LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (LOCF) FOR POSTGRADUATE PROGRAMME

(With effect from 2022-23)

M.Sc. MATHEMATICS

PG & RESEARCH DEPARTMENT OF MATHEMATICS

Effective from the Academic Year 2022 - 2023

LOYOLA COLLEGE (AUTONOMOUS)

CHENNAI - 600034

PREFACE

UGC has established a learning outcomes-based curricular framework for postgraduate education in order to shift from a teacher-centric to a learner-centric strategy. This is taken into account when developing the learning outcomes-based curricular structure for M.Sc., Mathematics.

The framework is designed to equip students with mathematical knowledge and abilities, as well as general and transferable skills in other areas that will aid in personal growth, employment, and higher education in a global environment.

The programme and course learning outcomes have been explicitly defined to assist prospective students, parents, and employers in understanding the nature and scope of the degree programme to maintain national and international standards and to facilitate student mobility.

The objectives designed by the school of computational sciences emphasis on the core competency in modern computational techniques to provide logical solutions for a sustainable growth to maintain standards in catering the needs of the industry and society.

The M.Sc. Mathematics curriculum covers the whole spectrum of mathematics, from calculus to space science. The course provides a systematic approach in Real & Complex Analysis, Abstract Algebra, Differential Equations, Number Theory, Graph Theory, Fuzzy theory and MATLAB Programming for Mathematics students exclusively.

Linear Algebra, Metric Spaces, Statistics, Linear Programming, Numerical Analysis, Mathematical Finance, Coding Theory, Mechanics, and Biomathematics are a few of the subjects covered in Pure and Applied Mathematics.

The LOCF framework's primary relevance is to extend the interest in connectivity across multiple and different disciplines and to improve their ability to acquire skills related to the main field. Electives provide the student the freedom to pursue his or her interests outside of the main subjects.

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We acknowledge the contributions of the following members of the Board of Studies **Dr. V. Vetrivel** (University Nominee-PG Board), **Dr. P. Loganathan** (Subject Expert), **Dr. Jude Annie Cynthia V** (Subject Expert), **Ms. Madonna N** (Alumna) and **Mr. C. V. Suresh Kumar** (Industry Representative)

CONTENTS

VISION AND MISSION OF LOYOLA COLLEGE, CHENNAI

VISION

- Towards holistic formation of youth, grounded in excellence, through accompaniment to serve the humanity.

MISSION

- To provide inclusive education through an integral and holistic formative pedagogy.
- To promote skills that prepares them for the future.
- To kindle in young minds, the spirit of social and environmental justice with a blend of academic excellence and empathy.
- To stimulate critical and conscientious scholarship leading to meaningful and innovative human capital.

CORE VALUES

- Cura Personalis
- Pursuit of Excellence
- Moral Rectitude
- Social Equity
- Fostering solidarity
- Global Vision
- Spiritual Quotient

VISION AND MISSION OF THE DEPARTMENT

VISION

- To acquaint coherent knowledge of mathematics to form credible, innovative and socially committed citizens.

MISSION

- To explore and elevate mathematical techniques and enable students with academic excellence and core competencies.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)
(School of Computational Sciences)

PEO1	**LEARNING ENVIRONMENT AND LIFE LONG LEARNING:** To access academic facilities in an environment of inclusiveness and inquisitiveness for effective and immersed learning throughout life to attain excellence in the chosen field of computational sciences.
PEO2	**GLOBALLY RELEVANT CURRICULUM AND SCIENTIFIC TEMPERAMENT** To think innovatively, analyse scientifically and make decisions appropriately, for handling contemporary global concerns through the knowledge earned in the computational sciences curriculum.
PEO3	**ACADEMIC EXCELLENCE AND CORE COMPETENCY** To excel in modern computational techniques and compete in higher studies/career, for addressing contemporary challenging problems with ease.
PEO4	**SKILL DEVELOPMENT AND ENTREPRENEURSHIP** To develop analytical, logical and critical problem-solving skills for executing professional work and become experts/entrepreneurs in the field of computational sciences.
PEO5	**ENVIRONMENT AND SUSTAINABILITY** To identify real world problems concerning environment and other issues; and apply the expertise in the computational sciences, to face the challenges and provide sustainable solutions.
PEO6	**PROFESSIONALISM AND ETHICS WITH SOCIAL RESPONSIBILITY** To equip themselves with the necessary competency towards professionalism in the computational sciences maintaining ethical standards in addressing the needs of industry and society.

PROGRAMME OUTCOMES (POs)
(School of Computational Sciences)

PO1	**DISCIPLINARY KNOWLEDGE & INFORMATION/DIGITAL LITERACY** To acquire literacy in the respective discipline of computational sciences and demonstrate scholarly knowledge in the information-digital era.
PO2	**SELF DIRECTED AND LIFE-LONG LEARNING** To adapt oneself to technological advancements in computing and engage in life-long self-learning for personal development in the context of interdisciplinary nature of future endeavours.
PO3	**SUSTAINABLE SOCIAL AND ENVIRONMENTAL CONSCIOUSNESS** To realize social and environmental problems and contribute the computational expertise to face the challenges and provide sustainable solutions.
PO4	**CRITICAL THINKING; ANALYTICAL REASONING & PROBLEM-SOLVING** To critically reason out, analyse and develop solutions through various computational techniques for real time problems.
PO5	**SCIENTIFIC REASONING AND COMMUNICATION SKILLS** To apply scientific reasoning in the approach to handle professional matters, communicate the solutions to stakeholders and enable them to understand and appreciate the outcomes.
PO6	**PROFESSIONALISM; TEAMWORK AND ETHICS** To manifest the core competencies, adhere to collaborative efforts within ethical frameworks and emerge as professionals holding key positions in the respective domains.
PO7	**SKILL DEVELOPMENT, EMPLOYABILITY, LEADERSHIP AND ENTREPRENEURSHIP:** To develop expertise and professional skills for employment in the domain of computational sciences and emerge as leaders and entrepreneurs.

PROGRAMME SPECIFIC OUTCOMES (PSOs)
(PG & Research Department of Mathematics)

PSO1	To study, analyse and solve the real-world issues by applying mathematical concepts and principles.
PSO2	To demonstrate logical, analytical and scientific skills to cater industrial requisites.
PSO3	To familiarize mathematical technologies to emerge as professionals and successful entrepreneurs with an ethical attitude and a culture of collaboration.
PSO4	To develop research competencies in dealing with global social issues and propose logical solutions with compassion.
PSO5	To create mathematical models for a sustainable world with environmental consciousness.
PSO6	To appreciate various aspects of modern mathematics and build and integrate suitable solutions to challenges encountered by individuals in various sectors.
PSO7	To expertise in recent trends of computational and mathematical techniques and emerge as analytics and prominent researchers.

Correlation Rubrics

High	Moderate	Low	No Correlation
3	2	1	0

Mapping of PEOs with Vision and Mission

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
Vision	3	3	3	3	3	3
Mission	3	3	3	3	3	3

Mapping of POs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PO1	3	3	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	2	2	3	3
PO4	3	3	3	3	2	3
PO5	3	2	3	3	3	3
PO6	3	3	3	3	3	3
PO7	3	3	2	3	3	2

Mapping of PSOs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PSO1	3	3	3	3	3	3
PSO2	3	3	3	3	3	3
PSO3	3	3	3	3	3	3
PSO4	3	3	3	3	3	3
PSO5	3	3	3	3	3	3
PSO6	3	3	3	3	3	2
PSO7	3	3	3	3	3	3

Mapping of PSOs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
PSO1	3	3	3	3	3	3	3
PSO2	3	3	3	3	3	3	3
PSO3	3	3	3	3	3	3	3
PSO4	3	3	3	3	3	3	3
PSO5	3	3	3	3	3	3	3
PSO6	3	3	3	3	3	3	3
PSO7	3	3	3	3	3	3	3

M.SC. MATHEMATICS RESTRUCTURED LOCF CURRICULUM WITH EFFECTIVE FROM JUNE 2022

PART	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV	Credits
MC	Linear Algebra (6h/6c)	Algebra (5h/4c)	Topology (5h/5c)	Functional Analysis (5h/5c)	79
	Real Analysis-I (6h/6c)	Real Analysis-II (5h/4c)	Number Theory (5h/4c)	Numerical Analysis (5h/5c)	
	Ordinary Differential Equations (5h/5c)	Partial Differential Equations (5h/4c)	Mathematical Programming (5h/5c)	Classical Mechanics (5h/5c)	
	Data Structures and Algorithms using Python (5h/5c)	Complex Analysis (5h/5c)	Fluid Dynamics and Space Science (5h/4c)		
	Data Structures and Algorithms using Python-LAB (3h/1c)	Research Methodology (3h/1c)			
	Probability Theory and Random Processes (5h/5c)				
ME		Fuzzy Logic and Neural Networks (4h/2c)	An introduction to Data Science (4h/2c)		4
		Parallel Interconnection Networks (4h/2c)	Actuarial Mathematics (4h/2c)		
		Financial Mathematics (4h/2c)	Representation Theory of Finite Groups (4h/2c)		
		Differential Geometry (4h/2c)	Coding Theory (4h/2c)		
ID			Mathematical Computing Using MATLAB and R (3h/2c)		3

			Mathematical Computing Using MATLAB and R - LAB (3h/1c)		
SSC		Self-Study/MOOC ##(2h/2c)			**2##**
SS		Soft Skills # (2h/1c)	Soft Skills #(2h/1c)		**2**
CD		Quantitative Aptitude for Combined Civil Services Examinations (3h/1c) Mathematical Tools for Humanities (3h/1c) Bio-Mathematics (3h/1c)			**1**
VA			Value Added Courses (from other Institutions) # (2h/1c)		**1**
SI		Summer Internship (3 to 4 Weeks) # (1c)			**1**
SL			LEAP # (2h/1c)		**1**
PR				Project Work (15h/5c)	**5**
Hr/C	**30h/28c**	**(30+4)h/(23+2##)c**	**(30+6)h/(26)c**	**30h/20c**	**(120+10)h/(97+2)c**

 # - Credits required outside class hours. **## - Additional Credits**

M.Sc. MATHEMATICS OVERALL COURSE STRUCTURE
(2022 - Restructured Curriculum)

Sem	Course Code	Course Title	T/L/ TP	Category	Cr	Hrs
I	PMT1MC01	Linear Algebra	T	MC	6	6
I	PMT1MC02	Real Analysis-I	T	MC	6	6
I	PMT1MC03	Ordinary Differential Equations	T	MC	5	5
I	PMT1MC04	Data Structures and Algorithms using Python	T	MC	5	5
I	PMT1MC05	Data Structures and Algorithms using Python-LAB	L	MC	1	3
I	PMT1MC06	Probability Theory and Random Processes	T	MC	5	5
II	PMT2MC01	Algebra	T	MC	4	5
II	PMT2MC02	Real Analysis-II	T	MC	4	5
II	PMT2MC03	Partial Differential Equations	T	MC	4	5
II	PMT2MC04	Complex Analysis	T	MC	4	5
II	PMT2MC05	Research Methodology	T	MC	2	3
II	PMT2ME01	Fuzzy Logic and Neural Networks	T	ME	2	4
	PMT2ME02	Parallel Interconnection Networks				
	PMT2ME03	Financial Mathematics				
	PMT2ME04	Differential Geometry				
II	PMT2MO01	Self-Study/MOOC	T	MO	2	2
II	PMT2SS01	Soft Skills	T	SS	1	2
II	PMT2CD01	Quantitative Aptitude for Combined Civil Services Examinations	T	CD	1	3

	PMT2CD02	Mathematical Tools for Humanities				
	PMT2CD03	Bio-Mathematics				
II	PMT2SI01	Summer Internship (3 to 4 Weeks)		SI	1	-
III	PMT3MC01	Topology	T	MC	5	5
III	PMT3MC02	Number Theory	T	MC	4	5
III	PMT3MC03	Mathematical Programming	T	MC	5	5
III	PMT3MC04	Fluid Dynamics and Space Science	T	MC	4	5
III	PMT3ME01	An introduction to Data Science	T	ME	2	4
	PMT3ME02	Actuarial Mathematics				
	PMT3ME03	Representation Theory of Finite Groups				
	PMT3ME04	Coding Theory				
III	PMT3ID01	Mathematical Computing Using MATLAB and R	T	ID	2	3
	PMT3ID02	Mathematical Computing Using MATLAB and R LAB	L	ID	1	3
III	PMT3SS01	Soft Skills	T	SS	1	2
III	PMT3VA01	Value Added Courses (from other Institutions)	T	VA	1	2
III	PMT3SL01	LEAP	-	SL	1	2
IV	PMT4MC01	Functional Analysis	T	MC	5	5
IV	PMT4MC02	Numerical Analysis	T	MC	5	5
IV	PMT4MC03	Classical Mechanics	T	MC	5	5
IV	PMT4PD01	Project Work	-	PD	5	15

COURSE DESCRIPTORS
(Offered by the Department)

Course Code	PMT1MC01
Course Title	Linear Algebra
Credits	6
Hours/Week	6
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Overview

1. This course provides a study of linear transformations on finite dimensional vector spaces.
2. This course helps to find a basis of a vector space such that the matrix of a linear transformation is in the simplest forms namely triangulable and diagonalizable forms.
3. This course deals with rational and Jordan canonical forms of matrices which help to identify the types of matrices.
4. This course gives a detailed study of finite dimensional inner product spaces.
5. It also provides a detailed study of operators on finite dimensional inner product spaces.

Course Objectives

1. To understand the representation of linear transformation in matrix form and its development.
2. To find an ordered basis for a finite dimensional vector space to represent the matrix of the linear operator in simple form.
3. To decompose the given vector space into a sum of its subspaces.
4. To analyse the relationships between positive operators, positive forms and positive matrices.
5. To apply the theory of linear algebra in different fields.

Prerequisites	A knowledge in elementary linear algebra.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Characteristic values – Annihilating polynomials – Invariant subspaces – Application to Input-Output Economic Models.	18	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

			CO4 CO5	
II	Simultaneous Triangulation; Simultaneous Diagonalization, Direct sum decompositions – Invariant direct sums – An Application to Linear Recurrences, An Application to Systems of Differential Equations.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	The Primary Decomposition theorem – Cyclic subspaces and Annihilators.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Cyclic Decompositions and the Rational form – the Jordan form – Computation of invariant factors.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Inner products – Inner product Spaces – Linear functionals and adjoints – Unitary operators – Normal operators. Forms on Inner product spaces – Positive forms – An application to computer graphics and best approximation and least squares.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Linear Algebra, Kenneth Hoffman & Ray Kunze, Prentice-Hall of India, 1975.
2. Linear algebra with applications, W. Keith Nicholson, Open Edition, BASE TEXTBOOK VERSION 2018 REVISION A

Suggested Readings

1. An Introduction to Linear Algebra, Alka Marwaha, PHI Learning, First Edition, e-Book, 2014.
2. Algebra, M. Artin, Prentice Hall of India, 1991.
3. Applied Linear Algebra, Ben Noble and James W. Daniel, Pearson, Third edition, 1987.
4. Linear Algebra, Promode Kumar Saikia, Pearson, First Edition, e-book, 2009.
5. Linear Algebra, Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Eastern Economy Edition, Fourth Edition, 2014.

Web Resources

1. http://joshua.smcvt.edu/linalg.html/
2. https://joshua.smcvt.edu/linearalgebra/book.pdf
3. https://personal.math.ubc.ca/~carrell/NB.pdf

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand characteristic values of matrices, decomposition of matrices and operators, and forms on inner product spaces.	K1, K2
CO2	To apply the theory of linear transformations in representing the transformation in simplex form of matrices and decomposition of finite dimensional vector spaces into its subspaces.	K3
CO3	To analyse the representation of matrices in simplest form, decomposition of finite dimensional vector spaces, and relationships between positive operators, positive forms and positive matrices.	K4
CO4	To compare the study of linear transformation of finite dimensional vector spaces and forms on inner product spaces.	K5
CO5	To demonstrate the solutions of some problems in economics, computer graphics and statistics using linear algebra.	K6

Course Code	PMT1MC02
Course Title	Real Analysis I
Credits	6
Hours/Week	6
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Overview

1. This course starts with an introduction of metric spaces, compact sets and connected sets.
2. It deals with a study of continuity and differentiability of real valued functions.
3. It covers the study of Riemann – Steiltjes integrable real valued functions.
4. Convergence and uniform convergence of sequences and series of real valued functions are dealt in detail.
5. It also provides applications of the theory of Real Analysis.

Course Objectives

1. To understand the basic concepts of metric spaces, compact sets and connected sets.
2. To apply the theory of continuity and differentiability of real valued functions in solving the real-life problems.
3. To identify the Riemann – Steiltjes integrable real valued functions.
4. To compare and identify Convergence and uniform convergence of sequences and series of real valued functions.
5. To apply the theory of Real analysis in approximating the given function.

Prerequisites	A basic knowledge in set theory, functions, limits of sequences and series of real numbers.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level

I	Basic Topology – Metric spaces, Compact sets, Connected sets, Continuity – Limits of functions, continuous functions, continuity and compactness, continuity and connectedness, discontinuities – monotonic functions.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
II	Differentiation, derivative of a real function, mean value theorems, continuity of derivatives, Derivatives of higher order, Taylor's theorem, Differentiation of vector valued function.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Riemann – Stieltjes Integral, Definition and Existence of the Integral, properties of the Integral, Integration and Differentiation.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Sequences and series of functions – Uniform Convergence – Uniform convergence and Continuity – Uniform convergence an Integration.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Uniform Convergence and Differentiation – Equicontinuous Families of Functions – Stone – Weierstrass Theorem Approximation by polynomials – Taylor's series, how not to approximate a function, Bernstein's proof of Weierstrass theorem, Accuracy of approximation, Existence of best approximation.	18	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Principles of Mathematical Analysis, Walter Rudin, Third Edition, McGraw Hill, 1976.
2. Real Analysis and Applications Theory in Practice, Kenneth R. Davidson Allan P. Donsig, Springer.

Suggested Readings

1. Mathematical Analysis, T. M. Apostol, Addison – Wesley, 1974.
2. Real Analysis, N. L. Carothers, Cambridge University Press, First Edition, e – book, 2000.

3. The Theory of Functions of Real Variables, Lawrence M Graves, Dover Publications, Second Edition, e – book, 2012.
4. Real Analysis, Royden H. L, PHI, fourth edition, 2011.
5. Real Analysis, Sharma & Vasishtha , Krishna Prakashan Media (P) Ltd., 43rd edition, 2014.

Web Resources

1. https://www.jirka.org/ra/
2. https://nptel.ac.in/courses/111/106/111106053/
3. http://facultymembers.sbu.ac.ir/shahrokhi/ProBookMathAnal1.pdf
4. https://bit.ly/3gSiNv8

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To recall and understand the basic concepts of Real analysis.	K1, K2
CO2	To apply the theory of continuity, differentiability and integrability of real valued functions in solving real life problems.	K3
CO3	To analyse the concepts of limits, continuity, differentiability, integrability of real valued functions and convergence of sequences and series of functions.	K4
CO4	To differentiate continuity and uniform continuity of real valued function, convergence and uniform convergence of sequence of real valued functions.	K5
CO5	To signify the applications of theory of Real Analysis in approximating functions.	K6

Course Code	PMT1MC03
Course Title	Ordinary Differential Equations
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Overview

1. Physical problems are transformed into mathematical problems using differential equations, which include initial and boundary conditions.
2. Various numerical as well as analytical methods are explained to find the solutions of linear and non-linear differential equations.
3. The existence and uniqueness of solutions are discussed for first – order linear equations.
4. The system of differential equations is considered based on real – world situations, and solutions are derived.
5. The Legendre and Bessel equations are discussed and their respective polynomials derived.

Course Objectives

1. To understand the need for differential equations and their importance in physical phenomena.
2. To apply various analytical methods to solve differential equation.
3. To recognize the necessity of approximate solutions when an exact solution is not possible.
4. To understand the power series method in solving engineering – related problems.
5. To derive the solutions for different kinds of boundary value problems.

Prerequisites	Basic knowledge on differentiation

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	How differential equations arise – Classification – Initial and boundary value problems – Purpose of theoretical considerations – First order linear equation – Lipschitz condition - Picard's successive	15	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

	approximations – Existence and Uniqueness of solutions: Picard's theorem – Existence of solutions in large.		CO4 CO5	
II	Higher order equations – A mathematical model – Linear dependence and Wronskian – Basic theory of linear equations – Homogeneous linear equations – Method of variations of parameters.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Systems of first order equations – Models for arms competition between two nations – Existence and uniqueness theorem – Fundamental matrix – Non-homogeneous linear systems.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Second order linear equations with ordinary points – Legendre equation and Legendre polynomials – Second order equations with regular singular points – Bessel's functions.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Oscillations of second order equations – Strum's comparison and separation theorems – Elementary linear Oscillations – Comparison theorem of Hille-Wintner – Applications of boundary value problems.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Text Book of Ordinary Differential Equations, S. G. Deo, V. Raghavendra, Rasmita Kar, V. Lakshmikantham, Third Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2015.

Suggested Readings

1. An Introduction to Ordinary Differential Equations, E. A. Coddington, Prentice Hall, 1961 (Reprint in PHI Learning, New Delhi, 2009).
2. Differential Equations: Theory, Technique and Practice, G. F. Simmons and S. G. Krantz, Tata McGraw-Hill, 2007.
3. Elementary Differential Equations and Boundary Value Problems, W. E. Boyce and R. C. Di-Prima, Seventh Edition, John Wiely & Sons, New York, 2001.

4. An Introduction to Ordinary Differential Equations, R. P. Agarwal and D. O'Regan, Springer-Verlag New York, 2008.
5. Differential and Integral Equations, P. J. Collins, Oxford University Press, 2006.
6. Essentials of Ordinary Differential Equations, R. P. Agarwal and R.C. Gupta, McGraw-Hill, 1993.

Web Resources

1. https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/
2. https://nptel.ac.in/courses/111/104/111104031/
3. https://www.math.tamu.edu/~don.allen/ODE_resources.htm
4. https://math.libretexts.org/Bookshelves/Calculus/Book%3A_Calculus_(OpenStax)/17%3A_Second-Order_Differential_Equations/17.4%3A_Series_Solutions_of_Differential_Equations
5. https://www.geeksforgeeks.org/program-for-picards-iterative-method-computational-mathematics/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic concepts of differential equations and how differential equations are formed from real life circumstances.	K1, K2
CO2	To employ various techniques for solving the differential equations.	K3
CO3	To analyze the existence and uniqueness of solutions and the efficacy of the power series method.	K4
CO4	To summarize the best possible solutions by considering analytical and numerical approaches.	K5
CO5	To develop a system of differential equations for the new problems and discuss potential solutions.	K6

Course Code	PMT1MC04
Course Title	Data Structures and Algorithms using Python
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Overview

1. This course aims to give the insights of data structures, algorithms and Python.
2. Decision structures, iteration structures and functions in Python are explored.
3. Python code for built-in and user-defined data structures and function is introduced.
4. Definitions, analysis of algorithm and data structure to design an algorithm are discussed elaborately.
5. The various approaches of algorithm strategy and analyzing its complexity classes are studied.

Course Objectives

1. To get well acquainted with the operators, expressions and control flow statements in Python.
2. To study the low – level arrays, dynamic arrays, list, stack, queue data structures and their implementation.
3. To acquire the knowledge about algorithm, analyzing an algorithm, asymptotic notations and designing an algorithm by divide and conquer strategy.
4. To learn the design techniques to solve optimization problems with one or more decision sequences.
5. To examine the modern techniques of algorithm design and its complexity classes.

Prerequisites	Familiar with a programming language.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Python Overview – Objects in Python – Expressions, Operators and Precedence – Control Flow – Functions – Simple Input and Output – Exception Handling – Iterators and Generators: for,	15	CO1 CO2 CO3 CO5	K1, K3, K4, K6

	while loop statement – Conditional Expression: if – else statement.			
II	Python's Sequence Types – Low-level Arrays – Implementing a Dynamic Array – Array-based stack and queue implementation – Circular Queues – Implementing a stack and queue with a singly linked list – Array based representation of binary trees.	15	CO1 CO2 CO3 CO5	K1, K2, K3, K4, K6
III	Algorithm – Algorithm Specification – Performance Analysis, Stacks, Queues, Trees, Dictionaries, Priority Queues, Graphs, Control Abstraction for Divide and Conquer – Time Complexity of Divide and Conquer Algorithms – Binary search – Merge Sort, Quick Sort – Selection.	15	CO1 CO3 CO5	K1, K2, K4, K6
IV	Greedy Method Control Abstraction for Subset Paradigm – Knapsack Problem – Minimum-Cost Spanning Trees – Optimal Storage on Tapes – Optimal Merge Patterns – Single-Source Shortest Paths – Dynamic Programming – Travelling Salesperson Problem.	15	CO2 CO3 CO4 CO5	K3, K4, K5, K6
V	Basic traversal and Search Techniques for binary trees and graphs – Backtracking – General Method – Sum of subsets, Graph Coloring – Nondeterministic Algorithms – Classes NP-hard and NP-Complete – Cook's theorem (Statement only).	15	CO2 CO3 CO4 CO5	K3, K4, K5, K6

Text Books

1. Data Structures and Algorithms in Python, Michael T. Goodrich, Irvine Roberto Tamassia, Michael H. Goldwasser, Wiley India, 2021.
2. Fundamentals of Computer Algorithms, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, Galgotia Publications, Second edition, 2017.

Suggested Readings

1. Data Structures and Algorithms using Python, Rance D. Necaise, Wiley India, 2016.
2. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, PHI Learning Pvt. Ltd., Third edition, 2010.
3. Fundamentals of Python: Data Structures, Kenneth Lambert, Cengage Learning, Second edition, 2018.
4. Data Structure and Algorithmic Thinking with Python: Data Structure and Algorithmic Puzzles, Narasimha Karumanchi, Career Monk Publications, First edition, 2015.

5. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python, Basant Agarwal, Benjamin Baka, Packt Publishing, Second edition, 2018.
6. Introduction to The Design and Analysis of Algorithms, Anany Levitan, Pearson India Education Services Pvt. Ltd., 2018.

Web Resources

1. https://www.coursera.org/learn/data-structures
2. https://nptel.ac.in/courses/106/106/106106145/
3. https://www.udacity.com/course/data-structures-and-algorithms-in-python--ud513

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To describe various data structures and define Python implementation for data structures.	K1, K2
CO2	To examine strategies of algorithm design and programs in Python.	K3
CO3	To identify a suitable data structure and develop the Python program to solve problems.	K4
CO4	To interpret different algorithm design techniques and evaluate their performance.	K5
CO5	To design pseudocode for various sorting algorithms and construct graph problems with their Python code.	K6

Course Code	PMT1MC05
Course Title	Data Structures and Algorithms using Python-LAB
Credits	1
Hours/Week	3
Category	Major Core (MC) – Lab
Semester	I
Regulation	2022

Course Overview

1. This course aims to develop the programming skills in Python programming language.
2. The coding techniques using programming constructs looping, decision making, branching and user-defined functions are practiced.
3. Implementation of an algorithm strategy to solve real-time problem using Python code is studied.
4. Python code for performing operations on user-defined data structures is discussed.
5. The steps to develop algorithms and implementation of Python code to solve social science problems are explored.

Course Objectives

1. To describe the various data structures and their significance.
2. To understand the modern techniques to implement data structures.
3. To practice the latest techniques to analyze various approaches of algorithm design.
4. To explore the techniques related to sorting and processing a node in traversal problems.
5. To evaluate Python coding and techniques in terms of time and space complexity.

Prerequisites	Familiar with Python.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	1. Implementation of a Dynamic Array class using an array. 2. Program to reverse data using stack. 3. Program to convert a decimal number to its binary form using a stack. 4. Array-based implementation of a queue.	9	CO1 CO2 CO3 CO5	K1, K3, K4, K5

II	1. Program to check whether a string is palindrome or not using dequeue. 2. Implementing a stack with a singly linked list. 3. Program to implement Tree ADT. 4. Implementation of graph ADT: Graph class.	9	CO1 CO2 CO3 CO5	K1, K2, K3, K4, K6
III	1. Recursive implementation of factorial function. 2. Non-recursive implementation of binary search algorithm. 3. Program to implement Depth-first search on a graph. 4. Program to implement of Breadth-first search on a graph.	9	CO2 CO3 CO4 CO5	K3, K4, K5, K6
IV	1. Program to implement Mergesort algorithm. 2. Implementation of Quicksort algorithm 3. Implementation of Tree Traversals. 4. Implementation of Heap.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3 K4, K5, K6
V	1. Program to perform search in a binary search tree. 2. Implementation of Prim's algorithm for minimum spanning tree problem. 3. Implementation of Kruskal algorithm for minimum spanning tree problem. 4. Program to implement Single-Source Shortest Paths.	9	CO1 CO3 CO4 CO5	K1, K2, K4, K5, K6

Text Books

1. Data Structures and Algorithms in Python, Michael T. Goodrich, Irvine Roberto Tamassia, Michael H. Goldwasser, Wiley India, 2016.

Suggested Readings

1. Fundamentals of Python: First Programs, Kenneth Lambert, Course Technology Inc; Second edition, 2018.
2. Data Structure and Algorithmic Thinking with Python: Data Structure and Algorithmic Puzzles, Narasimha Karumanchi, Career Monk Publications, First edition, 2015.
3. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python, Basant Agarwal, Benjamin Baka, Packt Publishing; Second edition, 2018.

Web Resources

1. https://www.coursera.org/learn/python

2. https://www.udemy.com/course/practical-python-with-joe-perry/3
3. https://www.udacity.com/course/data-structures-and-algorithms-in-python--ud513
4. https://jovian.ai/learn/data-structures-and-algorithms-in-python

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To recognize Python functions for implementation of various data structures.	K1, K2
CO2	To apply Python code to solve real-time problems.	K3
CO3	To illustrate the implementation of various algorithm techniques.	K4
CO4	To evaluate the algorithm strategy for solving particular problem.	K5
CO5	To create Python code for solving real-world problems.	K6

Course Code	PMT1MC06
Course Title	Probability Theory and Random Processes
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Overview

1. The power of reasoning and critical thinking which supports to identify fairness in the calculation are developed.
2. The estimation theory which helps to allocate good estimation for a project is presented.
3. The concept of random processes and its application in signal processing are studied.
4. Various statistical skills and their practical application on various field of sciences are emphasized.
5. The course provides statistical methods which helps to finish the business/ industry tasks effectively and efficiently.

Course Objectives

1. To understand the concepts of various statistical inequalities, correlation, regression and demonstrate them through various real-life problems.
2. To apply the concept of estimator in the industry for finding a good estimation.
3. To analyse and interpret the results by the concept of testing of hypothesis.
4. To illustrate the concepts of Random processes in statistical problems related to time.
5. To realize the application of statistics in Commerce, Industry, Social Sciences and Life Sciences which helps to do research in multidisciplinary approach.

Prerequisites	A solid knowledge of statistical formulae and concepts.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Introduction – Random variables and distribution functions (Univariate and Multivariate) – Mathematical expectation – Markov's inequality – Chebyshev's inequality – weak law of	15	CO1 CO2	K1, K2, K3, K4, K5, K6

	large numbers – Bernoulli's law of large numbers – Khintchin's Theorem – Application of Statistics in Business, Commerce and Industry.		CO3 CO4 CO5	
II	Correlation – Rank correlation – partial and multiple correlation – Regression – Application of Statistics in Social Science.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Inference – Concept of estimation – unbiasedness – Consistency – Efficiency and minimum variance – Sufficiency – Method of point estimation – Cramer-Rao inequality.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Statistical hypothesis – Null Hypothesis – Critical region – Type I and Type II errors – Power of a test – Uniformly most powerful test – Neyman-Pearson fundamental lemma – The likelihood function – Likelihood ratio test – Application of statistics in Physical Sciences.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Introduction – Classification of random Processes – Stationary Processes – Markov Processes – Markov Chain – Homogeneous Markov Chain-Transition Probabilities – Chapman-Kolmogorov equations – Stochastic Matrix-Problems – Signal processing applications.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Mathematical Statistics, O.P. Gupta and Vishal Sharma, Kedar Nath Ram Nath Publisher, Meerut, Revised edition 2020.
2. Probability and Random Processes, P. Sivaramakrishna Das, C. Vijayakumari, Pearson publications, India, sixth edition, 2015.
3. Introduction to Random Processes with applications to signals and systems, William A. Gardner, MC-Graw Hill, Inc. publishers, second edition, USA, second edition, 1990.

Suggested Readings

1. Probability and Random Process, S. K. Srinivasan and K.M. Mehata, Tata McGraw- Hill Publishing, New Delhi, 1978.
2. Fundamentals of Mathematical Statistics, S. C. Gupta and V. K. Kapoor, Sultan Chand and Sons, New Delhi, 2002.
3. Stochastic Processes, J. Medhi, New age international publishers, New Delhi, Fourth Edition, 2019.
4. Probability Random Processes and Queuing Theory, A. M. Natarajan, A. Tamilarasi, New age international publishers, New Delhi, First Edition, 2019.

Web Resources

1. http://www.uop.edu.pk/ocontents/Book.pdf
2. https://people.math.harvard.edu/~knill/books/KnillProbability.pdf
3. https://www.dcpehvpm.org/E-Content/Stat/E%20L%20Lehaman.pdf
4. https://people.duke.edu/~hpgavin/SystemID/References/Estimation_Theory.pdf
5. https://bank.engzenon.com/tmp/5e7f97b9-c014-4995-972e-4bc8c0feb99b/541eecd2-a7dc-4d24-89e2-60cec0e8c6f8/Probability_Random_Variables_and_Random_Signal_Principles_Peebles_4th.pdf

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To recall the basic statistical concepts and to identify them in industrial situation.	K1, K2
CO2	To understand the basic statistical concepts of inequalities, correlation, regression, estimators, testing of hypothesis, random processes and to apply them to solve problems.	K3
CO3	To investigate the optimal solution for industry/business related problems using various inequalities, good estimators, rank correlation, testing of hypothesis and random processes.	K4
CO4	To decide the best statistical skills required in solving the real-world problems.	K5
CO5	To develop a business strategy using the ideas of good estimation, regression analysis and testing of hypothesis.	K6

Course Code	PMT2MC01
Course Title	Algebra
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Overview

1. This course deals with an advanced study of algebraic structures.
2. It helps to have a detailed study of counting principle and Sylow's theorems.
3. A study of structure theorem on groups and polynomial rings are dealt with in this course.
4. This course covers a study of fields and extension of fields.
5. It also provides applications of fields.

Course Objectives

1. To understand the counting principle and Sylow's theorems as particular cases of the converse of Lagrange's theorem.
2. To solve related problems using structure theorem on groups and theory of polynomial rings.
3. To find extension of a field in which the given polynomial has all its roots.
4. To analyze the Galois group of given polynomial and its implementation.
5. To apply the theory of fields and Galois groups in different areas.

Prerequisites	A knowledge in undergraduate Abstract Algebra.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Another counting principle – class equation for finite groups and applications	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Sylow's theorems (For theorem 2.12.1, First proof only), Direct products – Finite abelian groups (Theorem 2.14.1 only).	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Polynomial rings – Polynomials over the Rational Field – Polynomial Rings over Commutative Rings	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Extension fields – Roots of polynomials – More about roots – Latin squares	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Elements of Galois theory – Solvability by radicals – Construction with straightedge and compass, Finite fields	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Topics in Algebra, I. N. Herstein, Wiley Eastern Limited, New Delhi, II Edition, Reprint 2014.
2. Modern Algebra with Applications, William J Gilbert, W. Keith Nicholson, John Wiley & Son, Second Edition, 2004.

Suggested Readings

1. Algebra, Artin M, Prentice Hall of India, 1991.
2. Galois Theory, David A. Cox, Second edition, Wiley & Sons Inc., e-Book, 2012.
3. Basic Algebra I, Jacobson N, Second Edition, Dover publications Inc., e-Book, 2012.
4. Basic Algebra, Jacobson N, Hindustan Publishing Corp. Vol I, 1982.
5. Algebra, Lang S, 2nd Edition, Addison Wesley (1965).

Web Resources

1. https://personal.math.ubc.ca/~carrell/NB.pdf
2. http://www.math.miami.edu/~ec/book/author.html

3. http://www.math.niu.edu/~beachy/study_guide/
4. http://abstract.ups.edu/index.html

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the theory of Sylow's theorems, extension of fields and Galois groups.	K1, K2
CO2	To apply the theory of Sylow's theorems, extension of fields and Galois group in solving the problems in polynomial equations.	K3
CO3	To analyse Sylow theorems and the theory of extension of fields and Galois groups.	K4
CO4	To compare the study of extension of field of a polynomial and its splitting field and subgroup of Galois group of polynomial and subfield and its splitting field.	K5
CO5	To demonstrate the applications of theory of fields in different areas.	K6

Course Code	PMT2MC02
Course Title	Real Analysis-II
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Overview

1. This course mainly aims to explore the notions of differentiability of a function of several variables and Lebesgue integration via measure.
2. Lebesgue measure of sets of real numbers which is the generalization of the concept of length of intervals is introduced.
3. Construction of Lebesgue and Riemann integrals is compared.
4. Convergence of sequence measurable functions on the measure space is examined.
5. Integration of functions of two variables with respect to product measures is discussed.

Course Objectives

1. To study the theory of derivatives of real-valued functions of several variables and implicit function theorem.
2. To familiarize with the properties of Lebesgue measure.
3. To establish the generalization of Riemann integral to Lebesgue integral.
4. To study the theory of integration with respect to arbitrary measure which applies to L^p-spaces.
5. To analyze the signed measure and measurability on product spaces.

Prerequisites	Basic concepts of real analysis and topology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Function of several variables – Linear transformation – Differentiation – The Contraction Principle – The Inverse Function theorem – The Implicit Function theorem.	15	CO1 CO3 CO4 CO5	K1, K2, K4, K5, K6

II	Lebesgue Outer Measure – Measurable Sets – Regular Measure – Measurable Functions – Borel and Lebesgue Measurability – Hausdroff Measures.	15	CO1 CO2 CO3 CO4	K1, K2, K3, K4, K5
III	Integration of Non-negative Functions – General Integral – Integration of Series – Riemann and Lebesgue Integrals – Integration of Complex Functions.	15	CO1 CO3 CO4 CO5	K1, K2, K4, K5, K6
IV	Measures and Outer Measures – Completion of a Measure – Measure Space – L^p Spaces – Inequalities – Convergence in Measure – Almost Uniform Convergence.	15	CO1 CO2 CO3 CO5	K1, K2, K3, K6
V	Signed measures and the Hahn decomposition – The Jordan decomposition – Measurability in Product Spaces – Product Measure and Fubini's theorem – Application of measure theory in Mathematical Finance.	15	CO1 CO3 CO4 CO5	K1, K2, K4, K5, K6

Text Books

1. Principles of Mathematical Analysis, Walter Rudin, Third Edition, McGraw Hill Education (India) Edition, 2013.
2. Measure Theory and Integration, G.de Barra, New Age International (P) Limited, Publishers, 2019.
3. Measure, Integral and Probability, Marek Capinski, Ekkehard Kopp, Springer-Verlag, Second Edition, 2004.

Suggested Readings

1. Mathematical Analysis, T. M. Apostol, Narosa Book Distributors Pvt Ltd., Second Edition, 1996.
2. Real Analysis, H. L. Royden, Pearson Education India, Fourth Edition, 2015.
3. An Introduction to Measure and Integration, Inder K. Rana, Alpha Science International Ltd, Second Edition, 2005.
4. Lebesgue Integration, J.H. Williamson, Dover Publications Inc., Reprint Edition, 2014.
5. Real Analysis: Theory of Measure and Integration, Yeh. J, World Scientific Pub Co., Third Edition, 2014.
6. Mathematical Analysis: An Introduction (Undergraduate Texts in Mathematics), Andrew Browder, Springer, 2001.

Web Resources

1. https://nptel.ac.in/courses/111/101/111101005/
2. https://nptel.ac.in/courses/111/106/111106140/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To recall and understand the general concepts of functions of more than one real variable and Lebesgue integral.	K1, K2
CO2	To apply inverse and implicit function theorems on a function of several variables function and measures to construct Lebesgue integration.	K3
CO3	To analyze differentiability of a function of real variables and measure in abstract spaces.	K4
CO4	To evaluate the solutions involving functions of several variables and value of Lebesgue integration.	K5
CO5	To design mathematical models of real-time problems and solve them.	K6

Course Code	PMT2MC03
Course Title	Partial Differential Equations
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Overview

1. Physical problems in science and engineering are modelled as partial differential equations with environmental constraints.
2. The classification of second order partial differential equations is discussed and their corresponding canonical forms are derived.
3. Analytical methods are explained to find the solutions of partial differential equations with boundary conditions.
4. **The maximum and minimum principles are considered for partial differential equations and their consequences are discussed.**
5. The Green's function method is applied to solve heat and wave equations.

Course Objectives

1. To understand the elements of partial differential equations and their significance in physical problems.
2. To derive the solutions of linear partial differential equation with constant coefficients.
3. To recognize the suitable methods for solving parabolic, elliptic and hyperbolic partial differential equations.
4. To obtain the solutions of Dirichlet and Neumann boundary value problems over rectangles and circles.
5. To compare the solutions of the wave and heat equations by numerical and separable methods.

Prerequisites	Basic knowledge on differential equations

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Solutions of partial differential equation of first order – Compatible systems of first order equations – Classification of second order partial differential equations – Canonical forms – Linear partial differential equations with constant coefficients – Homogeneous linear partial differential equations with constant coefficients.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
II	Laplace equation – Boundary value problems – Some important mathematical tools – Properties of harmonic functions – Separation of variables – Dirichlet and Neumann problems for rectangle and circle.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Occurrence of the diffusion equation – Boundary conditions – Elementary solutions of diffusion equations – Separation of variable method – Maximum and minimum principles and consequences.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Wave equations – Derivation of one-dimensional wave equations – solutions of wave equation by canonical reduction – The initial value problem: D' Alembert's solution – Vibrating string problem – Boundary and initial value problems for two-dimensional wave equations.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Green's function for Laplace equation – The method of images – The eigenfunction method – Green's function for the wave equation – Green's function for the diffusion equation.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Book

1. Introduction to Partial Differential Equations, K. Sankara Rao, Third Edition, PHI Learning, Delhi, 2011.

Suggested Readings

1. Partial Differential Equations: Methods and Applications, Robert C. McOwen, Prentice-Hall, Second Edition, 2003.
2. Partial Differential Equations for Engineers and Scientists, J. N. Sharma and Kehar Singh, Alpha Science Int. Ltd., Second Edition, 2009.
3. Ordinary and Partial Differential Equations: Theory and Applications, Nita H. Shah, Second Edition, PHI Learning Pvt. Ltd., 2015.
4. Elements of Partial Differential Equations, I. N. Sneddon, Mcgraw Hill International Book Company, 1957 (Reprint in Dover Publications, 2006).
5. An Introduction to Partial Differential Equations, M. Renardy and R. C. Rogers, Second Edition, Springer, 2004.

Web Resources

1. https://people.bath.ac.uk/masrs/ma20010/
2. https://personal.math.ubc.ca/~peirce/math257_316e14.htm
3. https://nptel.ac.in/courses/111/101/111101153/
4. https://tutorial.math.lamar.edu/Classes/DE/TheWaveEquation.aspx

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic concepts of partial differential equations with initial and boundary conditions.	K1, K2
CO2	To solve first and second order partial differential equations using various approaches.	K3
CO3	To investigate the diffusion and vibrating string problems under given constraints.	K4
CO4	To compare the solutions obtained by analytical and numerical methods.	K5
CO5	To construct a system of partial differential equations for problems arising from real-life situations and explore possible solutions.	K6

Course Code	PMT2MC04
Course Title	Complex Analysis
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Overview

1. This course is an extensive study of analytic functions.
2. It deals with power series representation of an analytic function.
3. The concept of winding number of a curve is used in proving integral theorems.
4. It provides the proof of major important theorems like Riemann mapping theorem, Weierstrass factorization theorem etc.
5. It also deals with some applications of Complex Analysis.

Course Objectives

1. To understand the basic concepts of an analytic function and its consequences.
2. To represent an analytic function as a power series and use its representation to evaluate complex integrals.
3. To understand the strategies and techniques used in proving the theorems in Complex Analysis.
4. To apply the theorems and lemmas in solving the problems of Complex Analysis.
5. To explore some applications of complex analysis in different fields.

Prerequisites	A basic knowledge in calculus.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Elementary properties and examples of analytic functions – power series, analytic functions, analytic functions as mapping, Mobius transformations, Power series representation of analytic functions, Power series representation of analytic functions	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Zeros of an analytic function, the index of a closed curve, Cauchy's theorem and integral calculus	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	The homotopic version of Cauchy's theorem, the open mapping theorem, Goursat's theorem, maximum priniciple, Schwarz lemma	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Convex functions, Hadamard's three circles theorem, The Arzela Ascoli theorem, The Riemann mapping theorem	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Weierstrass factorization theorem and its application- the factorization theorem of the sine function, the Gamma function, the Riemann Zeta function, solving Dirichlet's problems with conformal mappings	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Functions of one complex variable, John B. Conway, Springer International, 1987.
2. Complex Analysis with Applications, Nakhlé H. Asmar, Loukas Grafakos, Springer, 2018.

Suggested Readings

1. Complex Analysis, Ahlfors L.V, McGraw-Hill, New York, 3rd edition, 1986.
2. Complex Analysis, Elias M. Stein, Rami Shakarchi, Princeton University Press, Princeton & Oxford, New Jersey, e-book, 2003.
3. Analytic Function Theory, Hille. E., 2nd Revised edition, volumes I and II, Chelsea, New York, 2012.
4. Theory of Functions of a complex variable, Markushewich, A.I, 2nd Revised edition, Volumes I, II and III, Chelsea, New York, 2005.
5. Complex Variables and Applications, James Ward Brown, Ruel V. Churchill, Seventh Edition, Mc Graw Hill Higher Education.

Web Resources

1. https://www.jirka.org/ra/
2. https://nptel.ac.in/courses/111/106/111106053/
3. http://facultymembers.sbu.ac.ir/shahrokhi/ProBookMathAnal1.pdf
4. http://facultymembers.sbu.ac.ir/shahrokhi/ProBookMathAnal1.pdf
5. https://www.google.com/search?biw=1536&bih=696&q=Kumaresan+Real+Analysis+Solutions+PDF&sa=X&ved=2ahUKEwjGyI7R6br1AhXCwTgGHSLlA2MQ1QJ6BAhJEAE

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the methods to evaluate complex integration.	K1, K2
CO2	To apply the theory of analytic functions in solving the related problems.	K3
CO3	To analyze the standard theorems in Complex Analysis and its significances.	K4
CO4	To construct an analytic function using the theorems in Complex Analysis.	K5
CO5	To signify the applications of theory of Complex analysis in different fields.	K6

Course Code	PMT2MC05
Course Title	Research Methodology
Credits	2
Hours/Week	3
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Overview

1. Research methodology course describes the scientific process of transforming new results and their importance in society and industry.
2. The ethical issues and research integrity are explained to bring the high-quality research findings.
3. The various types of research objectives are discussed along with step-by-step process of carrying the research.
4. The structural importance of a research paper is addressed to acquire scientific publication.
5. The main characteristics of layout design as well as the method of writing a project dissertation are discussed.

Course Objectives

1. To understand the meaning of research and the different methodologies involved in the research process.
2. To familiar with the research design and its various components.
3. To realize the importance of research ethics and intellectual honesty.
4. To write a scientific research manuscript containing important key sections.
5. To manage the manuscript for publication and to write a project dissertation**.**

Prerequisites	Basic knowledge on mathematical problems

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Meaning and objectives of research – Types of research – Significance of research – Research methods verses methodology – Research and scientific methods – Research	9	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

	process – Research problem – Selecting the problem – Necessity of defining the problem – Techniques involved in defining a problem.		CO4 CO5	
II	Meaning of research design – Need for research design – Features of a good design – Concepts related to research design – Different research designs – Basic principles of experimental designs – Important experimental designs.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Ethics with respect to science and research – Intellectual honesty and research integrity – Scientific misconducts – Falsification, fabrication and plagiarism – Redundant publications – Duplicate and overlapping publications – Selective reporting and misrepresentation of data.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Layout of a research paper – Preparation of the title – Listing of the authors and addresses – Preparation of theabstract – Writing the introduction – Writing the materials and methods section, Writing the results – Writing the discussion – Stating the acknowledgements – Citing the references.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Rights and permissions – Submission of the manuscript – The review process (How to deal with editors) – The publishing process (How to deal with proofs) – Writing a review paper – Writing a project report.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Research Methodology - Methods and Techniques, C. R. Kothari and Gaurav Garg, New Age International Publishers, Fourth Edition, 2020.
2. How to Write and Publish a Scientific Paper, Barbara Gastel and Robert A. Day, Greenwood, California, Eighth Edition, 2016.
3. Ethical issues in scientific publication, A. K. Jain, Indian Journal of Orthopaedics, 44(3) 235-237, 2010.
4. Plagiarism and self-plagiarism: What every author should know, M. Roig, Biochemia Medica, 20(3) 295-300, 2010.

Suggested Readings

1. How to Read and Critique a Scientific Research Article: Notes to Guide Students Reading Primary Literature (with teaching tips for faculty members), F. M. Yeong, World Scientific Publishing Company, 2014.
2. Writing the Research Paper: A Handbook, A. C. Winkler and J. R. Metherell, Cengage Learning, Eighth Edition, 2011.

Web Resources

1. http://edutechwiki.unige.ch/en/Research_methodology_resources
2. https://nptel.ac.in/courses/121/106/121106007/
3. https://www.indeed.com/career-advice/career-development/types-of-research

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic ideas of research and the various stages in the research process.	K1, K2
CO2	To employ various research designs in response to the demands of the problems.	K3
CO3	To formulate a research problem and analyze the techniques for solving it with research integrity.	K4
CO4	To summarize the best feasible solutions, arrive from different computation methods.	K5
CO5	To create a research design for the emerging problems.	K6

Course Code	PMT2ME01
Course Title	Fuzzy Logic and Neural Networks
Credits	2
Hours/Week	4
Category	Major Elective (ME)– Theory
Semester	II
Regulation	2022

Course Overview

1. Fuzzy set theory deals with problems related to ambiguous and uncertainty.
2. The main aim of this course is to introduce the concepts of fuzzy set fuzzy relations and neural networks.
3. This course deals with fuzzy models such as Hetroassociative Memory Neural Network – Auto associative Net-Iterative associative Net-Bidirectional associative memory and its applications.
4. The working principles of fuzzy expert system, adaptive resonance and back propagation neural network are discussed.
5. It helps to understand Fuzzy logic techniques and neural networks applied in commercial products and in analyzing social issues.

Course Objectives

1. To introduce the concept of fuzzy set theory and neural networks and their basic operations.
2. To understand the concepts and properties of fuzzy relations, fuzzy logic and fuzzy systems.
3. To describe the Pattern association & Neural Networks based on some real- world problems.
4. To explore and analyze the behavior of bidirectional associative memories models and demonstrate its application to cater social needs.
5. To apply fuzzy expert system, fuzzy control and neural network to solve problems.

Prerequisites	Basic knowledge in statistics and R language.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	**Introduction:** The case for imprecision – A historical Perspective – The utility of Fuzzy Systems – Limitations of	12	CO1 CO2	K1, K2, K3, K4, K5, K6

	Fuzzy Systems – The Illusion: Ignoring Uncertainty and Accuracy- Uncertainty and Information – Fuzzy Sets and Memberships – Chance Versus Fuzziness – Sets as points in Hypercubes. **Classical Sets and Fuzzy sets** Operation and Properties on Classical sets – Mapping of Classical Sets in Functions. **Classical Relations and Fuzzy Relations** Cartesian Products - Crisp Relations – Fuzzy Relations – Tolerance and Equivalence Relations – Fuzzy Tolerance and Equivalence Relations – Value Assignments – Other forms of fuzzy composition.		CO3 CO4 CO5	
II	Features of the Membership Function – Various Forms – Fuzzification – Defuzzification to Crisp Sets – ƛ-Cuts for Fuzzy Relations – Defuzzification to Scalars. **Logic** Classical Logic – Proof- Fuzzy Logic – Approximate Reasoning – Other forms of the Implication Operation. **Fuzzy Systems** Natural Language – Linguistic Hedges – Fuzzy (Rule-Based) systems – Graphical Techniques of Interference.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	**Introduction to Neural Network- Simple Neural networks for pattern classification** What is a Neural Net? -Where and how Neural Nets used? – Typical Architecture – Development of Neural networks – McCulloch-Pitts Neuron-Architecture – Biases and Thresholds – Linear Separability – Data representation – Hebb Net-Perception – Adaline.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	**Pattern association & Neural Networks based on Competition** Training Algorithms for Pattern Association – Hetroassociative Memory Neural Network – Autoassociative Net-Iterative associative Net-Bidirectional Asociative Memory (BAM)-Fixed-Weight Competitive Nets-Kohonen Self Organizing Maps-Learning Vector Quantization – Counterpropagation.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

V	**Adaptive resonance theory & backpropagation neural net** Introduction – Adaptive Resonance Theory 1 – Adaptive Resonance Theory 2 – Standard backpropagation – Variations – Theoretical results.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Fuzzy Logic with Engineering Applications, Timothy J. Ross- 3rd Edition – Wiley and sons Ltd, 2010.
2. Fundamental of Neural network, Laurene Faussett-1st Edition – Prentice Hall.

Suggested Readings

1. Neural Networks and Fuzzy Systems, Bart Kosko, Printice-Hall, INC., New Jersey, 1992.
2. Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence, Bart Kosko, Printice-Hall, INC., New Jersey, 1992.
3. Fuzzy Sets and Fuzzy Logic: Theory and Applications, George J Klir and Bo Yuan, Prentice-Hall, INC., New Jersey 2002.

Web Resources

1. https://www.javatpoint.com/fuzzy-logic
2. https://www.tutorialspoint.com/fuzzy_logic/index.html
3. https://www.tutorialspoint.com/artificial_neural_network/index.html
4. https://nptel.ac.in/courses/127/105/127105006/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand and recognize the development of fuzzy theory, neural networks and its applications.	K1, K2
CO2	To apply and solve social problems related to fuzzy set theory and neural networks.	K3
CO3	To analyze different fuzzy models and interpret the results.	K4
CO4	To compare different Fuzzy models for a problem and assess their results.	K5
CO5	To create models for real life situations using fuzzy theory.	K6

Course Code	PMT2ME02
Course Title	Parallel Interconnection Networks
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	II
Regulation	2022

Course Overview

1. The aim of this course is to provide design an analysis of interconnection networks.
2. Construction of classes of topological structures are explored.
3. Properties of various interconnection networks are studied.
4. Parallel computation involving network architectures namely arrays, and hypercubes are explained.
5. Problems arising in interconnection networks of large – scale parallel processing real – time systems are introduced.

Course Objectives

1. To give an insight of modelling of interconnection networks by a graph.
2. To study the various methods involved in network design.
3. To describe the structural properties of various interconnection networks.
4. To explain the underlying concepts of network architecture effectively.
5. To report graph optimization problem which arise in network design.

Prerequisites	Basic knowledge in Graph Theory.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Graphs and Interconnection networks – Trees and k-ary trees – Embedding of graphs – Planar graphs and layout of VLSI circuits – Diameter of graphs.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Vertex transitive graphs – Edge transitive graphs – Cayley graphs – Properties of Cayley graphs – Cartesian product of undirected graph and digraph.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Hypercube networks, de Brujin networks.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Circulant networks – Mesh networks and grid networks – Cube connected cycles – Butterfly networks – Benes networks.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Fault tolerance of networks – Basic principles of network design – Routing in networks – Forwarding index of routing – Edge forwarding index of routing – Delay of fault tolerant routing.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Introduction to Parallel Algorithm and Architecture: Arrays, Trees, Hypercubes, T.F. Leighton, Morgan Kaufmann Publishers, 1992.
2. Topological Structure and Analysis of Interconnection Networks, Junming Xu, Network Theory and Applications, Springer-Verlag New York Inc, 2002.

Suggested Readings

3. Embedding Complete Trees into the Hypercube, S. l. Bezrkov, Discrete Appl. Math., Vol. 110, 2001, pp. 101 – 119.
4. A guide to the theory of NP-Completeness, M.R. Garey and D.S. Johnson, Computers and Intractability, Freeman, San Fransisco, 1979.

Web Resources

1. https://towardsdatascience.com/
2. https://www.r-bloggers.com/

3. https://www.kaggle.com/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To recall and understand the basic concepts of Graph theory and Parallel interconnection networks.	K1, K2
CO2	To apply graph theoretical tools in network architectures.	K3
CO3	To analyse the interconnection network design. relate the learnt concepts with the Planar graph, Hypercube and Butterfly networks.	K4
CO4	To evaluate various parameters in measuring an interconnection network.	K5
CO5	To formulate graph optimization problem arising in network design and solve it.	K6

Course Code	PMT2ME03
Course Title	Financial Mathematics
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	III
Regulation	2022

Course Overview

1. Financial mathematics is a field that mainly focus on analysing and solving financial problems.
2. The main aim of this course is to introduce various mathematical techniques and its applications in the field of finance.
3. It also deals with the interest rates and present value analysis elaborately.
4. This course discusses the significance and applications of Black Scholes formula in detail.
5. The significance of Monte Carlo Simulations is explained.

Course Objectives

1. To gain familiarity with the application of mathematics in the field of finance.
2. To understand the standard and advanced quantitative methodologies and its importance to a range of careers in investment banks and other financial sectors.
3. To explain the significance of Arbitrage theorem and its applications.
4. To design, build, investigate and evaluate forward contract using arbitrage-free pricing methods.
5. To create and evaluate potential models for the price of shares.

Prerequisites	Fundamental knowledge in elementary Mathematics and Statistics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Probability: Probability and Events – Conditional Probability – Random Variables and Expected Values – Covariance and Correlation – Continuous Random Variables – Normal Random Variables – Properties of Random Variables – Central Limit Theorem.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Interest rates and Present value Analysis: Interest Rates – Present value Analysis – Rate of Return – Continuously Varying Interest Rates – Options Pricing – Pricing Via Arbitrage.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	The Arbitrage Theorem: The Arbitrage Theorem – Multiperiod Binomial Model – Arbitrage Theorem – The Black Scholes Formula – Properties of Black Scholes Option Cost – The Delta Hedging Arbitrage Strategy.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Valuing by Expected utility: Call Options on Dividend Paying Securities – Pricing American Put Options – Estimating the Volatility Parameter – Valuing investments by Expected utility – The capital Assets Pricing Model – Mean variance Analysis of Risk, Neutral and priced call options – Rates of return.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Exotic Options: Deterministic Optimization Models – Barrier options – Asian and Lookback Options – Monte Carlo Simulation – Pricing Exotic Options by Simulation.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. An Elementary introduction to Mathematical Finance, Sheldon M Ross, Cambridge university press, Third Edition, 2011.

Suggested Readings

1. The Mathematics of Financial Models: Solving Real-World Problems with Quantitative Methods, Kannoo Ravindran, Wiley Finance, 2014.
2. Mathematical Techniques in Finance:́ Tools for Incomplete Markets, Aleˇs Cern'y, Princeton University Press, Second Edition, 2009.

Web Resources

1. http://www.freetechbooks.com
2. https://www.khanacademy.org/
3. https://www.quantstart.com/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To recall and understand the mathematical foundations of quantitative finance.	K1, K2
CO2	To employ methods related to mathematical concepts in financial applications.	K3
CO3	To solve problems using wide range of formats and approaches in basic mathematics.	K4
CO4	To analyse various of financial formula.	K5
CO5	To formulate relationship between different branches of financial mathematics, as well as between probability and other sciences.	K6

Course Code	PMT2ME04
Course Title	Differential Geometry
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	II
Regulation	2022

Course Overview

1. Differential Geometry studies the geometry of smooth shapes and spaces using the techniques of calculus and algebra.
2. The main aim is to understand the fundamental conceptions of the theory of curves and surfaces.
3. It investigates the geometrical forms and the intrinsic properties curves and surfaces.
4. It deals with some applications of abstract algebra and analysis to geometrical problems and facts.
5. This course helps to solve real life problems using differential geometry.

Course Objectives

1. To understand the concept of curves and surfaces in three dimensional.
2. To improve logical and analytical skills to solve problems in differential geometry.
3. To analyze and locate geodesics on a variety of surfaces.
4. To familiarize with the application of Calculus and Linear Algebra in geometry of curves and surfaces.
5. To apply geometry of curves and surfaces to computer aided graphics.

Prerequisites	Basic knowledge in Calculus and Linear Algebra.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Analytic representation, Arc length, tangent, Osculating plane, Curvature, Torsion, Formula of Frenet.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Contact, Natural equations, Helices, General solution of the natural equations, Evolutes and Involutes, Imaginary curves, Ovals, Monge	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Analytical representation, First Fundamental form, Normal, Tangent plane, Developable Surfaces, Second Fundamental form, Meusnier's Theorem, Euler's Theorem, Dupin's indicatrix, Some surfaces.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Gauss, Equations of Gauss and Weingarten, Theorem of Gauss and the equations of Coddazi, Curvilinear coordinates in space, The Fundamental Theorem of Surface Theory.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Geodesic curvature, Geodesics, Geodesic coordinates, Surfaces of constant curvature, The Gauss-Bonnet theorem, Conformal mapping, Isometric and geodesic mapping.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Lectures on Classical Differential Geometry, Dirk J. Struik, Dover Publications, Second Edition, 1988.

Suggested Readings

1. Elementary Differential Geometry, Andrew Pressley, Springer Publication, Second Edition, 2010.
2. Lectures on Classical Differential Geometry, Dirk J Struik, Dover Publications, Second Edition, e-Book, 2012.
3. Differential Geometry, Erwin Kreyszig, Dover Publications, First Edition, e-Book, 2013.
4. Differential Geometry, Gupta, Malik, Pundir, Pragati Prakashan, Thirteenth Edition, 2010.
5. Differential Geometry, Heinrich W Guggenheimur, Dover Publications, Second Edition, e-Book, 2012.
6. Differential Geometry, Mittal, Agarwal, Krishna Prakashan, Thirtieth Edition, 2014.
7. Differential Geometry, Somasundaram D., Narosa Book Distributors, 2008.

8. Elementary Topics in Differential Geometry, Thorpe J A, Springer, First Edition, 1994.
9. Differential Geometry, Venkatachalapthy S G, Margham Publications, First Edition, 2012.

Web Resources

1. http://etananyag.ttk.elte.hu/FiLeS/downloads/_01_Csikos_Differential_geometry.pdf
2. https://people.math.ethz.ch/~salamon/PREPRINTS/diffgeo.pdf
3. https://download.tuxfamily.org/openmathdep/geometry_advanced/Differential_Geometry-Weatherburn.pdf

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the fundamental conceptions of the theory of curves and surfaces	K1, K2
CO2	To apply the appropriate techniques from differential geometry in solving various complex problems.	K3
CO3	To analyse the different types of curves in surfaces including principal curves and geodesics.	K4
CO4	To summarize the physical properties of curves and surfaces.	K5
CO5	To explore the geodesics and geometrical forms of various curves and surfaces in space.	K6

Course Code	PMT3MC01
Course Title	Topology
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Overview

1. Topology is a broad field of Mathematics, concerned with structures.
2. This course deals with generalized concepts of Analysis.
3. The concept of continuous functions, homeomorphisms, connectedness, compactness in topological spaces are introduced.
4. Countability Axioms and separation Axioms are explored.
5. Various applications of topological spaces are discussed.

Course Objectives

1. To introduce various types of topological spaces.
2. To understand the concept continuous functions and product topology.
3. To study the properties of connected spaces and compact spaces.
4. To analyze countability and separation axioms.
5. To explore the applications of topology in various fields.

Prerequisites	Basic knowledge of Real Analysis.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology – Closed sets and limit points.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Continuous functions – The pasting lemma – The product topology – The metric topology – The sequence lemma – uniform limit theorem.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Connected spaces – Connected subspaces of the real line – Components and local connectedness – Compact spaces – Compact subspaces of the real line – Limit point compactness – Local compactness.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	The countability axioms – The separation axioms – Normal spaces.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	The Uryshon Lemma – The Uryshon Metrization theorem – Imbedding theorem – The Tietze extension theorem – Application of topology to Digital imaging.	15	CO1 CO2 CO3 CO4 CO5	K2, K3, K4, K5, K6

Text Books

1. Topology, James R Munkers, Pearson Education limited, New Delhi, second edition, 2019.
2. Essentials of Topology with applications, Steven G Krantz, CRC Press, Taylor and Francis group, 2009.

Suggested Readings

1. Introduction to Topology and Modern Analysis, Simmons G. F, Tata Mc Graw – Hill Education Private Limited, New Delhi - 2004.
2. Topology, Dugundji. J, University Book Stall, New Delhi, 1990.
3. , Introduction to General Topology, Joshi K. D. New Age International, New Delhi, 2000.
4. Topology, Gupta. B.D., Kedar Nath Ram Nath. Meerut, 2015.
5. General topology, Murdeshwar M.G., Wiley Eastern, Second Edition, 1990.

Web Resources

1. https://nptel.ac.in/courses/111/106/111106054/1

2. https://nptel.ac.in/courses/111/101/111101144/
3. https://nptel.ac.in/courses/111/106/111106159/
4. https://math.stackexchange.com/questions/304121/resources-for-self-study-of-general-topology
5. http://at.yorku.ca/index.html

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand and recognize the concepts of topological spaces.	K1, K2
CO2	To realize the theory of order topology continuous functions and countability axioms.	K3
CO3	To analyze the concepts of product topology compactness and connectedness.	K4
CO4	To interpret the theoretical aspects of continuity, countability and separation axioms.	K5
CO5	To create different types of topological spaces and apply to various fields.	K6

Course Code	PMT3MC02
Course Title	Number Theory
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Overview

1. This course delves into number theory in depth.
2. It starts with the fundamental assumption and moves on to the derivation of all congruence guiding rules.
3. There are illustrations and exercise problems in residues with mathematical computations.
4. It elucidates the foundations of the primitive roots.
5. It illustrates the applications in cryptosystems.

Course Objectives

1. This course delves into number theory in depth.
2. It starts with the fundamental assumption and moves on to the derivation of all congruence guiding rules.
3. There are illustrations and exercise problems in residues with mathematical computations.
4. It elucidates the foundations of the primitive roots.
5. It illustrates the applications in cryptosystems.

Prerequisites	Basic knowledge in Algebra.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Divisibility, greatest common divisor, prime numbers, the fundamental theorem of arithmetic, Euclidean algorithm, Euler's summation formula.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Congruence definition and basic properties, residue class and complete residue systems, liner congruences, Euler-Fermat theorem, Chinese reminder theorem, applications of Chinese reminder theorem.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Quadratic residues, Legendre's symbol and its properties, Gauss lemma, Applications of the reciprocity law, Jacobi symbol, applications to Diophantine equations.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	The exponent of a number mod *m*, primitive roots and reduced residue system, existence of primitive roots md *p* for odd prime *p*, primitive roots and quadratic residues.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Cryptography: some simple cryptosystems, enciphering matrices, the idea of public key cryptography: RSA, Knapsack problem.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Introduction to Analytical Number Theory, Tom M Apostol, Springer, 2010.
2. A course in Number Theory and Cryptography, Neil Koblitz, Springer, 1994.

Suggested Readings

1. An Introduction to the Theory of Numbers, Niven, H.S. Zuckerman, and H.L. Montgomery, Wiley, 1991.
2. Discrete Mathematics with Applications, T. KoshyElsevier, 2004.
3. A Classical Introduction to Modern Number Theory, K.F. Ireland and M.I. Rosen, Springer, 1990.
4. Rational Points on Elliptic Curves, J. Silverman and J. Tate, Springer-Verlag, 2005.
5. An Introduction to Cryptography, R.A. Mollin, Chapman & Hall, 2001.

Web Resources

1. https://www.coursera.org/learn/number-theory-cryptography
2. https://www.coursera.org/learn/introduction-to-number-theory

3. http://www2.math.uu.se/~astrombe/analtalt08/www_notes.pdf
4. http://www.math.tifr.res.in/~publ/ln/tifr02.pdf
5. http://cr.yp.to/2005-261/bender1/NT.pdf

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand basic concepts of number theory.	K1, K2
CO2	To apply the fundamental ideas in problem solving.	K3
CO3	To analyze number theory with conceptualization.	K4
CO4	To exhibit the analytics of residues and congruences.	K5
CO5	To signify the applications in cryptography.	K6

Course Code	PMT3MC03
Course Title	Mathematical Programming
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Overview

1. Mathematical Programming is an applied mathematics that helps to make better and effective decisions.
2. This course helps to study various types of programming models.
3. This course deals with quantitative methods and techniques to make use of the available scarce resources in the best way for achieving a certain objective.
4. In this course, the methodologies to formulate and interpret a mathematical model for a problem and finding an optimal solution are discussed.
5. Mathematical programming can be applied in industry, business, management, and everyday life.

Course Objectives

1. To understand the concepts and acquire the knowledge of certain programming models in operations research.
2. To learn the methodology and some prominent techniques of decision-making.
3. To obtain the integer solution using branch & bound method and find the approximate solution using heuristics.
4. To apply dynamic programming technique for shortest route and allocation problems.
5. To find optimal value for both unconstrained and constrained objective functions.

Prerequisites	Fundamental knowledge on number system, arithmetic, calculus and matrices.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	**Linear Programming**	15	CO1 CO2	K1, K2, K3, K4, K5, K6

	Introduction to Operations Research – LP Model in Equation Form – Simplex Method – Sensitivity Analysis – Algebraic Sensitivity Analysis – Changes in the Right-hand Side – Objective Function – Case Study.		CO3 CO4 CO5	
II	**Goal Programming** A Goal Programming Formulation – Goal Programming Algorithms – The Wrights Method – The Preemptive Method – Case study.	15	CO1 CO2 COC CO4 CO5	K1, K2, K3, K4, K5, K6
III	**Integer Programming** Branch Bound Method – Applications of Integer Programming – Capital Budgeting – Case Study. **Dynamic Programming** Recursive Nature of Dynamic Programming Computations – Forward and Backward Recursion – DP Applications – Cargo Loading Model – Work Force Size Model – Equipment Replacement Model – Investment Model – Inventory Model – Case Study.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	**Non-Linear Programming** Unconstrained Problems – Constrained Problems – Unconstrained Algorithms – Constrained Algorithms – Case Study.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	**Heuristic Programming** Introduction – Greedy Heuristics – Metaheuristics – Application of Metaheuristics in Integer Linear Programs – Case Study.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Operations Research, Hamdy A. Taha, Pearson India, New Delhi, 10th Edition, 2019.

Suggested Readings

1. Introduction to Operations Research, F. S Hiller, G. J. Liberman, B Nag and Preetam Basu, McGraw Hill Private Limited, Chennai, 10th edition, 2017.
2. Model Building in Mathematical Programming, H Paul Williams, Wiley India private Limited, New Delhi, 5th Edition, 2013.
3. Operations Research - Principles and Practice, Ravindran, Philips and Solberg, Wiley India private Limited, New Delhi, 2nd Edition, 2010.
4. Optimization in Operations Research, Ronald L. Radin, Pearson India, 2018.
5. Operations Research Theory and Applications, J. K. Sharma, Trinity Press, New Delhi, 6th Edition, 2017.
6. , Operations Research, S. D. Sharma, Kedar Nath Ram Nath and Co., Meerut, 2012.

Web Resources

1. Operation Research, S. R. Yadav, P. K. Dwivedi and C.B. Gupta, S. Chand, New Delhi, 2016, e-book.
2. Operation Research, Prem Kumar, Gupta and Hira, I. K. International Publishing House, New Delhi, 2017, e-book.
3. https://www.doc.ic.ac.uk/~br/berc/integerprog.pdf
4. https://nptel.ac.in/courses/106101060/184,
5. http://www.opensource.org
6. www.mathworld.wolfram.com
7. www.wolframalpha.com
8. https://mathsolver.microsoft.com

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the terminology in different programming models.	K1, K2
CO2	To examine the technique of branch and bound to solve industry related problems.	K3
CO3	To solve constrained nonlinear programming problem using Lagrangian multiplier method and Kuhn Tucker conditions.	K4

CO4	To analyse the basic characteristic features of dynamic programming and find the range within which the availability of resources can vary using post optimality analysis.	K5
CO5	To formulate the general goal programming problem and apply the branch and bound method to get the integer solution.	K6

Course Code	PMT3MC04
Course Title	Fluid Dynamics and Space Science
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Overview

1. This course takes an in-depth look into fluid mechanics.
2. It commences with the fundamental premise and proceeds to the derivation of all governing equations of fluid motion.
3. Physical concepts and mathematical calculations are covered, along with examples and practice problems.
4. It provides the insight in the planetary motions.
5. It also deals with the projection of satellites in space. It starts with the fundamental assumption and moves on to the derivation of all congruence guiding rules.

Course Objectives

1. To understand the basic concepts of fluid motion.
2. To familiarize with kinematics of fluids.
3. To understand the equation of motion of fluid particles.
4. To apply the mathematical concepts in space science.
5. To explore the interplanetary and lunar trajectories.

Prerequisites	Basic knowledge in trigonometry and calculus.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Kinematics of fluid motion: Lagrangian method, Eulerian method, velocity of fluid particle, acceleration of fluid particle.	15	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

			CO4 CO5	
II	Equation of continuity, Euler's equation of motion, conservation field force, Bernoulli's equation of motion and its applications. Source and sinks.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Kutta-Joukowski's theorem, Joukowski transformation, Aero foil, flow around an aero foil and lift, Navier Stokes equation of stream functions.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	The celestial sphere, parallaxes, Kepler's law of planetary motions.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Elements of orbit in space, motion of rocket, transfer between orbit, Inter planetary trajectories.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Fluid Dynamics, M.D. Raisinghania, S. Chand & Company, 1982.
2. Spherical Trigonometry and Space Science, Bhupendra Singh, Pragati Prakashan, 2014.

Suggested Readings

1. Modern Fluid Dynamics, N. Curle and H. Davies, Van Nostrand Reinhold, 1966.
2. Theoretical Hydrodynamics, L. M. Milne Thomson, Macmillan and Co., 1960.
3. An Introduction to Fluid Dynamics, G. K. Batchelor, Cambridge University Press, 1993.
4. A Text Book of Fluid Dynamics, F. Chorlton, Von Nostrand Reinhold/CBS, 1985.
5. An Introduction to Astrophysical Fluid Dynamics, M.J. Thompson, Imperial College press, 1992.

Web Resources

1. https://www.iare.ac.in/sites/default/files/lecture_notes/IARE_FLUID%20MECHANICS_LECTURE_NOTES.pdf
2. https://www.math.nyu.edu/~childres/fluidsbook.pdf
3. http://web.engr.uky.edu/~acfd/me691-lctr-nts.pdf
4. https://ocw.mit.edu/courses/physics/8-282j-introduction-to-astronomy-spring-2006/study-materials/
5. https://www.nap.edu/read/750/chapter/2

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the flow of fluid motion.	K1, K2
CO2	To apply equation of motion in solving real life problems.	K3
CO3	To analyze planetary motion in space.	K4
CO4	To exhibit computational dynamics in orbital phenomenon.	K5
CO5	To signify the applications of computational fluid dynamics in rocket dynamics.	K6

Course Code	PMT3ME01
Course Title	An introduction to Data Science
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	III
Regulation	2022

Course Overview

1. Data science is the study of analysing the raw data to make conclusions.
2. The main aim of this course is to give a basic knowledge about Big data analytics.
3. Fundamental idea about various analytic methods is offered.
4. Clustering of the collected data using K-means Clustering is explained.
5. Application of analytic techniques with suitable examples are illustrated.

Course Objectives

1. To understand the need for Big data Analytics.
2. To find the trends by analysing raw data using appropriate analytic technique.
3. To categorise the data using K-means Clustering.
4. To predict the possibilities by applying the Apriori algorithm on the data.
5. To apply the text and time analysis technique over the Big data.

Prerequisites	Basic knowledge in Statistics and Mathematics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Introduction to Big Data Analytics – Big Data Overview – State of the practice in analytics – Business intelligence vs Data science – Evaluation of Data science – Examples of Big Data Analysis.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Clustering and association Rules – Centroid – Clustering – K-means – Association rules – Apriori Algorithm – Support – Confidence – Lift – Leverage.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Regression and classification – Linear regression – Logistic Regression – Ordinary Least Square – Receiver operating Characteristics curve – Residuals.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Classification learning – Naïve Bayes – Decision tree – ROC curve – Confusion Matrix.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Text Analysis – Term – Corpus – Text normalization – TFIDF – Topic Modeling – Sentiment Analysis.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Data Science and Big data analytics, David Dietrich, Barry Heller and Beibei yang, Wiley, 2015.

Suggested Readings

1. Doing Data Science, Cathy O'Neil and Rachel Schutt, O'Reilly, 2015.
2. Big Data Analytic, Seema Acharya, Subhasini Chellappan, Second edition, Wiley, 2019.
3. R for Data Science, Hardley Wickham & Garrett Grolemund, O'Reilly, 2017.

Web Resources

1. https://towardsdatascience.com/
2. https://www.r-bloggers.com/
3. https://www.kaggle.com/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic concepts of Data Science.	K1, K2
CO2	To apply the appropriate analytic technique for raw data analysis.	K3
CO3	To analyse the unsupervised data using various data science methods.	K4
CO4	To brief the insights of datasets and draw conclusions.	K5
CO5	To formulate and solve real life problems using appropriate technique.	K6

Course Code	PMT3ME02
Course Title	Actuarial Mathematics
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	III
Regulation	2022

Course Overview

1. This course provides a study of Actuarial Mathematics, helpful for beginners.
2. It deals with a study of life table and life expectancy.
3. It helps to calculate life annuities of different available schemes.
4. It covers a detailed study of life insurances.
5. It helps students to explore in a new field namely actuarial mathematics and become professional actuaries in future.

Course Objectives

1. To understand the basic concepts of Actuarial Mathematics.
2. To apply the theory of Actuarial Mathematics to obtain life tables.
3. To obtain annuity premiums and study the relationships of survivor function.
4. To compare annuities with different premiums by calculating spread sheets.
5. To apply the theory of Actuarial Mathematics in deciding the suitable insurance policy.

Prerequisites	A basic knowledge in interest calculations and probability.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	The life table- Basic definitions, Probabilities, Constructing the life table from the values of q_x.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Life expectancy, Choice of life tables, Standard notation and terminology, A sample table.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Life annuities – Introduction, Calculating annuity premiums, The interest and survivorship discount function, the basic definition, Relations between y_x for various values of x, Guaranteed payments.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Deferred annuities with annual premiums, Some practical considerations, Gross premiums, Gender aspects, Standard notation and terminology, Spreadsheet calculations.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Life insurance- Introduction, calculating life insurance premiums, Types of life insurance, Combined insurance–annuity benefits, Insurances viewed as annuities.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Fundamentals of Actuarial Mathematics, S. David Promislow, John Wiley & Sons, Ltd, 2015.

Suggested Readings

1. An introduction to Actuarial Mathematics, Arjun K Gupta, Tamas Varga, Klewer Academic Publications, 2002.
2. Actuarial Mathematics for Life Contingent Risks, David C.M Dickson, Mary R Hardy, Cambridege University Press, 2009.
3. Introduction to Actuarial and Financial Mathematical Methods, S. J. GARRETT, Elsevier,2015.
4. Actuarial Mathematics and Life-Table Statistics, Eric V. Slud.
5. Financial mathematics for Actuaries, Wai-Sum Chan, Yiu-Kuen Tse, World Scientific Publishing Company, 2018.

Web Resources

1. http://actuaries.cirqahosting.com/HeritageScripts/Hapi.dll/relatedsearch?SearchTerm=~[!61089]~&PlainTerm=61089&Dispfmt=F
2. https://actuarialscience.natsci.msu.edu/links/resources-for-exam-preparation/
3. https://libguides.iun.edu/bysubject/math
4. https://www.maa.org/sites/default/files/ActuarialMathPASGReportOnline.pdf
5. https://www.towson.edu/careercenter/students/careers/major/math.html

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the study of life contingencies.	K1, K2
CO2	To obtain life tables, life annuities and life insurances.	K3
CO3	To analyse the choices of life tables, life annuities and life insurances.	K4
CO4	To compare the choices of life tables, life annuities and life insurances.	K5
CO5	To signify the importance of study of Actuarial Mathematics in taking financial risks to safeguard our beloved.	K6

Course Code	PMT3ME03
Course Title	Representation Theory of Finite Groups
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	III
Regulation	2022

Course Overview

1. This course is a basic course useful for quantum chemists.
2. It describes the correspondence, due to Frobenius, between linear representations and characters.
3. It deals with a fundamental result, of constant use in mathematics as well as in quantum chemistry or physics.
4. It provides proofs as elementary as possible, using only the definition of a group and the rudiments of linear algebra.
5. It discusses examples useful for chemists.

Course Objectives

1. To establish the study of classical groups.
2. To understand the concepts of linear representations on groups.
3. To develop the theory of linear representations to irreducible representations.
4. To exhibit the representation of symmetric groups.
5. To apply the theory of representation in finite abelian groups and dihedral groups.

Prerequisites	Knowledge in elementary group theory and linear algebra.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Classical groups: General linear group, Orthogonal group, Symplectic group, Unitary group.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Group representation, conjugate representation, G-invariant spaces – irreducible representations – Schur's lemma	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	The Group Algebra – Maschke's theorem – characters. Orthogonality relations for characters – Number of irreducible representations.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Permutation representations – Regular representation. Representations of Symmetric groups	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Representation of Finite abelian groups – Dihedral groups	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Linear Representations of Finite Groups, Serre, Jean-Pierre, Springer-verlog, 1977.
2. The Symmetric Group, Representations, Bruce sagan, Combinatorial Algorithms, and Symmetric Functions, Springer-Verlog, New York, 2001.

Suggested Readings

1. Representation theory of finite groups, Benjamin Steinberg, Lecture Notes.
2. Introduction to representation theory of finite groups, Alex Bartel, Lecture Notes, 2021.
3. Representations of finite groups, Hirosi Nagao,Yukio Tsushima, Elsevier, First edition, e-book, 1989.
4. Representation Theory of Finite Groups, Anupam Singh, Lecture Notes.
5. Character Theory of Finite Groups, Jun.-Prof. Dr. Caroline Lassueur TU Kaiserslautern, Lecture Notes.

Web Resources

1. http://users.metu.edu.tr/sozkap/513-2013/Steinberg.pdf
2. https://www.maths.gla.ac.uk/~abartel/docs/reptheory.pdf
3. https://www.elsevier.com/books/representations-of-finite-groups/nagao/978-0-12-513660-0
4. https://www.iiserpune.ac.in/~anupam/Rep-Theory.pdf
5. https://kluedo.ub.uni-kl.de/files/6228/CharaktertheorieSS20.pdf

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the concepts of theory of representation on groups.	K1, K2
CO2	To apply the theory of representation in classical groups, symmetric and dihedral groups.	K3
CO3	To analyse the representation theory on groups and its implementation.	K4
CO4	To differentiate the representation theory on different groups.	K5
CO5	To signify the importance of theory of representation on groups.	K6

Course Code	PMT3ME04
Course Title	Coding Theory
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	III
Regulation	2022

Course Overview

1. Coding theory is a tool for computation and visualization in an integrated environment.
2. Coding theory helps to detect errors in Transmission of messages.
3. This course introduces the basic concepts of coding theory such as Linear codes, BCH codes, Decoding of BCH codes and Group codes.
4. It focusses on encoding and decoding techniques of linear codes.
5. Bounds on the parameters have been discussed and cyclic codes have been explored.

Course Objectives

1. To get an insight into matrix representation of a code as well as encoding and decoding.
2. To familiarize with different types of codes.
3. To develop error detection and correction using coding theory.
4. To design mathematical structures using coding and decoding.
5. To write function files for solving problems on mathematics.

Prerequisites	Basic knowledge in computer and mathematics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Introduction to coding theory – Basic Definitions- Weight, Minimum Weight and Maximum Weight – Likelihood Decoding – Syndrome Decoding – Perfect Codes, Hamming Codes-Error detection and correction – Matrix encoding techniques – Matrix Codes – Group Codes – Dual codes.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Linear codes – Matrix description of linear codes – Equivalence of linear codes – Minimum distance of linear codes – Dual code of a linear code.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	BCH codes, Minimum distance and BCH Bounds, Decoding of BCH codes, Reed – Solomon codes.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Tree codes, Convolution codes, Description of linear tree and convolutional codes by matrices, Distance for convolutional codes, Maximum likelihood decoding of convolutional codes.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Cyclic codes, Algebraic description of cyclic codes, Check polynomial, BCH and Hamming codes as cyclic codes.	12	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Elements of Algebraic coding, Vermani L. R, Chapman and Hall, 1996.
2. Introduction to the Theory of Error Correcting Codes, Vera P, John Wiley and Sons, 1998.
3. Coding and Information Theory, Roman Steven, Springer Verlag, 1992.
4. The Mathematics of Coding Theory, Garret Paul, Pearson Education, 2004.
5. Error Control Coding – Fundamentals and Applications, Peterson W. W. and E. J. Weldon, Jr., Pearson Education India, 2011.

Suggested Readings

1. Fundamentals of Error – Correcting Codes, W. C. Huffman and Pless V, Cambridge University Press, Cambridge, Reprint, 2010.
2. Foundations of Coding: Theory and Applications of Error – Correcting Codes with an Introduction to cryptography and Information Theory, Jiri Adamek, John Wiley and Sons, USA, 1991.

Web Resources

1. https://u.cs.biu.ac.il/~lindell/89-662/coding_theory-lecture-notes.pdf
2. https://users.math.msu.edu/users/halljo/classes/codenotes/coding-notes.html
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-895-essential-coding-theory-fall-2004/lecture-notes/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand and explain the basic concepts of Coding Theory.	K1, K2
CO2	To apply programming skills in writing mathematical script files.	K3
CO3	To write and examine program scripts and functions for coding and decoding.	K4
CO4	To customize and visualize mathematical structures by using appropriate coding theory.	K5
CO5	To generate commands and codes to handle mathematical concepts.	K6

Course Code	PMT3ID01
Course Title	Mathematical Computing Using MATLAB and R
Credits	2
Hours/Week	3
Category	Inter Disciplinary (ID) – Theory
Semester	III
Regulation	2022

Course Overview

1. This course provides an introduction of R and MATLAB programming software for beginners.
2. R and MATLAB are software package used for computation and visualization in an integrated environment.
3. It focusses on skill development in analyzing data for numerous statistical and mathematical problems.
4. Topics covered include basic library functions, graphical representations and analytical tools with user defined function.
5. The course emphasizes on the applications to real-life problems.

Course Objectives

1. To impart basic knowledge of R and MATLAB in understanding commands for simple problems.
2. To familiarize with syntax, semantics, data-types and library functions.
3. To develop a top-down, modular and systematic approach for debugging programs.
4. To design mathematical structures using various functions.
5. To write programs using user defined function to solve real-life problems.

Prerequisites	Basic knowledge in computer, statistics and mathematics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Introduction to R Language and Data Visualization for univariate, bi-variate and multivariate charts.	9	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

			CO4 CO5	
II	Descriptive statistics, degree of relationship and predictive modelling.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Introduction to MATLAB, Vectors and Matrices, Introduction to MATLAB programming.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5 K6
IV	Selection statements, Loop statements and Vectorizing code, MATLAB programs, Advanced file input and output.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Advanced functions, Advanced plotting techniques, Advanced mathematics.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Using R and RStudio for Data Management, Statistical Analysis and Graphics, Nicholas J. Horton, Ken Kleinman, 2nd Edition, 2015.
2. A handbook of statistical analysis using R, Brian S. Everitt, Torsten Hothom, 1st Edition.
3. Data Science with R, A step by step guide with Visual Illustrations and examples, Andrew Oleksy, 1st Edition, 2018.
4. Matlab: A practical introduction to programming and problem solving, Stormy Attaway, Elsiver, Butterworth Heinemann Publication, 4th Edition, 2017.

Suggested Readings

1. Statistical data analysis explained: applied environmental statistics with R, Clemens Reimann, Peter Filzmoser, Robert Garrett, Rudolf Dutter, 2008.
2. Learn R for Applied Statistics: With Data Visualizations, Regressions, and Statistics, Eric Goh Ming Hui, 1st Edition, 2019.
3. Introduction to Matlab 7 for Engineers, William J Palm III, McGraw Hill, 4th edition, 2018.
4. Introduction to MATLAB for Engineering Students, David Houcque, Northwestern University, 2005, e-book.

Web Resources

1. https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf
2. https://www.analyticsvidhya.com/blog/2015/07/guide-data-visualization-r/
3. https://statsandr.com/blog/descriptive-statistics-in-r/
4. www.in.mathsworks.com
5. https://www.javatpoint.com/matlab-introduction
6. https://www.mathworks.com/videos/introduction-to-matlab-81592.html
7. https://www.educba.com/introduction-to-matlab/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the statistical and mathematical library functions of R and MATLAB.	K1, K2
CO2	To apply programming skills in writing mathematical and statistical scripts.	K3
CO3	To analyze and examine the statistical and mathematical concepts using R and MATLAB softwares.	K4
CO4	To customize and visualize mathematical structures using data visualization functions.	K5
CO5	To generate R and MATLAB programs to handle real-life problems.	K6

Course Code	PMT3ID02
Course Title	Mathematical Computing Using MATLAB and R LAB
Credits	1
Hours/Week	3
Category	Inter Disciplinary (ID) – Lab
Semester	III
Regulation	2022

Course Overview

1. This course provides an introduction of R and MATLAB programming software for beginners.
2. R and MATLAB are software package used for computation and visualization in an integrated environment.
3. It focusses on skill development in analyzing data for numerous statistical and mathematical problems.
4. Topics include basic library functions, graphical representations and analytical tools with user defined function.
5. The course emphasizes on the applications to real-life problems.

Course Objectives

1. To understand basic commands and its uses.
2. To familiarize with syntax, semantics, data-types and library functions.
3. To develop a top-down, modular and systematic approach in debugging programs.
4. To design statistical and mathematical structures using graphical features.
5. To write programs using user defined function to solve real-life problems.

Prerequisites	Basic knowledge in computer, statistics and mathematics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Setting up the R platform, construction of simple and multiple bar diagram, pie chart, scatter plot, histogram and boxplot.	9	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

			CO4 CO5	
II	Measures of central tendency, Measures of dispersion, Chi-square test, pearson and spearman correlation coefficient, simple and Multi-variate model builing with dummy variable creation.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Simple MATLAB programs – Introduction, function file writing.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Programs using – selection statements and looping variables File handling techniques.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Programs using graphical tools.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Using R and RStudio for Data Management, Statistical Analysis and Graphics, Nicholas J. Horton, Ken Kleinman. 2nd Edition, 2015.
2. A handbook of statistical analysis using R, Brian S. Everitt, Torsten Hothom, 1st Edition.
3. Data Science with R, A step by step guide with Visual Illustrations and examples, Andrew Oleksy, 1st Edition, 2018.
4. Matlab: A practical introduction to programming and problem solving, Stormy Attaway, Elsiver, Butterworth Heinemann Publication, 4th Edition, 2017.

Suggested Readings

1. Learn R for Applied Statistics: With Data Visualizations, Regressions, and Statistics, Eric Goh Ming Hui, 1st Edition, 2019.
2. Storytelling with Data: A Data Visualization Guide for Business Professionals, Cole Nussbaumer Knaflic, 1st Edition, 2015.
3. Applied Statistics: Theory and Problem Solutions with R, Dieter Rasch Rostock, Rob Verdooren Wageningen, Jurgen Pilz Klagenfurt, 1st Edition, 2020.
4. Matlab with applications to engineering, physics and finance, David Baez-Lopez, CRC Press, 2010.
5. Solving Applied Mathematical Problems with MATLAB, Dingyu Xue Yangquan chen, CRC Press, 2008.

Web Resources

1. https://statsandr.com/blog/descriptive-statistics-in-r/
2. https://www.tutorialspoint.com/r/r_linear_regression.html
3. www.in.mathsworks.com
4. https://www.javatpoint.com/matlab-introduction
5. https://www.geeksforgeeks.org/introduction-to-matlab/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the statistical and mathematical library functions of R and MATLAB.	K1, K2
CO2	To apply programming skills in writing mathematical and statistical scripts.	K3
CO3	To analyze and examine the statistical and mathematical concepts using R and MATLAB softwares.	K4
CO4	To customize and visualize mathematical structures using data visualization functions.	K5
CO5	To generate R and MATLAB programs to handle real-life problems.	K6

Course Code	PMT4MC01
Course Title	Functional Analysis
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	IV
Regulation	2022

Course Overview

1. Functional analysis is the branch of mathematics originating from calculus of variation in the study of operators dealing with spaces of functions.
2. This course deals with certain topological-algebraical structures.
3. This course focus on metric spaces, Banach and Hilbert spaces.
4. In the context of normed linear spaces, various important theorems and their applications are analysed.
5. This course provides the results on vector-valued analytic function and semigroup applications.

Course Objectives

1. To understand the fundamentals of Functionals.
2. To study in detail about Banach spaces and to introduce duality.
3. To know the concepts in Hilbert spaces and its properties.
4. To understand deeply the theory of operators.
5. To explore the nature of C_0 _semigroup and to develop aptitude for research.

Prerequisites	Fundamental knowledge on linear algebra and real analysis.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Banach Spaces: Definition – Some Examples – Continuous Linear Transformations – The Hahn-Banach Theorem – Application.	15	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

			CO4 CO5	
II	The Natural Imbedding of N in N** – Open Mapping Theorem – Conjugate of an Operator – Applications.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Hilbert Spaces: Definition and Some Simple Properties – Orthogonal Complements – Orthonormal Sets – Hilbert Spaces: Conjugate Space H* – Applications.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Adjoint of an Operator – Self – Adjoint Operator – Normal and Unitary Operators – Projections – Applications.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Finite Dimensional Spectral Theory and Banach Algebra: Finite Dimensional Spectral Theory – Regular and Singular Elements – Topological Divisor of Zero – The Spectrum – Formula for the Spectral Radius – Topological Vector Spaces– The Radical and Semi–Simplicity – The Gelfand Mapping – The Applications of the Spectral Radius–Involutions in Banach Algebras.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Introduction to Topology and Modern Analysis, G F Simmons**,** McGraw Hill International Book Company, New York, Reprint 2017.

Suggested Readings

1. Functional Analysis, Bachman. G and Narici. L, Dover Publications, New York, 2000.
2. Functional Analysis, Balmohan Vishnu Limaye, New Age International(P) Limited, New Delhi, Second Edition, 2014.
3. Functional Analysis with Applications, Choudhary. B and Sudarsan Nanda, New Age International Publications, New Delhi, 2018.

4. First Course in Functional Analysis, Goffman. H. C and Fedrick. G, Prentice Hall of India, New Delhi. 1987.
5. A course in functional Analysis, John B Conway, Springer International Edition, Second Edition, 2014.
6. Introductory Functional Analysis with Applications, Kreyszig, John Wiley & Sons, New York. 2014.
7. Functional Analysis, Riesz and SZ Nagy, Dover Publication, New York, Second Edition, 2017.
8. Functional Analysis, Rudin. W, Tata McGraw – Hill Publishing Company, New Delhi, 2017.
9. Introduction to Functional Analysis with Applications, Siddiqi, Khalil Ahmad and Manchnda, Anamaya Publishers, New Delhi, 2007.
10. Functional Analysis - A first course, Thamban Nair. M, Prentice Hall of India, New Delhi, 2002.

Web Resources

1. http://math-forum.org,
2. https://www.sciencedirect.com/journal/journal-of-functional analysis
3. http://ocw.mit.edu/ocw web/Mathematics
4. http://www.opensource.org
5. https://www.elsevier.com/mathematics
6. https://mathworld.wolfram.com
7. https://mathsolver.microsoft.com

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the theory of bounded linear operators and the basic concepts in spectral and structure theories.	K1, K2
CO2	To examine the properties of real and complex Banach spaces and Hilbert spaces with continuity.	K3
CO3	To apply the knowledge of orthonormal sets and different operators.	K4
CO4	To explain the results of various spaces with the notions of completeness, separability and density.	K5
CO5	To create new problems in conjugate space and projection.	K6

Course Code	PMT4MC02
Course Title	Numerical Analysis
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	IV
Regulation	2022

Course Overview

1. Numerical analysis is the study of algorithms that use numerical approximation for the problems of mathematical analysis.
2. The main of this course is study and analyze the numerical data to give appropriate conclusion.
3. It offers fundamental ideas about various analytic methods.
4. This course is to gives a broad knowledge in mathematics, physics, engineering, finance, and the life sciences.
5. It deals with the real-life problems and give solutions using different analytic methods.

Course Objectives

1. To understand the basic concepts in numerical analysis and how they are used to obtain approximate solutions for algebraic and transcendental equations.
2. To analyse and evaluate the solutions for system of linear algebraic equations.
3. To construct a function by using interpolation method.
4. To analyze the derivatives for equally spaced data using differentiation and integration and finite difference of ODE & PDE.
5. To apply regression analysis technique over the numerical analysis.

Prerequisites	Basic knowledge in Statistics and Mathematics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	**Solution of Algebraic and Transcendental Equations**	15	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

	Bisection method – Method of false position – Newton Raphson method – Ramanujan's method – secant method – Muller's method – Graeffe's root squaring method.		CO4 CO5	
II	**Interpolation** Finite differences – Forward differences – Backward differences – Central differences – Newton's formulae for interpolation – Centre difference interpolation formulae – Stirling's – Bessel's formula – Lagrange's interpolation.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	**Numerical Differentiation and Integration** Derivatives using Newton's forward and backward interpolation formula – Trapezoidal rule – Simpson's one-third rule – Simpson's three-eight's rule – Weddle's rule.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	**Numerical Solutions of ordinary differential equations and partial differential equations** Taylor's series method – Picard's method of successive approximations – Euler's method – Runge-Kutta methods – Laplace's equation – Jacobi's Metho – Gauss seidel method.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	**Regression Analysis** Regression – regression equation – curve of regression – linear fit – angle between two lines of regression – multilinear linear regression.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Introductory Methods of Numerical Analysis, Sastry S. S, PHI Learning Pvt. Limited, New Delhi, Fifth Edition, 2012.
2. Numerical Analysis, Shanker Rao. G, New Age International Pvt. Limited, New Delhi, Fourth Edition, 2010.

Suggested Readings

1. An introduction to Numerical methods and analysis, James F. Epperson, John Wiley & Sons, Second edition, 2013.
2. Applied Numerical analysis, Gerald, Wheatley, Pearson college, Seventh edition, 2003.

Web Resources

1. https://nptel.ac.in/courses/111/106/111106101/
2. https://nptel.ac.in/courses/111/101/111101003/
3. https://www.tutorialspoint.com/ebook/numerical_analysis/index.asp

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic concepts of numerical analysis.	K1, K2
CO2	To apply the appropriate analytic technique to solve raw data.	K3
CO3	To relate the learnt mathematical problems concepts on the computer.	K4
CO4	To analyze the supervised and unsupervised data using various methods.	K5
CO5	To formulate and solve real life problems using appropriate technique.	K6

Course Code	PMT4MC03
Course Title	Classical Mechanics
Credits	5
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	IV
Regulation	2022

Course Overview

1. Classical Mechanics studies the motion of everyday objects and the force that affect them.
2. The main aim is to provide a conceptual understanding of the core concepts and familiarity with the verification of theoretical laws.
3. It investigates the Lagrangian and Hamiltonian formulation of classical mechanics.
4. It deals with various techniques involved in describing the motion of macroscopic objects, from projectiles to parts of machinery and astronomical objects.
5. This course helps to solve real life problems using force and conservation laws.

Course Objectives

1. To understand the basic principles in dynamical system and techniques involved in calculus of variations.
2. To improve critical thinking skills to formulate and solve problems in classical mechanics.
3. To analyze and predict the motion of bodies with the help of theoretical laws.
4. To familiarize with the mathematical techniques associated with classical mechanics.
5. To apply the appropriate techniques to find solution for the problems applied in physics.

Prerequisites	Basic knowledge in mechanics.

SYLLABUS

Unit	Content	Hours	COs	Cognitive Level
I	Constraints, D'Alembert's Principle and Lagrange's equations, Simple Applications of the Lagrangian Formulation, Hamilton's Principle and Derivation of Lagrange's equation from Hamilton's Principle.	15	CO1 CO2 CO3	K1, K2, K3, K4, K5, K6

			CO4 CO5	
II	The Euler Angles, Euler's theorem on the motion of a Rigid Body, Angular Momentum and Kinetic Energy of motion about a point, The Heavy Symmetrical Top with one point fixed.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Legendre transformations and the Hamilton Equations of motion, Cyclic coordinates and conservation theorems, Routh's procedure, The Principle of Least Action.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	The equations of Canonical Transformation, Poisson Brackets and other Canonical Invariants, Equations of motion, The Angular Momentum Poisson Bracket Relations, Liouville's theorem.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	The Hamilton-Jacobi equation for Hamilton's Principal Function, The Harmonic Oscillator as an example of the Hamilton-Jacobi Method, Action Angle variables in systems of one degree of freedom, The Kepler problem in Action-angle variables.	15	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Classical Mechanics, Herbert Goldstein, Charles Poole, John Safko, Pearson Education Asia, 3rd Edition, 2002.

Suggested Readings

1. Classical Mechanics, H. Goldstein, Narosa Publishing, 2nd Edition, 1994.
2. Classical Mechanics, D.E. Rutherford, Oliver Boyd, New York, 2000.
3. Classical Dynamics, D.T. Greenwood, Prentice Hall, 1979.
4. An introduction to Mechanics, Daniel Kleppne & Robert J. Kolenkow, Cambridge University Press, e-Book, 2013.
5. Principle of Mechanics, J. L. Synge and B. A. Griffith, McGraw Hill, 1959.
6. Classical Mechanics, Martin W. McCall, John Wiley & sons Ltd, first edition, e-Book, 2011.

Web Resources

1. https://dlscrib.com/queue/greenwood-d-t-classical-dynamics_58da8c4ddc0d60db03c34625_pdf?queue_id=59f40c43e2b6f5f1658c5860
2. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
3. https://www.physics.rutgers.edu/~shapiro/507/book.pdf
4. https://shahroodut.ac.ir/fa/download.php?id=1111133406

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic mechanical concepts related to discrete and continuous mechanical systems.	K1, K2
CO2	To apply the mathematical techniques to solve problems involving the dynamical motion of classical mechanical system.	K3
CO3	To analyze the Lagrange - Hamiltonian formulation of classical mechanics and Kinematics of a rigid body.	K4
CO4	To summarize the motion of a mechanical system using Lagrange-Hamilton formulations.	K5
CO5	To explore the motion of a rigid body using the Lagrangian and Hamiltonian formulation.	K6

COURSE DESCRIPTORS
(Offered to other Departments)

Course Code	PMT2CD01
Course Title	Quantitative Aptitude for Combined Civil Services Examinations
Credits	1
Hours/Week	3
Category	Cross Disciplinary (CD) – Theory
Semester	II
Regulation	2022

Course Overview

1. The aim of this course is to provide aptitude training for competitive exams.
2. Divisibility test for numbers have been discussed in detail.
3. Real life problems related to space, time and work are solved.
4. Interpretation of data using graphs, pie charts and tables.
5. Business related problems like profit, loss have been discussed.

Course Objectives

1. To develop analytical and logical skills.
2. To save time at a competitive exam.
3. To solve problem using appropriate formula.
4. To extract data on reading the Graphs, pie charts and tables.
5. To effectively compete in the competitive exams.

Prerequisites	Knowledge in elementary mathematics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Numbers – Number System – Fractions – LCM and HCF – Elementary Algebra – Sets and functions – Sequence and Series.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Business Mathematics – Average – Percentage – Profit loss and discount – Simple and Compound interest – Ratio and Proportion, Partnership and Mixture – Probability – statistics.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Mensuration and Geometry – Area and Perimeter – Volume and Surface area of solid figures – Plane geometry.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Arithmetic – Time and Work – Speed, Time and Distance – Clocks and Calendars – Order of Magnitude – Permutation and Combination.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Data Interpretation – Introduction to data interpretation – Study of Graphs – Tables – Pie Charts – Bar Charts/Graphs – Line Graphs – Caselets – Mixed Graphs.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Cracking the CSAT Civil Service Aptitude Test, Arihant Experts, Arihant Publications (India) Ltd., 2021.
2. Quantitative Aptitude, R. S. Aggarwal, S. Chand & Company Ltd., Revised edition, 2013.

Suggested Readings

1. Magical book on Quicker Maths, M. Tyra, BSC Publishing Co. Pvt. Ltd, Fifth edition, 2018.
2. Quantitative Aptitude for All Competitive Examination, Abhijit Guha, McGraw Hill Education, Sixth edition, 2016.
3. Fast Track Objective Arithmetic, Rajesh Verma, Arihant Publications, 2021.

Web Resources

1. www.indiabix.com
2. www.testpot.com
3. www.freedo.in

4. www.sawaal.com
5. www.careerbless.com

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand and recall the concepts of Number system, Algebra, Business Maths and geometrical shapes.	K1, K2
CO2	To apply the appropriate technique to solve financial, physical and statistical problems.	K3
CO3	To determine precise solution to the financial, physical and statistical problems.	K4
CO4	To analyse the problems in finance, statistics, algebra and geometry.	K5
CO5	To formulate a mathematical model for real life situations.	K6

Course Code	PMT2CD02
Course Title	Mathematical Tools for Humanities
Credits	1
Hours/Week	3
Category	Cross Disciplinary (CD) – Theory
Semester	II
Regulation	2022

Course Overview

1. This course introduces two important mathematical tools namely Graph Theory, Fuzzy Set theory and their applications.
2. Concepts of Graph theory and Fuzzy Set Theory are explained.
3. Recent application of graph theory is introduced.
4. The basic of Fuzzy models, Fuzzy graphs and Fuzzy numbers are described.
5. Fundamental results and techniques of some Fuzzy models are illustrated.

Course Objectives

1. To understand the concepts of graph theory.
2. To apply graph theory-based tools in solving practical problems.
3. To study the fundamental concepts such as Fuzzy sets, Fuzzy operations and Fuzzy relations.
4. To get familiarized with Fuzzy graphs.
5. To solve apply in real world problems using Fuzzy tools.

Prerequisites	Basic knowledge in set theory.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Graphs – subgraphs – Walks, Paths, Circuits – Connected graphs, Disconnected graphs, Components – Euler graphs – Operations on graphs – Hamiltonian Paths and circuits – Planar graphs.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Incidence matrix – Circuit matrix – Application to a switching network – Cut set matrix – Path matrix – Adjacency matrix – Matchings – coverings – Five colour theorem - Basic algorithms – Shortest path algorithms.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Concepts of Fuzzy set – Standard operations of Fuzzy sets – Fuzzy complement – Fuzzy union – Fuzzy intersections – Fuzzy numbers.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Fuzzy graphs – Fuzzy relations – Compositions of Fuzzy relations – Properties of Fuzzy binary relations – Paths in a finite fuzzy graph.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Different Fuzzy Models – Bidirectional Associative Memories (BAM) – Fuzzy Cognitive Maps (FCM) – Fuzzy Relational Maps – Simple applications of Fuzzy graphs and Fuzzy numbers.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Invitation to Graph Theory, Arumugam and S. Ramachandran, New gamma publishing house, 1994.
2. Fuzzy Sets and Fuzzy Logic: Theory and Applications, George J Klir and Bo Yuan, Prentice-Hall, INC., New Jersey, 2002.
3. Neural Networks and Fuzzy Systems, Bart Kosko, Prentice-Hall, INC., New Jersey, 1992.

Suggested Readings

1. Graph Theory with Applications, A. Bondy and U. S. R. Murty, Macmillan Press Ltd., 1976.
2. Introduction to the Theory of Fuzzy Subsets, A. Kauffman, Academic Press, INC, New York, 1975.

Web Resources

1. https://cse.iitkgp.ac.in/~dsamanta/courses/sca/index.html
2. https://mathigon.org/course/graph-theory/applications

3. https://owlcation.com/stem/What-are-the-Basics-and-Real-World-Applications-of-Graph-Theory
4. https://www.tutorialspoint.com/fuzzy_logic/fuzzy_logic_applications.html
5. https://www.hindawi.com/journals/afs/2013/581879/

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic concepts of Graph Theory and Fuzzy Set Theory.	K1, K2
CO2	To apply the appropriate analytic techniques of Graph Theory and Fuzzy Set Theory.	K3
CO3	To analyse the learnt concepts with the Planar graphs, Matchings, Coverings and Fuzzy models.	K4
CO4	To evaluate the concept of networks, basic algorithms and arithmetic operations on fuzzy relation.	K5
CO5	To formulate and solve real - life problems using fuzzy models.	K6

Course Code	PMT2CD03
Course Title	Bio-Mathematics
Credits	1
Hours/Week	3
Category	Cross Disciplinary (CD) – Theory
Semester	II
Regulation	2022

Course Overview

1. The aim of this course is to provide the mathematical concepts applicable to Bio - Medical Sciences.
2. An integrated way to analyse biological systems using mathematics is illustrated.
3. Applications of matrices, determinants, graphs and functions in biology are discussed.
4. The basic concepts of graph theory and their applications in Bio Science related problems are explained.
5. Concepts of differentiation and integral calculus in Bio - Medical Sciences are studied.

Course Objectives

1. To study various types of matrices and its operations.
2. To classify graphs and functions.
3. To acquire the knowledge of differentiation and integration and to solve Bio medical problems.
4. To apply the concepts in graph theory in Biological Sciences.
5. To solve real time problems of medical sciences using mathematical concepts.

Prerequisites	Basic knowledge in fundamental mathematics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Determinants – Properties of determinants – Minors – Cofactors – Multiplications of determinants – Matrices – Operations on Matrices – Inverse of Matrices – Solution of Simultaneous equations.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

II	Graphs and functions – Linear function – Quadratic function, Exponential function, Periodic functions, Examples from Biology.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
III	Limits – Differentiation – Successive differentiation – Maxima and Minima – Simple problems. Integration of $f(x) = x^n$, e^x, logx – Definite integrals – Simple problems.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Differential equations – Simple differential equations – First order differential equations – Second order Differential equations. Basic ideas of graph theory – Connectivity – Trees – Various matrices connected with graphs.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
V	Interaction between Mathematics and Bio-Medical Sciences – Some problems of Medical Sciences Solved through Mathematics – Mathematical models in Medicine – Bio arithmetic of the Human Body.	9	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. Introduction to Mathematics for Life Scientist, E. Batschelet, Springer Verlag, 3rd Edition, 2013.
2. Calculus for Life Sciences, R. De Sapio, W. H. Freeman and Co., 1976.
3. Mathematics for the Biological Sciences, Jagdish C. Arya/ Robin W. Lardner, 704.
4. Invitation to Graph Theory, S. Arumugam and S. Ramachandran, New gamma publishing house, 1994.
5. Biomathematics, Pundir & Pundir, Pragati Prakashan, Meerut, 2012.

Suggested Readings

1. Calculus Vol I, Narayanan. S and Manikavasagam Pillai T. K., S. Viswanathan Printers, 1996.
2. Graph Theory with Applications, A. Bondy and U. S. R. Murty, Macmillan Press Ltd., 1976.
3. Random Walks in Biology, H. C. Berg, Princeton University press, 1993.

Web Resources

1. http://www.math.rutgers.edu/~sontag/336.html

2. https://www.tutorialsduniya.com/notes/biomathematics-notes
3. https://www.di.univr.it/documenti/OccorrenzaIns/matdid/matdid262230.pdf

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand the basic concepts of matrices, differentiation, integration, graph theory, graphs and functions.	K1, K2
CO2	To apply techniques of integrals, matrices, differential equations and graph theory in Bio Medical Sciences problem.	K3
CO3	To analyse Bio medical problems using the concepts of integrals, matrices, differential equations and graph theory.	K4
CO4	To evaluate integrals, matrices and differential equations in Bio Medical Science problems.	K5
CO5	To facilitate the applications of mathematics in the stream of Bio-Medical Sciences.	K6

Course Code	PMT3VAO1
Course Title	Operation Research for Logistics Management
Credits	01
Hours/Week	02
Category	Value Added (VA) – Theory
Semester	III
Regulation	2022

Course Overview

1. Operation Research is an area of applied mathematics focused with using analytical methods to aid in management decision-making.
2. This course covers the basic Operation Research techniques and deals with the application of these techniques in logistics.
3. This course demonstrates the working of various methods to solve different type of linear programming problems.
4. This course introduces the transportation and assignment problems.
5. The analysis of network models as a representation of real-life problems is done elaborately.

Course Objectives

1. To understand operations, research techniques used for planning, scheduling and controlling large and complex projects.
2. To solve linear programming problems using graphical and simplex methods to find degenerate, alternative, and infeasible solutions.
3. To apply the knowledge of linear programming concepts to formulate the logistic management problems.
4. To become familiar with the process of locating a transportation solution.
5. To gain an understanding of key concepts of inventory management.

Prerequisites	Basic knowledge in probability distribution.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level

I	Logistics: Origin and Definition, Logistics Management, types of logistics. Linear programming – Formulation of LPP – Graphical solution –Simplex algorithm	6	CO1 CO2 CO3 CO4	K1, K2, K3, K4, K5
II	Transportation –Balanced and Unbalanced problems – Assignment Problem– Balanced and Unbalanced problems.	6	CO2 CO3 CO4 CO5	K2, K3, K4, K5, K6
III	Replacement of items that deteriorate gradually – with time, without time, that fails completely – individual replacement – group replacement.	6	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6
IV	Network Analysis – Network definitions – Shortest route problem – Minimal spanning tree problem – Project scheduling by PERT and CPM.	6	CO1 CO2 CO3 CO4 CO5	K1, K2, K4, K5, K6
V	Inventory models, Inventory costs, Models and deterministic demand – demand rate uniform and production rate infinite, demand rate non – uniform and production rate infinite, demand rate uniform and production rate finite.	6	CO1 CO2 CO3 CO4 CO5	K1, K2, K3, K4, K5, K6

Text Books

1. J K Sharma, Operations Research, Theory and applications, Macmillan Publications India, 2007, Third Edition.
2. Hamdy A. Taha, Operations Research – An Introduction, Pearson publications, 2014, Seventh Edition.
3. Walters, D. Inventory control and management, West Sussex: John Wiley & Sons Ltd., 2003, Second Edition.

Suggested Readings

1. C. R. Kothari, An Introduction to Operational Research, Vikas Publishing house Pvt. Ltd., 2009, Third Edition.
2. S. D. Sharma, Operations Research – Theory, Methods and Applications, Kedar Nath Ram Nath, 2014.
3. G. Srinivasan, Operations Research: Principles and Applications, Prentice Hall of India, e-Book, 2010.
4. E. S. Buffa, R. K. Sarin,, Modern Production/ operations management, New Delhi: Wiley India (Indian Print), 2009, Eighth Edition.

Web Resources

1. https://web.itu.edu.tr/topcuil/ya/OR.pdf
2. https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8720.pdf
3. https://hithaldia.in/faculty/sas_faculty/Dr_M_B_Bera/Lecture%20note_3_CE605A&CHE705B.pdf
4. https://ocw.ehu.eus/pluginfile.php/40935/mod_resource/content/1/5_Transportation.pdf
5. https://hithaldia.in/faculty/sas_faculty/Dr_M_B_Bera/Lecture%20note_8_CE605A&CHE705B.pdf

COURSE OUTCOMES (COs) & COGNITIVE LEVEL MAPPING

COs	CO Description	Cognitive Level
CO1	To understand and identify the activities, model, methods and procedure of linear programming concepts.	K1, K2
CO2	To adopt the linear programming problem, Transportation problem and Assignment problem methods to real life/ business problems.	K3
CO3	To analyze the various selective inventory control techniques to classify inventory items into broad categories.	K4
CO4	To analyze the optimization techniques of linear programming, theory of games and network analysis in solving real world problems.	K5
CO5	To design a mathematical model for an optimization problem in real life by adopting the techniques of operations research.	K6

LOCF BASED DIRECT ASSESSMENTS

COGNITIVE LEVEL (CL) AND COURSE OUTCOME (CO) BASED CIA QUESTION PAPER FORMAT (PG)

SECTION		Q. NO	COGNITIVE LEVEL (CL)					
			K1	K2	K3	K4	K5	K6
A	(5 x 1 = 5) Answer ALL	1(a)	+					
		(b)	+					
		(c)	+					
		(d)	+					
		(e)	+					
	(5 x 1 = 5) Answer ALL	2(a)		+				
		(b)		+				
		(c)		+				
		(d)		+				
		(e)		+				
B	(1 x 8 = 8) Answer 1 out of 2	3			+			
		4			+			
C	(1 x 8 = 8) Answer 1 out of 2	5				+		
		6				+		
D	(1 x 12 = 12) Answer 1 out of 2	7					+	
		8					+	
E	(1 x 12 = 12) Answer 1 out of 2	9						+
		10						+
No. of CL based Questions with Max. marks			5 (5)	5 (5)	1 (8)	1 (8)	1 (12)	1 (12)
No. of CO based Questions with Max. marks			CO1		CO2	CO3	CO4	CO5
			10 (10)		1 (8)	1 (8)	1 (12)	1 (12)

Forms of questions of **Section A** shall be MCQ, Fill in the blanks, True or False, Match the following, Definition, Missing letters. Questions of **Sections B, C, D and E** could be Open Choice/ built in choice/with sub sections. Component III shall be exclusively for cognitive levels K5 and K5 with 20 marks each. CIA shall be conducted for 50 marks with 90 min duration.

COGNITIVE LEVEL (CL) AND COURSE OUTCOME (CO) BASED END SEMESTER EXAMINATION QUESTION PAPER FORMAT (PG)

SECTION		Q. NO	COGNITIVE LEVEL (CL)					
			K1	K2	K3	K4	K5	K6
A	(5 x 1 = 5) Answer ALL	1(a)	+					
		(b)	+					
		(c)	+					
		(d)	+					
		(e)	+					
	(5 x 1 = 5) Answer ALL	2(a)		+				
		(b)		+				
		(c)		+				
		(d)		+				
		(e)		+				
B	(3 x 10 = 30) Answer 3 out of 5	3			+			
		4			+			
		5			+			
		6			+			
		7			+			
C	(2 x 12.5 = 25) Answer 2 out of 4	8				+		
		9				+		
		10				+		
		11				+		
D	(1 x 15 = 15) Answer 1 out of 2	12					+	
		13					+	
E	(1 x 20 = 20) Answer 1 out of 2	14						+
		15						+
No. of CL based Questions with Max. marks			5 (5)	5 (5)	3 (30)	2 (25)	1 (15)	1 (20)
No. of CO based Questions with Max. marks			CO1		CO2	CO3	CO4	CO5
			10 (10)		3 (30)	2 (25)	1 (15)	1 (20)

IMPORTANT

- Forms of questions of **Section A** shall be MCQ, Fill in the blanks, True or False, Match the following, Definition, Missing letters.
- Questions of **Sections B, C, D and E** could be Open Choice/ built in choice/questions with sub divisions.
- Maximum sub divisions in questions of Sections B, C shall be 2 and 4 in Sections D, E).

TOTAL MARKS DISTRIBUTION OF DIRECT ASSESSMENTS BASED ON CL AND CO (PG)

Course Outcome	**CO1**		**CO2**	**CO3**	**CO4**	**CO5**	**TOTAL**
Cognitive Levels	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	
CIA 1	5	5	8	8	12	12	50
CIA 2	5	5	8	8	12	12	50
Comp III	-	-	-	-	20	20	40
Semester	5	5	30	25	15	20	100
Total Marks (CL)	**15 (6%)**	**15 (6%)**	**46 (19%)**	**41 (17%)**	**59 (25%)**	**64 (27%)**	**240**
Total Marks (CO)	**30 (12%)**		**46 (19%)**	**41 (17%)**	**59 (25%)**	**64 (27%)**	**240**