CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

(Nationally Re-accredited (III cycle) with 'A' (CGPA 3.41 out of 4)

Grade by NAAC

PG AND RESEARCH DEPARTMENT

OF

MATHEMATICS

AUTONOMOUS SYLLABUS

M. Sc MATHEMATICS

2019 – 2020 onwards

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

PG AND RESEARCH DEPARTMENT OF MATHEMATICS

M.Sc MATHEMATICS

PROGRAMME OUTCOMES

PO1	Apply the ideas of mathematics to solve the scientific issues and problems being faced in society.
PO2	Utilize the knowledge of pure and applied mathematics to solve complex mathematical Problems.
PO3	Use mathematical models to relate mathematical sciences in real world problems.
PO4	Communicate effectively in the field of expertise on their activities, and write effective reports and make effective presentations.
PO5	Prepare themselves completely to the demands of the growing field of mathematics.
PO6	Plan to crack lectureship and fellowship exams approved by UGC like CSIR-NET and SET.

CAUVERY COLLEGE FOR WOMEN (AUTONOMOUS)

PG AND RESEARCH DEPARTMENT OF MATHEMATICS

M. Sc MATHEMATICS COURSE STRUCTURE

(For the candidates admitted in the year 2019-2020)

SEM	Course	Course Title	Subject code	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
							Int.	Ext.	
I	Core Course – I (CC)	Algebra –I	19PMA1CC1	6	5	3	25	75	100
	Core Course – II (CC)	Ordinary Differential Equations	19PMA1CC2	6	5	3	25	75	100
	Core Course – III (CC)	Integral Equations, Calculus of Variations and Transforms	19PMA1CC3	6	5	3	25	75	100
	Core Course – IV (CC)	Algebraic Number Theory	19PMA1CC4	6	5	3	25	75	100
	Core Course - V (CC)	Discrete Mathematics	19PMA1CC5	6	5	3	25	75	100
			TOTAL	**30**	**25**				**500**
II	Core Course – VI (CC)	Algebra- II	19PMA2CC6	6	5	3	25	75	100
	Core Course – VII (CC)	Real Analysis I	19PMA2CC7	6	5	3	25	75	100
	Core Course – VIII (CC)	Linear Algebra	19PMA2CC8	6	5	3	25	75	100
	Core Course – IX (CC)	Topology	19PMA2CC9	6	5	3	25	75	100
	Elective Course – I (EC)	Partial Differential Equations	19PMA2EC1A	6	3	3	25	75	100
		Difference Equations	19PMA2EC1B						
			TOTAL	**30**	**23**				**500**

SEM	Course	Course Title	Subject code	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
							Int.	Ext.	
III	Core Course – X (CC)	Real Analysis – II	19PMA3CC10	6	5	3	25	75	100
	Core Course – XI (CC)	Measure and Integration	19PMA3CC11	6	5	3	25	75	100
	Core Course – XII (CC)	Analytical skills for competitive examinations	19PMA3CC12	6	5	3	-	100	100
	Elective Course – II (EC)	Computational Numerical Analysis	19PMA3EC2A	6	3	3	25	75	100
		Fluid Dynamics	19PMA3EC2B						
	Elective Course – III (EC)	Probability Theory and Machine learning	19PMA3EC3A	6	3	3	25	75	100
		Stochastic Processes	19PMA3EC3B						
	Extra Credit Course	**SWAYAM ONLINE COURSE**	**To be fixed later**	**As per UGC Recommendation**					
			TOTAL	**30**	**21**				**500**
IV	Core Course – XIII (CC)	Functional Analysis	19PMA4CC13	6	5	3	25	75	100
	Core Course – XIV(CC)	Complex Analysis	19PMA4CC14	6	5	3	25	75	100
	Elective Course – IV (EC)	Optimization Techniques	19PMA4EC4A	6	3	3	25	75	100
		Fuzzy Sets and their Applications	19PMA4EC4B						
	Elective Course – V (EC)	Differential Geometry	19PMA4EC5A	6	3	3	25	75	100
		Automata Theory	19PMA4EC5B						
	Project		19PMA4PW	6	5	-	-	-	100
			TOTAL	**30**	**21**				**500**
			GRAND TOTAL	**120**	**90**				**2000**

Note:

Project	: 100 Marks
Dissertation	: 80 Marks
Viva Voce	: 20 Marks

Core Papers	- 14
Core Practical	- Nil
Elective Papers	- 5
Project	- 1

Note:

1. Theory Internal 25 marks External 75 marks
2. Practical Internal 40 marks External 60 marks
3. Separate passing minimum is prescribed for Internal and External

a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks).

b) The passing minimum for End Semester Examination shall be 40% out of 75 marks (i.e. 30 marks).

c) The passing minimum not less than 50% in the aggregate.

CORE COURSE – I (CC)

Title of the Course: ALGEBRA-I
Course Code: 19PMA1CC1
Syllabus:

L	T	P	C
90	6	-	5

Unit I:

Binary Operations – Groups – Subgroups - Permutations I - Permutations II - Cyclic Groups.

Unit II:

Isomorphism - Direct products - Finitely Generated Abelian Groups - Groups of Cosets - Normal Subgroups and Factor Groups - Homomorphisms.

Unit III:

Series of Groups - Isomorphism Theorems - Proof of the Jordan - Holder Theorem - Group Action on a Set - Applications of G - Sets to Counting - Sylow Theorems - Applications of the Sylow Theorem.

Unit IV:

Rings - Integral domains - Some Noncommutative examples - The Field of Quotients of an Integral Domain - Quotient Rings and Ideals.

Unit V:

Homomorphism of Rings - Factorization of Polynomials over a Field - Unique Factorization Domains -Euclidean Domains - Gaussian Integers and Norms.

Text Books:

John B. Fraleigh,A First Course in Abstract Algebra, Narosa Publishing House, Third edition,1992.

Chapters and Sections:

UNIT I Chapter 1,2,3,4,5,6.
UNIT II Chapter 7,8,9,11,12,13.
UNIT III Chapter 14,15,16,17,18,19 .
UNIT IV Chapter 23,24,25,26,27,28.
UNIT V Chapter 29,30,31.32,33,34.

Reference Books:

[1] David S. Dummit and Richard M.Foote,Abstract Algebra,Wiley and sons,Third Edition ,2004
[2]Joseph A.Gallian,Contemporary Abstract Algebra,Narosa Publishing House,Fourth Edition,1999.
[3]I.N.Herstein,Topics in Algebra,John Wiley,2nd Edition,1975.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Gain expertise in the basic concepts of group theory with the help of numerous examples	K4
CO2	Examine in detail about Permutation Groups and Normal Groups and discuss in counting tricks in algebra	K4
CO3	Illustrate Jordan holder theorem with examples	K2
CO4	To classify groups of finite order upto 120 using Sylow's theorems	K3
CO5	To evaluate the Field of Quotients of an integral domain	K5
CO6	Determine various forms of Polynomial rings,Further they will be able to discuss Euclidean domain	K4

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**M**	**S**	**S**	**S**
CO2	**M**	**S**	**S**	**S**	**S**	**S**
CO3	**M**	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**
CO6	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong, M-Medium, L-Low

CORE COURSE – II (CC)

Title of the Paper: ORDINARY DIFFERENTIAL EQUATIONS
Course Code: 19PMA1CC2

L	T	P	C
90	6	-	5

UNIT I

The General Solution of the Homogeneous Equation – The Use of a Known Solution to Find Another – The Method of Variation of Parameters – Power Series Solutions and Special Functions : A Review of Power Series – Series Solutions of First Order Equations – Second Order Linear Equations. Ordinary Points .

UNIT II

Regular Singular Points – Gauss's Hypergeometric Equation – The Point at Infinity. Legendre Polynomials – Properties of Legendre Polynomials - Bessel Functions. The Gamma Function, Properties of Bessel Functions.

UNIT III

Linear Systems – Homogeneous Linear Systems With Constant Coefficients – The Existence and Uniqueness of Solutions: The Method of Successive Approximations - Picard's Theorem.

UNIT IV

Qualitative Properties of Solutions: Oscillations and the Strum Separation Theorem – The Sturm Comparison Theorem – Eigen Values , Eigen Functions and the Vibrating String.

UNIT V

Nonlinear Equations: Autonomous Systems. The Phase Plane and Its Phenomena – Types Of Critical Points. Stability – Critical Points and Stability for Linear Systems – Stability by Liapunov's Direct Method – Simple Critical Points of Nonlinear Systems.

Text Book(s):

[1] George F. Simmons, Differential Equations with Applications and Historical Notes, Second Edition, McGraw-Hill International Editions, 1957.

Chapters and Sections:

UNIT I	Chapter 3:	Sections 15, 16, 19
	Chapter 5:	Sections 26 to 28
UNIT II	Chapter 5:	Sections 29, 31, 32
	Chapter 8:	Sections 44 to 47
UNIT III	Chapter 10:	Sections 55, 56
	Chapter 13:	Sections 68, 69
UNIT IV	Chapter 4:	Sections 24, 25

	Chapter 7:	Sections 40
UNIT V	Chapter 11:	Sections 58 to 62

Reference(s):

[1] M.D.Raisinghania, Ordinary and Partial Differential Equations, S.Chand & co. 2005

[2] E.A. Coddington and N.Levinson, Theory of Ordinary Differential Equations, McGraw Hill Publishing Company, Newyork, 1955.

[3] Chicone, Carmen, A Ordinary Differential Equations With Applications, Spring Verlag , Newyork, 2006

Course Outcomes:

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

CO Number	CO Statement	Knowledge Level
CO1	Compute the Solutions of First Order Homogeneous Equations by using Different Methods.	**K3**
CO2	Solve the Linear System Of Homogeneous Equations And Compute the Solutions Of Initial Value Problems using Picard's Method Of Successive Approximations.	**K3**
CO3	Diagnose the Functions of Gauss Hyper Geometric, Bessel's and Legendre Polynomials.	**K4**
CO4	Discriminate the Qualitative Properties of Solutions for Boundary Value Problems by Using Sturm Theorems.	**K4**
CO5	Analyze the Stability Nature Of Linear and Non-Linear System	**K4**

Mapping Programme with Outcomes:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**M**	**S**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**

S – Strong, M – Medium, L - Low

CORE COURSE – III (CC)

Title of the course: INTEGRAL EQUATIONS, CALCULUS OF VARIATIONS AND TRANSFORMS

L	T	P	C
90	6	-	5

Course Code: 19PMA1CC3

Syllabus:

UNIT I

Calculus of variations and applications: Maxima and Minima – The simplest case – Illustrative examples - Natural boundary conditions and transition conditions – The Variational notation – The More general case – constraints and Lagrange multipliers – variable end points – Sturm-Liouville problems.

UNIT – II

Fourier transforms: Dirichlet's conditions – Fourier series – Fourier's Integral formula – Fourier transform or complex Fourier transform – Inversion theorem for complex Fourier transform – Fourier sine transform - Inversion formula for Fourier sine transform - Fourier cosine transform - Inversion formula for Fourier cosine transform – Linearity property of Fourier transform – Change of scale property – Shifting Property – Modulation Theorem – Multiple Fourier transforms - Convolution - The convolution or Falting theorem for Fourier transforms - Parseval's identity for transforms – Relationship between Fourier and Laplace transforms – Fourier transform of the derivatives of a function – Problems related to integral equations - Finite Fourier transforms - Finite Fourier sine transforms - Inversion formula for sine transform – Finite Fourier cosine transform - Inversion formula for cosine transform – Multiple finite Fourier transform – Operational properties of finite Fourier sine transforms - Operational properties of finite Fourier cosine transforms - Combined properties of finite Fourier sine and cosine transforms – Convolution.

UNIT III

Hankel Transforms: Definition – Inverse formula – Some important results for Bessel function – Linearity property – Hankel Transform of the derivatives of the function – Hankel Transform of differential operators – Parseval's Theorem

UNIT IV

Definition, Regularity Conditions – Special Kind of Kernels – Eigen values and Eigen functions – Convolution Integral – The Inner or Scalar Product of Two Functions – Notation – Integral Equations with Separable Kernals : Reduction to a System of Algebraic Equations – Examples– Fredholm Alternative - Examples – An Approximate Method – Fredholm Integral Equation of the First Kind.

UNIT V

Method of Successive Approximations: Iterative Scheme – Examples – Volterra Integral Equation – Examples – Some Results about the Resolvent Kernel - Classical Fredholm Theory: The Method of Solution of Fredholm – Fredholm's First Theorem – Examples – Fredholm's Second Theorem – Fredholm's Third Theorem.

Text Books:

[1]. Francis.B. Hildebrand, Methods of Applied Mathematics, Prentice – Hall of India Pvt Ltd. New Delhi,1972.

[2]. A.R.Vasishtha & R.K. Gupta, Integral Transforms, Krishna Prakashan Media Pvt Ltd, 2002.

[3]. Ram.P.Kanwal, Linear Integral Equations, Academic Press, U.S.A, 1971

Chapters and Sections:

UNIT I Chapter 2: Section 2.1 – 2.9 [1]
UNIT II Chapter 6: Section 6.1 – 6.20 [2]
Chapter 7: Section 7.1 – 7.9 [2]
UNIT III Chapter 9: Section 9.1 – 9.7 [2]
UNIT IV Chapter 1: Section 1.1 – 1.7 [3]
Chapter 2: Section 2.1 – 2.6 [3]
UNIT V Chapter 3: Section 3.1 – 3.5 [3]
Chapter 4: Section 4.1 – 4.5 [3]

Reference Books:

[1]. A.S.Gupta, Calculus of variations with Applications, Prentice Hall of India Private Limited, New Delhi, 2006.
[2]. M.D.Raisinghania, Integral Equations and Boundary Value problems, S.chand & Company Ltd, New Delhi, 2007.
[3]. P.P.Gupta and Sunjay Gupta, Integral Transforms, Kedarnath RamNath , Meerut, 2003.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Apply the concepts of calculus of variations to find the maxima and minima of quantities defined as integrals containing unknown functions.	K3
CO2	Classify various kinds of Fourier sine and cosine transforms with their properties and simple problems.	K3
CO3	Examine some of Hankel transform and its inverse transform.	K4
CO4	Determine the solution of Integral equations.	K4
CO5	Evaluate the integral equations by the method of successive approximations.	K5

Mapping with Programme Outcomes

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	S
CO2	S	S	S	S	S	S
CO3	S	S	S	S	S	S
CO4	S	S	S	S	S	S
CO5	S	S	S	S	S	S

S- Strong; M-Medium; L-Low

CORE COURSE – IV (CC)

Title of the Course: ALGEBRAIC NUMBER THEORY

Course Code: 19PMA1CC4

L	T	P	C
90	6	-	5

Syllabus:

UNIT I

Introduction – Divisibility – Primes – The Binomial Theorem – Congruences – Solutions of congruences – The Chinese Remainder theorem.

UNIT II

Techniques of numerical calculations – Public key cryptography – Prime power Moduli – Prime Modulus – Primitive roots and Power Residues – Congruences of degree two, Prime Modulus.

UNIT III

Quadratic Residues – Quadratic Reciprocity – The Jacobi Symbol .

UNIT IV

Binary Quadratic Forms – Equivalence and Reduction of Binary Quadratic Forms – Sums of three squares – Greatest integer Function – Arithmetic Functions – The Mobius Inversion Formula – Recurrence Functions.

UNIT V

The equation $ax+by = c$ – Simultaneous Linear Equations – Pythagorean Triangles – Assorted examples.

Text Books:

[1] Ivan Niven, Herbert S.Zuckerman, Hugh L.Montgomery, An Introduction to the theory of numbers, John Wiley &Sons, Inc, 2004.

Chapters and Sections:

UNIT I Chapter 1 : Section 1.1 -1.4
Chapter 2 : Section 2.1 - 2.3
UNIT II Chapter 2 : Section 2.4 - 2.9

UNIT III Chapter 3: Section 3.1 - 3.3

UNIT IV Chapter 3: Section 3.4 - 3.6
Chapter 4: Section 4.1 - 4.4
UNIT V Chapter 5: Section 5.1 - 5.4

Reference Books:

[1]. David M. Burton, Elementary Number Theory, Tata McGraw Hill Education Private

Limited, NewDelhi, 2012.
[2] . Melvyn B.Nathanson, Methods in Number Theory, Springer-Verlag Newyork, Inc, 2005.
[3] . S.G.Telang, Number Theory, Tata McGraw Hill Education Private Limited, NewDelhi, 2005.

Course Outcomes:

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

CO Number	CO Statement	Knowledge Level
CO1	Apply the concepts of divisibility, primes, congruence and derive Binomial, Euler, Fermat, Wilson and the Chinese remainder theorems.	**K3**
CO2	Discriminate the techniques of numerical calculations, primitive roots and power residues.	**K4**
CO3	Diagnose Number theory from an algebraic viewpoint and compute Legendre and Jacobi symbols.	**K4**
CO4	Reduce the different types of Binary quadratic forms and derive the Mobius Inversion Formula.	**K4**
CO5	Determine the solutions of simultaneous linear Diophantine equations and Pythagorean triangles.	**K4**

Mapping with Programme Outcomes

CO's/PO's	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	M
CO2	S	S	S	S	S	M
CO3	S	S	S	S	S	M
CO4	S	M	M	S	S	M
CO5	S	S	S	S	S	M

S – Strong, M – Medium, L – Low

CORE COURSE –V (CC)

Title of the Course: DISCRETE MATHEMATICS

Course Code: 19PMA1CC5

L	T	P	C
90	6	-	5

Syllabus:

Unit I – Grammars, Languages and Automaton

Grammars and Languages - Finite Automaton or Finite State Acceptors - Finite Automaton and Regular Languages, Regular Expressions.

Unit II – Graph Theory: Basic Results

Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness.

Connectivity: Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity - Blocks - Cyclical Edge Connectivity of a Graph.

Unit III - Independent Sets and Matchings

Vertex Independent Sets and Vertex Coverings - Edge Independent Sets - Matchings and Factors - Matchings in Bipartite Graphs.

Graph Colorings: Vertex Coloring - Critical Graphs - Triangle - Free Graphs - Edge Colorings of Graphs.

Unit IV – Planarity

Planar and Nonplanar Graphs - Euler Formula and its Consequences - K_5 and $K_{(3,3)}$ are Nonplanar Graphs - Dual of a Plane Graph - The Four-Color Theorem and the Heawood Five-Color Theorem - Kuratowski's Theorem.

Unit V - Cryptography

Some Simple Cryptosystems - Enciphering Matrices.

Public Key: The idea of Public Key Cryptography - RSA - Discrete log.

Text Books:

[1] RM.Somasundaram, Discrete Mathematical Structures, PHI, Learning Private Limited, 2009.

[2] R. Balakrishnan & K. Ranganathan, A Textbook of Graph Theory, Springer, 2008.

[3] Neal Koblitz, A Course in Number Theory & Cryptography, Springer, 2006.

Chapters and Sections:

UNIT I Chapter 7 : 7.1-7.3 [1]
UNIT II Chapter I : Section 1.1-1.4 & Chapter III: Section 3.1-3.4 [2]
UNIT III Chapter V : Section 5.1-5.4 & Chapter VII : Section 7.1-7.4 [2]

UNIT IV Chapter VIII: Section 8.1-8.6 [2]
UNIT V Chapter III: Section 1 & 2 [3] & Chapter IV: Section 1-3 [3]

Reference Books:

[1] J.P.Tremblay & R.Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, 2011.

[2] J.A. Bondy, U.S.R. Murty, Graph Theory, Springer, 2013.

[3] Douglas R.Stinson, Cryptography: Theory and Practice, Chapman & Hall/CRC, Second Edition, 2005.

Course Outcomes:

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

CO Number	CO Statement	Knowledge Level
CO1	Classify grammars and languages with its types.	**K3**
CO2	Classify the various types of graphs.	**K3**
CO3	Compute the Graph Colourings and related theorems.	**K3**
CO4	Ascertain the meaning of Vertex Cuts, Edge Cuts, Connectivity and related theorems.	**K4**
CO5	Access the details of Planar and Non-Planar graphs, Dual of a Plane graph.	**K5**
CO6	Apply the concepts of cryptography using matrices	**K3**
CO7	Develop the idea of Public key cryptography by RSA cryptosystem	**K6**

Mapping with program outcomes:

COS\POS	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**M**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**M**	**S**	**S**
CO5	**M**	**S**	**S**	**S**	**S**	**S**
CO6	**S**	**S**	**S**	**S**	**S**	**M**
CO7	**S**	**S**	**S**	**M**	**S**	**S**

S – Strong, M – Medium, L – Low.

CORE COURSE - VI(CC)

Title of the Course: ALGEBRA-II
Course Code: 19PMA2CC6

L	T	P	C
90	6	-	5

Objectives

- To understand the fundamentals in algebraic structures.
- To motivate the students how to compute using algebraic structures for research.
- To familiarize the fundamentals in Galois group.

Syllabus:

Unit I:

Prime Ideals and Maximal Ideals - Irreducible Polynomials

Unit II:

Classical Formulas - Splitting Fields.

Unit III:

The Galois Group - Roots of Unity - Solvability by Radicals

Unit IV:

Independence of Characters - Galois Extensions.

Unit V:

The Fundamental Theorem of Galois Theory – Applications – Galois's Great Theorem.

Text Books:

Joseph Rotman, Galois Theory, 2nd Edition, Springer Verlag, 2006.

Chapters and Sections

UNIT I Pages 31- 43.
UNIT II Pages 44-58.
UNIT III Pages 59-75.
UNIT IV Pages 76-82.
UNIT V Pages 83-95.

Reference Books:

[1] David S. Dummit and Richard M.Foote, Abstract Algebra, Wiley and Sons, Third Edition, 2004.
[2] John B. Fraleigh, A First Course in Abstract Algebra, Narosa Publishing House, Third edition,1992.
[3]I.N.Herstein, Topics in Algebra, John Wiley, 2nd Edition, 1975.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Analyse the important concepts of Prime ideal and maximal ideal and identify them in various examples.	K4
CO2	Predict the notions principal ideal domain and unique factorization domains and their connections with Euclidean domain.	K3
CO3	Examine the proof of solvability by Radicals.	K4
CO4	Evaluate clear cut idea in the notions of Galois groups,normal extensions and separable extensions and illustrate them with various examples.	K5
CO5	Learn Galois correspondence and give a proof of fundamental theorem of algebra. Able to conclude the proof of Fundamental theorem of Galois theory.	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**M**	**S**	**S**	**S**
CO2	**M**	**S**	**S**	**S**	**S**	**S**
CO3	**M**	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**S**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**S**	**S**

S - Strong , M - Medium , L - Low

CORE COURSE – VII (CC)

Title of the Course: REAL ANALYSIS – I

Course Code: 19PMA2CC7

L	T	P	C
90	6	-	5

Objectives

- To study the basic concepts of real analysis.
- To comprehend the qualitative aspects of real analysis in the setting of metric spaces.
- To give an in-depth knowledge of the intrinsic geometric ideas through completeness, connectedness of metric spaces.

Syllabus:

UNIT I

Sets and Functions – Mathematical Induction – Finite and Infinite Sets – The Algebraic and Order Properties of $\mathbb{R}$ - Absolute value and Real line – Completeness property of $\mathbb{R}$ - Applications of the Supremum Property – Intervals.

UNIT II

Metric Spaces – Definition and Examples – Open Balls and Open Sets.

UNIT III

Sequences and their Limits – Limit Theorems – Monotone Sequences – Subsequences and Bolzano – Weierstrass Theorem – The Cauchy Criterion – Properly Divergent Sequences – Introduction to Series – Convergent Sequences – Limit and Cluster Points – Cauchy Sequences and Completeness – Bounded Sets – Dense Sets.

UNIT IV

Continuous Functions – Combinations of Continuous Functions – Continuous Functions on Intervals – Uniform Continuity – Monotone and Inverse Functions – Compact Spaces and their Properties – Continuous Functions on Compact Spaces – Characterization of Compact Metric Spaces – Arzela- Ascoli Theorem.

UNIT V

Connected Spaces – Complete Metric Spaces: Examples of Complete Metric Spaces – Completion of a Metric Space – Baire Category Theorem – Banach's Contraction Principle.

Text Books:

[1] Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, 3rd Edition, John Wiley & Sons Private Limited, 2007.

[2] S. Kumaresan, Topology of Metric Spaces, 2nd Edition, Narosa Publishing House, 2014.

Chapters and Sections:

UNIT I Chapter 1: Section 1.1 – 1.3 [1]
Chapter 2: Section 2.1 – 2.5 [1]

UNIT II Chapter 1: Section 1.1 & 1.2 [2]

UNIT III Chapter 3: Section 3.1 – 3.7 [1]
Chapter 2: Section 2.1 – 2.5 [2]

UNIT IV Chapter 5: Section 5.1 – 5.4, 5.6 [1]
Chapter 4: Section 4.1 – 4.4 [2]

UNIT V Chapter 5: Section 5.1 [2]
Chapter 6: Section 6.1 – 6.4 [2]

Reference Books:

[1] Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Book Company, 1976.
[2] Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, 2002.
[3] H.L. Royden, Real Analysis, PHI Learning Private Limited, 2009.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Apply the fundamental concepts such as sets and functions in various problems.	K3
CO 2	Discriminate the basic concepts in metric spaces geometrically.	K4
CO 3	Ascertain the notion of convergence of sequences and some related theorems.	K4
CO 4	Distinguish the concept of continuity of functions and uniform continuity.	K4
CO 5	Diagnose the ideas of metric topology connecting compactness and continuity and connectedness and continuity.	K4
CO 6	Evaluate various important problems using the Banach contraction principle.	K5

Mapping with Programme Outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	S
CO2	S	S	S	M	S	S
CO3	S	S	M	S	S	S
CO4	S	S	S	S	S	S
CO5	S	M	M	S	S	S
CO6	S	S	M	M	S	S

S – Strong, M – Medium, L – Low.

CORE COURSE - VIII(CC)

Title of the Paper: LINEAR ALGEBRA

L	T	P	C
90	6	-	5

Course Code: 19PMA2CC8

Objective

- To enable the students with thorough knowledge of the various aspects of Linear Algebra
- To make the students to solve the problems for competitive exams.
- To ensure the students to interpret the concepts of Linear Algebra with real life situations.

Syllabus:

UNIT I:

Linear Equations: Fields - Systems of linear Equations - Matrices and Elementary Row operations - Row-reduced echelon Matrices - Matrix Multiplication - Invertible Matrices - **Vector Spaces**: Vector spaces -Subspaces - Bases and Dimension.

Unit II:

Linear Transformations: Linear Transformations - The Algebra of Linear Transformations – Isomorphism - Representation of Transformations by Matrices - Linear Functionals.

Unit III:

Polynomials: Algebras - The Algebra of Polynomials - Lagrange Interpolation - Polynomial Ideals -The Prime Factorization of a Polynomial.

Unit IV:

Determinants: Commutative Rings - Determinant Functions- Permutations and the Uniqueness of Determinants –Additional Properties of Determinants - Modules.

Unit V:

Elementary Canonical Forms: Introduction – Characteristic Values – Annihilating Polynomials - Invariant subspaces - Simultaneous Triangulation; Simultaneous Diagonalization- Direct-Sum Decompositions - Invariant Direct sums – The Primary Decomposition Theorem.

Text book:

[1] Linear Algebra, Second Edition, Kenneth Hoffman and Ray Kunze, PHI Learning Private Limited, New Delhi, 2009.

UNIT I Chapter 1 : Section 1.1 -1.6

Chapter 2 : Section 2.1 - 2.3

UNIT II Chapter 3 : Section 3.1 - 3.5

UNIT III Chapter 4 : Section 4.1 – 4.5

UNIT IV Chapter 5 : Section 5.1 - 5.5

UNIT V Chapter 6 : Section 6.1 - 6.8

Reference Books:

[1] Linear Algebra : A Geometric Approach, S. Kumaresan, Prentice-Hall of India Pvt., Ltd., New Delhi, 2000.

[2] An Introduction to Linear Algebra, V. Krishnamurthy, V.P. Mainra, J.L. Arora, East West Press Pvt., Ltd., 1976.

[3] An Introduction to Linear Algebra, Arnold Insel and Lawrence Spence, Prentice Hall of India Pvt., Ltd., 2004.

Course outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Relate the basic terminologies, principles and methods in Vector Spaces.	K3
CO2	Apply algebra of linear transformation, Linear Functionals, the Double Dual and Transpose of Linear Transformation.	K3
CO3	Analyze mathematical proof techniques to prove or disprove certain claims in determinant functions and Modules.	K4
CO4	Assess Characteristic Values with triangulation Diagonalization, Direct sum decomposition and Primary decomposition.	K5
CO5	Integrate Lagrange's Interpolation, polynomial ideals and prime factorization of a polynomial.	K6

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	S
CO2	M	S	S	M	S	S
CO3	S	M	S	S	M	S
CO4	S	S	M	M	S	S
CO5	S	S	S	S	M	S

S – Strong; M – Medium; L – Low

CORE COURSE - IX (CC)

Title of the Course: TOPOLOGY
Course Code: 19PMA2CC9

L	T	P	C
90	6	-	5

Objectives

- To study the concepts concerned with properties that are preserved under continuous deformations of objects.
- To train the students to develop analytical thinking and the study of continuity and connectivity.
- To motivate for research in real life challenging problems.

Syllabus:

UNIT I
Topological Spaces:

Topological Spaces - Basis for a Topology - The Order Topology - The Product Topology on X x Y - The Subspace Topology - Closed Sets and Limit Points.

UNIT II
Continuous Functions :

Continuous Functions - The Product Topology - The Metric Topology.

UNIT III
Connectedness:

Connected Spaces- Connected Subspaces of the Real line - Components and Local Connectedness.

UNIT IV
Compactness:

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

UNIT V
Countability and Separation Axioms:

The Countability Axioms - The Separation Axioms - Normal Spaces - The Urysohn Lemma - The Urysohn Metrization Theorem - The Tietze Extension Theorem.

Text Books:

[1] James R. Munkres , Topology(2^{nd} Edition), Pearson Education Pvt.Ltd.,2002.

Chapters and Sections:
UNIT I Chapter 2 : Section 12-17
UNIT II Chapter 2 : Section 18-21(OMIT SEC 22)
UNIT III Chapter 3 : Section 23-25

UNIT IV Chapter 3 : Section 26-29
UNIT V Chapter 4 : Section 30-35

Reference Books:

[1] M.G.Murdeshwar, General Topology, New Age International(P) Limited, 2008.
[2] George F.Simmons, Introduction to Topology and Modern Analysis , McGraw Hill Book co.., 1963.
[3] Sze-Tsen Hu, Introduction to General Topology , TATA McGraw-Hill Publishing Company Ltd,1979.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Classify the topological spaces .	K3
CO 2	Apply the concept of Continuous functions in Product Topology and Metric Topology.	K3
CO 3	Prepare the consequences of Connected Spaces of the real line.	K3
CO 4	Assess the details of Compact Spaces of the real line.	K5
CO 5	Compose a study of Countability and Separation Axioms.	K6

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**S**	**S**	**S**	**M**
CO2	**S**	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**M**	**M**
CO5	**S**	**S**	**S**	**S**	**M**	**M**

S-Strong , M-Medium , L-Low

ELECTIVE COURSE – I (A) - (EC)

Title of the Course: PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
90	6	-	3

Course Code: 19PMA2EC1A

Objectives:

- To give an in-depth knowledge of solving partial differential equations.
- To allow them in deterministic mathematical formulations of phenomena in scientific and engineering problems.
- To study the other aspects of PDE.

Syllabus:

UNIT I

Partial Differential Equations Of The First Order: Partial Differential Equations - Origins of First-order Partial Differential Equations - Cauchy's Problem for First-order Equations - Linear Equations of the First Order - Integral Surfaces Passing through a Given Curve - Surfaces Orthogonal to a Given System of Surfaces - Nonlinear Partial Differential Equations of the First Order.

UNIT II

Cauchy's Method of Characteristics - Compatible Systems of First-order Equations –Charpit's Method - Special Types of First-order Equations - Solutions Satisfying Given Conditions - Jacobi's Method.

UNIT III

Partial Differential Equations of the Second Order: The Origin of Second-order Equations – Second-order Equations in Physics – Higher-order Equations in Physics - Linear Partial Differential Equations with Constant Coefficients - Equations with Variable Coefficients - Characteristic Curves of Second-order Equations .

UNIT IV

Characteristics of Equations in Three Variables - The Solution of Linear Hyperbolic Equations - Separation of variables - The Method of Integral Transforms – Nonlinear Equations of the Second Order.

UNIT V

Laplace's Equation: Elementary Solutions of Laplace's Equation - Families of Equipotential Surfaces - Boundary Value Problems - Separation of Variables – Problems with Axial Symmetry.

Text Book:

[1] Ian N. Sneddon, Elements of Partial Differential Equations, Dover Publication – INC. Mineola, Newyork, 1957.

Chapters and Sections:

UNIT I	Chapter 2:	Sections 1 to 7
UNIT II	Chapter 2:	Sections 8 to 13
UNIT III	Chapter 3:	Sections 1 to 6
UNIT IV	Chapter 3:	Sections 7 to 11
UNIT V	Chapter 4:	Sections 2 to 6

Reference(s):

[1] M.D.Raisinghania, Advanced Differential Equations, S.Chand and Company Ltd., NewDelhi, 2001.

[2] T.Amarnath, Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi, 2003.

[3] Sauvigny, Friedrich, A Partial Differential Equations 2: Functional Analytic Methods, , Springer, Arizona, 2006.

Course Outcomes:

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

CO Number	CO Statement	Knowledge Level
CO1	Compute the solutions of linear and non-linear partial differential equations using various Methods.	**K3**
CO2	Determine the solutions of first order equations using the methods of Cauchy's, Charpit's and Jacobi's.	**K4**
CO3	Diagnose the characteristics of the second order partial differential equations with constant and variable coefficients.	**K4**
CO4	Discriminate the solutions of linear hyperbolic equations in three variables and non-linear equations of the second order.	**K4**
CO5	Ascertain the concepts of Laplace equation to find the solution of boundary value problems.	**K4**

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**M**	**S**	**S**	**S**
CO3	**S**	**S**	**M**	**S**	**S**	**S**
CO4	**S**	**M**	**M**	**S**	**S**	**S**
CO5	**S**	**S**	**M**	**S**	**S**	**S**

S – Strong; M – Medium; L – Low

ELECTIVE COURSE – I (B) - (EC)

Title of the Course: DIFFERENCE EQUATIONS
Course Code: 19PMA2EC1B

L	T	P	C
90	6	-	3

Objectives

- To examine linear difference equations of high order.
- To introduce the results of oscillation for linear difference equations.
- To extend them to nonlinear difference equations.

SYLLABUS:

Unit I – Linear Difference Equations of Higher Order

Difference Calculus - General Theory of Linear Difference Equations - Linear Homogeneous Equations with Constant Coefficients

Nonhomogeneous Equations: Method of Undetermined coefficients – Limiting behavior of solutions.

Unit II – System of Linear Difference Equations

Autonomous Systems – the Basic Theory

The Jordan form: Autonomous Systems Revisited – Linear Periodic systems.

Unit III - The Z-Transform Method and Volterra Difference Equations

Definition and Examples – The Inverse Z-transform and solutions of Difference Equations – Power series method, partial fraction method, the inverse integral method

Volterra Difference Equations of convolution types: Volterra Systems.

Unit IV – Oscillation Theory

Three-Term Difference Equations – Self-Adjoint Second- Order Equations - Nonlinear Difference Equations.

Unit V - Asymptotic Behavior of Difference Equations

Tools and Approximation – Poincare's theorem – Asymptotically Diagonal Systems – High-Order Difference Equations - Second-Order Difference Equations.

Text Books:

[1] Saber N elaydi, An Introduction to Difference Equations, Springer Verlag, New York, 2004.

Chapters and Sections

UNIT I Chapter 2 : Section 2.1-2.5 [1]

UNIT II Chapter 3 : Section 3.1-3.4 [1]

UNIT III Chapter 6 : Section 6.1-6.3 & 6.5 [1]
UNIT IV Chapter 7: Section 7.1-7.3 [1]
UNIT V Chapter 8: Section 8.1-8.5 [1]

Reference Books:

[1] V.Lakshmi Kantham & Triginate, Theory of Difference Equations, Academic press, Newyork, 1988.

[2] Peterson, A difference Equations, an Introduction with applications, Academic press, Newyork, 1991.

[3] S.Goldberg, Introduction to Difference Equations, Dover Publications, 1986.

Course Outcomes:

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

CO Number	CO Statement	Knowledge Level
CO1	Examine linear difference equations of high order.	**K4**
CO2	Prepare to deal with systems of two or more dependent variables.	**K3**
CO3	Reduce the study of a linear difference or differential equation to examination of an associated complex function.	**K4**
CO4	Criticize the solutions oscillate around zero or eventually positive or eventually negative.	**K5**
CO5	Compile the basic results of oscillation for three-term linear difference equations.	**K6**
CO6	Extend at these results to nonlinear difference equations.	**K6**
CO7	Modify to oscillation theory for self-adjoint equations.	**K6**

Mapping with program outcomes:

COS\POS	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**M**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**M**	**S**	**S**
CO5	**M**	**S**	**S**	**S**	**S**	**S**
CO6	**S**	**S**	**S**	**S**	**S**	**M**
CO7	**S**	**S**	**S**	**M**	**S**	**S**

S – Strong, M – Medium, L – Low.

CORE COURSE – X (CC)

Title of the Course: REAL ANALYSIS – II
Course Code: 19PMA3CC10

L	T	P	C
90	6	-	5

Objectives

- To study the powerful tool of maxima-minima in calculus using mean value theorems.
- To study the concept of convergence of sequences and series of functions.
- To acquire the knowledge of the theory of multivariable calculus.

Syllabus

UNIT I

Differentiation of single variable: Derivatives – The chain rule – local extrema –Rolle's theorem – Mean Value Theorem – Taylor's formula – Derivatives of vector – valued functions – Functions of Bounded variation and rectifiable curves – Total variation –Functions of bounded variation – Equivalence of paths – Change of parameter.

UNIT II

Riemann-Stieltjes integral: Definition – linear properties of the integral – Necessary conditions for the existence - First fundamental theorem of Integral calculus - Mean Value Theorems for integrals – Second fundamental theorem of Integral calculus- Change of variable in a Riemann integral – Second Mean value Theorem for Riemann.
integrals

UNIT III

Sequence and series of functions – Point wise convergence – Uniform convergence – Uniform convergence and integration – Uniform convergence and Differentiation -Sufficient conditions for uniform convergence of a series.

UNIT IV

Functions of Severable variables – Directional derivative –Total derivative – Jacobian – Chain rule –Mean Value Theorem – Taylor's formula.

UNIT V

Inverse function theorem – Implicit function theorem – Extremum problems with side conditions.

Text Book

Tom M. Apostol, Mathematical Analysis, 2nd edition, Narosa Publishing House, 2002.

Chapters and Sections

UNIT I: Chapter 5 – Sections 5.1 – 5.5, 5.9 – 5.11
Chapter 6 – Sections 6.3 – 6.12
UNIT II: Chapter 7 –Sections 7.1 – 7.22
UNIT III: Chapter 9 Sections 9.1 – 9.6, 9.8 – 9.11, 9.14, 9.15
UNIT IV: Chapter 12 – Sections 12.1 – 12.11, 12.14
UNIT V: Chapter 13 – Sections 13.1 – 13.7

Reference Books

1.
2. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, John Wiley & Sons Private Limited, 2007.
3. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Publishing Company, 1976.
4. H.L. Royden, Real Analysis, PHI Learning Private Limited, 2009.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Apply the concepts of derivatives, the mean-value theorem in various problems.	**K3**
CO 2	Classify the functions of bounded variations and rectifiable paths.	**K3**
CO 3	Ascertain the notion of Riemann-Stieltjes integral.	**K4**
CO 4	Diagnose the concept of convergence of sequences and series of functions.	**K4**
CO 5	Discriminate the fundamentals of multivariable calculus, directional derivative, total derivative of functions and jacobian matrix.	**K4**
CO 6	Evaluate extremum problems using implicit function theorem.	**K5**

Mapping with Programme Outcomes

Cos / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	M	S	S
CO2	S	S	M	M	S	S
CO3	S	S	M	S	S	S
CO4	S	S	S	S	S	S
CO5	S	S	S	M	S	S
CO6	S	S	M	S	S	S

S – Strong, M – Medium, L – Low.

CORE COURSE – XI (CC)

Title of the Course: MEASURE AND INTEGRATION

Course Code: 19PMA3CC11

L	T	P	C
90	6	-	5

Objectives

- To introduce the concepts of measure and integral with respect to measure.
- To show that their basic properties.
- To provide a basis for further study in Analysis.

Syllabus:

UNIT I

Measure on Real line - Lebesgue outer measure - Measurable sets - Regularity - Measurable function - Borel and Lebesgue measurability.

UNIT II

Integration of non-negative functions - The General integral - Integration of series - Riemann and Lebesgue integrals.

UNIT III

Abstract Measure spaces - Measures and outer measures - Completion of a measure - Measure spaces - Integration with respect to a measure.

UNIT IV

Convergence in Measure- Almost uniform convergence- Signed Measures and Halin Decomposition –The Jordan Decomposition

UNIT V

Measurability in a Product space – The product Measure and Fubini's Theorem.

Text Book:

[1].G.De Barra,Measure Theory and Integration,New age international (p) Limited,2003

Chapters and Sections:

UNIT I Chapter 2: Section 2.1 – 2.5
UNIT II Chapter 3: Section 3.1 – 3.4
UNIT III Chapter 5: Section 5.1 – 5.6
UNIT IV Chapter 7: Section 7.1 & 7.2
Chapter 8: Section 8.1 & 8.2
UNIT V Chapter 10: Section 10.1 & 10.2

Reference Books:

[1].M.E. Munroe, Measure and Integration,Addison - Wesley Publishing Company, Second Edition,1971.

[2].P.K. Jain, V.P. Gupta,Lebesgue Measure and Integration,New Age International Pvt Limited Publishers, New Delhi, 2000.
[3]. Richard L. Wheeden and Antoni Zygmund,Measure and Integral: An Introduction to Real Analysis,Marcel Dekker Inc, 1977.
[4]. Inder, K. Rana, An Introduction to Measure and Integration,Narosa Publishing House,

New Delhi,1997.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO1	Classify the convergence in measures.	K3
CO2	Ascertain the various aspects of Lebesgue measure.	K4
CO3	Distinguish the relation between Riemann and Lebesgue integral.	K4
CO4	Examine about measure space and compute the integration with respect to the measure.	K4
CO5	Diagnose the measurability in product space.	K4
CO6	Evaluate the integration of non-negative functions and series.	K5
CO7	Appraise the signed measures by decomposition.	K5

Mapping with Programme Outcomes

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	M	M	M
CO2	S	M	S	M	M	M
CO3	S	S	S	S	S	S
CO4	S	S	S	S	S	S
CO5	S	S	S	M	M	M
CO6	S	S	S	S	M	M
CO7	S	S	S	S	M	M

S – Strong , M – Medium, L– Low

CORE COURSE –XII (CC)

Title of the Course: ANALYTICAL SKILLS FOR COMPETITIVE EXAMINATIONS

L	T	P	C
90	6	-	5

Course Code: 19PMA3CC12

Objectives

- To study the concepts concerned with linear properties that are preserved under continuous deformations of objects.
- To train the students to develop analytical thinking and the study of continuity and connectivity
- To motivate the advance treatment of theory at a fairly understandable level.

Syllabus:

UNIT I
Vector Spaces:

Vector Spaces – Subspaces – Linear dependence – Basis – Dimension – Algebra of linear transformations.

UNIT II
Linear transformation and Its Properties :

Algebra of matrices – Rank and Determinant of matrices – Linear equations

UNIT III
Matrices and their Properties:

Eigenvalues - Eigenvectors – Cayley –Hamilton theorem – Matrix representation of linear transformations – Change of basis.

UNIT IV
Diagonalizability and Canonical Forms:

Canonical forms – Diagonal forms – Triangular forms –Jordan forms.

UNIT V
Inner Product Spaces and Bilinear Form and Quadratic Form:

Inner product spaces – Ortho normal basis – Quadratic forms –Reduction and Classification of Quadratic forms.

Text Books:

[1] A.R.Vasistha, Linear Algebra, Krishna Prakashan media(P) ,2006.

[2] Stephen.H, Friedberg , Linear Algebra, Prentice Hall of India Pvt Ltd, 2004.

[3] S.Kumaresan, Linear Algebra: A Geometric Approch , Prentice hall, 2000.

[4] Seymour Lipschutz , Marc Lipson , Schaum's outlines- Linear Algebra ,Mcgraw Hill Education,third edition

[5] Krishnamurthy , Introduction to linear Algebra, Mainra V P and Arora JL, New Delhi 1976.

Reference Books:

[1] Roger A.Horn Charles R.Jhonson, Matrix Analysis, New Age International(P) Limited, 2008.
[2] Dr.Sudhir kumar Pundir, A Competitive Approach to Linear Algebra , CBS Publishers, 2019.
[3] Kenneth Hoffman and R. Kunze: Linear Algebra,Prantice Hall India , 2nd Edition

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Classify the vector spaces .	K3
CO 2	Apply the concept of linear transformations.	K3
CO 3	Prepare the consequences of Matrices.	K3
CO 4	Explain the Diagonalizability and Canonical Forms.	K4
CO 5	Choose the basis in innerproduct space.	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**S**	**S**	**S**	**M**
CO2	**S**	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**M**	**M**
CO5	**S**	**S**	**S**	**S**	**M**	**M**

S-Strong , M-Medium , L-Low

ELECTIVE COURSE – II (A) - (EC)

Title of the Course: COMPUTATIONAL NUMERICAL ANALYSIS

L	T	P	C
90	6	-	3

Course Code: 19PMA3EC2A

Objectives

- To know the theory behind various numerical methods.
- To apply these methods to solve mathematical problems.
- To train the students to develop analytical thinking and the study of stability analysis.

Syllabus:

Unit I

Transcendental and polynomial equations: Rate of convergence – Secant Method, Regula Falsi Method, Newton Raphson Method, Muller Method and Chebyshev Method. Polynomial equations: Descartes' Rule of Signs - Iterative Methods: Birge-Vieta method, Bairstow's method. Direct Method: Graeffe's root squaring method.

Unit II

System of Linear Algebraic equations and Eigen Value Problems: Error Analysis of Direct methods – Operational count of Gauss elimination, Vector norm, Matrix norm, Error Estimate. Iteration methods - Jacobi iteration method, Gauss Seidel Iteration method, Successive Over Relaxation method - Convergence analysis of iterative methods, Optimal Relaxation parameter for the SOR method. Finding Eigen values and Eigen vectors – Jacobi method for symmetric matrices and Power methods only.

Unit III

Interpolation and Approximation: Hermite Interpolations, Piecewise and Spline Interpolation – piecewise linear interpolation, piecewise quadratic interpolation, piecewise cubic interpolation, spline interpolation-cubic Spline interpolation. Bivariate Interpolation-Lagrange Bivariate interpolation.

Unit IV

Differentiation and Integration: Numerical Differentiation – Optimum choice of Step length – Extrapolation methods – Partial Differentiation. Numerical Integration: Methods based on undetermined coefficients - Gauss Legendre Integration method and Lobatto Integration Methods only.

Unit V

Ordinary differential equations – Singlestep Methods- Local truncation error or Discretization Error, Order of a method, Taylor Series method, Runge-Kutta methods: Explicit Runge–Kutta methods– Minimization of Local Truncation Error, System of Equations, Implicit Runge-Kutta methods. Stability analysis of single step methods (RK methods only).

Text Book:

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

Chapters and Sections:

UNIT I Chapter 2 : Section 2.5 & 2.9
UNIT II Chapter 3 : Section 3.3- 3.5, 3.7, 3.11
UNIT III Chapter 4 : Section 4.5 – 4.7

UNIT IV Chapter 5 : Section 5.2 - 5.5, 5.8
UNIT V Chapter 6 : Section 6.4 - 6.5

Reference Books:

[1] M.K. Jain, Numerical Solution of Differential Equations, New Age International Pvt Ltd., second edition, 1983
[2] Samuel. D. Conte, Carl. De Boor, Elementary Numerical Analysis, Mc Graw-Hill International Edn., 1988.
[3] Kendall E. Atkinson, An Introduction to Numerical Analysis, John Wiley & Sons, Second edition, 1989.

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

CO Number	CO Statement	Knowledge Level
CO1	Apply various methods to solve transcendental and polynomial equations	K3
CO2	Solve system of linear algebraic equations and Eigen value problems	K3
CO3	Classify the various techniques of interpolation and approximation	K3
CO4	Compute the integration and differentiation problems	K4
CO5	Determine the various methods to solve ordinary differential equations.	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**S**	**S**	**S**	**M**
CO2	**S**	**S**	**S**	**S**	**S**	**M**
CO3	**S**	**S**	**S**	**S**	**S**	**M**
CO4	**S**	**S**	**S**	**S**	**M**	**M**
CO5	**S**	**S**	**S**	**S**	**M**	**M**

S-Strong , M-Medium , L-Low

ELECTIVE COURSE – II (B) - (EC)

Title of the Course: FLUID DYNAMICS

Course Code: 19PMA3EC2B

L	T	P	C
90	6	-	3

Objectives

- To understand the dynamics of real fluids.
- To familiarize with the properties of fluids and the applications of fluid dynamics.
- To understand the concept of fluid measurement, types of flows and dimensional analysis.

SYLLABUS:

UNIT I

Real Fluids and Ideal Fluids – Velocity of a Fluid at a point – Streamlines and Path lines; Steady and Unsteady Flows – The Velocity potential – The Vorticity vector – Local and Particle Rates of Change – The Equation of continuity – Worked examples – Acceleration of a Fluid – Conditions at a rigid boundary – General analysis of fluid motion – Pressure at a point in a Fluid at Rest – Pressure at a point in a Moving Fluid – Conditions at a Boundary of Two Inviscid Immiscible Fluids – Euler's equations of motion – Bernoulli's equation – Worked examples.

UNIT II

Discussion of the case of steady motion under conservative body forces – Some potential theorems – Some Flows Involving Axial Symmetry – Some special two- Dimensional Flows – Impulsive Motion – Sources, Sinks and Doublets – Images in a Rigid Infinite Plane – Images in solid spheres – Axi-Symmetric Flows; Stokes's stream function.

UNIT III

Meaning of a Two-Dimensional Flow – Use of cylindrical Polar coordinates – The stream function – The Complex Potential for Two-Dimensional, Irrotational, Incompressible Flow – Complex velocity potentials for Standard Two-Dimensional Flows – Some worked examples – Two-Dimensional Image systems – The Milne-Thomson circle theorem – The Theorem of Blasius.

UNIT IV

The use of conformal Transformation – The Schwarz-Christoffel Transformation – Vortex rows – Stress components in a Real fluid – Relations between Cartesian components of stress – Translational Motion of Fluid Element – The Rate of Strain Quadric and Principal Stresses – Some Further properties of the Rate of Strain Quadric – Stress Analysis in Fluid Motion – Relations Between stress and rate of strain – The coefficient of viscosity and Laminar Flow – The Navier-Stokes equations of Motion of a Viscous Fluid.

UNIT V

Some solvable problems in Viscous Flow – Steady Viscous Flow in Tubes of Uniform cross section – Diffusion of Vorticity – Energy Dissipation due to Viscosity – Steady Flow past a Fixed Sphere Dimensional Analysis; Reynolds Number – Prandtl's Boundary Layer.

Text Books:

[1] F. Chorlton, Text Book of Fluid Dynamics, CBS Publishers & Distributors, New Delhi, 2004.

UNIT I Chapter 2 : Section 2.1-2.11
Chapter 3 : Section 3.1-3.6

UNIT II Chapter 3 : Section 3.7-3.12
Chapter 4 : Section 4.2-4.5

UNIT III Chapter 5 : Section 5.1-5.9

UNIT IV Chapter 5 : Section 5.10-5.12
Chapter 8 : Section 8.1-8.9

UNIT V Chapter 8 : Section 8.10-8.16

Reference Books:

[1] Md.Motiur Rahman, Hydrostatics, New central book agency, Private limited, 2009.

[2] J.H.Ferziger & M.Peric, Computational methods for fluid Dynamics, Springer, 3rd edition, 2005.

[3] M.Narayanamurti &N.Nagarathnam, Statics, Hydrostatics and Hydrodynamics, The National publishing co, Chennai, 2002.

Course Outcomes:

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

CO Number	CO Statement	Knowledge Level
CO1	Apply Euler's and Bernoulli's equations and the conservation of mass to determine velocities, pressures, and accelerations for incompressible and inviscid fluids.	**K3**
CO2	Apply Laplace equation and its relation to elementary plane flows of inviscid fluids: sinks, sources, vortex flows, and superposition of these flows.	**K3**
CO3	Compute the Navier - Stokes equations of Motion of a Viscous Fluid.	**K3**
CO4	Solve problems in Viscous Flow.	**K3**
CO5	Distinguish the concepts of rotational and irrotational flows of stream functions & velocity potentials.	**K4**
CO6	Analyze a variety of practical fluid-flow problems and utilize fluid dynamics principles.	**K4**

Mapping with programme outcomes:

COS\POS	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	M	S	M
CO2	S	S	M	S	M	S
CO3	M	S	M	S	M	S
CO4	M	M	S	S	S	M
CO5	S	S	S	S	M	S
CO6	S	M	S	M	S	M

*S – Strong, M – Medium, L – Low.

ELECTIVE COURSE – III (A) – (EC)

Title of the Course: PROBABILITY THEORY AND MACHINE LEARNING
Course Code: **19PMA3EC3A**

L	T	P	C
90	6	-	3

Objectives

- To deal with random variables.
- To introduce expectations, convergence in random variables and distribution functions.
- To understand about Bayesian models

Syllabus:

Unit I - Probability Space

Definition of probability – some simple properties – discrete probability space – General probability space – Induced probability space.

Unit II - Distribution functions

Distribution functions of a random variable –Decomposition of distributive functions- Distribution functions of vector random variables – Correspondence theorem.

Unit III - Expectation and Moments

Definition of Expectation –Properties of expectation – Moments, Inequalities**.**

Unit IV - Convergence of Random Variables

Convergence in Probability –Convergence almost surely – Convergence in distribution – Convergence in the r^{th} mean -Convergence theorems for Expectations .

Unit V – Machine learning

Linear and logistic regression – K- nearest neighbor classifier – Naïve Bayes classifier – Support Vector Machine (SVMS) – bagging and boosting – random forest classifier – clustering algorithms.

Text Book:

(1) B.R .Bhat, Modern probability theory, New Age International private Ltd, New Delhi, Third Edition, 2001.
(2) Richie Dorsey, Machine learning for Beginners: A complete guide for getting started with Machine learning, Kindle Edition, 2018.

Chapters and Sections:

UNIT I Chapter 3 (omit 3.6) (1)
UNIT II Chapter 4 (1)
UNIT III Chapter 5 (1)
UNIT IV Chapter 6 (omit 6.6) (1)
UNITV

Reference Books:

[1] Chandra T.K and Chatterjee, A first course in probability, Narosa Publishing House, New Delhi, 2000.
[2] Kailai Chung and Farid Aitsahlia, Elementary Probability Theory, Springer Verlag New York, 2004.
[3] Marek Capinski and Thomasz Zastawniak, Probability through problems, Springer Verlag, New York, 2001.

Course Outcomes:

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

CO Number	CO Statement	Knowledge Level
CO1	Compute functions, Inverse functions, Random variables	**K3**
CO2	Classify discrete probability space, General probability space, Induced probability space	**K3**
CO3	Examine the various distribution functions	**K4**
CO4	Determine expectations and Moments	**K4**
CO5	Evaluate the convergence of Random Variables	**K5**

Mapping with program outcomes:

COS\POS	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	M
CO2	M	S	M	S	S	M
CO3	S	S	S	S	S	M
CO4	M	S	S	S	S	M
CO5	S	S	S	S	S	M

S – Strong, M – Medium, L – Low.

ELECTIVE COURSE - III (B) – (EC)

Title of the Course: STOCHASTIC PROCESSES
Course Code: 19PMA3EC3B

L	T	P	C
90	6	-	3

Objectives

- To understand the stochastic models for many real life probabilistic situations.
- To learn the well known models like birth-death process and queuing to reorient the Knowledge of stochastic processes.
- Motivating the students to compare the real life problem with varies renewal and queuing models.

Syllabus:

UNIT I

Stochastic Processes: Some Notions : Introduction- Specification of Stochastic processes – Stationary processes

Markov Chains : Definitions and examples – Higher Transition Probabilities – Generalization of Independent Bernoulli trails: Sequence of Chain –Dependent Trials.

UNIT II

Markov chains: Classification of States and Chains – Determination of Higher transition Probabilities – Stability of a Markov System – Markov Chain with Denumerable Number of States(or countable state space) - Reducible Chains – Markov Chains with Continuous State Space.

UNIT III

Markov Processes with Discrete State Space : **Poisson Process and its Extensions** – Poisson Process -Poisson Process and Related Distributions – Generalisations of Poisson Process- Birth and Death Process – Markov Processes with Discrete State Space (Continuous Time Markov Chains).

UNIT IV

Renewal processes and Theory : Renewal Process – Renewal Processes in Continuous Time – Renewal Equation – Stopping time : Wald's Equation – Renewal Theorems.

UNIT V

Stochastic Processes in Queuing and Reliability – Queuing Systems : General Concepts – the Queuing model M/M/1 : Steady State Behaviour – Transient Behaviour of M/M/1 Model – Non-Markovian Queuing Models.

Text Books:

[1] J. Medhi, Stochastic Processes, New age international(P) limited publishers, New Delhi– Second edition ,2006

Chapters and Sections:

UNIT I Chapter 2: Section 2.1 – 2.3
Chapter 3: Section 3.1 – 3.3
UNIT II Chapter 3: Section 3.4 – 3.6, 3.8, 3.9 and 3.11
UNIT III Chapter 4: Section 4.1 – 4.5
UNIT IV Chapter 6: Section 6.1 – 6.5
UNIT V Chapter 10: Section 10.1– 10.3 and 10.7 (omit sec 10.2.3 and 10.2.3.1)

Reference Books:

[1] . B.R.Bhat, Stochastic Models Analysis and Applications ,New age international(P) limited publishers, New Delhi,2004

[2] Biswas, Suddhendu , Stochastic Processes in Demography and Applications, New Central Book Agency Calcutta,2006.

Course Outcomes

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

CO Number	CO Statement	Knowledge Level
CO 1	Relate the basic concepts of Stochastic Processes.	K3
CO 2	Classify the various states space and chains of the Stochastic Processes.	K3
CO 3	Describe the birth and death process of Markovian	K3
CO 4	Apply the renewal processes in continuous time.	K4
CO 5	Determine the steady state behavior and transient behavior of M/M/1 model and GI/M/1 model.	K4

Mapping with Programme Outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**S**	**S**	**S**	**S**	**M**	**S**
CO2	**S**	**S**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**S**	**M**	**M**	**M**
CO5	**S**	**S**	**S**	**M**	**M**	**M**
CO6	**S**	**S**	**S**	**S**	**M**	**S**

S – Strong, M – Medium, L – Low.

CORE COURSE – XIII (CC)
FUNCTIONAL ANALYSIS
2019-2020 Onwards

Semester – IV	**FUNCTIONAL ANALYSIS**	**Hours/Week – 6**	
Core Course – XIII		**Credits – 5**	
Course Code – 19PMA4CC13		**Internal 25**	**External 75**

Objectives

- To study the three structure theorems of Functional Analysis viz., Hahn-Banach theorem, Open mapping theorem and Uniform boundedness principle.
- To introduce Hilbert spaces and operator theory which leads to the spectral theory of operators on a Hilbert space.
- To enable the thorough knowledge of Banach* Algebra with the Gelfand-Neumark theorem.

Course Outcome

On the Successful completion of the course the student would be able to

CO No.	CO Statement	Knowledge Level
CO1	Relate the concepts of groups, rings and linear transformation	**K3**
CO2	Apply general principle of Banach Algebra to define the regular and singular elements of topological divisors and prove spectral radius formula.	**K3**
CO3	Determine the concepts of Hilbert Space and discriminate different types of operators.	**K4**
CO4	Analyze the structure of Commutative Banach Algebras to prove the Gelfand Neumark theorem.	**K4**
CO5	Compose clear, accurate proof of Hahn Banach Theorem, Open Mapping Theorem using continuous linear transformation and Conjugate of an operator.	**K6**
CO6	Generalize finite dimensional spectral theory for different types of operators.	**K6**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	S	S	S	S	S
CO2	M	S	M	S	S	S
CO3	S	M	S	S	S	S
CO4	S	S	S	M	S	S
CO5	S	S	S	S	M	S
CO6	M	S	S	S	S	S

S-Strong, M-Medium, L-Low

CORE COURSE - XIII (CC)
FUNCTIONAL ANALYSIS
2019-2020 Onwards

UNIT I

ALGEBRAIC SYSTEMS **(18 Hours)**

Groups – Rings – The structure of rings – Linear spaces – The dimension of a linear space – Linear transformations – Algebras.

BANACH SPACES

The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N** - The open mapping theorem – The conjugate of an operator.

UNIT II

HILBERT SPACES **(18 Hours)**

The definition and some simple properties – Orthogonal complements – Orthonormal sets - The conjugate space H* - The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections.

UNIT III

FINITE-DIMENSIONAL SPECTRAL THEORY **(18 Hours)**

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

UNIT IV

GENERAL PRELIMINARIES ON BANACH ALGEBRAS **(18 Hours)**

The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius – The radical and semi-simplicity.

UNIT V

THE STRUCTURE OF COMMUTATIVE BANACH ALGEBRAS **(**18 **Hours)**

The Gelfand mapping – Applications of the formula $r(x) = \lim \left\| x^n \right\|^{1/n}$ - Involutions in Banach Algebras – The Gelfand-Neumark theorem.

Text Book:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	George F. Simmons	Introduction To Topology and Modern Analysis	McGraw-Hill International student Edition	1963

Chapters and Sections:

S.No.	Unit	Chapter
1	I	8 and 9
2	II	10
3	III	11
4	IV	12
5	V	13

Reference Books:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	Walter Rudin	Functional Analysis	TMH Edition	1974
2	B.V. Limaye	Functional Analysis	Wiley Eastern Limited, Bombay, Second Print	1985
3	K.Yosida	Functional Analysis	Springer-Verlag	1974
4	Laurent Schwarz	Functional Analysis	Courant Institute of Mathematical Sciences, New York University	1964

Web links

1. **https://youtu.be/8DtYlUgike8**
2. **https://youtu.be/A_9QRYHIvRY**
3. **https://youtu.be/LAG-FxIFyTs**
4. **https://youtu.be/ZXVA-_q8Ltc**

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.

CORE COURSE – XIV (CC)
COMPLEX ANALYSIS
2019-2020 Onwards

Semester - IV	COMPLEX ANALYSIS	Hours/Week – 6	
Core Course – XIV		Credits – 5	
Course Code – 19PMA4CC14		Internal 25	External 75

Objectives

- To learn the various intrinsic concepts and the theory of Complex Analysis.
- To enable the concept of Analyticity, Complex Integration.
- To make the students to solve the problems for competitive exams.

Course Outcome

On the Successful completion of the course the student would be able to

CO No.	CO Statement	Knowledge Level
CO1	Apply the basic concepts of Elementary Point Set Topology and Conformality.	**K3**
CO2	Ascertain the basic properties of Harmonic function and theorem and series.	**K4**
CO3	Examine the Local Properties and theorems of Analytic functions.	**K4**
CO4	Evaluate definite integral by Cauchy's theorem and Residue theorem.	**K5**
CO5	Evaluate line integral, Cauchy's integral formula for higher derivatives.	**K5**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	S	M	S	M	S
CO2	S	M	M	S	M	S
CO3	S	S	S	S	M	S
CO4	S	S	S	S	M	S
CO5	S	M	M	S	S	S

S - Strong, M - Medium, L - Low

CORE COURSE – XIV (CC)
COMPLEX ANALYSIS
2019-2020 Onwards

UNIT I **(18 Hours)**

Elementary Point Set Topology: Sets and Elements – Metric Spaces – Connectedness – Compactness – Continuous Functions – Topological Spaces. **Conformality:** Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area. **Linear Transformations:** The Linear Group – The Cross Ratio – Symmetry.

UNIT II **(18Hours)**

Fundamental Theorems: Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk. **Cauchy's Integral Formula:** The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.

UNIT III **(18 Hours)**

Local Properties of Analytic Functions: Removable Singularities. Taylor's Theorem - Zeros and Poles - The Local Mapping – The Maximum Principle.

UNIT IV **(18 Hours)**

The General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions. **The Calculus of Residues:** The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals.

UNIT V **(18 Hours)**

Harmonic Functions: Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle. **Power Series Expansions**: Weierstrass's Theorem – The Taylor Series – The Laurent Series.

Text Book:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	Lars V. Ahlfors	Complex Analysis	McGraw-Hill Book Company	1979

Chapters and Sections:

Unit	Chapter	Section
I	3	1.1 - 1.6, 2.1 - 2.4, 3.1 - 3.3.
II	4	1.1 -1.5, 2.1 - 2.3
III	4	3.1 - 3.4
IV	4	4.1 - 4.7, 5.1 - 5.3
V	4	6.1 - 6.5
	5	1.1- 1.3

Reference Books:

S.No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	Serge Lang	Complex Analysis	Springer International Edition	2005
2	J.N. Sharma	Functions of a Complex Variable	Krishna Prakashan Media Pvt. Ltd	2014
3	James Ward Brown, Ruel V. Churchill	Complex Variables and Applications	Mc Graw - Hill Higher Education	2009

Web links

1. **https://youtu.be/iUhwCfz18os**
2. **https://youtu.be/qTDDFMAt7j4**
3. **https://youtu.be/0JZMyutBk9o**
4. **https://youtu.be/0ZOMkmy-aTo**
5. **https://youtu.be/YWIseo5LwgQ**
6. **https://youtu.be/E3-Hji569w4**

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.

ELECTIVE COURSE – IV (A) (EC)
OPTIMIZATION TECHNIQUES
2019-2020 Onwards

Semester - IV	OPTIMIZATION TECHNIQUES	Hours/Week –6	
Elective Course – IV (A)		Credits – 3	
Course Code – 19PMA4EC4A		Internal 25	External 75

Objectives

- To enlighten the students in the field of Resource Management Techniques.
- To help the students to apply Resource Management Techniques in business and management problems.
- To develop an understanding of problemsolving methods based upon model formulation.

Course Outcome

On the Successful completion of the course the student would be able to

CO Number	CO Statement	Knowledge Level
CO1	Solve Integer Programming by various types.	**K3**
CO2	Classify several Dynamic Programming problems.	**K3**
CO3	Compute Decision Theory problems and solve problems on games.	**K3**
CO4	Predict Inventory models and solve them accordingly.	**K3**
CO5	Diagnose Non-linear Programming problems.	**K4**

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M	S	S	S	S
CO2	S	S	S	S	S	M
CO3	M	M	S	S	S	M
CO4	M	M	S	S	S	M
CO5	S	S	S	S	S	S

S - Strong, M - Medium, L - Low

ELECTIVE COURSE – IV (A) (EC)
OPTIMIZATION TECHNIQUES
2019-2020 Onwards

UNIT I

INTEGER LINEAR PROGRAMMING: **(18 Hours)**

Illustrative Applications of Integer Programming – Solutions methods of Integer Programming – Branch and Bound Algorithm – Cutting–Plane Algorithms – Zero-One Integer Program.

UNIT II

DYNAMIC (MULTISTAGE) PROGRAMMING: (18 Hours)

Elements of the DP model: The Capital Budgeting Example – More on the Definition of the State – Examples of DP models and Computations – Problem of Dimensionality in Dynamic Programming – Solution of Linear Programs by Dynamic Programming.

UNIT III

DECISION THEORY AND GAMES: (18 Hours)

Decisions under Risk – Decision Trees – Decisions under uncertainty – Game Theory.

UNIT IV

INVENTORY MODELS: (18 Hours)

The ABC Inventory system – A Generalized Inventory Models – Deterministic Models – Probabilistic Models.

UNIT V

NON-LINEAR PROGRAMMING ALGORITHMS: (18 Hours)

Unconstrained Nonlinear Algorithms – Constrained Nonlinear Algorithms.

Text Book:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	Hamdy A. Taha	Operations Research: An Introduction	Macmillan Publishing Company, 5th Edition	1992

Chapters and Sections:

Unit	Chapter	Section
I	9	9.1 to 9.5
II	10	10.1 to 10.5
III	12	12.1 to 12.4
IV	14	14.1 to 14.4
V	20	20.1, 20.2 (omit 20.2.4 & 20.2.6)

Reference Books:

S.No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	KantiSwarup, P.K.Gupta and Man Mohan	Operations Research	Sultan Chand & Sons	2010
2	Prem Kumar Gupta and D.S. Hira	Operations Research-An Introduction	S.Chand	2011

Web links

1. https://nptel.ac.in/courses/112/106/112106131/#
2. https://www.youtube.com/watch?v=gxLQ7Q26SkE
3. https://www.youtube.com/watch?v=fPllAAevo-4
4. https://www.youtube.com/watch?v=fSuqTgnCVRg
5. https://www.youtube.com/watch?v=kf8VqBzUodA
6. https://www.youtube.com/watch?v=7SBKFVkbGU4

Pedagogy

Power point presentation, Group Discussion, Seminar, Quiz, Assignment.

ELECTIVE COURSE – IV (B) (EC)
FUZZY SETS AND THEIR APPLICATIONS
2019-2020 Onwards

Semester - IV	**FUZZY SETS AND THEIR APPLICATIONS**	**Hours/Week – 6**	
Elective Course – IV(B)		**Credits – 3**	
Course Code – 19PMA4EC4B		**Internal 25**	**External 75**

Objectives

- To introduce the concept of fuzzy theory and study its application in real problems.
- To acquire knowledge of the uncertainty environment through the fuzzy sets that incorporates imprecision and subjectivity.
- To provide a good outline of a model formulation and solution process.

Course Outcome

On the Successful completion of the course the student would be able to

CO No.	CO Statement	Knowledge Level
CO1	Explain the basic concepts of Fuzzy set theory.	**K2**
CO2	Classify the operations on Fuzzy sets and Fuzzy measures and give examples.	**K3**
CO3	Relate type-2 Fuzzy sets with Fuzzy numbers.	**K3**
CO4	Compose clear and accurate proofs using the concepts of Fuzzy relations and Fuzzy graphs.	**K6**
CO5	Develop Fuzzy concepts to compute Fuzzy decision, Fuzzy Linear Programming Program, Dynamic Programming.	**K6**

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	M
CO2	S	S	S	S	S	M
CO3	S	S	S	S	M	M
CO4	S	S	S	S	S	M
CO5	S	S	S	S	M	M

S-Strong, M-Medium, L-Low

ELECTIVE COURSE – IV (B) (EC)
FUZZY SETS AND THEIR APPLICATIONS
2019-2020 Onwards

UNIT I

INTRODUCTION TO FUZZY SETS: **(18 Hours)**

Crispness, Vagueness, Fuzziness, Uncertainty - Fuzzy Set Theory.

FUZZY SETS:

Basic Definitions - Basic Set-Theoretic Operations for Fuzzy Sets.

UNIT II

EXTENSIONS: **(18 Hours)**

Types of Fuzzy Sets - Further Operations on Fuzzy Sets - Algebraic Operations - Set–Theoretic Operations.

FUZZY MEASURES AND MEASURES OF FUZZINESS:

Fuzzy Measures - Measures of Fuzziness.

UNIT III

THE EXTENSION PRINCIPLE AND APPLICATIONS: **(18 Hours)**

The Extension Principle - Operations for Type-2 Fuzzy Sets - Algebraic Operations with Fuzzy Numbers - Special Extended Operations - Extended Operations for LR-Representation of Fuzzy Sets.

UNIT IV

FUZZY RELATIONS AND FUZZY GRAPHS: **(18 Hours)**

Fuzzy Relations on Sets and Fuzzy Sets - Compositions of Fuzzy Relations - Properties of the Min-Max Composition - Fuzzy Graphs - Special Fuzzy Relations.

UNIT V

DECISION MAKING IN FUZZY ENVIRONMENTS: **(18 Hours)**

Fuzzy Decisions - Fuzzy Linear Programming - Symmetric Fuzzy LP - Fuzzy LP with Crisp Objective Function - Fuzzy Dynamic Programming.

Text Books:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	H. J. Zimmermann	Fuzzy Set Theory and its Applications, Fourth Edition	Springer(India) Private Limited	2006

Chapters and Sections:

Unit	Chapter	Section
I	1 2	1.1,1.2 2.1,2.2
II	3 4	3.1,3.2(OMIT 3.2.3) 4.1,4.2
III	5	5.1-5.3
IV	6	6.1 - 6.3
V	14	14.1-14.3

Reference Books:

S.No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	G.J.Klir and B.Yuan	Fuzzy Sets and Fuzzy Logic	Prentice-Hall of India	1995
2	Kwang H.Lee	First course on Fuzzy theory and Applications	Springer	2005
3	M.Ganesh	Introduction to Fuzzy Sets and Fuzzy Logic	Prentice-Hall of India	2006

Weblink

1. **https://youtu.be/rln_kZbYaWc**
2. **https://youtu.be/P8wY6mi1vV8**
3. **https://youtu.be/YQY8yGl7xBM**
4. **https://youtu.be/fpojnXFp9dk**
5. **https://youtu.be/oWqXwCEfY78**
6. **https://youtu.be/ZosV61vlZgw**
7. **https://youtu.be/WZVAfLreIwM**

Pedagogy

Power point presentation, Group Discussion, Seminar, Quiz, Assignment.

ELECTIVE COURSE – V (A) (EC)
DIFFERENTIAL GEOMETRY
2019-2020 Onwards

Semester - IV	DIFFERENTIAL GEOMETRY	Hours/Week – 6	
ELECTIVE COURSE – V (A)		Credits – 3	
Course Code – 19PMA4EC5A		Internal 25	External 75

Objectives

- To equip the students with mathematical methods formatted for their major concepts.
- To introduce the students the notion of surfaces with their properties.
- To study geodesics and differential geometry of surfaces.

Course Outcome

On the Successful completion of the course the student would be able to

CO Number	CO Statement	Knowledge Level
CO1	Define space curves and the concepts of fundamental existence theorem	K2
CO2	Explain the notion of surfaces and their intrinsic properties.	K2
CO3	Ascertain various concepts on geodesics.	K4
CO4	Deduce non intrinsic properties of a surface.	K3
CO5	Classify Differential Geometry of several surfaces.	K3

Mapping with Programme Outcomes

Cos / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	M	S	S
CO2	S	S	M	M	S	S
CO3	S	S	M	S	S	S
CO4	S	S	S	S	S	S
CO5	S	S	S	M	S	S

S - Strong, M - Medium, L - Low

ELECTIVE COURSE – V (A) (EC)
DIFFERENTIAL GEOMETRY
2019-2020 Onwards

UNIT I

The Theory of Space Curves **(18 Hours)**

Introductory remarks about space curves – Definitions – Arc length – Tangent, normal and binormal – Curvature and torsion of a curve given as the intersection of two surfaces – Contact between curves and surfaces – Tangent surface, involutes and evolutes – Intrinsic equations, fundamental existence theorem for space curves – Helices.

UNIT II

The Metric: Local intrinsic properties of a surface **(18 Hours)**

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

UNIT III

Geodesics **(18 Hours)**

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

UNIT IV

The Second Fundamental Form: Local Non-intrinsic properties of a surface (18 Hours)

The Second fundamental form – Principal curvatures – Lines of curvature – Developables – Developables associated with space curves – Developables associated with curves on surfaces.

UNIT V

Differential Geometry of surfaces in the large **(18 Hours)**

Minimal surfaces – Ruled surfaces – Compact surfaces whose points are umblics – Hilbert's Lemma – Compact surfaces of constant Gaussian or mean curvature.

Text Book:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	T.J. Willmore	An Introduction to Differential Geometry	Oxford university Press, 21st Impression	2006

Chapters and Sections:

Unit	Chapter	Section
I	1	1 to 9
II	2	1 to 9
III	2	10 to 18
IV	3	1 to 6
V	3 4	7 and 8 2 to 4

Reference Books:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	D. Somasundaram	Differential Geometry, A first course	Narosa Publishing House	2010
2	Christian Bar	Elementary Differential Geometry	Cambridge University Press	2011
3	J.A. Thorpe	Elementary topics in Differential Geometry, Under-graduate Texts in Mathematics	Springer-Verlag	1979

Weblink

1. https://www.youtube.com/watch?v=4fB0VfKZRXM
2. https://youtu.be/1HUpNAS81PY?list=PLIljB45xT85DWUiFYYGqJVtfnkUFWkKtP
3. https://youtu.be/J-RgiQca6Q8?list=PLIljB45xT85DWUiFYYGqJVtfnkUFWkKtP
4. https://youtu.be/drOldszOT7I?list=PLIljB45xT85DWUiFYYGqJVtfnkUFWkKtP
5. https://youtu.be/QXrqsz5zD2I
6. https://youtu.be/zADj0k0waFY
7. https://youtu.be/wtpe-y9eqcM

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.

ELECTIVE COURSE – V (B) (EC)
AUTOMATA THEORY
2019-2020 Onwards

Semester - IV	AUTOMATA THEORY	Hours/Week – 6	
Elective Course – V (B)		Credits – 3	
Course Code – 19PMA4EC5B		Internal 25	External 75

Objectives

- To make the students to understand the nuances of Automata and Grammar.
- To make them to understand the applications of these techniques in Computer science.
- To enable thorough Knowledge in constructing the Regular Expressions.

Course Outcome

On the Successful completion of the course the student would be able to

CO No.	CO Statement	Knowledge Level
CO1	Relate the concepts of Deterministic and Nondeterministic Finite Automata and Grammars.	**K3**
CO2	Determine the implementation of Lexical analyzers.	**K4**
CO3	Compare Pushdown Automaton with Context free languages.	**K5**
CO4	Develop the concepts of Lexical analyzers.	**K6**

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	S	M	S	S
CO2	M	M	S	M	S	S
CO3	S	S	M	S	M	S
CO4	S	S	M	S	M	S

S-Strong, M-Medium, L-Low

ELECTIVE COURSE – V (B) (EC)
AUTOMATA THEORY
2019-2020 Onwards

UNIT I

FINITE AUTOMATA AND REGULAR EXPRESSIONS: (18 Hours)
Finite state systems – Basic definitions – Nondeterministic finite Automata – Finite Automata with ε – moves.

UNIT II (18 Hours)

FINITE AUTOMATA AND REGULAR EXPRESSIONS: Regular expressions.
CONTEXT- FREE GRAMMARS: Motivation and introduction – Context-free grammars – Derivation trees – Chomsky normal form – Greibach normal form.

UNIT III

PUSHDOWN AUTOMATA: (18 Hours)
Definitions - Pushdown Automata and Context-free languages.

UNIT IV

FINITE AUTOMATA AND LEXICAL ANALYSIS: (18Hours)
The Role of the lexical analyzer – A simple approach to the design of lexical analyzers – Regular expressions – Finite automata.

UNIT V

FINITE AUTOMATA AND LEXICAL ANALYSIS: (18 Hours)
From regular expressions to finite automata – Minimizing the number of states of a DFA – A language for specifying lexical analyzers – Implementation of a lexical analyzer.

Text Books:

S. No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	John E. Hopcroft and Jeffrey D. Ullman	Introduction to Automata theory, Languages and Computations	Narosa Publishing House Pvt. Ltd	1979
2	Alfred V. Aho and Jeffrey D. Ullman	Principles of Compiler Design	Narosa Publishing House	2002

Chapters and Sections:

Unit	Chapter	Sections
I	2 [1]	2.1 - 2.4
II	2 [1]	2.5
	4 [1]	4.1-4.3, 4.5, 4.6
III	5 [1]	5.2, 5.3
IV	3 [2]	3.1 – 3.4
V	3 [2]	3.5– 3.8

Reference Books:

S.No.	Authors Name	Title of the Book	Publishers Name	Year of Publication
1	John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman	Introduction to Automata Theory, Languages and Computation	Pearson Education	2009
2	Bakhadyr Khoussainov and Anil Nerode	Automata Theory and its Applications	Springer (India) Pvt Ltd	2001

Web links

1. **https://youtu.be/58N2N7zJGrQ**
2. **https://youtu.be/TpIBUeyOuv8**
3. **https://youtu.be/Qa6csfkK7_I**
4. **https://youtu.be/40i4PKpM0cI**
5. **https://youtu.be/WrzaPNj9OZ4**
6. **https://youtu.be/6aRJQNYYz4s**

Pedagogy

Power point presentation, Group Discussion, Seminar, Assignment.