniform convergence.	Apply
CO3	Develop the Equi-continuous families of functions , families of functions and Stone Weierstrass Theorem.	Analyze
CO4	Identify the special Functions, Power series , exponential , Logarithmic functions and trigonometric functions.	Knowledge
CO5	Develop the Fourier series and Gamma function	Analyze

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	M	M	S	M	S	S	M	M
CO2	S	S	S	M	M	S	S	L	L	M
CO3	S	S	M	M	M	L	S	M	M	M
CO4	M	M	S	S	M	L	L	M	S	S
CO5	S	S	M	M	M	L	L	S	S	M

S- Strong; M-Medium; L-Low

SEMESTER I

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT03	Ordinary Differential Equations	75	15	-	5

OBJECTIVE

Differential Equations occur frequently in many branches of science and in both pure and applied mathematics. The purpose of this course is make student to study the model changing patterns in both physical and mathematical problems.

LEARNING OUTCOMES

At the end of this course students will be able to

- Identify a system of linear equations (or linear systems) and describe its solution.
- Have to know the formula for Wronskian and solve the DE by Wronskian method.
- Find the general solution of second order linear homogeneous equation.
- Have to solve the linear differential equation with variable coefficient.
- Compute the solutions and properties of Legendre and Bessel's equations.
- Solve the DE by the method of successive approximations.

SYLLABUS

UNITI

Linear equations with constant coefficients- second order homogenous equationsInitial value problems- Linear dependence and independence-formula for Wronskian.

Chapter – 2, Sec: 1 to 5

UNITII

Non-homogenous equations of order two - Homogenous and non -homogenous equations of order n - Initial value problems - Annihilator method to solve a non-homogenous equation.

Chapter – 2, Sec: 6, 7, 8, 10 and 11

UNITIII

Initial value problems for homogenous equations - Solutions of homogenous equations – Wronskian and linear independence – Reduction of the order of homogenous equation.

Chapter - 3, Sec: 1 to 5

UNITIV

Linear equation with regular singular points- Euler equation- Second order equations with regular singular points – Solution and properties of Legendre Bessel equations.

Chapter -3, Sec: 8, Chapter - 4, Sec: 1 to 4, 7 and 8

UNITV

Existence and uniqueness of solutions to first order equations-Equations with variables separated – Exact equations – Method of successive approximation and the existence theorem.

Chapter -5, Sec: 1 to 4 and 6

TEXTBOOKS

1. E.A. Coddington, An introduction to Ordinary Differential Equations, Prentice – Hall of India Ltd., New Delhi,1994

REFERENCE BOOKS

1. P. Hartman, Ordinary Differential Equations, JohnWiley,1964.
2. R.P. Agarwal and Ramesh C. Gupta, Essentials of Ordinary Differential Equations, McGraw Hill,1991.

WEB RESOURCES

1. *en.wikipedia.org/wiki/*
2. *mathworld.wolfram.com*
3. *wiki.answers.com*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Initial value problems
- Legendre Bessel Equations
- Existence and Uniqueness of Solutions

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Reduction of the order of homogenous equations
- Method of Successive approximation

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Identify a system of linear equations (or linear systems) and describe its solution. Have to know the formula for Wronskian and solve the DE by Wronskian method.	Understand
CO2	Find the general solution of second order linear homogeneous equation and know annihilator method to solve non homogeneous equation.	Understand
CO3	Have to solve the linear differential equation with variable coefficient.	Apply
CO4	Compute the solutions and properties of Legendre and Bessel's equations.	Apply
CO5	Solve the DE by the method of successive approximations.	Apply

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	M	L	-	L	S	S	M	M	S
CO2	M	M	M	-	M	S	S	M	M	S
CO3	S	S	M	-	M	S	S	S	L	S
CO4	S	S	M	-	M	S	S	S	M	S
CO5	S	S	S	-	S	S	S	S	M	S

S- Strong; M-Medium; L-Low

SEMESTER –I

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture (L)	Tutorial (T)	Practical (P)	Credit
21PMT04	CLASSICAL MECHANICS	75	15	-	5

OBJECTIVE

The purpose of this course is to learn and understand principles of mechanics. Topics include: Mechanical system, Lagrange's equation, Hamilton's equations, Hamilton-Jacobi equation and Canonical transforms. And also is to provide the students the necessary analytical skills to solve the variety of Dynamical system of equations and related problems.

LEARNING OUTCOMES

Students who successfully complete the course will demonstrate the following outcomes by tests and homework.

1. An ability to identify the mechanical systems, constraints, virtual work and energy and momentum.
2. An ability to predict the Lagrange's equation, derivative of Lagrange's equation and examples of integral of motions.
3. Knowledge of Hamilton's principle and Hamilton's equation.
4. An ability to use the Hamilton's-Jacobi theory and Hamilton's principle in Hamilton Jacobi equation.
5. An exposure to canonical transforms, differential forms and generating functions, especially Lagrange and Poisson Brackets.

SYLLABUS

UNIT I:Mechanical System

The mechanical system – Generalized Co-ordinates – Constraints – Virtual work – Energy and momentum

Chapter 1: Sec 1.1 to 1.5

UNIT II:Lagrange'sEquations

Lagrange's Equation – Derivative of Lagrange's equations- Example Integrals of motion

Chapter 2: Sec 2.1 to 2.3

UNIT III:Hamilton'sEquation

Hamilton's Equations – Hamilton's Principle- Hamilton's Equation.

Chapter 4: Sec 4.1 to 4.3

UNIT IV:Hamilton-JacobiEquations

Hamilton-Jacobi Theory - Hamilton Principle Function – Hamilton- Jacobi Equation.

Chapter 5: Sec 5.1 to5.3

UNIT V:CanonicalTransforms

Canonical Transforms – Differential forms and generating functions – Lagrange and Poisson Brackets.

Chapter 6: sec 6.1 to6.3

TEXT BOOK

1. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

REFERENCE BOOKS

1. H. Goldstein, Classical Mechanics, Narosa Publishing House, NewDelhi,2001.
2. J.L.Synge and B.A.Griffth, Priniciples of Mechanics,Mc Graw Hill Book Co.New York,1970.
3. N.C.RaneandP.S.C.Joga, Classical Mechanics,TataMcGrawHill,NewDelhi,1991.

WEB RESOURCES

1. *en.wikipedia.org/wiki/*
2. *mathworld.wolfram.com*
3. *wiki.answers.com*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Lagrange's Equation
- Hamilton's Equation
- Hamilton – Jacobi Equation

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- The Mechanical System
- Canonical Transforms

COURSE OUTCOMES

On successful completion of the course, students will be able to

S.No	Course Outcome	Blooms Verb
CO1	Understand the fundamentals of mechanical systems, constraints, virtual work and energyand momentum.	Remember
CO2	Providethe Lagrange's equation, derivative of Lagrange's equation and examples of integral of motions.	Apply
CO3	Comprehend the concepts of Hamilton's principle and Hamilton's equation.	Understand
CO4	Identify the Applications of Hamilton's-Jacobi theory and Hamilton's principle in Hamilton Jacobi equation.	Analyze
CO5	Explore the concepts of canonical transforms, differential forms and generating functions, especially Lagrange and Poisson Brackets.	Evaluate

MAPPING WITH PROGRAMME OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	L	L	S	M	M	L	M	S
CO2	S	S	L	L	S	M	M	S	L	S
CO3	S	S	L	L	S	M	M	S	L	L
CO4	S	S	L	L	S	M	M	L	S	M
CO5	S	S	L	L	S	M	M	L	S	L

S-Strong; M-Medium; L-Low

SEMESTER I

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMTM1	CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS	55	5	-	5

OBJECTIVE

Calculus of variations and integral equations play an important role in both pure and applied mathematics. The objective is to provide an introduction to the central ideas of variational problems and integral equations and to guide students through derivations of appropriate integral equations governing the behavior of several standard physicalproblems.

LEARNING OUTCOMES

After completion of these chapters students are expected to

- Analyze and solve various fundamental problems in calculus of variation.
- Demonstrate knowledge and understanding of variational problem with a movable boundary.
- Demonstrate knowledge and understanding of One-Sided Variations, Reflection and Refraction of externals.
- Examine the theory of integral equations and their applications.
- Classify the solution of real life modeling problems.
- Apply the solution type to most common special functions in science and engineering

SYLLABUS

UNIT I : Variational problems withfixedboundaries

The concept of variation and its properties – Euler's equation – Variational problems for Functionals– Functionals dependent on higher order derivatives – Functions of several independent variables – Some applications to problems of Mechanics.

Chapter 1: Sections 1.1 to 1.7 of [1]

UNIT II : Variational problems withmovingboundaries

Movable boundary for a functional dependent on two functions – one-side variations – Reflection and Refraction of externals – Diffraction of light rays

Chapter 2: Sections 2.1 to 2.5 of [1]

UNIT III: IntegralEquation

Introduction – Types of Kernels – Eigen Values and Eigen functions – Connections with differential equation – Solution of an integral equation – Initial value problems – Boundary value problems.

Chapter1: Sections 1.1 to 1.3 and 1.5 to 1.8 of [2]

UNIT IV : Solution of Fredholmintegralequation

Second kind with separable kernel – Orthogonality and reality eigen function – Fredholm Integral equation with separable kernel – Solution of Fredholm integral equation by successive substitution – Successive approximation – Volterra Integral equation – Solution by successive substitution.

Chapter 2: Sections 2.1 to 2.3 and Chapter 4: Sections 4.1 to 4.5 of [2]

UNIT V :Hilbert–Schmidt Theory

Complex Hilbert space – Orthogonal system of functions – Gram Schmitt orthogonolization process –

Hilbert – Schmidt theorem – Solutions of Fredholm integral equation of first kind.

Chapter 3: Sections 3.1 to 3.4 and 3.8 to 3.9 of [2]

TEXTBOOKS

1. A. G. Gupta, Calculus of Variation with Application, Prentice Hall of India, NewDelhi,2005
2. K. Pundir and Rimple Pundir, Integral Equations and Boundary Value Problems, Pragati Prakasam, Meerut,2005

REFERENCEBOOKS

1. F. B. Hildebrand, Methods of Applied Mathematics, Prentice – Hall of India Pvt. NewDelhi,1968
2. R. P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York, 1971
3. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers,Moscow,1973.

WEBRESOURCES

1. *en.wikipedia.org/wiki/*
2. *mathworld.wolfram.com*
3. *wiki.answers.com/help/asking_questions*.

ASSIGNMENTS

Three Assignments can be given from the following topics

- Integral Equation
- Solution of Fredholm integral equation
- Hilbert-Schmidt Theory

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Variational problems with fixed boundaries
- Variational problems with moving boundaries

COURSEOUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Define Variational problems with fixed boundaries.	Understand
CO2	Illustrate the Variational problems with moving boundaries.	Understand
CO3	Demonstrate Integral Equation.	Apply
CO4	Implement method for Solution of Fredholm integral equation.	Apply
CO5	Evaluate Hilbert – Schmidt Theory	Apply

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	M	S	M	S	S	S	M	M	S
CO2	M	S	S	S	M	S	M	M	M	S
CO3	M	S	M	M	S	M	S	S	L	M
CO4	S	S	S	M	M	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	M	S

S- Strong; M-Medium; L-Low

SEMESTER-I

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture (L)	Tutorial (T)	Practical (P)	Credit
21PMTM2	**MATHEMATICAL METHODS**	55	5	-	5

OBJECTIVE

The purpose of this course is to understand the concepts of fourier transform in signals from the continuous time domain to the corresponding frequency domain and to apply the mellin's transform in time series models and Also finite fourier transform of various analytical techniques in which exact solutions of boundary value problems canbe constructed.

LEARNING OUTCOMES

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

- Apply the basic knowledge of Fourier Sine and Cosine transforms,Fourier transforms of derivatives,
- Fourier transforms of simple functions,Solution of PDE by Fourier transform.
- Apply the acquired knowledge of Mellin Transforms of derivatives and Integrals.
- Apply the acquired knowledge of Parseval Relation for Kontorovich-Lebedev Transforms.

SYLLABUS

UNIT I:FOURIERTRANSFORMS

Fourier Sine and Cosine transforms-Fourier transforms of derivaties- Fourier transforms of simple functions-Convolution integral-Parsevals's Theorem-Solution of PDE by Fourier transform-Laplace equation in half plane,in infinite srrips,insemi infinite strip-The Linear diffusion equation on a semi infinite line.

Chapter 2 :Section 2.4-2.7,2.9-2.10,2.16-2-(a).(c)2.16

UNIT II: THEMELLINTRANSFORM

Elementary Properties of the Mellin Transform-Mellin Transforms of derivatives and Integrals-The Mellin Inversion Theorem-Convolution Theorems for the Mellin Transform-The Solution of SomeIntegral Equations.

Chapter 4 : Section 4.1-4.5

UNIT III:HANKELTRANSFORMS

Properties of Hankel Transforms-Hankel transformation of derivatives of functions-Hankel Inversion Theorem (Statement only) - The Parseval's relation-Relation between parseval's equation and hanklel transform

Chapter 5 : 5.2-5.4,5.6-5.7,5.10-5.12

UNIT IV:THEKONTOROVICH-LEBEDEVTRANSFORM

The Kontorovich-Lebedev Transform-An Operational Proof of the Inversion Formula-Parseval Relation for Kontorovich-Lebedev Transforms-Functions Which are Harmonic in an Infinite Wedge.

Chapter 6 : Section 6.2-6.5

UNITV:FINITETRANSFORMS

Finite Fourier Transforms-Generalized Finite Fourier Transforms-Finite Hankel Transforms.

Chapter 8 : Section 8.1,8.3,8.4

TEXT BOOKS

1. The Use of Integral Transforms by I.N.Sneddon, Tata McGraw Hill Publishing Company, NewDelhi,TMH Edition 1974.

REFERENCE BOOKS

1. The Fourier Transform and its Applications 3 rd Edition by RonaldBracewell
2. Handbook of Mellin Transforms 1 st Edition by Yu.A.Brychkov , O.I.Marichev , N.V.Savischenko**.**
3. Application of Mellin and Hankel Transforms to Network with Time -Varying Parameters F.Gerardi ,Douglas Aircraft Company, SantaMonica,USA

WEB RESOURCES

1. *https://en.m.wikipedia.org/wiki/Fourier sine andcosinetransform.*
2. *https://en.m.wikipedia.org/wiki/Mellin'sTransform*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Solution of PDE by Fourier transform
- Mellin Transforms of derivatives and Integrals
- Hankel transformation of derivatives of functions

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- The Kontorovich-Lebedev Transform
- Finite Fourier Transforms

COURSE OUTCOMES

On successful completion of the course, students will be able to

S.No	Course Outcome	Blooms Verb
CO1	Understand the concept of Fourier Sine and Cosine transforms,Fourier transforms of derivatives	Remember
CO2	Provide the Fourier transforms of simple functions,Solution of PDE byFourier transform.	Apply
CO3	Concept of Mellin Transforms of derivatives and Integrals	Understand
CO4	Identify the Applications of Parseval Relation for Kontorovich-Lebedev Transforms	Analyze
CO5	Explore the concepts of finite Fourier Transforms-Generalized Finite Fourier Transforms	Evaluate

MAPPING WITH PROGRAMME OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	L	L	S	M	M	L	M	S
CO2	S	S	L	L	S	M	M	S	L	S
CO3	S	S	L	L	S	M	M	S	L	L
CO4	S	S	L	L	S	M	M	L	S	M
CO5	S	S	L	L	S	M	M	L	S	L

S-Strong; M-Medium; L-Low

SEMESTER I

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21RAC01	RESEARCH ACUMEN COURSE-I: INTELLECTUAL PROPERTY RIGHTS	SELF STUDY COURSE			

OBJECTIVE

This course aims to provide an introductory study to the subject of Intellectual Property Rights, which is one of the basic pillars of modern Research and Development. The focus of the course will be the study of certain structures called Patents, Copyrights and related rights, Trademarks, Geographical Indications, Industrial designs, Layout Designs of integrated circuits, Trade Secrets and Plant Varieties. Introduction to IPR gives to student a good maturity and enables to build intellectual thinking and skill.

SYLLABUS

UNIT I : Introduction to Intellectual Property Rights

International Intellectual Property Regime - New dimensions and issues for Resolution - IPR in developing countries - Impact of stronger IPR in developing countries – World Intellectual Property Day

UNIT II : Categories of Intellectual property Rights

Patents – Patentable invention – Not-patentable inventions - Patent application - Form of application - Types of patent specification - Contents of specification

UNIT III : Procedure for obtaining patents

Publication - Request for examination – Examination - Search for anticipation by previous publication and by prior claim - Opposition proceedings to grant of patents.

UNIT IV : Grant of patents

Grant of patents to be subjected to certain conditions - Rights of patentee - Register of patents - Renewal fee – Restoration - Drafting of patent specification in patent application - Parts of the complete specification

UNIT V : Claims of IPR

Function of claims - Categories of claim – Categories of claim - Independent and dependent claims- Number of claims - Form of claims- The scope of the claims

WEB RESOURCES

1. Open Source Book "Introductroy **Intellectual Property Rights" by** Sakthivel Lakshmana Prabu, Timmadonu Narasimman Kuppusami Suriyaprakash and Rathinasabapathy Thirumurugan, (*http://dx.doi.org/10.5772/intechopen.69359*)

2. OpenSourceBook"HAND BOOK ON INTELLECTUAL PROPERTY RIGHTS ININDIA"by

Rajkumar S. Adukia(*http://rishabhacademy.com*)

3. Open Source Book "HANDBOOK ON INTELLECTUAL PROPERTY RIGHTS - Basic information on concepts related to Intellectual Property Rights – 3rd Edition" by Origiin IP Solutions LLP (*http://www.origiin.com,http://www.origiinipa.com*)

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	know what is IPR and Origin and Development of IPR of the ModernWorld	Understand
CO2	differentiate the different categories of IPR	Analyze
CO3	Know the procedure for obtaining IPR and related issues	Understand
CO4	draft content specification for the Application for the Grant of Patent	Apply
CO5	Know the categories of Claims of IPR and its Forms for Application	Understand

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	S	-	-	-	-	-	-	-
CO2	S	S	S	-	-	-	-	-	-	-
CO3	S	S	S	-	-	-	-	-	-	-
CO4	S	S	S	-	-	-	-	-	-	-
CO5	S	S	S	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

SEMESTER II

SEMESTER II

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT05	**COMPLEX ANALYSIS**	**75**	**15**	**-**	**5**

OBJECTIVE

This course aims to provide an extended study to the subject of complex analysis, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of analytic functions, properties of power series, mappings, evaluation of complex integration by Cauchy's residue theorem. Complex Analysis gives to student a good mathematical maturity and enables to build mathematical thinking and skill.

LEARNING OUTCOMES

Students should achieve mastery of the topics listed below. This means that they should

- know all relevant definitions, correct statements of the major theorems (including their hypotheses and limitations), and examples and non-examples of the various concepts.
- be able to demonstrate their mastery by solving non-trivial problems related to these concepts, and by proving simple (but non-trivial) theorems about the below concepts, related to, but not identical to, statements proven by the text or instructor

SYLLABUS

UNITI:**Complex Functions**

Spherical representation of complex numbers – Analytic functions – Limits and continuity – Analytic functions – Polynomials – Rational functions – Elementary Theory of power series – sequences – series – Uniform convergence – Power series – Abel's limit theorem – Exponential and Trigonometric function – Periodicity – the logarithm.

Chapter - 1, Sec: 2.4 and Chapter -2: Sec: 1 to 3

UNIT II :Analyticalfunctions as mappings

Analytical functions as mappings – Co formality – Arcs and closed curves – Analytic functions in Regions – Conformal mapping – Length and area – Linear transformations – Linear group – Cross ratio – Symmetry – Oriented circles – Families of circles – Elementary mappings – Elementary Riemann surfaces.

Chapter -3: Sec: 2 to 4

UNITIII:Complex Integration

Complex Integration – Fundamental Theorems – Line Integrals - Rectifiable Arcs – Line Integrals as Arcs – Cauchy's Theorems for a rectangle and in a Disk – Cauchy's integral Formula – Index of a point with respect to a closed curve – The integral formula – Higher order derivatives – Local properties of analytic functions – Taylor's

Theorem – Zeros and Poles – Local mapping – Maximum Principle.

Chapter - 4: Sec: 1 to 3

UNIT IV:Complex Integration(Contd.)

The General form of Cauchy's Theorem – Chains and Cycles – Simple Connectivity – Homology – General statement of Cauchy's theorem – Proof of Cauchy's theorem – Locally exact differentials – Multiply connected regions – Calculus of residues – Residue Theorem – Argument Principle – Evaluation of definite integrals.

Chapter - 4: Sec: 4 to 5

UNIT V : Harmonic functionsandPower Series expansions

Harmonic Function – Definition and basic properties – Mean-ValueProperty–Poisson's formula – Schwarz's theorem – Reflection Principle – Weierstrass's theorem – Taylor's series –Laurentseries.

Chapter -4: Sec: 6 and Chapter -5: Sec: 1

TEXT BOOKS

1. L.V. Ahlfors, Complex Analysis, 3rd edition, Mc Graw Hill Inter., Edition, New Delhi,1979.

REFERENCE BOOKS

1. J.B. Conway, Functions of One Complex Variable, arosa Publ. House, NewDelhi1980.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publ. House, NewDelhi2004.
3. S. Lang, Complex-Analysis, Addison-WesleyMass,1977.

WEB RESOURCES

1. *en.wikipedia.org/wiki/Wikipedia*
2. *mathworld.wolfram.com*
3. *wiki.answers.com/help/asking_questions.*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Analytical functions as mappings
- Complex Functions
- Harmonic functions and Power series expansion

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Complex Integration – Cauchy's Integral Theorem
- Complex Integration – Cauchy's Residue Theorem

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Identity the Analytic functions, power series, – Exponential and Trigonometric function.	Knowledge
CO2	Analyze the Cross ratio, conformal mapping and elementary Riemann surfaces.	Apply
CO3	Develop the Cauchy's integral Formula, Taylor's Theorem and Maximum Principle.	Analyze
CO4	Identity chains and Cycles, Simple Connectivity, Locally exact differentials , Multiply connected regions.	Knowledge
CO5	Develop the Harmonic Functions, Taylor's series and Laurent series	Analyze

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	S	M	S	M	L	M	S	S
CO2	M	M	S	M	M	S	M	S	L	S
CO3	S	S	M	M	S	S	M	M	L	L
CO4	M	S	S	M	M	S	S	L	L	M
CO5	M	M	M	S	S	M	M	L	M	M

S- Strong; M-Medium; L-Low

SEMESTER II

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT06	**Partial Differential Equations**	**75**	**15**	**-**	**5**

OBJECTIVE

The purpose of the course is to make students to master techniques for solving PDE's, along with an understanding of crucial properties such as well-posedness, existence and uniqueness of solutions, etc. The latest results on modeling, analysis and simulations for partial differential equations that appear as novel mathematical models in many emerging areas of the social and life sciences and to encourage interactions and target new interesting problems and applications.

LEARNING OUTCOMES

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Have a sound knowledge of second order PDE reducible to canonical forms and Riemann's method.
- Have a sufficient exposure to get the solution of Laplace equation and poison's equation, Dirichlet, Neumann's problem for sphere and circle.
- Have an idea of Boundary conditions, separation of variables method and diffusion equation in cylindrical and spherical coordination.
- Have an idea of D'Alemberts solution, Duhamel's principle and also wave equation its periodic solution in cylindrical and spherical polar coordinates.
- Have knowledge of Laplace transform and Fourier transform and their applications to PDE such as Laplace, diffusion and wave equation.

SYLLABUS

UNIT I : Second OrderPartialDifferential Equations

Origin of second order partial differential equations – Linear partial differential equations with constant coefficients – Method of solving partial (linear) differential equation – Classification of second order partial differential equations – Canonical forms – Adjoint operators – Riemann Method.

Chapter 2: Section 2.1 to 2.5

UNIT II : EllipticDifferentialEquations

Elliptic differential equations – Occurrence of Laplace and Poisson equations – Boundary value problems – Separation of variables Method – Laplace equation in cylindrical – Spherical co-ordinates, Dirichlet and Newman problems for circle-sphere.

Chapter 3: Section 3.1 to 3.9

UNIT III : ParabolicDifferentialEquations

Parabolic differential equations – Occurrence and derivation of the Diffusion equation – Boundary condition - Separation of variable method – Diffusion equation in cylindrical – Spherical co-ordinates.

Chapter 4: Section 4.1 to 4.5

UNIT IV : HyperbolicDifferentialEquations

Hyperbolic Differential Equations – Occurrence of Wave equation – One dimensional Wave equation – Reduction to Canonical form – D' Alembert's Solution – Separation of Variable Method – PeriodicSolutions – Cylindrical Spherical Co-ordinates – Duhamel Principle for Wave equations.

Chapter 5: Sections 5.1 and 5.6 and Section 5.9

UNIT V :IntegralTransform

Laplace transforms - Solution of partial differential equation – Diffusion equation – Wave equation – Fourier Transform – Application to partial differential equation – Diffusion equation – Wave equation – Laplace equation.

Chapter 6: Section 6.2 to 6.4

TEXTBOOKS

1. J.N. Sharma and K. Singh, Partial Differential Equation for Engineers and Scientists. Narosa Publication House,Chennai,2001.

REFERENCE BOOKS

1. I.N. Snedden, Elements of Partial Differential Equations, McGraw Hill,Newyork1964
2. K. Sankar Rao, Introduction to Partial Differential Equations, Prentice Hall of India, New Delhi, 1955.
3. S.J. Farlow, Partial Differential Equations for Scientists and Engineers, John Wiley's sons,New York, 1982.

WEB RESOURCES

1. en.wikipedia.org/wiki/Wikipedia

2.*mathworld.wolfram.com*

3.*wiki.answers.com/help/askingquestions.*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Elliptic Differential Equations
- Parabolic Differential Equations
- Hyperbolic Differential Equations

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Second order Partial Differential Equation
- Integral Transforms

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Have a sound knowledge of second order PDE reducible to canonical forms and Riemann's method.	Remember
CO2	Have a sufficient exposure to get the solution of Laplace equation and Poisson equation, Dirichlet, Neumann's problem for sphere and circle.	Apply
CO3	Have an idea of Boundary conditions, separation of variables method and diffusion equation in cylindrical and spherical coordination.	Apply
CO4	Have an idea of D'Alemberts solution, Duhamel's principle and also wave equation its periodic solution in cylindrical and spherical polar coordinates.	Apply
CO5	Have knowledge of Laplace transform and Fourier transform and their applications to PDE such as Laplace, diffusion and wave equation.	Apply

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	M	S	M	-	S	S	S	M	M	S
CO2	S	S	M	-	S	S	M	S	M	S
CO3	S	S	M	S	S	S	M	S	M	S
CO4	S	S	M	S	S	S	M	S	M	S
CO5	S	S	M	-	M	S	M	S	M	S

S- Strong; M-Medium; L-Low

SEMESTER II

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT07	MEASURE THEORY AND INTEGRATION	75	15	-	5

OBJECTIVE

It was designed for Post Graduate students to understand the measures and integration. The integral has the advantage that one can give specific formulas for integrand .It gives thorough treatment of integration and different ion on R together with fundamentals of abstract measure and integration.

LEARNING OUTCOMES

At the end of this course

- The Students can understand the measurable sets and lebegue measure.
- The leaner can understand lebegue integral and measurable functions.
- How to apply these spaces in space theory

SYLLABUS

UNIT I :LebesgueMeasure

Lebesgue Measure – Introduction – Outer measure – Measurable sets and Lebesgue measure – Measurable functions – Little Wood's Three Principle.

Chapter 3: Sec: 1 to 3, 5 and 6

UNIT II :LebesgueIntegral

Lebesgue Integral – The Riemann integral – Lebesgue integral of bounded – The general Lebesgue integral.

Chapter 4: Sec: 1 to 4

UNIT III : DifferentiationandIntegration

Differentiation and Integration – Differentiation of monotone functions – Functions of bounded variation –

Differentiation of an integral Absolute continuity.

Chapter 5: Sec: 1 to 4

UNIT IV : General MeasureandIntegration

General Measure and Integration – Measure spaces – Measurable functions – integration – General convergence theorem – Signed Measure – The Radon – Nikodym theorem.

Chapter 11: Sec: 1 to 3, 5 and 6

UNIT V : : Measure andOuter Measure

Measure and Outer measure – Outer measure and measurability – The Extension theorem – Product measures.

Chapter 12: Sec: 1, 2 and 4

TEXTBOOKS

1. L. Royden, Real Analysis, MC Millan Publication Company, New York 1993 Books

REFERENCE BOOKS

1. G. de Barn, Measure Theory and Integration, Wiley EasternLtd.,1981.
2. P. K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age Int. (P) Ltd., New Delhi, 2000.
3. Watter Rudin, Real and Complex Analysis, Tata McGraw Hill Publication Company Ltd., New Delhi,1996.

WEBRESOURCES

1. en.wikipedia.org/wiki/Wikipedia

2. mathworld.wolfram.com

3. wiki.answers.com/help/asking_questions.

ASSIGNMENTS

Three Assignments can be given from the following topics

- Lebesgue Measure
- Lebesgue Integral
- Measure and Outer Measure

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Differentiation and Integration
- General Measure and Integration

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Understand the measurable sets and lebegue measure.	Understand
CO2	Understand the Riemann integral , Lebesgue integral.	Understand
CO3	Have knowledge on differentiation of monotone functions	Remember
CO4	Understand lebegue integral and measurable functions	Apply
CO5	Apply these spaces in space theory.	Apply

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	M	-	S	S	S	M	M	M
CO2	L	M	S	-	M	S	S	S	L	M
CO3	M	S	M	-	M	M	S	M	M	M
CO4	M	S	S	-	S	S	S	S	L	S
CO5	M	M	M	-	M	M	S	M	M	M

S- Strong; M-Medium; L-Low

SEMESTER II

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT08	OPTIMIZATION TECHNIQUES	75	15	-	5

OBJECTIVE

This module aims to introduce students to use techniques for effective decisions–making; model formulation and applications that are used in solving business decision problems. Operations research helps in solving problems in different environments that needs decisions. The Syllabus module cover topics that include: Integer programming and Dynamic Programming, Inventory Models, Queuing Theory and Classical optimization Theory and Non linear Programming.

LEARNING OUTCOMES

Students who successfully complete the course will demonstrate the following outcomes by tests and homework.

- An ability to solve integer programming, some applications of integer programming, cutting plane algorithm and Dynamic Programming, DP models, problem of dimensionality in dynamic programming.
- An ability to predict the Decisions under risk, decision trees and Games theory.
- Knowledge of inventory models like ABC Inventory System, A Generalized Inventory Model-Deterministic models, Single Item static model with price breaks and Single Item N-period dynamic model.
- An ability to use the basic elements of the queuing model, Roles of the Poisson and exponential distributions and queues with combined arrivals and departures.
- An exposure to classical optimization theory and non linear programming.

SYLLABUS

UNIT I : Integer Programming andDynamicProgramming **15 + 3 HOURS**

Integer programming-some applications of Integer programming-methods of Integer programming-cutting plane algorithms-Branch and Bound method-zero- one implicit enumeration. Dynamic Programming-Elements of DP Model-The Capital Budgeting problem-Definition of the state-Examples of DP Models and computations-Problem of Dimensionality in Dynamic Programming-Solution of L.P.P. by Dynamic Programming.

Chapter 8 and 9

UNIT II:InventoryModels **15 +3 HOURS**

The ABC Inventory System-A Generalized Inventory Model-Deterministic models-Single Item static model-Single Item static model with price breaks-Multiple item static model with storage limitation- Single Item N-period dynamic model.

Chapter 13

UNIT III: MarkovianDecisionProcess **15 +3 HOURS**

Scope of Markovian decision process- Finite Stage decision process- Infinite stage model- Exhaustive enumeration method- Policy iteration method without discounting- Policy iteration method with discounting.

Chapter 14

UNIT IV:QueuingTheory **15 +3 HOURS**

Basic elements of the queueing model-Roles of the Poisson and exponential distributions-queues with combined arrivals and departures-(M/M/1):(GD/∞/∞)-(M/M/1):(GD/N/∞)-(M/G/1):(GD/∞/∞) . ThePollaczek- khintchine formula - (M/M/C):(GD/∞/∞) - (M/M/C):(GD/N/∞), C≤N - (M/M/∞) :(GD/∞/∞) selfService Model. Chapter 15

UNIT V: Classical optimization Theory and NonlinearProgramming **15 +3 HOURS**

Unconstrained extremal problems-Necessary and sufficient conditions for extrema -The Newton Raphson method- Constrained extremal problems-Equality constraints and unequality constraints. Unconstrained non linear algorithms-Direct search method-Gradient method.

Chapter 18 and 19

TEXTBOOKS

1. Hamdy.A.Taha, Operations Research-An introduction, Fourth Edition, Macmillan Publishing Company, New York,1987.

REFERENCE BOOKS

1. F.S.Hillier and G.J. Lieberman, Introduction to Operations Research 4th Edition, McGraw Hill Book Company, New york, 1989.
2. Philips D.T., Ravindra A. and Solberg J., Operations Research, Principles and Practice, John Wiley and Sons, Newyork,1991.
3. B.E. Gillett, Operation Research-A Computer Oriented Algorithmic Approach, Tata McGraw Hill, NewDelhi,1976.

WEBRESOURCES

1. *en.wikipedia.org/wiki/Wikipedia*
2. *mathworld.wolfram.com*
3. *wiki.answers.com/help/asking_questions.*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Decision Theory and Games
- Inventory Models
- Queuing Theory

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Integer Programming and Dynamic Programming
- Non-linear Programming

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	An ability to solve integer programming, some applications of integer programming, cutting plane algorithm and Dynamic Programming, DP models, problem of dimensionality in dynamic programming.	Remember
CO2	Knowledge of inventory models like ABC Inventory System, A Generalized Inventory Model-Deterministic models, Single Item static model with price breaks and Single Item N-period dynamic model.	Understand
CO3	Scope for Markovian decision process in the finite stage and infinite stage decision model. Policy iteration method with and without discounting.	Apply
CO4	An ability to use the basic elements of the queuing model, Roles of the Poisson and exponential distributions and queues with combined arrivalsand departures.	Analyze
CO5	An exposure to classical optimization theory and non linear programming.	Evaluate

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	S	M	M	M	S	S	S	M
CO2	S	S	S	M	M	M	M	M	S	M
CO3	S	S	M	M	L	S	S	M	S	M
CO4	S	S	M	S	S	S	M	M	S	M
CO5	S	S	S	M	M	L	M	L	S	L

S- Strong; M-Medium; L-Low

SEMESTER II

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMTM3	**DIFFERENTIAL GEOMETRY**	**55**	**5**	**-**	**4**

OBJECTIVE

The purpose of the course is to learn the concept of theory of space curves, the first fundamental form and local intrinsic properties of a surface and geodesics on a surface. This course aims to acquaint the students with various topics of Differential geometry.

LEARNING OUTCOMES

On successful completion of the chapters, students should be able to:

- Define a surface.
- Understand the shape operator.
- Derive Serret –Frenet Formula.
- Define the different types of curvatures and understand their properties and uses.
- Define minimal surfaces and geodesics.
- Deduce simple properties from any definitions or theorems given in the course.

SYLLABUS

UNIT I : TheoryofSpace Curves

Theory of space curves - Representation of space curves – unique parametric representation of a space curve - Arc – length –tangent and oscillating plane – principal normal and bi normal – curvature and torsion - Behaviour of a curve near one of its points - the curvature and torsion of a curve as the intersection of two surfaces

Chapter 1 , section 1.1 to 1.9

UNIT II : Theory of SpaceCurves(contd)

Contact between curves and surfaces - Oscillating circle and Oscillating sphere - Locus of center of Spherical curvature - Tangent surfaces - Involutes and Evolutes – Intrinsic equations of space curves - Fundamental Existence Theorem-Helices.

Chapter 1: sections 1.10 to 1.18

UNIT III : Local Intrinsic properties ofasurface

Definition of a surface - Nature of points on a surface - Representation of a surface - Curves on surfaces - Tangent plane and surface normal - The general surface of revolution - Helicoids – Metric on a surface – Direction coefficients on a surface.

Chapter 2: section 2.1 to 2.10

UNIT IV : Local intrinsic properties of surface and geodesic onasurface

Families of Curves – Orthogonal trajectories - Double family of curves - isometric correspondence – intrinsic properties –Geodesicsand their differential equation – Canonical geodesic equation – Geodesics on surfacerevolution.

Chapter 4: section 2.11 to 2.15 and Chapter 3: section 3.1 to 3.4

UNIT V : Geodesics

Normal property of geodesics - Differential equations of geodesics using normal property – Existence theorems - Geodesic parallels – Geodesic curvature – Gauss – Bonnet theorems – Gaussian curvature –Surface of constant curvature .

Chapter 3: section 3.5 to 3.8 and section 3.10 to 3.13

TEXT BOOKS

1. D.Somasundaram, Differential Geometry, Narosa publ. House, Chennai, 2005

REFERENCE BOOKS

1. T.willmore, An introduction to Differential Geometry, Clarendanpress Oxford,1959.
2. D.T.Struik , lectures on Classical Differential Geometry, Addison-Wesely,Mass.1950.
3. J.A.Thorpa , Elementary Topics in Differential Geometry, Springer, Verlag, NewYork,1979.

WEB RESOURCES

1. *en.wikipedia.org/wiki/Wikipedia*
2. *mathworld.wolfram.com*
3. *wiki.answers.com/help/askingquestions*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Intrinsic properties of Surface
- Intrinsic properties of Geodesics
- Geodesics

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Theory of Space Curves
- Contact between the curves and surfaces.

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Define the theory of Space curves for building differential calculus based applications.	Understand
CO2	Illustrate the theory of Space curves and its related results.	Understand
CO3	Demonstrate the Local Intrinsic properties of surface.	Apply
CO4	Implement method for Local Intrinsic properties of surface.	Apply
CO5	Apply Geodesic on a surface and its applications.	Apply

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	M	S	M	S	S	S	M	M	S
CO2	M	M	S	S	M	M	S	M	M	S
CO3	M	S	M	S	S	S	S	S	L	M
CO4	S	M	S	M	S	S	M	L	M	S
CO5	S	S	M	S	S	S	S	S	M	S

S- Strong; M-Medium; L-Low

SEMESTER II

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMTM4	**COMMUTATIVE ALGEBRA**	**55**	**5**	**-**	**4**

OBJECTIVE

The purpose of the course is to learn the concept of commutative rings and to introduce algebraic structure through modules and its algebraic application.

LEARNING OUTCOMES

After completion of these chapters, the students will have a good understanding of the following topics

- Operations on ideals, extension and contraction of ideals
- Modules , sub modules , homomorphism , direct sum and product of modules
- Modulesof fractions, Primarydecomposition
- Notherian rings , Artin rings

SYLLABUS

Unit I : RingsandIdeals

A brief review of rings, ideals and homomorphisms - Operations on ideals –Extension and contraction of ideals –Nil radical and Jacobson radical.

Chapter – 1

UnitII:Modules

Modules, submodules - Homomorphism, direct sum and products of modules- Exact sequences- Tensor product of modules and algebras and basic properties.

Chapter:2

UNIT III: Modules of Fractions andPrimaryDecomposition Total differential co-efficient – Implicit functions – Jacobian – maxima and minima of functions of two variables – Lagrange's multiplier methods.

Chapters: 3 and 4

Unit IV : Integral Dependence andValuationRings

Integral dependence, Going up and going down theorems-Valuation rings- Chain conditions

Chapters :5and6

UnitV:NoetherianandArtinrings

Primary decomposition in Noetherian rings- Discrete valuation rings-Fractional ideals.

Chapters: 7,8 &9

TEXTBOOKS

1. M.F.Atiyah & I.G.Macdonald, Introduction to Commutative Rings, Addison Wesley

REFERENCE BOOKS

1. N.S.Gopalakrishnan–CommutativeAlgebra, OxonianPress
2. Zarinski and P.Samuel,Commutative Algebra with a view towards AlgebraicGeometry,Springer

WEB RESOURCES

1. *Amazon.com*
2. *wiki.answers.com*
3. *mat.bham.ac.uk*
4. *ects.ieu.edu.tr*
5. *Math.hawaii.edu*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Operationsonideals
- Modules
- Noetherianrings, Artinrings

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Extensionandcontractionofideals
- Tensorproductofmodulesandalgebras
- Valuationrings

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Know operations on ideals, extension and contraction of ideals	Apply
CO2	Understand modules, sub modules, homomorphism, direct sum and product of modules	Understand
CO3	Knowledge on modules of fractions, Primary decomposition	Apply
CO4	Know different kinds of modules based on chain conditions	Remember
CO5	Know the notions of Noetherian and Artinian rings	Understand

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	M	M	-	L	S	S	M	M	S
CO2	S	M	L	-	L	M	S	S	M	L
CO3	S	M	-	-	M	S	S	M	M	S
CO4	S	M	L	-	L	S	S	S	M	M
CO5	S	M	M	-	L	M	M	M	M	L

S- Strong; M-Medium; L-Low

SEMESTERII

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21RAC02	RESEARCH ACUMEN COURSE-II: Research Writing	SELF STUDY COURSE			

OBJECTIVE

- Introduce students to the discipline of Research Writing and itsspecific purposes.
- Educate students in the basics of researchwriting.
- Provide students with the critical faculties necessary in an academic environment and in an increasingly complex, interdependentworld.

LEARNING OUTCOMES

- **Generic:** The learner is required to have a basic understanding ofresearch
- **Adaptive:** Assist students in the development of intellectual flexibility, creativity, and research ethics so that they may engage in life-longlearning.
- Exposure to varied approaches toresearch.
- The student gets a fair understanding of the politics of human interactions and to work for a peaceful co-existence of all living beings in theworld.
- The student gets an analytical skill in taking upresearch.
- The student understands the different tools ofresearch.
- The student gets a clear understanding of the format of researchpaper.

SYLLABUS

UNIT I: **Basics of Research Writing**

Research and its Characteristics -The Purpose of Research - properplacementofelementsinasentence- Structuringtheparagraph-breakingup long sentence - word choice - proper use of punctuation - Avoiding Ambiguity, Repetition, and Vague Language.

UNIT II :Steps Involved in Research

Topic of Research - Data Collection – Primary Source and Secondary Sources - Topic selection – narrowing the topic through (peer discussion, online forum, library, electronic data base, periodicals.

UNIT III :Research Writing Styles

Basic components of a research paper – Abstract- introduction, body, conclusion and references -

Pagination - Margin - Fonts - Spacing – Spelling - Punctuation - Documentation Styles (MLA Style, APA Style and CMSStyle)

UNIT IV :Dissertation Writing

Comparison between term paper and dissertation - Title - Cover Page – Declaration – Certificate – Acknowledgement – Contents - Introduction - Statement of Problem – Methodology - Review of Literature - Main Body – Conclusion - Bibliography -Works Cited –References

UNIT V :Research Proposal Writing

Types of funding agencies in India – proposal writing (summary of research, background literature, research question, research methodology, anticipatory problems and limitations, significance of research, ethical considerations, resources required, budget cost, references)

Definition of plagiarism – UGC regulation for plagiarism – plagiarism detection programs – plagiarism free writing .

REFERENCE BOOKS

1. Adrian Wallwork, "English for Writing Research Papers", Second Edition, Italy, Springer(2016).
2. Laurie Rozakis, "Schaum's Quick Guide to Writing Great Research Papers", Second Edition, India, McGraw-Hill(2007).
3. James D. Lester • James D. Lester, Jr. "Writing Research Papers-A Complete Guide" Fifteenth edition, New Delhi,Pearson(2015).
4. Jennifer Peat, Elizabeth Elliott, Louise Baur, Victoria Keena, "Scientific Writing Easy when you know how", BMJ Books,London(2002).
5. Jean-luclebrun, "ScientificWriting;A Reader and writer's guide", Singapore, World Scientific Publishing Co. Pte.Ltd(2007).
6. Brian Paltridge and Sue Starfield , "Thesis and Dissertation Writing in a Second Language", USA,Routledge(2007).
7. Subhash Chandra Parija, Vikram Kate, "Thesis Writing for Master's and Ph.D. Program", Singapore,Springer(2018).

WEB RESOURCES

1. https://www.casemine.com/
2. http://www.legalservicesindia.com/article/284/Plagiarism.html
3. R. Saha ,"Plagiarism, research publications and law", Current Science, VOL. 112, NO. 12, 25 JUNE 2017. https://www.currentscience.ac.in/Volumes/112/12/2375.pdf
4. https://virtualwritingtutor.com/

SEMESTER III

SEMESTER III

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21 PMT09	**GENERAL TOPOLOGY**	**75**	**15**	**-**	**5**

OBJECTIVE

The purpose of the course is to learn the concept of topological spaces, continuous functions, connectedness, compactness, countability and separation axioms. This course aims to acquaint the students with various topics of topology**.**

LEARNING OUTCOMES

After completion of these chapters, the students are expected to

- Define a metric space and a topological space and state standard properties and example of each.
- Define the product topology, and the quotient topology.
- Define a continuous map between spaces; state and apply standard properties.
- Distinguish open and closed subsets.Construct closure, interior, and boundary of a set.
- Define metric topology and its properties.
- Explain the compactness of a topological space.
- Distinguish the differences between the limit point compactness, sequential compactness, local compactness, and countable compactness.
- Compare the topological spaces with the help of separation axioms.

SYLLABUS

Unit I : Topological spaces

Topological Spaces- Basis for a Topology- The Order Topology- The Product Topology on XxY - The Subspace topology – Closed sets and Limit points.

Chapter – 2: sec 12 to 17

UnitII:Continuous Functions

Continuous functions – The product Topology- the Metric Topology.

Chapter - 2 : sec 18 to 21

UNIT III: Connectedness

Connected spaces – Connected Subspaces of the Real Line – Components and Local Connectedness.

Chapter - 3 : sec 23 to 25

Unit IV : Compactness

Compact Spaces – Compact Subspaces of the Real Line- Limit Point Compactness - Local Compactness.

Chapter – 3 : sec 26 to 29

UnitV: Countability and Separation axioms

The Countability Axioms – The Separation Axioms – Normal Spaces – The Urysohn's Lemma – TheUrysohn's Metrization Theorem – The Tietze Extension Theorem

Chapter - 4: sec 30 to 35

TEXTBOOKS

1. James R. Munkres- Topology, 2nd Edition, Prentice Hall of India Ltd., New Delhi, 2005.

REFERENCE BOOKS

1. J.Dugundji, Topology, Prentice Hall of India, New Delhi 1975
2. G.F.Simmons , Introductions to Topology and Modern Analysis, McGraw Hill Book Co., New York 1963
3. S.T.Hu, Elements of General Topology, Holden Day, Inc. New York , 1965.

WEBRESOURCES

1. Amazon.com
2. wiki.answers.com
3. mat.bham.ac.uk
4. ects.ieu.edu.tr
5. Math.hawaii.edu

ASSIGNMENTS

Three Assignments can be given from the following topics

- Connectedness
- Compactness
- Countablility and Separation axioms

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Topological Spaces

- Continuous Functions
- Connectedness and compactness
- Countability and Separation axioms

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	learn the concepts of topological spaces, connected and compact spaces, continuous functions, countability and separation axioms.	Recall
CO2	understand the attributes of continuous functions and inspect their applications in connected and compact spaces, countability and separation axioms	Understand , Analyse
CO3	apply the notions of different topological spaces and solve real world problems	Apply
CO4	interpret various forms of tological spaces and assess their attributes	Understand , Evaluate
CO5	prove extreme value theorem, lebesgue number lemma, uniform continuity theorem, countability and separation axioms and inspect their applications	Analyse, Evaluate

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	M	L	L	M	S	S	S	M	M
CO2	S	S	M	M	M	S	S	S	M	M
CO3	S	M	M	L	L	M	S	M	M	M
CO4	S	M	M	L	L	M	S	M	M	L
CO5	S	M	L	L	L	M	S	M	M	L

S- Strong; M-Medium; L-Low

SEMESTER III

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21 PMT10	**PROBABILITY THEORY**	**75**	**15**	**-**	**5**

OBJECTIVE

The overall purpose of the course is that the student should be well acquainted with basic concepts in probability theory, models and solution methods applied to real problems.

LEARNING OUTCOMES

The students should be able to do the following:

- Define and apply basic concepts and methods of probability theory
- Use common probability distributions and analyze their properties (exponential distribution, multivariate normal distribution, etc.)
- Compute conditional probability distributions and conditional expectations
- Solve problems and compute limits of distributions by use of transforms (characteristic functions, generating functions)
- Define and use the properties of Stochastic processes, especially random walks, branching processes, the Poisson and Wiener process, applied to real problems
- Explain the concept of measurability and define and work with sigma algebras and construct probability measures on sample spaces
- Combine all the concepts and methods mentioned above in order to solve more complex problems.

SYLLABUS

Unit I: Random Events and Random Variables

Random events – Probability axioms – Combinatorial formulae – Conditional Probability – Baye's Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables.

Chapter 1: Sections 1.1 to 1.7, Chapter 2: Sections 2.1 to 2.9

Unit II: Parameters of the Distribution

Expectation – Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.

Chapter 3: Sections 3.1 to 3.8

Unit III: Characteristic functions

Properties of characteristic functions – Characteristic functions and moments – semi invariants – characteristic function of the sum of the independent random variables Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions.

Chapter 4: Sections 4.1 to 4.7

Unit IV: Some Probability distributions

One point, two point, Binomial – Polya – Hyper geometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions.

Chapter 5: Sections 5.1 to 5.10 (Omit Section 5.11

Unit V: Limit Theorems

Stochastic convergence – Bernoulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Movire-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theorem – Borel-Cantelli Lemma – Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

Chapter 6: Sections 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12 (Omit Sections 6.5, 6.10, 6.13 to 6.15)

TEXTBOOKS

1. M.Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963

REFERENCE BOOKS

1. F.B. Ash, Real Analysis and Probability, Academic press, New York, 1972.
2. K.L. Chung, A Course in probability, probability, Academic press, New York, 1974.
3. Y.S. Chow and H. Teicher , probability theory, Springer Verlag, Berlin, 1988 (2nd Edition)
4. R.Durrett, probability theory and examples, (2nd Edition) Duxbury press, New York, 1996.

5. V.K. Rohatgi an introduction to probability theory and Mathematical Statistics , Wiley Eastern Ltd., New Delhi, 1988(3rd Print)
6. S.I. Resnick, A probability path, Birhauser, Berlin, 1999.
7. B.R. Bhat, Modern Probability theory (3rd Edition), New Age International (p) Ltd, New Delhi 1999.
8. J.P.Romano and A.F. Siegel, Counter Examples in probability and Statistics, Wadsworth and Brooks/ Cole Advanced Books and Software, California, 1968.

WEB RESOURCES

1. en.wikipedia.org/wiki/Wikipedia
2. mathworld.wolfram.com
3. wiki.answers.com/help/asking_questions.

ASSIGNMENTS

Three Assignments can be given from the following topics

- Characteristic Functions
- Some Probability Distributions
- Limit Theorems

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Random Events and Random Variables
- Parameters of Distribution

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Define and apply basic concepts and methods of probability theory Use common probability distributions and analyze their properties (exponential distribution, multivariate normal distribution, etc.)	Recall ,Analyze
CO2	Compute conditional probability distributions and conditional expectations	Understand , Analyze
CO3	Solve problems and compute limits of distributions by use of transforms (characteristic functions, generating functions)	Apply
CO4	Explain the concept of measurability and define and work with sigma algebras and construct probability measures on sample spaces	Understand , Evaluate
CO5	Define and use the properties of Stochastic processes, especially random walks, branching processes, the Poisson and Wiener process, applied to real problems	Analyse, Evaluate

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	S	-	M	S	S	M	M	S
CO2	S	S	S	-	S	S	S	S	S	S
CO3	S	S	M	-	S	S	S	M	M	S
CO4	S	S	M	-	M	S	S	M	M	M
CO5	S	S	M	-	M	S	S	M	M	S

S- Strong; M-Medium; L-Low

SEMESTER III

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21 PMT11	GRAPH THEORY	75	15	-	5

OBJECTIVE

The purpose of this course is to make student to understand Graph Theory and its various model and applications which are widely used in different areas such as study of molecules, construction of bonds in chemistry, study of atoms, biology, operation research, sociology, engineering, economics and war science to find optimal way to perform.

LEARNING OUTCOMES

1. Have a sound knowledge of simple and sub graphs, paths and connection,cycle's application and shortest path problem.
2. Have sufficient exposure to get the solution of trees, Cayley's formula and their application of connector problem and Reliable communication networks.
3. Have an idea of Euler tours, Hamilton cycles, matching, perfect matching and applications of Chinese postman problem, personal assignment problem and optimal assignment problem.
4. Have an idea of Edge coloring, Edge chromatic number, Vizing's, Ramseys and Turan's theorems and Time tabling problem.
5. Have knowledge of Vertex colourings, Chromatic number and polynomials and storage problem.

SYLLABUS

Unit I : Graphs and Sub graphs

Graphs and simple graphs-Graph isomorphism-incidence and Adjacency Matrices - Sub graphs-Vertex degrees-paths and connection – cycles – Application-The shortest path problem.

Chapter – 1 :sec 1.1 to 1.8

UnitII:Trees and Connectivity

Trees-cut edges and bonds-Cut vertices- Cayley's formula – Application-connector problem-Connectivity – Block – Application-Reliable Communication Networks.

Chapter - 2:sec 2.1 to 2.5 and chap 3: sec 3.1 to 3.3

UNIT III: Euler Tours and Matching

Euler Towers-Hamilton cycles-Application – Chinese Postman problem-Travelling Salesman problem – Matching -Matching and covering in Bipartite Graphs-Perfect Matching – Applications- personnel Assignment problem-Optimal Assignment problem.

Chapters - 4 sec 4.1 to 4.4 and chap5: sec: 5.1 to 5.5

Unit IV : Edge Colouring and Independent Sets

Edge Colouring –Edge Chromatic Number-Vizing's Theorem Application- Timetabling problem – Independents sets- Ramsey's theorem-Turan's Theorem.

Chapters –6: sec 6.1 to 6.3 and chap 7: sec 7.1 to 7.3

UnitV: Vertex Colourings

Vertex Colouring-Chromatic Number-Brook Theorem-HajosConjecture –Chromatic Polynomials-Girth and Chromatic Number –A Storage problem.

Chapters - 8: sec 8.1 to 8.6

TEXTBOOKS

1. J.A..Bondy and U.S.R. Murty,Graph Theory with Applications, North Holland,New York,1982.

REFERENCE BOOKS

1. NarasingDeo, Graph Theory with Applications to Engineeringand Computer Science, Prentice Hall of India, New Delhi 2003.
2. F.Harary, Graph Theory, Addison-WeselyPublication Co., the Mass, 1960.
3. L.R.Foulds, Graph Theory Application,Narasa publication House, Chennai,1993.

WEB RESOURCES

1. *en.wikipedia.org/wiki/Wikipedia*
2. *mathworld.wolfram.com*
3. *wiki.answers.com/help/asking_questions*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Trees and Connectivity
- Euler Tours and Matching
- Edge Colouring and Independent Sets

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Graphs and Sub-Graphs
- Vertex Colouring

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Know the basic definitions and concepts of Graphs and Subgraphs.	**Recall**
CO2	Getting acquainted with the concepts of Trees and connectivity study its applications.	**Understand**
CO3	Recognize the concepts and properties of Euler Tours and Matchings and study its applications.	**Apply**
CO4	Assimilate the knowledge about edge coloring of Graphs, its applications and to understand the notations of independent Sets.	**Apply**
CO5	Acquire the knowledge about the concepts of Vertex colorings colourings and model in the real life problem.	**Analyze**

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	L	M	M	M	M	L	L	M	M	L
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strong; M-Medium; L-Low

SEMESTERIII

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture (L)	Tutorial (T)	Practical (P)	Credit
21PMT12	**PROGRAMMING IN R**	**75**	**15**	**-**	**5**

OBJECTIVE

To enable the students to understand the concept of R Programming in matrices, vectors and linear programming.

LEARNING OUTCOMES

- Install R and R Studio
- Write simple pseudocode and create simple flow charts
- Document your code
- Use file management and version control tools
- Perform simple arithmetic and statistical operations in R
- Read data files into R
- Create loops for iteration(e.g. for loop)

SYLLABUS

UNIT I : R – Overview

Evolution of R - Features of R -- R - Data Types - R - Variables-R – Operators- R – Vectors:Vector Creation-Accessing Vector Elements-Vector Manipulation-Vector Element Sorting.

UNIT II : R – Lists

Creating a List-Accessing List Elements-Manipulating List Elements-Merging Lists-Converting List to Vector-R – Matrices: Syntax-Accessing Elements of a Matrix-Matrix Addition & Subtraction-Matrix Multiplication & Division-R – Arrays: Syntax- Naming Columns and Rows- Manipulating Array Elements

UNIT III : R - Data Frames

Create Data Frame- Get the Structure of the Data Frame- Summary of Data in Data Frame- Extract Data from Data Frame- Expand Data Frame.

UNIT IV : R - Pie Charts

Syntax - Pie Chart Title and Colors - Slice Percentages and Chart Legend - 3D Pie Chart - R - Bar Charts - Bar Chart Labels, Title and Colors- Group Bar Chart and Stacked Bar Chart - R - Line Graphs - Syntax - Line Chart Title, Color and Labels - Multiple Lines in a Line Chart

UNIT V : R - Mean, Median and Mode

Mean Syntax with example - Applying Trim Option-Applying NA Option- Median Syntax with example - Mode Syntax with example- R - Linear Regression- Steps to Establish a Regression-Visualize the Regression Graphically

TEXT BOOK

R Tutorial – Tutorials point

https://www.tutorialspoint.com › r

REFERENCES

1. R Tutorial - W3Schools https://www.w3schools.com/r/
2. R Programming for Data Science by Roger D. Peng
3. Big data Analytics by David Loshin, MK Publications, USA.

WEB RESOURCES

1. en.wikipedia.org/wiki/Wikipedia

2. mathworld.wolfram.com

3. wiki.answers.com/help/asking_questions**.**

ASSIGNMENTS

Three Assignments can be given from the following topics

- R - LIST
- R – PIE CHART
- R – DATA FRAMES

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- STATISTICAL MEASUREMENTS IN R - PROGRAMMING

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO 1	Understand the operations on vectors using R	**Understand**
CO 2	Understand basic operations on matrices using R	**Understand**
CO 3	Apply commands on data frames to understand various operations on it using R	**Apply**
CO 4	Multiple Lines in a Line Chart using R	**Analyse**
CO 5	Applying Trim Option using R	**Evaluate**

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	M	L	M	S	L	-	L	M	S
CO2	S	M	L	M	S	L	-	M	M	S
CO3	S	M	M	S	S	L	M	M	M	S
CO4	S	S	M	S	S	M	M	M	M	S
CO5	S	S	S	S	S	M	M	M	S	S

S- Strong; M-Medium; L-Low

SEMESTER III

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PECMT	MATHEMATICAL ECONOMICS	25	5	-	2

OBJECTIVE

This course puts the literary form of Economic Theory in Mathematical Language and provides concrete form of Economic laws and relationships and makes it more precise and practical. This course provides concise exposition of the methods and techniques of Mathematics along with their application in Economics and Business.

LEARNING OUTCOMES

After completion of this course the students will be able to

- Apply simple derivatives to find Elasticity of Demand, Marginal Utility, Marginal Revenue etc.
- Find Total, Average and Marginal cost and the relation between Average and Marginal Cost curves.
- Use LPP in many industrial and Economic Problems.
- Apply Transportation Model to determine the amount to be shifted from each destination such that the total transportation cost is minimum.
- Apply Assignment Problem in which the objective is to assign a number of tasks (Jobs or origin or sources) to an equal number of facilities(machines or persons or destinations) at a minimum cost(or maximum profit).

SYLLABUS

UNIT I : Demand and Elasticity

Demand – Definition – Differential co-efficient and elasticity of Demand – Utility – Total Utility – Computation of Marginal Demand – Elasticity of demand - Relationship between Total Revenue, Average Revenue and Marginal Revenue.

Chapter 7: Section 7.1 [1]

UNIT II :Cost and Revenue Analysis

Cost – Definition – Types of Cost – Total, Average and Marginal cost curves – Relation between Average and Marginal cost Curves – Minimum Average cost – Cost Function in Cubic form – Total, Average, Marginal Revenue Curves.

Chapter 7: Section 7.2 to 7.6 [1]

UNIT III :**Linear Programming Problems (LPP)**

LPP – Introduction – Requirements for employing LPP Techniques –Mathematical formulation of LPP (Two variables only) – Graphical method of the solution of a LPP.

Chapter 2: Sections 2.1 to 2.5 [3]

UNIT IV:Transportation Problems

Introduction – Mathematical Formulation of Transportation Problem(TP) – Methods for finding Initial Basic Feasible Solution – North West Corner Rule (NWCR) – Least Cost Method Rule (LCMR) – Vogel's Approximation Method (VAM).

Chapter 7: Section 7.1 [3]

UNIT V: Assignment Problem

Introduction – Mathematical Formulation of Assignment Problem(AP) – Comparison with Transportation Problem – Difference between TP and AP – Hungarian Method for Solving AP (Balanced Problems only)

Chapter 8: Sections 8.1 to 8.5

REFERENCE BOOKS

1. Mehta.B.C & Madnani.G.M.K, "Mathematics for Economists", Sultan Chand & Sons, New Delhi, Seventh Edition, 1992.

2. Bose.D, "An Introduction to Mathematical Economics", Himalaya Publishing house, 2004.

3. Sundaresan.V, Ganapathy Subramanian.K.S, Ganesan. K, "Resource Management Techniques (Operations Research)", A.R.Publications, Arpakkam, 2000.

WEB RESOURCES

1. http://www.rejinpaul.com/2015/03/ma6459-numerical-methods-syllabus-notes-questions- papers regulation-2013.html

2. http://authors.library.caltech.edu/down.html

3. http://www.ou.edu/class/che-design/Num-Meth-06/

ASSIGNMENTS

1. Find the Elasticity of demand and AR at p = 3, if the demand function $q=32-4p-p^2$
2. Problems can be given in the following topics (i) Transportation Problem (ii) Assignment Problem.

GROUP TASK

1. Find the Elasticity of demand and MR for the demand function $P = -2q^2 +18$ for q = 1.
2. Mathematical formulation of LPP can be done for various examples.

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Apply simple derivatives to find Elasticity of Demand, Marginal Utility, Marginal Revenue etc.	Understand
CO2	Find Total, Average and Marginal cost and the relation between Average and Marginal Cost curves.	Understand
CO3	Use LPP in many industrial and Economic Problems.	Apply
CO4	Apply Transportation Model to determine the amount to be shifted from each destination such that the total transportation cost is minimum.	Apply
CO5	Apply Assignment Problem in which the objective is to assign a number of tasks (Jobs or origin or sources) to an equal number of facilities (machines or persons or destinations) at a minimum cost (or maximum profit).	Apply

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	M	-	M	M	L	M	S	M
CO2	M	M	M	-	S	S	M	S	S	M
CO3	M	S	M	-	S	S	M	S	S	M
CO4	M	S	M	-	M	S	M	M	S	M
CO5	M	S	M	-	M	S	M	M	S	M

S- Strong; M-Medium; L-Low

SEMESTER IV

SEMESTER IV

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT13	FUNCTIONAL ANALYSIS	**75**	**15**	**-**	**6**

OBJECTIVE

The Functional analysis becomes a basic subject of study. For post graduate students it is very advanced subject. The Banach spaces, linear operators, Hilbert spaces, Banach spaces are important topics in Functional analysis. It is very useful subject to face all India examinations conducted by UGC and CSIR.

LEARNING OUTCOMES

At the end of this course:

- Students can understand very important theorem given by Hahn-Banach.
- The leaner can understand Hilbert's spaces and Banach spaces.
- How to apply these spaces in space theory. The leaner can apply these concepts in network.

SYLLABUS

Unit I : Banach Spaces

Banach spaces – Definition and examples – Continuous linear transformations – The Hahn Banach Theorem.

Chapter -9: Sec: 46 to 48

UnitII:Banach Spaces and Hilbert Spaces

The natural imbedding of N in N** - The open mapping theorem - The conjugate of an operator - Hilbert space – The definition and some simple properties.

Chapter - -9: Sec: 49 to 51, Chap-10: Sec: 52

UNIT III: Hilbert Spaces

Orthogonal complements – Orthonormal sets – The conjugate space H* - The adjoint of an operator.

Chapters - 10: Sec: 53 to 56

Unit IV : Operations on Hilbert Spaces

Self adjoint operator - Normal and Unitary operators – Projections.

Chapters – 10: Sec: 57 to 59

UnitV: Banach Algebras

Banach Algebras – Definition and examples – Regular and simple elements – Topological divisors of zero – The Spectrum – The formula for the spectral radius – The radical and semi -Simplicity.

Chapters - 12: Sec: 64 to 69

TEXTBOOKS

1. E.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill International Book Co. New York 1963.

REFERENCE BOOKS

4. W. Rudin, Functional Analysis, Tata McGraw Hill Publication Co. New Delhi 1973
5. H. C. Goffman and G. Fedrick, First Course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
6. D. Somasundaram, A First Course in Functional Analysis, Narosa Publishing House, New Delhi, 2008.

WEBRESOURCES

1. *en.wikipedia.org/wiki/Wikipedia*
2. *mathworld.wolfram.com*
3. *wiki.answers.com/help/asking_questions*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Banach Spaces
- Hilbert Spaces
- Banach Algebras

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Banach Spaces and Hilbert Spaces
- Banach Algebras

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	learn the central concepts of Banach Space, Hilbert spaces	Recall
CO2	understand the notions of continuous linear transformations, Natural imbedding ,orthogonal complements, various operators, Banach algebra	Understand
CO3	recognize and analyze conjugate of an operator, axiomatic knowledge of the properties of a Hilbert space, including orthogonal complements, orthonormal sets	Understand , Analyze
CO4	apply the properties of various operators to the resolution of integral equations and projection	Apply
CO5	Prove Hahn Banach Theorm, open mapping theorem, properties of Hilbert spaces, the spectral theorem.	Evaluate

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	M	L	M	S	S	M	M	M
CO2	S	S	M	L	M	S	S	L	L	S
CO3	S	S	M	M	M	M	S	M	S	S
CO4	S	S	L	M	S	M	S	M	M	S
CO5	S	S	L	L	S	S	S	M	M	S

S- Strong; M-Medium; L-Low

SEMESTER IV

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21PMT14	**Fuzzy Sets & Fuzzy Logic**	**75**	**15**	**-**	**5**

OBJECTIVE

Modern mathematics and physics rely on our ability to understand the basic knowledge of fuzzy set theory and to gain knowledge in fuzzy relations and fuzzy measures and allow us to learn the basics of pattern recognition and decision making.

LEARNING OUTCOMES

Students who successfully complete the course will demonstrate the following outcomes by tests and homework.

- It lays foundation for difference between the concepts of crisp and fuzzy set, principle for fuzzy sets in the real lifesituations.
- The ability to use and understand the concept of operations on fuzzy sets- Union, intersection, complement properties of α-cuts. This course also provides the several relations according to the fuzzy set theory and possibilitytheory.
- Knowledge and understanding of the applications such as Fuzzy clustering; Fuzzy image processing, fuzzy decision making and fuzzy rankingmethods.

SYLLABUS

Unit I: **Crisp sets and Fuzzy sets**

Fuzzy Sets (basic concepts); Representation of fuzzy sets; Decompositions theorems; Extension Principle for fuzzy sets.

Chapter: 1.1, 2.2 &2.3

Unit II: **Operation on fuzzy sets**

Operations on Fuzzy sets-Union, intersection and complement; Properties of De-Morgan's Laws: α-cuts of fuzzy operations.

Chapter: 3.1 – 3.5

Unit III: Fuzzy Relations

Crisp and fuzzy relations-Projections; Binary fuzzy relations; Binary relations on a single set; Fuzzy equivalence relations; Fuzzy compatibility relations; Fuzzy ordering relations; Fuzzy morphisms ; Compositions of fuzzy relations.

Chapter: 5.1 – 5.10

Unit IV: **Possibility theory**

Fuzzy Measure; Evidence Theory; Possibility theory; fuzzy sets and possibility theory.

Chapter:7.1 – 7.4

Unit V: **Pattern Recognition**

Fuzzy clustering; Fuzzy image processing. **Fuzzy Decision Making:** Multi-person decision making; Multicriteria decision making; Multistage decision making; Fuzzy Ranking Methods.

Chapter:13.2, 13.4 & 15.3 – 15.6

TEXT BOOKS

1. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Pearson India Education Services Pvt. Ltd , 2016.

REFERENCE BOOKS

1. H.J. Zimmerman "Fuzzy Set theory and its Applications", Kluwer AcademicPublishers
2. D. DuBois and H.M. Prade, Fuzzy Sets and Systems: Theory and Applications", Academic Press,1994.

WEB RESOURCES

- *en.wikipedia.org/wiki/*
- *mathworld.wolfram.com*
- *wiki.answers.com*

ASSIGNMENTS

Three Assignments can be given from the following topics

- Fuzzy Image Processing
- Possibility Theory
- Fuzzy Ranking Methods

GROUP TASKS

Two Group Tasks can be given in the form of Seminar, Group Discussion, and Quiz etc. in the topics

1. Operations on Fuzzy sets-Union, intersection and complement, Properties of De-Morgan's Laws.
2. Multi-person decision making, Multi criteria decision making.

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	Identity the logic behind the execution and solving of the Crisp sets and Fuzzy sets	Knowledge
CO2	Analyze the field of Operations on Fuzzy sets,Union, intersection and complement and the Properties of De-Morgan's Laws.	Apply
CO3	Develop the solution methods of solving Binary fuzzy relation, Binary relations on a single set, Fuzzy equivalence relations, Fuzzy compatibility relation and Fuzzy ordering relations.	Analyze
CO4	Identify the difference between Evidence Theory and Possibility theory.	Knowledge
CO5	Develop the concept of Fuzzy clustering and Fuzzy image processing.	Analyze

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	S	S	M	M	S	M	S	S	M	M
CO2	S	S	S	M	M	S	S	L	L	M
CO3	S	S	M	M	M	L	S	M	M	M
CO4	M	M	S	S	M	L	L	M	S	S
CO5	S	S	M	M	M	L	L	S	S	M

S- Strong; M-Medium; L-Low

SEMESTERIV

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture (L)	Tutorial (T)	Practical (P)	Credit
21PMT15	NUMBER THEORY	75	15	-	5

OBJECTIVE

The primary goal of this course is to introduce the theory of numbers. Although this is an introductory course to the subject, the approach is rigorous, and many of the concepts are subtle and deep. Students will learn some of the history of the theory of numbers, see the importance deductive proofs of many of the theorems in the subject, and develop and write up some of their own proofs.

LEARNING OUTCOMES

- To know what is meant by Divisibility – Primes – Congruence's and finding solutions
- To analyze the function – Congruence of higher degree – Prime power moduli & modulus
- To Know Quadratic residues – Quadratic reciprocity – The Jacobi symbol – Greatest Integer function
- To apply the Mobius inverse formula and its functions
- To know the application of Sums of four and five squares – Waring's problem

SYLLABUS

Unit I: Divisibility and Congruence

Divisibility – Primes – Congruence's – Solutions of Congruence's – Congruence's of Degree one.

Chapter -1: Sec: 1.1 to 1.3 and Chap-2: Sec: 2.1 to 2.3

Unit II: Congruence

The function ← (n) – Congruence of higher degree – Prime power moduli – Prime modulus – congruence's of degree two, prime modulus – Power Residues.

Chapater -2: Sec: 2.4 to 2.9

Unit III: Quadratic reciprocity

Quadratic residues – Quadratic reciprocity – The Jacobi symbol – Greatest Integer function.

Chapter -3: Sec: 3.1 to 3.3 and Chap-4: Sec: 4.1

Unit IV: Some Function of Number Theory

Arithmetic function – The Mobius inverse formula – The multiplication of arithmetic functions.

Chapter -4: Sec: 4.2 to 4.4

Unit V: Some Diaphantine Equations

The equation ax+by = c – positive solutions – Other linear equations – The equation $x^2 + y^2 = z^2$ – The equation $x^4 + y^4 = z^4$ – Sums of four and five squares – Waring's problem – Sum of fourth powers – Sum of Two squares.

Chapter -5: Sec: 5.1 to 5.10

TEXTBOOKS

1. Ivan Niven and H.S. Zuckerman, An Introduction to the Theory of Numbers, 3rd edition, Wiley Eastern Ltd., New Delhi, 1989.

REFERENCE BOOKS

1. D. M. Burton, Elementary Number Theory, Universal Book Stall, New Delhi, 2001
2. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, New York, 1972.
3. T. M. Apostol, Introduction to Analytic Number Theory, Narosa Publication House, Chennai, 1980.

WEB RESOURCES

1. en.wikipedia.org/wiki/Wikipedia

2. mathworld.wolfram.com

3. wiki.answers.com/help/asking_questions.

ASSIGNMENTS

Three Assignments can be given from the following topics

- Congruence
- Divisibility and congruence
- Quadratic reciprocity

GROUP TASK

Two Group Tasks can be given in the form of Seminar, Group Discussion, Quiz etc. in the topics

- Some Functions of Number Theory
- Some Diaphantine Equations

COURSE OUTCOMES

On successful completion of the course, students will be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO1	know what is meant by Divisibility – Primes – Congruence's and finding solutions	Understand
CO2	To analyze the function – Congruence of higher degree – Prime power moduli & modulus	Analyze
CO3	To Know Quadratic residues – Quadratic reciprocity – The Jacobi symbol – Greatest Integer function	Understand
CO4	To apply the Mobius inverse formula and its functions	Apply
CO5	To know the application of Sums of four and five squares – Waring's problem	Understand

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	L	M	M	M	M	L	L	M	M	L
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strong; M-Medium; L-Low

SEMESTERIV

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture (L)	Tutorial (T)	Practical (P)	Credit
21PMTP1	**PRACTICAL - R - PROGRAMMING**	**20**	**-**	**40**	**3**

OBJECTIVE

To enable the students to understand the concept of R Programming in matrices, vectors and linear programming.

LEARNING OUTCOMES

After the successful completion of this module students will be able to

- Install, Code and use the R- Programming Language in R- Studio
- IDE to perform basic task on Vectors, Matrices and Data frames
- Conduct and interpret a variety of hypothesis test to aid Decision Making
- Understand,Interpret Correlation and Regression to analyse the underlying relationships between different variables

SYLLABUS

1. Vector Manipulations using one or more vectors,Matrix Manipulations
2. Data Frame Manipulations-Creation, adding rows, adding columns ,NA entries, set operations
3. Explore different types of Graphs/plots using datasets
4. Statistical Analysis using Datasets
   - Loading a Dataset/Displaying first and last rows
   - Extracting Column/Row on conditions
   - Working with NA entries
5. Experimenting, Correlation, Regression, and t-test with Vectors/Data Frames

TEXTBOOKS

3. R Tutorial - Tutorials point https://www.tutorialspoint.com › r

REFERENCE BOOKS

1. R Tutorial - W3Schools https://www.w3schools.com/r/
2. R Programming for Data Science by Roger D. Peng
3. Big data Analytics by David Loshin, MK Publications, USA.

WEB RESOURCES

1. en.wikipedia.org/wiki/Wikipedia

2. mathworld.wolfram.com

3. wiki.answers.com/help/asking_questions**.**

COURSE OUTCOMES

On completion of the course, students should be able to

S. NO.	COURSE OUTCOME	BLOOMS VERB
CO 1	Understand the various List of operations using R	Understand
CO 2	Understand basic operations on matrices using R	Analyze
CO 3	Apply the structure of a given data frame using R	Understand
CO 4	Analyse missing values in a dataset : Count NA, Replace NA using R	Apply
CO 5	Evaluate Correlation problems using R	Understand

MAPPING WITH PROGRAM OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	**S**	**M**	**L**	**M**	**S**	**L**	**-**	**L**	**M**	**S**
CO2	**S**	**M**	**L**	**M**	**S**	**L**	**-**	**M**	**M**	**S**
CO3	**S**	**M**	**M**	**S**	**S**	**L**	**M**	**M**	**M**	**S**
CO4	**S**	**S**	**M**	**S**	**S**	**M**	**M**	**M**	**M**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

SEMESTERIV

(For the Candidates admitted from the academic year 2021-2022 onwards)

Course code	Course name	Lecture(L)	Tutorial(T)	Practical(P)	Credit
21RAC03	RESEARCH ACUMEN COURSE-III: Research and Publication Ethics	SELF STUDY COURSE			

OBJECTIVE

- To provide the students with the fundamental knowledge of basics of philosophy of science and ethics, research integrity, publicationethics.
- To expose the students to Indexing and citation databases, open access publications, research metrics (citations, h-index, ImpactFactor).
- To create awareness about plagiarism, and plagiarism tools for a valid and ethical researchreport.

LEARNING OUTCOMES

Students will be able to:

- Understand the scientific philosophy and publicationethics.
- Know plagiarism andmisconduct.
- Learn about publication of research findings and publicationsources.
- Aware about various scientific databases andaltimetrics.

SYLLABUS

UNIT I

Unit I: Philosophy and ethics

Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgements and relations.

Unit II: Research conduct

Ethics with respect to science and research - Intellectual honest and research integrity - Scientific misconducts: falsification, fabrication, and plagiarism. Redundant publications: duplicate and overlapping publications.

Unit III: Publication ethics and misconduct

Publication ethics: Definition, introduction and importance - UGC-CARE - Publication misconduct: definition, concept, problems that lead to unethical behavior and vice verse, types - Violation of publication ethics, authorship and contributorship - Identification of publication misconduct, complaints andappeals.

Unit IV: Open access publishing and search tools

Open access publications and initiatives - SHERPA/RoMEO online resources to check publisher copyright and self-archiving policies. Journal finder/ journal suggestion tools -Tools/software for plagiarism detection - Turnitin, Urkund and other open source softwaretools.

Unit V: Databases and research metrics

Databases-Indexingdatabases;Citationdatabases-ResearchMetrics-ImpactFactorof journalasperjournalcitationreport(JCR),SNIP,SJR,IPP,CiteScore.Metrics: *h*-index, *g*-index, *i10*-index,altimetrics.

REFERENCE BOOKS

1. Bird, A. (2006). Philosophy of Science. RoutledgeImprint.
2. Chaddah, P. (2018). Ethics in Competitive Research: Do not get scooped; do not get plagiarized. ISBN:9787-9387480865.
3. Cvetkovic, V. B. and Anderson, K. E. (2010). Stop Plagiarism: New Resources for Understanding and Prevention. Neal-Schuman PublishersInc.
4. Darr, T. (2019). Combating Plagiarism: A Hands-On Guide for Librarians, Teachers, and Student. Libraries UnlimitedInc.
5. Lipson, C. (2004). Doing Honest Work in College – How to Prepare Citations, Avoid Plagiarism and Achieve Real Academic Success (Chicago Guides to Writing, Editing, and Publishing). University of ChicagoPress.
6. Lipson, C. (2018). Cite Right, Third Edition – A Quick Guide to Citation Styles— MLA, APA, Chicago, the Sciences, Professions, and More (Chicago Guides to Writing, Editing, and Publishing). University of ChicagoPress.
7. MacIntyre, A. (1998). A Short History of Ethics: A History of Moral Philosophy from the Homeric Age to the Twentieth Century, Second Edition. 1998. University of Notre-DamePublication.
8. Muralidhar, K., Amit Ghosh, and Singhvi, A. K. (Eds.) (2019). Ethics in Science Education, Research and Governance. Indian National Science Academy, New Delhi, India.https://www.insaindia.res.in/pdf/Ethics_Book.pdf

9. National Academy of Sciences; National Academy of Engineering (2009). A Guide to Responsible Conduct in Research: Third Edition. ISBN: 978-0-309- 11970-2; Ebook:978-0-309-14135-2
10. Parsons,H.L.(1980).Self,GlobalIssues,andEthics:4(Praxis:Philosophicaland Scientific Publications.). B.R. Gruner PublishingCo.
11. Williams, K. and Davis, M. (2017). Referencing and Understanding Plagiarism. Red GlobePress.
12. Yadav, S. K. (2020). Research and Publications Ethics. Ane Books Pvt. Ltd., Chennai.

WEB RESOURCES

- The top list of academic research databases. https://paperpile.com/g/academic- research-databases/
- Publication ethics. http://www.lnit.org/index.php?m=content&c=index&a=lists& catid=41
- Ethics in Research & Publication.https://www.elsevier.com/ data/assets/pdf_file /0008/653885/Ethics-in- research-and-publication-brochure.pdf
- COPE and Publication Ethics. http://publicationethics.org/files/Overview_ publication_ethics.pdf
- Understanding Academic Integrity, Research, and Classroom Ethics.https://pitt.libguides.com/academicintegrity