SEMESTER – I

PCMAA20 - MODERN ALGEBRA

Year: I **SEM:** I	**Course Code:** PCMAA20	**Title of the Course:** Modern Algebra	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 5	**MARKS** 100

Course Objectives

1. To know about the concepts of extension field.
2. To learn the concepts of Galois Theory.

Course Outcomes (CO)

The Learners will be able to

1. Assess the properties of Groups and Sylow's theorem.
2. Apply field extension property in Algebraic extensions.
3. Get the knowledge of Transcendence e and roots of polynomial.
4. Know about the Galois Theory.
5. Have the knowledge on the concepts of solvability by radicals.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	M	H	H	M	H
CO2	H	H	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	M	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Group Theory **(18 Hours)**

1.1 Conjugacy (K1,K2,K3,K4,K5,K6)
1.2 Cauchy's theorem (K1,K2,K3,K4,K5,K6)
1.3 Partitions (K1,K2,K3,K4,K5,K6,)
1.4 First part of Sylow's Theorem (K1,K2,K3,K4,K5,K6)
1.5 Second part of Sylow's Theorem (K1,K2,K3,K4,K5,K6)
1.6 Third part of Sylow's Theorem (K1,K2,K3,K4,K5,K6)
(Sylow's Theorem First part: first version of the proof)
(Chapter 2: Sections 2.11, 2.12 Omit: Lemma 2.12.1, Lemma 2.12.2)

Unit II: Group Theory and Fields **(18 Hours)**

2.1 External direct product (K1,K2,K3,K4,K5,K6)
2.2 Internal direct product (K1,K2,K3,K4,K5,K6)
2.3 Finite Abelian group (K1,K2,K3,K4,K5,K6)
2.4 Invariants (K1,K2,K3,K4,K5,K6)
2.5 Finite extension, Algebraic over the field (K1,K2,K3,K4,K5,K6)
2.6 Algebraic extensions (K1,K2,K3,K4,K5,K6)
(Chapter 2: Sections: 2.13, 2.14, Chapter 5:Section5.1)

Unit III: Fields (Contd.) **(18 Hours)**

3.1 Transcendence e (K1,K2,K3,K4,K5,K6)
3.2 Remainder theorem (K1,K2,K3,K4,K5,K6)
3.3 Factor theorem (K1,K2,K3,K4,K5,K6)
3.4 Splitting field (K1,K2,K3,K4,K5,K6)
3.5 Derivative of a polynomial (K1,K2,K3,K4,K5,K6)
3.6 Simple extension (K1,K2,K3,K4,K5,K6)
(Chapter 5: Sections: 5.2, 5.3 and 5.5)

Unit IV: Galois Theory **(18 Hours)**

4.1 Galois group (K1,K2,K3,K4,K5,K6)
4.2 Subfield (K1,K2,K3,K4,K5,K6)
4.3 Group of Automorphism (K1,K2,K3,K4,K5,K6)
4.4 Elementary symmetric functions (K1,K2,K3,K4,K5,K6)
4.5 Normal Extensions (K1,K2,K3,K4,K5,K6)
4.6 Fundamental theorem on Galois theory (K1,K2,K3,K4,K5,K6)
(Chapter 5: Section: 5.6)

Unit V: Solvability by Radicals **(18 Hours)**

5.1 Solvable (K1,K2,K3,K4,K5,K6)
5.2 Abel's theorem (K1,K2,K3,K4,K5,K6)
5.3 Introduction to Galois group over the rationals (K1,K2,K3,K4,K5,K6)
5.4 Galois group over the rationals (K1,K2,K3,K4,K5,K6)
5.5 Polynomial rings (K1,K2,K3,K4,K5,K6)

5.6 Polynomial rings continued (K1,K2,K3,K4,K5,K6)
(Chapter 5: Sections: 5.7 and 5.8. Chapter 3: Sections: 3.9)

Books for study and reference:

Text Book:

1. I.N. Herstein - Topics in Algebra, 2nd Edition - H.S. Polai for Wiley Eastern Limited, New Delhi –1993.

Books for Reference:

1. John B. Fraleigh – A First Course in Abstract Algebra, 5th Edition - Addison Wesley Longman, Mexico City, Inc., 1999.
2. Kenneth Hoffman and Ray Kunze – Linear Algebra, 2nd Edition – Prentice Hall of India, New Delhi, 2005.
3. Surjeeth Singh and Quazi Zameeruddin, Modern Algebra, 2-e, Vikas Publishing House Pvt. Ltd., New Delhi, 1975.
4. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
5. S. Arumugam and A. Thandapani, Modern Algebra, SciTech Publications Pvt. Ltd, 1985.

E- Resources:

1. https://marinazahara22.files.wordpress.com/2013/10/i-n-herstein-topics-in-algebra-2nd-edition-1975-wiley-international-editions-john-wiley-and-sons-wie-1975.pdf
2. http://abstract.ups.edu/download/aata-20110810.pdf
3. https://greggrant.org/hoffman_and_kunze.pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. www.algebra.com
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – I

PCMAB20 - REAL ANALYSIS - I

Year: I **SEM**: I	**Course Code:** PCMAB20	**Title of the Course:** Real Analysis – I	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 5	**MARKS** 100

Course Objectives

1. To introduce some of the Abstract thinking that pervades Modern Analysis.
2. To deepen the knowledge of certain topics in Real Analysis such as Functions of bounded variations, R-S integral and Lebesgue integral.

Course Outcomes (CO)

The learners will be able to

1. Understand n-dimensional space R^n and the metric space whose topology is uniquely determined by the algebraic structure.
2. Deal with the functions of bounded variations and some of their properties.
3. Know about the Riemann-Stieltjes integral and its properties which is a generalization of the Riemann integral.
4. Recognize the necessary and sufficient conditions for the existence of the R-S integral.
5. Grasp the class of Lebesgue integrable functions which is defined in terms of upper and lower bounds using the Lebesgue measure of a set.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Euclidean Space R^n **(18 Hours)**

1.1 Euclidean space R^n, Open balls and open sets in R^n, The structure of open sets in R^1 (K1,K2,K3,K4,K5,K6)
1.2 Closed sets, Adherent and Accumulation points, Closed sets and Adherent points (K1,K2,K3,K4,K5,K6)
1.3 Bolzano – Weierstrass Theorem, Cantor Intersection theorem (K1,K2,K3,K4,K5,K6)
1.4 Lindelof Covering theorem, Heine Borel Covering theorem (K1,K2,K3,K4,K5,K6)
1.5 Compactness in R^n , Metric spaces (K1,K2,K3,K4,K5,K6)
1.6 Point set topology in metric spaces, Compact subsets of a metric space, Boundary of a set (K1,K2,K3,K4,K5,K6)
(Chapter 3: Sections 3.2– 3.16)

Unit II: Functions of bounded variation and Rectifiable Curves **(18 Hours)**

2.1 Properties of Functions, Functions of bounded variation (K1,K2,K3,K4,K5,K6)
2.2 Total variation, Additive property of total variation (K1,K2,K3,K4,K5,K6)
2.3 Total variation on [a,x] as a function of x, Functions of bounded variation expressed as the difference of increasing functions (K1,K2,K3,K4,K5,K6)
2.4 Continuous functions of bounded variation (K1,K2,K3,K4,K5,K6)
2.5 Curves and paths, Rectifiable paths and arc length (K1,K2,K3,K4,K5,K6)
2.6 Additive and continuity properties of arc length, Equivalence of paths, Change of Parameter (K1,K2,K3,K4,K5,K6)
(Chapter 6: Sections 6.2– 6.12)

Unit III: Riemann Stieltjes' Integral **(18 Hours)**

3.1 Notation, Definition of the Riemann Stieltjes integral, Linear properties (K1,K2,K3,K4,K5,K6)
3.2 Integration by parts, Change of variable in a Riemann Stieltjes integral (K1,K2,K3,K4,K5,K6)
3.3 Reduction to a Riemann integral, Step functions as integrators (K1,K2,K3,K4,K5,K6)
3.4 Reduction of a Riemann Stieltjes integral to a finite sum, Euler's summation formula (K1,K2,K3,K4,K5,K6)
3.5 Monotonically increasing integrators, Additive and linearity properties of upper and lower Integrals (K1,K2,K3,K4,K5,K6)
3.6 Riemann's condition, Comparison theorems (K1,K2,K3,K4,K5,K6)
(Chapter 7: Sections 7.2 –7.14)

Unit IV: Riemann Stieltjes' Integral (Contd…) **(18 Hours)**

4.1 Integrators of bounded variation (K1,K2,K3,K4,K5,K6)
4.2 Sufficient conditions for Existence of Riemann Stieltjes integral, Necessary conditions for Existence of Riemann Stieltjes integral (K1,K2,K3,K4,K5,K6)

4.3 Mean Value Theorem for Riemann Stieltjes integrals, The Integrals as a function of the Interval (K1,K2,K3,K4,K5,K6)
4.4 Second fundamental Theorem of Integral Calculus, Change of variable in a Riemann Integral (K1,K2,K3,K4,K5,K6)
4.5 Second Mean Value Theorem for Riemann integral, Riemann Stieltjes integrals depending on a parameter (K1,K2,K3,K4,K5,K6)
4.6 Differentiation under the integral sign, Interchanging the order of integration (K1,K2,K3,K4,K5,K6)
(Chapter 7: Sections 7.15 - 7.25)

Unit V: Lebesgue Integral **(18 Hours)**

5.1 The integral of a step function, Monotonic sequences of step functions (K1,K2,K3,K4,K5,K6)
5.2 Upper functions and their integrals (K1,K2,K3,K4,K5,K6)
5.3 Riemann integrable functions as examples of upper functions, The class of Lebesgue integrable functions on a general interval(K1,K2,K3,K4,K5,K6)
5.4 Basic properties of the Lebesgue integral (K1,K2,K3,K4,K5,K6)
5.5 Lebesgue integration and sets of measure zero (K1,K2,K3,K4,K5,K6)
5.6 The Levi monotone convergence theorems (K1,K2,K3,K4,K5,K6)
(Chapter 10: Sections 10.2-10.9)

Books for study and reference:

Text Book:

1. Tom M. Apostol – Mathematical Analysis, 2nd Edition, Narosa Publishing House, New Delhi,1997.

Books for Reference:

1. Walter Rudin – Principles of Mathematical Analysis, 3rd Edition – McGraw Hill Company, New York, 1976.
2. R.R. Goldberg - Methods of Real Analysis, Indian Edition - Oxford and IBH Publishing Company, 1970.
3. S.C. Malik and Savita Arora – Mathematical Analysis, 2nd Edition – New Age International (P) Limited Publishers, New Delhi, 1991.

E-Resources:

1. http://webpages.iust.ac.ir/amtehrani/files/Addison%20Wesley%20-%20Mathematical%20Analysis%20_%20Apostol%20%285Th%20Ed%29%20%281981%29.pdf
2. https://web.math.ucsb.edu/~agboola/teaching/2021/winter/122A/rudin.pdf
3. https://alansinyal.files.wordpress.com/2012/08/method-of-real-analysis.pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org

7. www.mathpages.com
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – I

PCMAC20 - COMPLEX ANALYSIS

Year : I SEM : I	Course Code : PCMAC20	Title Of The Course : Complex Analysis	Course Type : Theory	Course Category : Core	H/W 6	CREDITS 4	MARKS 100

Course Objectives

1. To introduce the fundamental ideas of the functions of complex variables.
2. To enable the use of concepts of analyticity, Cauchy-Riemann relations and harmonic functions.

Course Outcomes (CO)

The Learners will be able to

1. Understand the elementary theory of power series and conformality to perform the linear transformation.
2. Solve the integration in the complex plane by using the fundamental theorems.
3. Be familiar with Cauchy's Integral Formula and the properties of analytical functions.
4. Determine the local mapping and learn the general form of Cauchy's theorem.
5. Deal with the concept of Calculus of Residues and Harmonic Functions.

CO	PSO					
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	L	H	M	M
CO2	H	M	L	H	H	M
CO3	H	M	L	H	M	M
CO4	H	M	L	H	M	L
CO5	H	M	L	H	H	L

(L-Low, M-Moderate, H-High)

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Elementary Theory of Power Series, Conformality and Linear transformations (18 Hours)

1.1 Sequences, Series (K1,K2,K3,K4,K5,K6)
1.2 Uniform Convergence, Power Series (K1,K2,K3,K4,K5,K6)
1.3 Abel's Limit Theorem, Arcs and Closed Curves(K1,K2,K3,K4,K5,K6)
1.4 Analytic Functions in Regions(K1,K2,K3,K4,K5,K6)
1.5 Conformal Mapping, Length and Area(K1,K2,K3,K4,K5,K6)
1.6 The Linear Group, The Cross Ratio, Symmetry (K1,K2,K3,K4,K5,K6)
(Chapter 2: Section 2.1 -2.5 and Chapter 3 : Section 2.1- 2.4, 3.1-3.3)

Unit II: Complex Integration – Fundamental Theorems (18Hours)

2.1 Line Integrals (K1,K2,K3,K4,K5,K6)
2.2 Rectifiable arcs (K1,K2,K3,K4,K5,K6)
2.3 Line integrals as functions of arcs (Theorems)(K1,K2,K3,K4,K5,K6)
2.4 Line integrals as functions of arcs (Problems)(K1,K2,K3,K4,K5,K6)
2.5 Cauchy's Theorem for a Rectangle(K1,K2,K3,K4,K5,K6)
2.6 Cauchy's Theorem in a Disk (K1,K2,K3,K4,K5,K6).
(Chapter 4: Sections 1.1-1.5)

Unit III: Cauchy's Integral formula and Local Properties of Analytical functions (18 Hours)

3.1 Index of a point with respect to a closed curve (K1,K2,K3,K4,K5,K6)
3.2 Integral formula (K1,K2,K3,K4,K5,K6)
3.3 Higher Derivatives (K1,K2,K3,K4,K5,K6)
3.4 Removable Singularities(K1,K2,K3,K4,K5,K6)
3.5 Taylor's Theorem (K1,K2,K3,K4,K5,K6)
3.6 Zeroes and poles(K1,K2,K3,K4,K5,K6)
(Chapter 4: Sections 2.1 - 2.3 and 3.1 - 3.2)

Unit IV: Local Mapping and the General form of Cauchy's Theorem (18 Hours)

4.1 Local Mapping (K1,K2,K3,K4,K5,K6)
4.2 Maximum Principle(K1,K2,K3,K4,K5,K6)
4.3 Chains and Cycles (K1,K2,K3,K4,K5,K6)
4.4 Simple Connectivity(K1,K2,K3,K4,K5,K6)
4.5 Homology (K1,K2,K3,K4,K5,K6)
4.6 General statement of Cauchy's Theorem, Proof of Cauchy's Theorem (K1, K2, K3, K4, K5, K6)
(Chapter 4: Sections 3.3, 3.4 and 4.1 - 4.5)

Unit V: The Calculus of Residues and Harmonic functions (18 Hours)

5.1 The Residue Theorem, The Argument Principle (K1,K2,K3,K4,K5,K6)
5.2 Evaluation of Definite Integrals (K1,K2,K3,K4,K5,K6)
5.3 Definition and Basic properties, The Mean value property(K1,K2,K3,K4,K5,K6)

5.4 Poisson's Formula, Schwarz's Theorem (K1,K2,K3,K4,K5,K6)
5.5 Weierstrass's Theorem, The Taylor Series, The Laurent Series(K1,K2,K3,K4,K5,K6)
5.6 Partial Fractions , Infinite Products(K1,K2,K3,K4,K5,K6)
(Chapter 4: Sections 5.1 - 5.3 and 6.1 - 6.4, Chapter 5: Sections 1.1 -1.3)

Books for study and reference:

Text Book:

1. Lars V. Ahlfors – Complex Analysis, 3rd Edition–McGraw Hill International Editions, Tokyo, 1979.

Books for Reference:

1. John B. Conway – Functions of one Complex Variable, 2nd Edition – Springer International Student Edition, 1987.
2. S. Ponnusamy - Foundation of Complex Analysis, 2nd Edition - Narosa Publishing House, New Delhi, 2012.
3. S. Arumugam, A. Thangapandi Isaac, A. Somasundram - Complex Analysis- Scitech Publications Pvt.Ltd., New Delhi, 2009.
4. Serge Lang- Complex Analysis, 2nd Edition- Springer-Verlag, New York, 1993.

E- Resources:

1. https://mccuan.math.gatech.edu/courses/6321/lars-ahlfors-complex-analysis-third-edition-mcgraw-hill-science_engineering_math-1979.pdf
2. https://www-users.cse.umn.edu/~arnold/502.s97/complex.pdf
3. https://perso.univ-rennes1.fr/guy.casale/enseignement/cours/FHFS/references/lang.pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. www.mathpages.com
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – I

PCMAD20 - DIFFERENTIAL EQUATIONS

Year : I **SEM :** I	**Course Code :** PCMAD20	**Title Of The Course :** Differential Equations	**Course Type :** Theory	**Course Category :** Core	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To introduce mathematical techniques for analyzing and solving ordinary differential equations.
2. To apply ordinary differential equations to dynamical problems of practical interest.

Course Outcomes (CO)

The Learners will be able to

1. Understand ordinary differential equations of various type, their solutions, and fundamental concepts about their existence.
2. Obtain solutions of the Homogeneous equation with constant coefficient and Homogeneous equation with analytic coefficient.
3. Comprehend the Bessel functions, Legendre equation, Legendre polynomials and Regular singular points.
4. Know Picard's method of obtaining successive approximations of solutions of first order differential equations.
5. Understand Eigen values and Eigen functions of Strum-Liovuille systems, and obtain the solutions of initial and boundary value problems.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	M	H	L	H	M
CO2	H	H	H	M	H	M
CO3	H	H	M	H	M	L
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	L

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Linear Differential Equations of Higher Order (18 Hours)

1.1 Introduction – Definition – Example – Higher order equations (K1,K2,K3,K4,K5,K6)
1.2 A mathematical model (K1,K2,K3,K4,K5,K6)
1.3 Linear Dependence- Wronskian (K1,K2,K3,K4,K5,K6)
1.4 Basic Theory for Linear Equations (K1,K2,K3,K4,K5,K6)
1.5 Two useful formulae (K1,K2,K3,K4,K5,K6)
1.6 Homogeneous linear equations with constant co-efficient (K1,K2,K3,K4,K5,K6)
(Chapter 4: Sections 4.1 – 4.6)

Unit II: Solutions in Power Series (18 Hours)

2.1 Introduction - Example (K1,K2,K3,K4,K5,K6)
2.2 Second order linear equations with ordinary points (K1,K2,K3,K4,K5,K6)
2.3 Legendre equation (K1,K2,K3,K4,K5,K6)
2.4 Legendre polynomials (K1,K2,K3,K4,K5,K6)
2.5 Second order equations with regular singular points (K1,K2,K3,K4,K5,K6)
2.6 Bessel's functions (K1,K2,K3,K4,K5,K6)
(Chapter 6: Sections 6.1 – 6.5)

Unit III: Systems of Linear Differential Equations (18 Hours)

3.1 Introduction - Systems of first order equations (K1,K2,K3,K4,K5,K6)
3.2 Model for Arms Competition between two nations (K1,K2,K3,K4,K5, K6)
3.3 Existence and uniqueness theorems (K1,K2,K3,K4,K5,K6)
3.4 Fundamental matrix (K1,K2,K3,K4,K5,K6)
3.5 Non-homogeneous linear systems (K1,K2,K3,K4,K5,K6)
3.6 Linear systems with constant co-efficient (K1,K2,K3,K4,K5,K6)
(Chapter 5: Sections 5.1 – 5.7)

Unit IV: Existence and Uniqueness of Solutions (18 Hours)

4.1 Introduction (K1,K2,K3,K4,K5,K6)
4.2 Preliminaries (K1,K2,K3,K4,K5,K6)
4.3 Picard's Successive approximations (K1,K2,K3,K4,K5,K6)
4.4 Picard's Theorem (K1,K2,K3,K4,K5,K6)
4.5 Some examples (K1,K2,K3,K4,K5,K6)
4.6 Continuation and dependence on initial conditions (K1, K2, K3, K4, K5,K6)
(Chapter 2: Sections 2.1 –2.6)

Unit V: Boundary- value problems (18 Hours)

5.1 Introduction- Definition- Example (K1, K2, K3, K4, K5,K6)
5.2 Sturm Liouville problem (K1, K2, K3, K4, K5,K6)
5.3 Green's functions (K1, K2, K3, K4, K5,K6)
5.4 Application of BVP's (K1,K2,K3,K4,K5, K6)
5.5 Picard's theorem (K1, K2, K3, K4, K5,K6)
5.6 Problems based on BVP's (K1, K2, K3, K4, K5, K6)
(Chapter 8: Sections 8.1 –8.5)

Books for study and reference:

Text Book:

1. S.G. Deo, V. Raghavendra, Rasmitakar and V. Lakshmikantham- Ordinary Differential Equations, 3rd Edition - Tata McGraw Hill Publishing Company Ltd., New Delhi, 2015.

Books for Reference:

1. Earl A. Coddington - An Introduction to Ordinary Differential Equations - Prentice Hall of India Pvt. Ltd., New Delhi, 1992.
2. M.D. Raisinghania - Advanced Differential Equations, 8th Edition – S. Chand and Co. Ltd., New Delhi, 2001.
3. M.D. Raisinghania - Ordinary and Partial Differential Equations - S. Chand and Co., Ltd., New Delhi, 1974.

E- Resources:

1. https://efaidnbmnnnibpcajpcglclefindmkaj/https://users.math.msu.edu/users/gnagy/teaching/ode.pdf
2. https://books.google.com.bd/books?id=vaorDAAAQBAJ&printsec=copyright#v=onepage&q&f=false
3. https://efaidnbmnnnibpcajpcglclefindmkaj/https://content.kopykitab.com/ebooks/2016/07/8107/sample/sample_8107.pdf
4. https://fb.marliesdekkers.com/fulldisplay?redir_esc=51681&FileName=Ordinary%20And%20Partial%20Differential%20Equations%20By%20M%20D%20Raisinghania%20Pdf%20Free%20Download.pdf
5. http://mathforum.org
6. http://ocw.mit.edu/ocwweb/Mathematics
7. http://www.opensource.org
8. www.mathpages.com
9. https://nptel.ac.in
10. www.coursera.org
11. https://swayam.gov.in

SEMESTER – I

PEMAA20 – ELECTIVE I A: DIFFERENTIAL GEOMETRY

Year: I **SEM:** I	**Course Code:** PEMAA20	**Title of the Course:** Elective I A: Differential Geometry	**Course Type:** Theory	**Course Category:** Elective	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To understand the concept of curvature of a space curve and signed curvature of a plane curve.
2. To compute the curvature and torsion of space curves.

Course Outcomes (CO)

The Learners will be able to

1. Understand the line integrals, deal with differential forms and calculate arc length, curvature of surfaces.
2. Analyze involutes, evolutes and fundamental existence theorem for space curves.
3. Apply problem solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.
4. Evaluate the fundamental forms of a surface.
5. Compute the Gaussian curvature, the mean curvature, the curvature lines and the asymptotic lines.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	M	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	M	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO 6**
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Theory of Space Curves (18 Hours)

1.1 Introduction – Representation of space curves (K1, K2, K3, K4,K5, K6)
1.2 Unique parametric representation of a space curve – Arc length (K1, K2, K3, K4, K5, K6)
1.3 Tangent and osculating plane – Principal normal and binormal (K1, K2, K3, K4, K5, K6)
1.4 Curvature and torsion – Behaviour of a curve near one of its points (K1, K2, K3, K4, K5, K6)
1.5 The curvature and torsion of a curve as the intersection of two surfaces (K1, K2, K3, K4, K5, K6)
1.6 Contact between curves and surfaces. (K1, K2, K3, K4, K5, K6)
(Chapter 1: Section 1.1 – 1.10)

Unit II: Theory of Space Curves (Contd…) (18 Hours)

2.1 Osculating circle and osculating sphere(K1, K2, K3, K4, K5, K6)
2.2 Locus of centres of spherical curvature (K1, K2, K3, K4, K5, K6)
2.3 Tangent surfaces, involutes and Evolutes – Betrand curves (K1, K2, K3, K4, K5, K6)
2.4 Spherical indicatrix – Intrinsic equations of space curves (K1, K2, K3, K4, K5, K6)
2.5 Fundamentals existence theorem for space curves (K1, K2, K3, K4, K5, K6)
2.6 Helices. (K1, K2, K3, K4, K5, K6)
(Chapter 1: Section 1.11- 1.18)

Unit III: The 1st Fundamental Form and Local Intrinsic Properties of a Surface (18 Hours)

3.1 Introduction – Definition of a surface (K1,K2,K3,K4,K5,K6)
3.2 Nature of points on a surface – Representation of a surface (K1, K2, K3, K4,K5,K6)
3.3 Curves on surfaces – Tangent plane and surface normal (K1, K2, K3, K4, K5, K6)
3.4 The general surfaces of revolution – Helicoids (K1, K2, K3, K4, K5, K6)
3.5 Metric on a surface – The 1st fundamental form (K1, K2, K3, K4, K5, K6)
3.6 Direction coefficients on a surface.(K1, K2, K3, K4, K5, K6)
(Chapter 2: Section 2.1 - 2.10)

Unit IV: The 1st Fundamental Form and Local Intrinsic Properties of a Surface (Contd…) (18 Hours)

4.1 Families of curves – Orthogonal trajectories (K1,K2, K3,K4,K5,K6)
4.2 Double family of curves – Isometric correspondence (K1, K2, K3, K4, K5, K6)
4.3 Intrinsic properties – Geodesics and their differential equations (K1, K2, K3, K4, K5, K6)
4.4 Canonical geodesic equations – Geodesics on surfaces of revolution (K1, K2, K3, K4, K5, K6)
4.5 Normal property of geodesic (K1, K2, K3, K4, K5, K6)
4.6 Differential equations of geodesics using normal property.(K1, K2, K3, K4, K5, K6)
(Chapter 2: Section 2.11 - 2.15 & Chapter 3: Section 3.1 – 3.6)

Unit V: Geodesics on a Surface (18 Hours)

5.1 Existence theorems – Geodesic parallels (K1, K2, K3, K4, K5, K6)
5.2 Geodesic polar coordinates – Geodesic curvature (K1, K2, K3, K4, K5, K6)

5.3 Gauss – Bonnet theorem (K1, K2, K3, K4, K5, K6)
5.4 Gaussain Curvature (K1, K2, K3, K4, K5, K6)
5.5 Surfaces of constant curvature – Conformal mapping (K1, K2, K3, K4, K5, K6)
5.6 Geodesic mapping(K1, K2, K3, K4, K5, K6)
(Chapter 3: Section: 3.7 – 3.15)

Books for study and reference:

Text Book:

1. D. Somasundaram - Differential Geometry, Second reprint, Narosa publishing house, 2008.

Books for Reference:

1. M. L. Khanna - Differential Geometry, 6thEdition - Jai Prakash Nath and Co., Garh Road, Meerut City,1998.
2. T.J Wilmore - An Introduction to Differential Geometry, 2ndEdition - Oxford at the Clarendon Press, First Reprint –2000.
3. Dirk JStruik- Lectures on Classical Differential geometry, 2nd edition, Dover publications, Inc, New York, 1961.

E-Resources:

1. https://math.libretexts.org/Bookshelves/Calculus/Calculus_(OpenStax)/13%3A_Vector-Valued_Functions/13.03%3A_Arc_Length_and_Curvature
2. https://books.google.gm/books?id=dbIAAQAAQBAJ&lpg=PR4&pg=PP1#v=onepage&q&f=false
3. https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/3/PG_M.Sc._Mathematics_31131%20DIFFERENTIAL%20GEOMETRY.pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. www.mathpages.com
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – I

PEMAB20 - ELECTIVE I B: MATHEMATICAL MODELLING

Year : I **SEM :** I	**Course Code :** PEMAB20	**Title Of The Course :** Elective I B:Mathematical Modelling	**Course Type :** Theory	**Course Category :** Elective	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. Demonstrate the ability to solve problems, including applications outside of mathematics, by means of intuition, creativity, guessing and the experience gained through the study of particular examples and mathematical models.
2. To determine the validity of a given case study and be able to construct mathematical models independently.

Course Outcomes (CO)

The Learners will be able to

1. Understand the mathematical basis of common algorithms, and the ability to calculate accurately and efficiently.
2. Demonstrate the use of mathematical reasoning by justifying and generalizing patterns and relationships between the variables in the mathematical models.
3. Formulate and qualitatively analyze mathematical models of a wide range of systems and processes.
4. Recognize the types of Mathematical models and the complexity in each system.
5. Recognize the power of mathematical modelling and analysis and be able to apply their understanding to their further studies.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	M	H
CO2	H	H	M	H	L	H
CO3	H	H	M	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	M	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	H
CO2	H	H	H	M	L	H
CO3	H	H	H	M	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit 1: What is Modelling? (18 Hours)

1.1 Models and Reality, Properties of Models(K1,K2,K3,K4,K5,K6)
1.2 Building a Model, Examples(K1,K2,K3,K4,K5,K6)
1.3 Effects of size(K1,K2,K3,K4,K5,K6)
1.4 Dimensional Analysis(K1,K2,K3,K4,K5,K6)
1.5 Using graphs in Modeling(K1,K2,K3,K4,K5,K6)
1.6 Comparative statics(K1,K2,K3,K4,K5,K6)
(Chapter 1: Section 1.1-1.6, Chapter 3: Section 3.1 – 3.2)

Unit II: Systems Modelling (18 Hours)

2.1 Modelling method for Complex systems(K1,K2,K3,K4,K5,K6)
2.2 Classification of Models(K1,K2,K3,K4,K5,K6)
2.3 Mathematical Modeling of Physical Systems(K1,K2,K3,K4,K5,K6)
2.4 Modeling of electrical systems(K1,K2,K3,K4,K5,K6)
2.5 Modeling of mechanical and electromechanical systems(K1,K2,K3,K4,K5,K6)
2.6 Modeling of fluid systems(K1,K2,K3,K4,K5,K6)
(Chapter 2: Section 2.3,2.4,2.7.1-2.7.4)

Unit III: Stability and Optimization of Mathematical Models (18 Hours)

3.1 Cobweb models in economics(K1,K2,K3,K4,K5,K6)
3.2 Small group dynamics(K1,K2,K3,K4,K5,K6)
3.3 Optimization by differentiation: Maintaining Inventories(K1,K2,K3,K4,K5,K6)
3.4 Geometry of Blood Vessels(K1,K2,K3,K4,K5,K6)
3.5 Fighting forest fires(K1,K2,K3,K4,K5,K6)
3.6 Problems in Optimization(K1,K2,K3,K4,K5,K6)
(Chapter 3: Section 3.3, Chapter 4: Section 4.1 – 4.2)

Unit IV: Basic Probability (18 Hours)

4.1 Sex preference and sex ratio(K1,K2,K3,K4,K5,K6)
4.2 Making simple choices(K1,K2,K3,K4,K5,K6)
4.3 Monte Carlo simulation(K1,K2,K3,K4,K5,K6)
4.4 Example: Doctor's waiting room(K1,K2,K3,K4,K5,K6)
4.5 Stream Network(K1,K2,K3,K4,K5,K6)
4.6 Problems in Probability(K1,K2,K3,K4,K5,K6)
(Chapter 5: Section 5.1-5.2)

Unit V: Approaches to Differential Equations and Quantitative Differential Equations (18 Hours)

5.1 Limitations of Analytical solutions(K1,K2,K3,K4,K5,K6)
5.2 Alternative approaches(K1,K2,K3,K4,K5,K6)
5.3 Analytical Methods and examples(K1,K2,K3,K4,K5,K6)
5.4 Problems in Analytical Methods(K1,K2,K3,K4,K5,K6)
5.5 Numerical Methods and examples(K1,K2,K3,K4,K5,K6)

5.6 Problems in Numerical Methods(K1,K2,K3,K4,K5,K6)
(Chapter 7: Section 7.1 – 7.4, Chapter 8: Section 8.1 – 8.2)

Books for Study and Reference:

Text Book:

1. Edward A. Bender, An introduction to mathematical modelling, Dover Publications, 1978.

Books for Reference:

1. Amos Gilat, MATLAB- An Introduction with Applications, John Wiley and Sons Inc., 2007.
2. Devendra K. Chaturvedi, Modeling and Simulation of Systems using MATLAB and Simulink, CRC press, 2010.
3. Edward A. Bender, An Introduction to Mathematical Modelling, Wiley Press, 1978.

E- Resources:

1. https://people.maths.bris.ac.uk/~madjl/course_text.pdf
   https://repository.ung.ac.id/get/kms/16993/referensi-mata-kuliah-an-introduction-to-mathematical-modelling.pdf
2. https://repository.ung.ac.id/get/kms/16993/referensi-mata-kuliah-an-introduction-to-mathematical-modelling.pdf
3. http://mathforum.org
4. http://ocw.mit.edu/ocwweb/Mathematics
5. http://www.opensource.org
6. www.mathpages.com
7. https://nptel.ac.in
8. www.coursera.org
9. https://swayam.gov.in

SEMESTER – I

PIMAA20 – INDEPENDENT ELECTIVE 1 A: FUNDAMENTALS OF GROUP THEORY

Year: I **SEM:** I	**Course Code:** PIMAA20	**Title of the Course:** Independent Elective 1 A: Fundamentals of Group Theory	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**CREDITS** 2	**MARKS** 100

Course Objectives

1. To get the basic knowledge about groups, subgroups, normalizer of subgroups.
2. To develop the ability to solve basic objective problems in group theory.

Course Outcomes (CO)

The Learners will be able to

1. Understand the importance of various types of Groups.
2. Extend the knowledge in some important groups (Homomorphism and Isomorphism)
3. Understand the concepts of fundamentals of finite abelian groups.
4. Acquire benefits of Sylow's theorem and classify the Class equations.
5. Solve various objective type problems using simple concepts.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	M	L	H	M	H
CO2	H	M	L	H	M	H
CO3	H	M	L	H	M	H
CO4	H	M	L	H	M	H
CO5	H	M	L	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Groups

Introduction to Groups - Sub Groups – Coset – AbelianGroup – Normal Sub Groups – Cyclic Groups.(K1,K2,K3,K4,K5,K6)
(Chapter 15: 15.1-15.3, 15.6)

Unit II: Groups (Continued)

Quotient Groups – Direct Products – Some important Groups – Homomorphism and isomorphism – centre of a Groups.(K1,K2,K3,K4,K5,K6)
(Chapter 15: 15.4-15.5)

Unit III: Groups (Continued)

Normalizer of Subgroups – Centralizer of an Element or Normalizer of an Element – Commutator Subgroups – Fundamental theorem of Finite Abelian groups – Number of Non isomorphic Abelian Groups. (K1,K2,K3,K4,K5,K6)
(Chapter 15: 15.4-15.5)

Unit IV: Permutations

Permutations – Symmetric Groups S_n – Alternating Groups A_n – Conjugacy Classes and Conjugacy Relations. (K1,K2,K3,K4,K5,K6)
(Chapter 15: 15.7)

Unit V: Sylows Theorem

Class Equation – Sylows theorem – Results on simple Group – Solvable Groups and Jondan - Holder theorem. (K1,K2,K3,K4,K5,K6)
(Chapter 15: 15.8-15.10)

Books for study and reference:

Text Book:

1. R. Gupta's - Joint CSIR - UGC-NET Mathematical Sciences Previous Year's Solved Paper, 2014.

Books for Reference:

1. Dr. A. P. Singh - Modern Algebra – Infostudy Publication, 2018.
2. Dr. A . Kumar - CSIR-UGC NET/JRF/SLET Mathematical Sciences (Paper I & II) – UPKAR Prakashan Publications, 2010.
3. Pawan Sharma, Neha Sharma, Suraj Singh, Mathematical Sciences, UGC CSIR NET/SET (JRF & LS), Arihant Publications(India) Ltd, 2016.

4. S.K. Shrivastava & M.K. Malik - CSIR-UGC NET/JRF MATHEMATICAL SCIENCES Previous Years Solved Papers Including Model Papers With Explanation – JBC Press,2019.

E - Resources:

1. https://unacademy.com/content/csir-ugc/study-material/mathematical-sciences/
2. https://nptel.ac.in/
3. https://swayam.gov.in/nc_details/NPTEL
4. https://www.coursera.org/
5. https://testbook.com/csir-net/mathematical-science-study-material

SEMESTER – I

PIMAB20 - INDEPENDENT ELECTIVE 1 B: QUANTITATIVE APTITUDE FOR COMPETITIVE EXAMINATIONS I

Year : I **SEM :** I	**Course Code :** PIMAB20	**Title Of The Course :** Independent Elective 1 B: Quantitative Aptitude for Competitive Examinations I	**Course Type :** Theory	**Course Category :** Independent Elective	**H/W** -	**CREDITS** 2	**MARKS** 100

Course Objectives

1. To enhance the problem solving abilities and improve the basic mathematical skills
2. To help students who are preparing for any type of competitive examinations and acquire satisfactory competency in use of verbal reasoning

Course Outcomes (CO)

The Learners will be able to

1. Understand the concepts of Number System and aptitude problems.
2. Recollect the formulae and solve problems on profit and loss, Interest and Time and Work.
3. Demonstrate basic understanding on data interpretation and exhibit eloquence in verbal reasoning.
4. Identify and respond effectively to questions on clerical ability.
5. Recognize the type of questions and answer them confidently with efficiency in grammar.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	M	H	M	H
CO5	H	H	M	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	M	M
CO2	H	H	H	M	M	M
CO3	H	H	H	M	M	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: General Aptitude

Number System- HCF and LCM- Simplification- Fractions and Decimals- Powers and roots- Average- Percentage- Ratio and Proportion.(K1,K2,K3,K4,K5,K6)
(Section 2: 2.1-2.7)

Unit II: General Aptitude (Contd..)

Profit and Loss- Simple Interest - Compound Interest- Time and Work- Time and Distance- Clocks- Calendar- Area and Volume.(K1,K2,K3,K4,K5,K6)
(Section 2: 2.8-2.16)

Unit III: Data Interpretation and Verbal Ability Test

Data Interpretation - Series Completion- Analogy Questions- Odd man out/ Classification- Coding/ Decoding- Blood and Family Relationships- Direction questions- Questions about age, time and Calendar.(K1,K2,K3,K4,K5,K6)
(Section 2B, 3.1-3.7)

Unit IV: Test of Clerical Ability

Address (Common and Uncommon)- Questions based on Tables- Word Arrangement- Category/Classification- Marketing – Psychometry – Computer- Descriptive English. (K1,K2,K3,K4,K5,K6)
(Section 5: A-E)

Unit V: Test of English Language

Test of spotting the errors- Test of Sentence Improvement- Test of Synonyms and Antonyms- Test of reading comprehension-Test of selecting words in a running paragraph- Fill in the blanks- Test of spelling- Jumbled Sentences.(K1,K2,K3,K4,K5,K6)
(Section 4)

Books for study and reference:

Text Book:

1. Showick Thorpe, The Pearson Guide to the Bank Clerical Recruitment Examination, Second Edition,Publisher: Pearson, 2010.

Books for Reference:

1. R.S Agarwal, Quantitative Aptitude for Competitive Examinations, S.Chand Publications, 2017.
2. Khattar, Quantitative Aptitude for Competitive Exams 3ed, Pearson Publications, 2015.

3. B.S. Sijwalii, InduSijwali, A New Approach to REASONING Verbal & Non-Verbal, Arihant Publications, 2014.

E -Resources:

1. https://www.indiabix.com
2. https://www.indiabix.com/aptitude/questions-and-answers
3. https://myupsc.com/wp-content/uploads/2020/11/Quantitative-Aptitude-for-Competitive-Examinations-by-Dinesh-Khattar-z-lib.org_.pdf
4. http://mathforum.org,
5. http://ocw.mit.edu/ocwweb/Mathematics,
6. http://www.opensource.org,
7. www.coursera.org
8. https://swayam.gov.in

SEMESTER – II

PCMAE20 – LINEAR ALGEBRA

Year:I **SEM:**II	**Course Code:** PCMAE20	**Title of the Course:** Linear Algebra	**Course Type:** Theory	**Course Category:** Core	**H/W** 5	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To introduce the concepts of linear transformations.
2. To learn about finite fields.

Course Outcomes (CO)

The Learners will be able to

1. Have knowledge on Modules and Canonical form.
2. Analyze Jordan and Rational canonical form.
3. Understand the concepts of linear transformation and apply it on linear operators.
4. Understand the concepts of finite division ring.
5. Know about division rings having the field in their centers.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	H	H	M	L
CO2	H	H	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Modules and Canonical form **(15 Hours)**

1.1 Module, Direct sum, Sub module, Cyclic (K1,K2,K3,K4,K5,K6)
1.2 Fundamental theorem on finitely generated R- modules (K1,K2,K3,K4,K5,K6)
1.3 Similar (K1,K2,K3,K4,K5,K6)
1.4 Triangular form (K1,K2,K3,K4, K5,K6)

1.5 Nilpotent transformation (K1,K2,K3,K4,K5,K6)
1.6 Invariant and Cyclic (K1,K2,K3,K4,K5,K6)
(Chapter 4: Sections 4.5; Chapter 6: Sections 6.4 and 6.5)

Unit II: **Canonical Forms (Contd...)** **(15 Hours)**

2.1 Introduction (K1,K2,K3,K4,K5,K6)
2.2 Jordan Canonical form (K1,K2,K3,K4,K5,K6)
2.3 Jordan Block (K1,K2,K3,K4,K5,K6)
2.4 Rational canonical form, Cyclic sub modules (K1,K2,K3,K4,K5,K6)
2.5 Companion matrix(K1,K2,K3,K4,K5,K6)
2.6 Elementary Divisors and Characteristic polynomial (K1,K2,K3,K4,K5,K6)
(Chapter 6: Sections 6.6 and 6.7)

Unit III: Linear transformations **(15 Hours)**

3.1 Unitary (K1,K2,K3,K4,K5,K6)
3.2 Hermitian (K1,K2,K3,K4,K5,K6)
3.3 Normal transformation (K1,K2,K3,K4,K5,K6)
3.4 Quadratic form (K1,K2,K3,K4,K5,K6)
3.5 Congruence (K1,K2,K3,K4,K5,K6)
3.6 Sylvester's law (K1,K2,K3,K4,K5,K6)
(Chapter 6: Sections 6.10 and 6.11)

Unit IV: Finite fields **(15 Hours)**

4.1 Finite field (K1,K2,K3,K4,K5,K6)
4.2 Properties of finite fields (K1,K2,K3,K4,K5,K6)
4.3 The existence of solutions of certain equations in a finite field(K1,K2,K3,K4,K5,K6)
4.4 Division ring (K1,K2,K3,K4,K5,K6)
4.5 Wedderburn's theorem (First proof only) (K1,K2,K3,K4,K5,K6)
4.6 Jacobson theorem (K1,K2,K3,K4,K5,K6)
(Chapter 7: Sections 7.1 and 7.2)

Unit V: Finite fields (Contd.) **(15 Hours)**

5.1 Division Algebra, Algebraic over a field (K1,K2,K3,K4,K5,K6)
5.2 Frobenius theorem (K1,K2,K3,K4,K5,K6)
5.3 Adjoint, Norm (K1,K2,K3,K4,K5,K6)
5.4 Lagrange's Identity (K1,K2,K3,K4,K5,K6)
5.5 Left Division algorithm (K1,K2,K3,K4,K5,K6)
5.6 Lagrange's theorem (K1,K2,K3,K4,K5,K6)
(Chapter 7: Sections 7.3 and 7.4)

Books for study and reference:

Text Book:

1. I.N. Herstein - Topics in Algebra, 2nd Edition - H.S. Polai for Wiley Eastern Limited, New Delhi, 1993.

Books for Reference:

1. John B. Fraleigh - A First Course in Abstract Algebra, 5th Edition – Addison Wesley Longman Inc., Mexico City, 1999.
2. Kenneth Hoffman and Ray Alden Kunze, Linear Algebra, Second Edition, Prentice Hall of India Private Limited, New Delhi, 1975.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, Fourth Edition, Prentice Hall of India Private Limited, New Delhi, 2007.
4. P. P Gupta, S. K. Sharma, Linear Algebra, S.Chand and Company Ltd,New Delhi,1982.
5. V. Krishnamurthy, V. P. Mainra, J. L. Arora, Introduction to Linear Algebra, EastWest Press Ltd, 1985.

E- Resources:

1. https://marinazahara22.files.wordpress.com/2013/10/i-n-herstein-topics-in-algebra-2nd-edition-1975-wiley-international-editions-john-wiley-and-sons-wie-1975.pdf
2. http://abstract.ups.edu/download/aata-20110810.pdf
3. https://greggrant.org/hoffman_and_kunze.pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. www.algebra.com
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – II

PCMAF20 - REAL ANALYSIS- II

Year: I **SEM**: II	**Course Code:** PCMAF20	**Title of the Course:** Real Analysis – II	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 4	**Marks** 100

Course Objectives

1. To introduce the concepts of double sequences, double series, and Fourier series.
2. To provide students with a strong foundation in sequence of functions, implicit functions, and multivariable differential calculus.

Course Outcomes (CO)

The Learners will be able to

1. Understand the theory of double sequences and double series which is an extension of the single or ordinary sequences and series and identify the convergence and divergence of infinite product.
2. Determine the properties of the Fourier coefficient and solve the problem for the orthonormal system of functions.
3. Identify the Convergence of a sequence and series of functions.
4. Link the multiplication of power series, reciprocal of power series, and real power series.
5. Deal with the concepts of Directional derivative, Total derivative, Chain rule, Inverse function, and Implicit function theorems.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Double Sequences and Infinite Products **(18 Hours)**

1.1 Double sequences, Double Series (K1,K2,K3,K4,K5,K6)
1.2 Rearrangement theorem for double series (K1,K2,K3,K4,K5,K6)
1.3 A sufficient condition for equality of Iterated series (K1,K2,K3,K4,K5,K6)
1.4 Multiplication of series (K1,K2,K3,K4,K5,K6)
1.5 Cesaro summability (K1,K2,K3,K4,K5,K6)
1.6 Infinite products (K1,K2,K3,K4,K5,K6)
(Chapter 8: Sections 8.20 - 8.26)

Unit II: Sequences of Functions **(18 Hours)**

2.1 Pointwise convergence of sequences of functions, Examples of sequences of real valued functions (K1,K2,K3,K4,K5,K6)
2.2 Definition of uniform convergence, Uniform convergence and Continuity(K1,K2,K3,K4,K5,K6)
2.3 Cauchy condition for uniform convergence, Uniform convergence of infinite series of functions (K1,K2,K3,K4,K5,K6)
2.4 Uniform convergence and Riemann Stieltjes Integration, Non uniformly convergent sequences that can be integrated term by term (K1,K2,K3,K4,K5,K6)
2.5 Uniform convergence and differentiation, Sufficient condition for Uniform convergence of a series (K1,K2,K3,K4,K5,K6)
2.6 Uniform convergence and double sequences, Mean convergence (K1,K2,K3,K4,K5,K6)
(Chapter 9: Sections 9.1– 9.13, Omit 9.7 and theorem 9.12)

Unit III: Sequences of Functions (Contd…) **(18 Hours)**

3.1 Multiplication of power series (K1,K2,K3,K4,K5,K6)
3.2 The Substitution Theorem (K1,K2,K3,K4,K5,K6)
3.3 The Reciprocal of Power series, Real Power series, The Taylor's Series generated by a Function (K1,K2,K3,K4,K5,K6)
3.4 Bernstein's Theorem(K1,K2,K3,K4,K5,K6)
3.5 Abel's Limit Theorem (K1,K2,K3,K4,K5,K6)
3.6 Tauber's Theorem (K1,K2,K3,K4,K5,K6)
(Chapter 9: Sections 9.15– 9.23, Omit 9.21)

Unit IV: Fourier series **(18 Hours)**

4.1 Orthogonal systems of functions, The theorem on best approximation (K1,K2,K3,K4,K5,K6)
4.2 The fourier series of a function relative to an ortho normal system, Properties of the Fourier Coefficients(K1,K2,K3,K4,K5,K6)
4.3 The Riesz Fischer theorem, The convergence and representation problems for Trigonometric series(K1,K2,K3,K4,K5,K6)
4.4 The Riemann Lebesgue lemma(K1,K2,K3,K4,K5,K6)
4.5 The Dirichlet integrals (K1,K2,K3,K4,K5,K6)
4.6 An integral representation for the partial sums of a Fourier series, Riemann’s localization Theorem (K1,K2,K3,K4,K5,K6)
(Chapter 11: Sections 11.2-11.11)

Unit V: Multivariable Differential Calculus and Implicit Functions (18 Hours)

5.1 Introduction, Directional derivative, Directional derivatives and continuity (K1,K2,K3,K4,K5,K6)
5.2 Total derivative, Total derivative expressed in terms of partial derivatives (K1,K2,K3,K4,K5,K6)
5.3 Matrix of a linear function, Jacobian Matrix, Chain rule (K1,K2,K3,K4,K5,K6)
5.4 Matrix form of the chain rule, Mean value theorem for differentiable functions (K1,K2, K3,K4,K5,K6)
5.5 Introduction, Functions with non-zero Jacobian determinant, Inverse function theorem (K1, K2,K3,K4,K5,K6)
5.6 Implicit function theorem, Extrema of real valued functions of one variable (K1,K2,K3,K4,K5,K6)
(Chapter 12: Sections 12.1 - 12.11, Omit 12.6 & Chapter 13: Sections 13.1 to 13.5)

Books for study and reference:

Text Book:

1. Tom M. Apostol - Mathematical Analysis, 2nd Edition - Narosa Publishing House, New Delhi, 1997.

Books for Reference:

1. Walter Rudin – Principles of Mathematical Analysis, 3rd edition – McGraw Hill Company, New York, 1988.
2. R.R. Goldberg - Methods of Real Analysis, Indian Edition - Oxford and IBH Publishing Company,1970.
3. S.C. Malik and Savita Arora – Mathematical Analysis, 2nd Edition – New Age International (P) Limited Publishers, New Delhi, 1992.

E-Resources:

1. http://webpages.iust.ac.ir/amtehrani/files/Addison%20Wesley%20-%20Mathematical%20Analysis%20_%20Apostol%20%285Th%20Ed%29%20%281981%29.pdf
2. https://web.math.ucsb.edu/~agboola/teaching/2021/winter/122A/rudin.pdf
3. https://alansinyal.files.wordpress.com/2012/08/method-of-real-analysis.pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. www.mathpages.com
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – II

PCMAG20 - PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL PARTIAL DIFFERENTIAL EQUATIONS

Year: I **SEM:** II	**Course Code:** PCMAG20	**Title of the Course:** Partial Differential Equations and Integral Partial Differential Equations	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To derive heat and wave equations.
2. To apply partial derivative equation techniques to predict the behavior of certain phenomena.

Course Outcomes (CO)

The Learners will be able to

1. Apply specific methodologies, techniques and resources to conduct research and produce innovative results.
2. Solve problems of heat conduction equation by using initial and boundary conditions.
3. Use the knowledge of PDEs, to solve one dimensional wave equation by canonical equation.
4. Solve practical PDE and integral PDE problems with finite difference methods.
5. Develop mathematical skills to solve problems involving convolutions.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	M	H	M	H
CO5	H	H	M	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Elliptic Differential Equations (18 Hours)

1.1 Occurrence of the Laplace and Poisson equations(K1, K2, K3, K4, K5, K6)
1.2 Boundary value problems (K1, K2, K3, K4, K5, K6)
1.3 Some important mathematical tools (K1, K2, K3, K4, K5, K6)
1.4 Properties of harmonic functions (K1, K2, K3, K4, K5, K6)
1.5 Separation of variables (K1, K2, K3, K4, K5, K6)
1.6 Problems (K1, K2, K3, K4,K5, K6)
(Chapter 2: Sections 2.1 –2.5 and related examples in 2.13)

Unit II: Parabolic Differential Equations (18 Hours)

2.1 Occurrence of the diffusion equation (K1, K2, K3, K4, K5, K6)
2.2 Boundary conditions (K1, K2, K3, K4, K5, K6)
2.3 Elementary solutions of the diffusion equations (K1, K2, K3, K4, K5, K6)
2.4 Dirac delta function (K1, K2, K3, K4, K5, K6)
2.5 Separation of variables method (K1, K2, K3, K4, K5, K6)
2.6 Problems (K1, K2, K3, K4, K5, K6)
(Chapter3:Sections3.1 – 3.5 and related examples in 3.9)

Unit III: Hyperbolic Differential Equations (18 Hours)

3.1 Occurrence of the wave equation (K1, K2, K3, K4, K5, K6)
3.2 Derivation of one dimensional wave equation (K1, K2, K3, K4, K5, K6)
3.3 Solution of one dimensional wave equation by canonical equation (K1, K2, K3, K4, K5, K6)
3.4 Initial value problem - D'Alembert's solution (K1, K2, K3, K4, K5, K6)
3.5 Vibration string – Variable separable solution (K1, K2, K3, K4, K5, K6)
3.6 Forced vibration – Solution of non-homogeneous equation (K1, K2, K3, K4, K5, K6)
(Chapter 4: Sections 4.1–4.6 and related examples in 4.13)

Unit IV: Classification of Integral Equations and Connection with DE. (18 Hours)

4.1 Historical Introduction - Linear Integral equations (K1, K2, K3, K4, K5, K6)
4.2 Special type of kernel - Square integrable functions and kernels (K1, K2, K3, K4, K5, K6)
4.3 Singular integral equations (K1, K2, K3, K4, K5, K6)
4.4 Nonlinear equations (K1, K2, K3, K4, K5, K6)
4.5 Linear differential equations (K1, K2, K3, K4, K5, K6)
4.6 Green's function (K1, K2, K3, K4, K5, K6)
(Chapter 1: Sections 1.1 – 1.6 and Chapter 2: Sections 2.1 - 2.2)

Unit V: Integral equations of the convolution type and Integral equations with singular kernels (18 Hours)

5.1 Integral transforms - Fredholm equation of the first kind (K1, K2, K3, K4, K5, K6)
5.2 Volterra equation of the first kind - Fredholm equation of the second kind (K1, K2, K3, K4, K5, K6)
5.3 Stieltjes integral equation (K1, K2, K3, K4, K5, K6)

5.4 Volterra equation of the second kind - Abel's integral equation (K1, K2, K3, K4, K5, K6)
5.5 Fox's integral equation – Generalization to higher dimensions (K1, K2, K3, K4, K5, K6)
5.6 Green's functions in two and three dimensions (K1, K2, K3, K4, K5, K6)
(Chapter3:Sections3.1-3.6 and Chapter 5: Sections 5.1 and5.2)

Books for study and reference:

Text Book:

1. Sankara Rao K - Introduction to Partial Differential Equations, 5thEdition - Prentice Hall of India, New Delhi, 2004. (for units I, II,III).
2. B.L. Moiseiwitsch - Integral Equation, 1st Edition - Longman Group limited, London, 1977. (for units IV andV).

Books for Reference:

1. Snedon I.N. - Elements of Partial Differential Equations, First edition - Tata McGraw Hill, New Delhi, 1957.
2. M.D. Raisingania - Advanced Differential Equations, 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2001.
3. Amarnath T - An Elementary Course in Partial Differential Equations, 2nd edition - Narosa Publishing House,1997.

E- Resources:

1. http://ndl.ethernet.edu.et/bitstream/123456789/78639/2/Introduction%20to%20Partial%20Differential%20Equations%20%20By%20K.%20Sankara%20Rao.pdf
2. http://103.62.146.201:8081/xmlui/bitstream/handle/1/9075/Introduction%20to%20Partial%20Differential%20Equations%20%28%20PDFDrive%20%29.pdf?sequence=1&isAllowed=y
3. https://gauravtiwari.org/solving-integral-equations-1-definitions-and-types/
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. www.coursera.org
8. https://swayam.gov.in

SEMESTER – II

PCMAH20 – MECHANICS

Year : I **SEM :** II	**Course Code:** PCMAH20	**Title Of The Course:** Mechanics	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To know about the Physics concepts and its applications to Mathematics.
2. To enhance the basic concepts of mechanical system.

Course Outcomes (CO)

The Learners will be able to

1. Define and understand basic mechanical concepts related to discrete and continuous mechanical systems.
2. Describe and understand the motion of a mechanical system using Lagrange's equation.
3. Use Euler-Lagrange equation to find stationary paths and understanding the theory of variational principles.
4. Acquire knowledge on Hamilton's principle and Hamilton's equation.
5. Study the concepts of canonical transformations and solve the transformations by using Lagrange and Poisson brackets.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	M	L
CO2	H	H	M	H	M	L
CO3	H	H	M	H	M	L
CO4	H	H	M	H	M	L
CO5	H	H	M	H	M	L

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Introductory Concepts **(18 Hours)**

1.1 Mechanical system (K1,K2,K3,K4,K5,K6)
1.2 Generalized co-ordinates (K1,K2,K3,K4,K5,K6)
1.3 Constraints (K1,K2,K3,K4,K5,K6)
1.4 Virtual Work (K1,K2,K3,K4,K5,K6)
1.5 Energy (K1,K2,K3,K4,K5,K6)
1.6 Momentum. (K1,K2,K3,K4,K5,K6)
(Chapter 1: Sections 1.1 – 1.5)

Unit II: Lagrange's Equations **(18 Hours)**

2.1 Derivation of Lagrange's equations (K1,K2,K3,K4,K5,K6)
2.2 Forms of the equations of motion (K1,K2,K3,K4,K5,K6)
2.3 Examples based on forms of the equations of motion (K1,K2,K3,K4,K5,K6)
2.4 Integrals of Motion (K1,K2,K3,K4,K5,K6)
2.5 Liouville's system (K1,K2,K3,K4,K5,K6)
2.6 Examples based on integrals of motion (K1,K2,K3,K4,K5,K6)
(Chapter 2: Sections 2.1- 2.3)

Unit III: Hamilton's Equations **(18 Hours)**

3.1 Hamilton's Principle (K1,K2,K3,K4,K5,K6)
3.2 Brachistochrone problem – Geodesic problem (K1,K2,K3,K4,K5,K6)
3.3 Hamilton's principle – Multiplier Rule (K1,K2,K3,K4,K5,K6)
3.4 Hamilton's Equations (K1,K2,K3,K4,K5,K6)
3.5 Other variational principles (K1,K2,K3,K4,K5,K6)
3.6 Examples (K1,K2,K3,K4,K5,K6)
(Chapter 4: Sections 4.1 – 4.3)

Unit IV: Hamilton - Jacobi Theory **(18 Hours)**

4.1 Introduction (K1,K2,K3,K4,K5,K6)
4.2 Hamilton's principal function (K1,K2,K3,K4,K5,K6)
4.3 Hamilton – Jacobi Equation (K1,K2,K3,K4,K5,K6)
4.4 Conservative systems and Ignorable coordinates (K1,K2,K3,K4,K5,K6)
4.5 Separability (K1,K2,K3,K4,K5,K6)
4.6 Kepler problem on seperability (K1,K2,K3,K4,K5,K6)
(Chapter 5: Sections 5.1-5.3)

Unit V: Canonical Transformations **(18 Hours)**

5.1 Differential Forms and Generating Functions (K1,K2,K3,K4,K5,K6)
5.2 Special Transformations (K1,K2,K3,K4,K5,K6)
5.3 Problems based on canonical transformations (K1,K2,K3,K4,K5,K6)
5.4 Lagrange Brackets (K1,K2,K3,K4,K5,K6)
5.5 Poisson Brackets (K1,K2,K3,K4,K5,K6)
5.6 Bilinear covariant (K1,K2,K3,K4,K5,K6)
(Chapter 6: Sections 6.1 - 6.3)

Books for study and reference:

Text Book:

1. T. Greenwood - Classical Dynamics, 2nd Edition – Prentice Hall of India Pvt. Ltd., New Delhi, 1985.

Books for Reference:

1. Goldstein - Classical Mechanics - Narosa Publishing House, New Delhi, 17th Reprint, 1998.
2. N.C. Ran and P.S. Joag - Classical Mechanics - Tata McGraw Hill Publishing Company Limited, New Delhi, 2004.
3. J. L. Synge and P. S. C. Joag - Classical Mechanics - Tata McGraw Hill, New Delhi, 1991.
4. P. G. Bergmann- Introduction to Theory of Relativity- Prentice Hall of India, Eddington, New Delhi, 1969.

E- Resources:

1. https://books.google.com.na/books?id=x7rj83I98yMC&printsec=frontcover#v=onepage&q&f=false
2. https://efaidnbmnnnibpcajpcglclefindmkaj/http://www.stet.edu.in/SSR_Report/Study%20Material/PDF/MATHS/PG/II%20Year/1.pdf
3. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
4. https://efaidnbmnnnibpcajpcglclefindmkaj/https://www.physics.rutgers.edu/~shapiro/507/book.pdf
5. https://nptel.ac.in/
6. https://swayam.gov.in/nc_details/NPTEL
7. https://www.coursera.org/

SEMESTER – II

PEMAC20 - Elective II A: LaTeX and MATLAB

Year : I **SEM :** II	**Course Code :** PEMAC20	**Title Of The Course :** Elective II A : LaTeX and MATLAB	**Course Type :** Theory	**Course Category :** Elective	**H/W** 5	**CREDITS** 4	**MARKS** 100

Course Objectives

1. Demonstrate the ability to type research papers in Latex software in a fluent manner.
2. To use and write script files (MATLAB programs) and enable the students to learn and use MATLAB software.

Course Outcomes (CO)

The Learners will be able to

1. Understand the mathematical basis of common algorithms in Latex.
2. Demonstrate the use of mathematical equations, tables and figures in Latex.
3. Demonstrate understanding and use of MATLAB software
4. Construct one dimensional array, two dimensional arrays and basic functions in MATLAB.
5. Recognize the power of mathematical modelling and analysis using MATLAB and be able to apply their understanding to their further studies.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	M	H	H	L	H	M
CO2	M	H	H	L	H	M
CO3	H	H	H	L	H	M
CO4	H	L	H	L	H	L
CO5	H	H	H	L	H	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Creating text using LATEX **(15 Hours)**

1.1 Fonts and Paragraphs(K1,K2,K3,K4,K4,K5,K6)
1.2 Lists(K1,K2,K3,K4,K5,K6)
1.3 Tables, Special Characters(K1,K2,K3,K4,K5,K6)
1.4 Line and page breaks, spacing(K1,K2,K3,K4,K5,K6)
1.5 Bibliography with Bibtex (K1,K2,K3,K4,K5,K6)
1.6 Create a document file to prepare a Chapter in a Book. (K1,K2,K3,K4,K5,K6)

Unit II: Math Mode, Graphics and special parts **(15 Hours)**

2.1 Mathematical symbols, Fractions (K1,K2,K3,K4,K5,K6)
2.2 Equations and arrays, Derivatives and Integrals (K1,K2,K3,K4,K5,K6)
2.3 Theorems and definitions (K1,K2,K3,K4,K5,K6)
2.4 Graphics (K1,K2,K3,K4,K5,K6)
2.5 Making special parts, front matter and back matter(K1,K2,K3,K4,K5,K6)
2.6 Create a Document file to prepare a research article.(K1,K2,K3,K4,K5,K6)

Unit III: Starting with MATLAB **(15 Hours)**

3.1 Starting MATLAB, MATLAB Windows (K1,K2,K3,K4,K5,K6)
3.2 Working in the command window (K1,K2,K3,K4,K5,K6)
3.3 Arithmetic operation with scalars, Using MATLAB as Calculator (K1,K2,K3,K4,K5,K6)
3.4 Display Formats, Elementary Math Built in Functions (K1,K2,K3,K4,K5,K6)
3.5 Defining Scalar Variables, Useful commands for managing variables (K1,K2,K3,K4,K5,K6)
3.6 Script Files (K1,K2,K3,K4,K5,K6)

Unit IV: Creating Arrays and Mathematical operations with Arrays **(15 Hours)**

4.1 Creating one dimensional array (K1,K2,K3,K4,K5,K6)
4.2 Creating two dimensional array (K1,K2,K3,K4,K5,K6)
4.3 The transpose operator, Addressing array as vector and matrix (K1,K2,K3,K4,K5,K6)
4.4 Using a colon in addressing arrays, Addition and Subtraction(K1,K2,K3,K4,K5,K6)
4.5 Array Multiplication, Array Division (K1,K2,K3,K4,K5,K6)
4.6 Element by element operations, using arrays in MATLAB built in MATLAB functions (K1,K2,K3,K4,K5,K6)

Unit V: Introduction to Systems **(15 Hours)**

5.1 System, System Boundary (K1,K2,K3,K4,K5,K6)
5.2 System components and their interactions, Environment (K1,K2,K3,K4,K5,K6)
5.3 Classification of systems (K1,K2,K3,K4,K5,K6)
5.4 According to complexity of system, nature and type of components (K1,K2,K3,K4,K5,K6)
5.5 Linear systems, Superposition theorem.(K1,K2,K3,K4,K5,K6)
5.6 Solution to linear non- homogeneous equations (4 unknowns). (K1,K2,K3,K4,K5,K6)

Books for study and reference:

Text Books:

1. Greenberg, Harvey J. "A simplified introduction to LATEX." University of Colorado at Denver, (2010).(Unit I and II)
2. Amos Gilat, MATLAB- An Introduction with Applications, John Wiley and Sons Inc., 2007.(Unit III -V)

Books for Reference:

1. Devendra K. Chaturvedi, Modeling and Simulation of Systems using MATLAB and Simulink, CRC press, 2010.
2. Edward A. Bender, An Introduction to Mathematical Modelling, Wiley Press, 1978.
3. Grätzer, G. Math into LATEX: An introduction to LATEX and AMS-LATEX. Springer Science & Business Media, 2013.

E- Resources:

1. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=ab4433ddb03085867fca6b70547c33b638bdad42
2. http://www.os.ac.me/MS_kn.pdf
3. https://people.maths.bris.ac.uk/~madjl/course_text.pdf
4. https://spoken-tutorial.org/
5. https://nptel.ac.in/
6. https://swayam.gov.in/nc_details/NPTEL
7. https://www.coursera.org/

SEMESTER – II

PEMAD20 - Elective II B: FLUID DYNAMICS

Year : I **SEM :** II	**Course Code:** PEMAD20	**Title Of The Course :** Elective II B : Fluid Dynamics	**Course Type :** Theory	**Course Category :** Elective	**H/W** 5	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To introduce the fundamental concepts of Fluid Dynamics
2. To understand the concepts of fluid motion, equations of motion of a fluid, three dimensional flows and viscous flows and apply it in practical situations.

Course Outcomes (CO)

The Learners will be able to

1. Understand the concepts of fluid flow
2. Identify pressure of fluid in different kind of Motion
3. Analyse the topics of Axi-Symmetric Flows, Stoke's Stream Function
4. Determine the Stream Function, the Complex Potential for Two-Dimensional, Irrotational, Incompressible Flow.
5. Explain the concepts the Rate of Strain Quadric and Principal Stresses, Stress Analysis in Fluid Motion, the Coefficient of Viscosity and Laminar Flow, the Navier-Stokes Equations of Motion of a Viscous Fluid.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	L	M	H	M
CO2	H	H	L	M	H	M
CO3	H	H	L	M	H	M
CO4	H	M	L	M	H	L
CO5	H	H	L	M	H	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Kinematics of Fluids in Motion (15 Hours)

1.1 Real fluids and Ideal fluids (K1, K2, K3, K4, K5, K6)
1.2 Velocity of a Fluid at a Point-Streamlines and Path lines (K1, K2, K3, K4, K5, K6)
1.3 Steady and Unsteady flows (K1, K2, K3, K4, K5, K6)
1.4 The Velocity Potential – The Vorticity Vector(K1, K2, K3, K4, K5, K6)
1.5 The Equation of Continuity – Worked Examples (K1, K2, K3, K4, K5, K6)
1.6 Acceleration of a Fluid.(K1, K2, K3, K4, K5, K6)
(Chapter 2, Sections: 2.1 to 2.9)

Unit II: Equations of Motion of a Fluid (15 Hours)

2.1 Pressure at a Point in a Fluid at Rest (K1, K2, K3, K4, K5, K6)
2.2 Pressure at a Point in a Moving Fluid (K1, K2, K3, K4, K5, K6)
2.3 Conditions at a Boundary of Two Inviscid immiscible Fluids(K1, K2, K3, K4, K5, K6)
2.4 Euler's Equations of Motion (K1, K2, K3, K4, K5, K6)
2.5 Bernoulli's Equation(K1, K2, K3, K4, K5, K6)
2.6 Some Worked examples (K1, K2, K3, K4, K5, K6)
(Chapter 3, Sections: 3.1 to 3.6)

Unit III: Some Three Dimensional Flows (15 Hours)

3.1 Introduction-Sources(K1, K2, K3, K4, K5, K6)
3.2 Sinks(K1, K2, K3, K4, K5,K6)
3.3 Doublets(K1, K2, K3, K4, K5,K6)
3.4 Images in a rigid infinite plane(K1, K2, K3, K4, K5, K6)
3.5 Axi-Symmetric Flows(K1, K2, K3, K4, K5, K6)
3.6 Stokes's Stream Function.(K1, K2, K3, K4, K5, K6)
(Chapter 4, Sections: 4.1, 4.2, 4.5)

Unit IV: Some Two Dimensional Flows (15 Hours)

4.1 Meaning of Two-Dimensional Flow (K1, K2, K3, K4, K5, K6)
4.2 Use of Cylindrical Polar Coordinates (K1, K2, K3, K4, K5, K6)
4.3 The Stream Function(K1, K2, K3, K4, K5, K6)
4.4 The Complex Potential for Two-Dimensional, Irrotational, Incompressible Flow (K1, K2, K3, K4, K5, K6)
4.5 Complex Velocity Potentials for Standard Two-Dimensional Flows(K1, K2, K3, K4, K5, K6)
4.6 Some Worked Examples.(K1, K2, K3, K4, K5, K6)
Chapter 5, Sections: 5.1 to 5.6)

Unit V: Viscous Flows **(15 Hours)**

5.1 Stress Components in Real Fluid (K1, K2, K3, K4, K5, K6)
5.2 Relations between Cartesian Components of Stress (K1, K2, K3, K4, K5, K6)
5.3 Translation Motion of Fluid Element (K1, K2, K3, K4, K5, K6)
5.4 The Rate of Strain Quadric and Principal Stresses (K1, K2, K3, K4, K5, K6)
5.5 Relation between Stress and Rate of Strain(K1, K2, K3, K4, K5, K6)
5.6 The Coefficient of Viscosity and Laminar Flow (K1, K2, K3, K4, K5, K6)
(Chapter 8, Sections: 8.1 to 8.9)

Books for study and reference:

Text Book:

1. F. Chorlton, Text book of Fluid Dynamics, CBS Publishers & Distributors Pvt. Ltd, New Delhi, Reprint 2004.

Books for Reference:

1. A. R. Paterson, A First Course in Fluid Dynamics, Cambridge University Press, New York, 1987.
2. G.K. Batchelor, An Introduction of Fluid Mechanics, Foundation Books, New Delhi, 1993.
3. R. K. Rathy, An Introduction to Fluid Dynamics, IBH Publishing Company, New Delhi, 1976.
4. E. Krause, Fluid Mechanics with problems and solutions, Springer, 2005

E- Resources:

1. https://pdfcoffee.com/fluid-dynamics-by-chorlton-pdf-free.html
2. https://kanchiuniv.ac.in/coursematerials/Fluid%20Dynamics%20MMAF183T40-course%20material.pdf
3. https://handoutset.com/wp-content/uploads/2022/07/A-First-Course-in-Fluid-Dynamics-A.-R.-Paterson.pdf
4. https://nptel.ac.in/
5. https://swayam.gov.in/nc_details/NPTEL
6. https://www.coursera.org/

SEMESTER – II

PIMAC20 -INDEPENDENT ELECTIVE 2 A: FUNDAMENTALS OF RING THEORY

Year:I **SEM:**II	**Course Code:** PIMAC20	**Title of the Course:** Independent Elective 2 A: Fundamentals of Ring Theory	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**CREDITS** 2	**MARKS** 100

Course Objectives

1. To get the basic knowledge about Rings, Sub rings and Types of Rings.
2. To engage them in self independent study of the Lecture notes and enable the students to workout unsolved problems using various tricks.

Course Outcomes (CO)

The Learners will be able to

1. Demonstrate various characteristic of Rings.
2. Extend the knowledge in Ideals, Fields of Quotients and polynomial rings.
3. Validate primitive polynomials and Irreducible Polynomials.
4. Acquire the knowledge in Field theory.
5. Solve various types of problems in finite fields.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	M	L	H	M	H
CO2	H	M	L	H	M	H
CO3	H	M	L	H	M	H
CO4	H	M	L	H	M	H
CO5	H	M	L	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Ring Theory

Ring – Sub Ring – Types of Ring – Zero Divisors – Integral Domain – Unit of Ring – Boolean Ring – Characteristic of a Ring – Equivalence Relation on Ring. (K1,K2,K3,K4,K5,K6)
(Chapter 16: 16.1)

Unit II: Ring Theory (Contd…)

Ideals – Quotient Ring – Ring Homomorphism – Field of Quotients – Polynomial Rings – Some Definitions.(K1,K2,K3,K4,K5,K6)
(Chapter 16: 16.2)

Unit III: Ring Theory (Contd…)

Principle Ideal Domain (PID) – Euclidean Domain (ED) – Unique Factorization Domain (UFD) - Content of Polynomial – Primitive Polynomial – Irreducible Polynomial. (K1,K2,K3,K4,K5,K6)
(Chapter 16: 16.3-16.7)

Unit IV: Field Theory

Definition of Field – Some Definitions – Simple Extension – Algebraic Extension – Monic polynomial – minimal polynomial – Factor Theorem – Splitting Field. (K1,K2,K3,K4,K5,K6)
(Chapter 16: 16.8)

Unit V: Field Theory (Contd…)

Conjugate Elements – Separable Polynomial – Separable Element – Purely Inseparable Extension – Normal Extension – Galois Extension – Fundamental Theorem of Galois Theory. (K1,K2,K3,K4,K5,K6)
(Chapter 16: 16.9-16.10)

Books for study and reference:

Text Book:

1. R. Gupta's - Joint CSIR - UGC-NET Mathematical Sciences Previous Year's Solved Paper, 2014.

Books for Reference:

1. Dr. A. P. Singh - Modern Algebra – Infostudy Publication, 2018.
2. Edward A. Bender, An Introduction to Mathematical Modelling, Wiley Press, 1978.
3. Grätzer, G. Math into LATEX: An introduction to LATEX and AMS-LATEX. Springer Science & Business Media,2013.

4. S.K. Shrivastava & M.K. Malik - CSIR-UGC NET/JRF MATHEMATICAL SCIENCES Previous Years Solved Papers Including Model Papers With Explanation – JBC Press, 2019.

E- Resources:

1. https://unacademy.com/content/csir-ugc/study-material/mathematical-sciences/
2. https://nptel.ac.in/
3. https://swayam.gov.in/nc_details/NPTEL
4. https://www.coursera.org/
5. https://testbook.com/csir-net/mathematical-science-study-material

SEMESTER – II

PIMAD20 -INDEPENDENT ELECTIVE 2 B: QUANTITATIVE APTITUDE FOR COMPETITIVE EXAMINATIONS II

Year :I SEM :II	Course Code : PIMAD20	Title Of The Course : Independent Elective 2 B: Quantitative aptitude for competitive examinations II	Course Type : Theory	Course Category : Independent Elective	H/W -	CREDITS 2	MARKS 100

Course Objectives

1. To introduce quantitative methods and techniques for effective decisions–making and provide a detailed knowledge about Mathematical, Transportation and Assignment models.
2. To analyze any real life system with limited constraints and depict it in a model form and examine the aspects of business and marketing with respect to operations research.

Course Outcomes (CO)

The Learners will be able to

1. Understand and solve aptitude problems.
2. Identify and develop the techniques to solve the problems using different methods.
3. Demonstrate procedural fluency with real number arithmetic operations and use those operations to represent real-world scenarios and to solve stated problems.
4. Solve linear equations, graph and interpret linear models, and read and apply formulas.
5. Ability to face the competitive examinations with a clear approach.

CO	PSO					
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	L	M	M	H
CO4	H	H	M	M	M	H
CO5	H	H	M	H	M	H

(L-Low, M-Moderate, H-High)

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	M	M
CO2	H	H	H	M	M	M
CO3	H	H	H	M	M	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Reasoning Ability

Series Completion- Arranging of figures in series- Classification- Pattern Comparison- Analogies- Analytical reasoning- Practical exercises- Critical Reasoning- Practical exercises.(K1,K2,K3,K4,K5,K6)
(Section: 3 : Part B and C)

Unit II: Arithmetical Ability

Surds and indices- Pipes and Cisterns- Problem on Trains- Boats and streams- Logarithms- Alligation or Mixture- Area- Volume and surfaces.(K1,K2,K3,K4,K5,K6)
(Section 1:1.9, 1.16, 1.18-1.20, 1.23-1.25)

Unit III: Arithmetic Ability (Contd…)

Partnership- Permutations and Combinations- Probability- True Discount- Banker's Discount- Heights and Discount- Odd man out and series.(K1,K2,K3,K4,K5,K6)
(Section 1:1.30-1.35, 1.13)

Unit IV: General Awareness

Banks Information- Socio economic status of India- Government schemes- Agriculture- National- Dateline-Art and Culture - News papers in India and Abroad- Awards- Space- International- Sports- Politics.(K1,K2,K3,K4,K5,K6)
(Section: 5)

Unit V: Current Affairs and Computers

International Affairs- Important days- Science and Medicine- Current Affairs- Social Banking- Real Banking- Glossary of Computer- Short Keys.(K1,K2,K3,K4,K5,K6)
(Section: 5)

Books for study and reference:

Text Books:

1. IBPS Clerks, Frontline Publication, 2012.
2. R.S. Agarwal, Quantitative Aptitude for Competitive Examinations, Revised Edition, S. Chand Publications, 2017.

Books for Reference:

1. R.S. Agarwal, Quantitative Aptitude for Competitive Examinations, S.Chand Publications, 2017.
2. Khattar, Quantitative Aptitude for Competitive Exams 3ed, Pearson Publications, 2015.
3. B.S. Sijwalii, InduSijwali, A New Approach to REASONING Verbal & Non-Verbal, Arihant Publications, 2014.

E-Resources:

1. https://www.indiabix.com
2. https://myupsc.com/wp-content/uploads/2020/11/Quantitative-Aptitude-for-Competitive-Examinations-by-Dinesh-Khattar-z-lib.org_.pdf
3. https://www.studocu.com/in/document/national-institute-of-technology-kurukshetra/applied-statistical-methods/1-rs-aggarwal-quantitative-aptitude-pdfdrivecom/44016064
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. www.coursera.org

SEMESTER – III

PCMAI20 - TOPOLOGY

Year: II **SEM**: III	**Course Code:** PCMAI20	**Title of the Course:** Topology	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To generalize the concepts that the students have learnt in Real analysis and to train the students to develop analytical thinking.
2. To introduce the topological spaces which provide a general framework for the study of convergence, continuity and compactness.

Course Outcomes (CO)

The Learners will be able to

1. Understand basis as a collection of basic open sets and the concepts of continuous functions and their properties in topological spaces.
2. Determine the topology generated by the given basis, connectedness, path connectedness of the product of an arbitrary family of spaces.
3. Grasp the concept of compactness which is the generalization to topological spaces of the property of closed and bounded subsets of the real line.
4. Deal with the countability and separation axioms
5. Know the theorems with the conditions under which a topological space can be embedded in metric space.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Topological Spaces **(18 Hours)**

1.1 Topological spaces (K1,K2,K3,K4,K5,K6)
1.2 Basis for a topology (K1,K2,K3,K4,K5,K6)
1.3 Ordered topology, Product topology on X x Y (K1,K2,K3,K4,K5,K6)
1.4 Subspace topology (K1,K2,K3,K4,K5,K6)
1.5 Closed sets (K1,K2,K3,K4,K5,K6)
1.6 Limit points (K1,K2,K3,K4,K5,K6)
(Chapter 2: Sections 12 – 17)

Unit II: Metric space topology and Connectedness **(18 Hours)**

2.1 Continuous Functions (K1,K2,K3,K4,K5,K6)
2.2 The product topology (K1,K2,K3,K4,K5,K6)
2.3 The metric topology (K1,K2,K3,K4,K5,K6)
2.4 The metric topology (continued) (K1,K2,K3,K4,K5,K6)
2.5 Connected spaces (K1,K2,K3,K4,K5,K6)
2.6 Connected subspaces of the Real line (K1,K2,K3,K4,K5,K6)
(Chapter 2: Sections 18 - 21 and Chapter 3: Sections 23 - 24)

Unit III: Connectedness and Compactness **(18 Hours)**

3.1 Components (K1,K2,K3,K4,K5,K6)
3.2 Local connectedness(K1,K2,K3,K4,K5,K6)
3.3 Compact spaces (K1,K2,K3,K4,K5,K6)
3.4 Compact subspaces of the Real Line (K1,K2,K3,K4,K5,K6)
3.5 Limit point compactness (K1,K2,K3,K4,K5,K6)
3.6 Local compactness (K1,K2,K3,K4,K5,K6)
(Chapter 3: Sections 25 - 29)

Unit IV: Separation Axioms **(18 Hours)**

4.1 The Countability Axioms (K1,K2,K3,K4,K5,K6)
4.2 The Countability Axioms (continued) (K1,K2,K3,K4,K5,K6)
4.3 The Separation Axioms (K1,K2,K3,K4,K5,K6)
4.4 The Separation Axioms (continued) (K1,K2,K3,K4,K5,K6)
4.5 Normal spaces(K1,K2,K3,K4,K5,K6)
4.6 Normal spaces (continued) (K1,K2,K3,K4,K5,K6)
(Chapter 4: Sections30 – 32)

Unit V: Complete Metric Spaces **(18 Hours)**

5.1 The Urysohn Lemma (K1,K2,K3,K4,K5,K6)
5.2 Regular Space (K1,K2,K3,K4,K5,K6)

5.3 The Urysohn Metrization Theorem (K1,K2,K3,K4,K5,K6)
5.4 Imbedding Theorem (K1,K2,K3,K4,K5,K6)
5.5 TheTietze Extension Theorem(K1,K2,K3,K4,K5,K6)
5.6 The Tychonoff Theorem (K1,K2,K3,K4,K5,K6)
(Chapter 4:Sections33 – 35, Chapter 5: Section 37)

Books for study and reference:

Text Books:

1. James R. Munkres – Topology, 2nd Edition – Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. James Munkres – Topology, 2nd Edition – Pearson New International Edition, Pearson Education Limited, USA, 2014.

Books for Reference:

1. George F. Simmons – Introduction to Topology and Modern Analysis – McGraw Hill Education (India) Private Limited, New Delhi, 2004 (26th Reprint 2016).
2. Nanda S. - General Topology, 2nd Edition – Oxford and IBH Publishing Co. Pvt. Ltd., 2014.
3. Sharma J.N. - Krishna's Topology (for Honours and Post Graduate Students of All Indian Universities), Thirty Seventh Edition – Krishna Prakashan Media (P) Ltd., Meerut, U.P, India, 2010.

E-Resources:

1. http://www.alefenu.com/libri/topologymunkres.pdf
2. https://www.mymathscloud.com/api/download/modules/University/Textbooks/topology/3)Topology%20A%20First%20Course%20Munkres.pdf?id=48928264
3. https://qcpages.qc.cuny.edu/~jdodziuk/320-s2019/Seymour%20Lipschutz%20-%20Schaum's%20Outline%20of%20General%20Topology-McGraw-Hill%20(1968).pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. http://en.wikipedia.org
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – III

PCMAJ20 - NUMERICAL ANALYSIS

Year: II **SEM:** III	**Course Code:** PCMAJ20	**Title of the Course:** Numerical Analysis	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To develop the skills in solving the Numerical problems and apply in other disciplines.
2. To implement various methods to apply in wider area of research.

Course Outcomes (CO)

The Learners will be able to

1. Find the solution in Numerical, Algebraic and transcendental equations.
2. Solve the set of algebraic equations by direct and iterative methods.
3. Analyze the values of a function for any intermediate value of the independent variable.
4. Compute the numerical solution of various types of ordinary differential equations.
5. Acquire the numerical solution of Partial Differential Equations.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	M	H	H	M	L
CO2	H	M	H	H	M	L
CO3	H	M	H	H	M	L
CO4	H	M	H	H	M	L
CO5	H	M	H	H	M	L

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Solution to Numerical, Algebraic and Transcendental Equations (18 Hours)

1.1 Introduction - Definition (K1,K2, K3,K4,K5,K6)

1.2 Bisection Method (K1,K2,K3,K4,K5,K6)

1.3 Method of successive approximation, False position (K1,K2,K3,K4,K5,K6)
1.4 Newton's Iteration Method (K1,K2,K3,K4,K5,K6)
1.5 Convergence of Newton- Horner's Method (K1,K2,K3,K4,K5,K6)
1.6 Descartes Rule of Signs- Graeffes Root Squaring Method (K1,K2,K3,K4,K5,K6)
(Chapter 3: Section 3.1 – 3.11)

Unit II: **Solving Sets of Equations** **(18 Hours)**

2.1 Introduction (K1,K2, K3,K4,K5,K6)
2.2 Types and algorithm for solving algebraic sets of equation (K1,K2, K3,K4,K5,K6)
2.3 The Gaussian Elimination (K1,K2,K3,K4,K5,K6)
2.4 Gauss Jordan Method (K1,K2,K3,K4,K5,K6)
2.5 Type I : Iterative Method (K1,K2,K3,K4,K5,K6)
2.6 Type II: Iterative Method (K1,K2,K3,K4,K5,K6)
(Chapter 4: 4.2- 4.10)

Unit III: Interpolation and Curve Fitting **(18 Hours)**

3.1 Introduction (K1,K2, K3,K4,K5,K6)
3.2 Problems solving in Lagrangian Polynomials(K1,K2,K3,K4,K5,K6)
3.3 Analyze data in Divided Differences (K1,K2,K3,K4,K5,K6)
3.4 Problems solving in Evenly Spaced Data (K1,K2,K3,K4,K5,K6)
3.5 Problems solving in Polynomial Approximation of Surfaces(K1,K2,K3,K4,K5,K6)
3.6 Finding solution of Getting Derivatives and Integrals Numerically (K1,K2,K3,K4,K5,K6)
(Chapter 5, Section 5.2 – 5.5)

Unit IV: Numerical Solution of Ordinary Differential Equations **(18 Hours)**

4.1 Introduction – Basic Definitions (K1,K2, K3,K4,K5,K6)
4.2 Basic steps and algorithm of Solving ordinary differential equations (K1,K2, K3,K4,K5,K6)
4.3 Solving ODE using Taylor's Series method (K1,K2,K3,K4,K5,K6)
4.4 Find solutions of ODE using Runge – Kutta Methods (K1,K2,K3,K4,K5,K6)
4.5 Milne's methods (K1,K2,K3,K4,K5,K6)
4.6 Compute ODE using Adam's Moulton Method (K1,K2,K3,K4,K5,K6)
(Chapter 11: 11.4-11.6 and 11.13 to 11.20)

Unit V: Numerical solution to Partial Differential Equations **(18 Hours)**

5.1 Introduction – Difference Quotients(K1,K2, K3,K4,K5,K6)
5.2 Geometrical Representation of Partial Difference Quotients(K1,K2,K3,K4,K5,K6)
5.3 Classification of Partial Differential Equations – Elliptic Equations(K1,K2,K3,K4,K5,K6)
5.4 Solution to Laplace's Equation by Liebmann's iteration process(K1,K2,K3,K4,K5,K6)

5.5 Poisson's Equation and its solutions – Crank – Nicholson method (K1,K2,K3,K4,K5,K6)
5.6 Hyperbolic equations(K1,K2,K3,K4,K5,K6)
(Chapter 12: 12.1-12.7, 12.8.2, 12.9)

Books for study and reference:

Text Book:

1. V.N. Vedamurthy N. Ch. S. N. Iyengar – Numerical Methods – Vikas Publishing Houe Pvt. Ltd, 2000.

Books for Reference:

1. R.L. Burden, J. Douglas Faires – Numerical Analysis – Thompson Books, USA, 2005.
2. S.S. Sastry – Introductory Methods of Numerical Analysis – Prentice Hall of India Pvt. Ltd., New Delhi, 2001.
3. M.K. Jain, S.R.K.Iyengar, R.K.Jain – Numerical Methods for Scientific and Engineering Computation, 3rd Edition – Wiley Eastern Ltd, New Delhi 1993.
4. M.K. Jain, S.R.K. Iyengar, R.K.Jain – Numerical Methods for Scientific and Engineering Computation, 3rd Edition – Wiley Eastern Ltd, New Delhi 1993.

E- Resources:

1. https://powersystemfreebooks.blogspot.com/2019/09/pdf-complete-book-numerical-methods-by.html
2. https://pdf.wecabrio.com/numerical-methods-by-p-kandaswamy.pdf
3. https://efaidnbmnnnibpcajpcglclefindmkaj/https://gdcboysang.ac.in/About/Droid/uploads/Numerical%20Methods.pdf
4. https://nptel.ac.in/
5. https://swayam.gov.in/nc_details/NPTEL
6. https://www.coursera.org/

SEMESTER – III

PCMAK20 - PROBABILITY THEORY

Year :II SEM :III	Course Code : PCMAK20	Title Of The Course : Probability Theory	Course Type : Theory	Course Category : Core	H/W 6	CREDITS 4	MARKS 100

Course Objectives

1. Apply problem solving technique to solve real world event.
2. Understand the concept of random variables.

Course Outcomes (CO)

The Learners will be able to

1. Characterize probability models and function of random variables based on single and multiple random variables.
2. Evaluate and apply expected value, moments and understand the concept of Chebyshev inequality.
3. Analyze the concepts of characteristic functions and its properties.
4. Apply probability distribution to solve the real world problems.
5. Understand the concept of limit theorem and its applications.

CO	PSO					
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	H	H	M
CO2	H	H	M	H	H	M
CO3	H	H	M	H	H	L
CO4	H	H	M	H	H	L
CO5	H	H	M	H	H	L

(L-Low, M-Moderate, H-High)

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	H	M	M
CO2	H	H	H	H	M	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Random Variables (18 Hours)

1.1 The concept of a random variable (K1,K2,K3,K4,K5,K6)
1.2 The distribution function-Random variables of the discrete type and the continuous type (K1,K2,K3,K4,K5,K6)
1.3 Function of random variables (K1,K2,K3,K4,K5,K6)
1.4 Multidimensional random variable (K1,K2,K3,K4,K5,K6)
1.5 Marginal and Conditional distributions (K1,K2,K3,K4,K5,K6)

1.6 Independent random variables - Functions of Multi dimensional random variables (K1,K2,K3,K4,K5,K6)
(Chapter 2: Sections 2.1 to 2.9)

Unit II: Parameters of the Distribution of a Random Variable (18 Hours)

2.1 Expected values (K1,K2,K3,K4,K5,K6)
2.2 Moments (K1,K2,K3,K4,K5,K6)
2.3 The Chebyshev Inequality (K1,K2,K3,K4,K5,K6)
2.4 Absolute moments (K1,K2,K3,K4,K5,K6)
2.5 Order parameters (K1,K2,K3,K4,K5,K6)
2.6 Moments of random vectors (K1,K2,K3,K4,K5,K6)
(Chapter 3: Sections 3.1 - 3.6)

Unit III: Characteristic Functions (18 Hours)

3.1 Properties of Characteristic function (K1,K2,K3,K4,K5,K6)
3.2 The characteristic function and moments (K1,K2,K3,K4,K5,K6)
3.3 Semi-invariants (K1,K2,K3,K4,K5,K6)
3.4 The characteristic function of the sum of independent random variables (K1,K2,K3,K4,K5,K6)
3.5 Determination of the distribution function by the characteristic function (K1,K2,K3,K4,K5,K6)
3.6 The characteristic function of multidimensional random vectors – Probability generating functions (K1,K2,K3,K4,K5,K6)
(Chapter 4: Sections 4.1 - 4.7)

Unit IV: Probability Distributions (18 Hours)

4.1 One – point and two - point distributions (K1,K2,K3,K4,K5,K6)
4.2 The Bernoulli scheme : The binomial distribution (K1,K2,K3,K4,K5,K6)
4.3 The Poisson scheme :The Generalized binomial distribution (K1,K2,K3,K4,K5,K6)
4.4 The Polya and Hypergeometric distributions (K1,K2,K3,K4,K5,K6)
4.5 The Poisson distribution – The uniform distribution (K1,K2,K3,K4,K5,K6)
4.6 The normal distribution – The gamma distribution (K1,K2,K3,K4,K5,K6)
(Chapter 5: Sections 5.1 - 5.8)

Unit V: Limits Theorems **(18 Hours)**

5.1 Preliminary remarks - Stochastic convergence (K1,K2,K3,K4,K5,K6)
5.2 Bernoulli's law of large numbers (K1,K2,K3,K4,K5,K6)
5.3 The convergence of a sequence of distribution functions (K1,K2,K3,K4,K5,K6)
5.4 The Riemann - Stieltjes integral (K1,K2,K3,K4,K5,K6)
5.5 The Levy - Cramer theorem (K1,K2,K3,K4,K5,K6)
5.6 The De Moivre - Laplace theorem - The Lindeberg - Levy theorem (K1,K2,K3,K4,K5,K6)
(Chapter 6: Sections 6.1 - 6.8)

Books for study and reference:

Text Book:

1. Marek Fisz - Probability Theory and Mathematical Statistics, 3rdEdition – John Wiley and Sons Inc, 1963.

Books for Reference:

1. Suddhenda Biswas and G. L. Sriwastav – Mathematical Statistics – Narosa Publishing House, 2011.
2. Alexander M. Mood, Franklin A.Graybill and Duane C.Bose – Introduction to Theoryof Statistics, 3rd Edition - Tata McGraw Hill, 1974.
3. P. Kandasamy, K. Thilagavathy and K. Gunavathy - Probability, Statistics and Queuing Theory, 2nd Edition - Sultan Chand and Sons, 2005.

E-Resources:

1. https://www.scribd.com/document/294762054/Probability-Theory-and-Mathematical
2. http://mathforum.org
3. http://ocw.mit.edu/ocwweb/Mathematics
4. http://www.opensource.org
5. https://nptel.ac.in
6. https://www.probability.net
7. www.coursera.org
8. https://swayam.gov.in

SEMESTER – III

PCMAL20 - OPERATIONS RESEARCH

Year : II **SEM :** III	**Course Code :** PCMAL20	**Title Of The Course :** Operations Research	**Course Type :** Theory	**Course Category :** Core	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To develop the knowledge of the students in the field of Operations Research which plays an important role in the Business Management.
2. To understand the mathematical tools that is used to solve optimization problems and to learn the concepts of queuing system and non-linear programming.

Course Outcomes (CO)

The Learners will be able to

1. Determine the feasible solution using Revised simplex method, Duality and bounded variable algorithm.
2. Understand the theoretical background of queuing systems and solve the real world problems.
3. Analyze the Inventory models and solve EOQ models.
4. Apply dynamic programming to solve real world problems.
5. Solve constrained and unconstrained optimization problems using Hookes and Jeeves algorithm, Gradient projection, Lagrange multipliers, Kuhn-Tucker conditions etc.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	H	H	M	M
CO2	H	H	H	H	M	H
CO3	H	H	H	H	L	M
CO4	H	H	H	H	M	H
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Advanced topics in Linear Programming (18 Hours)

1.1 Simplex method fundamentals(K1,K2,K3,K4,K5,K6)
1.2 From Extreme points to basic solutions – Examples – Generalized simplex tableau in matrix form (K1,K2,K3,K4,K5,K6)
1.3 The Revised simplex method (K1,K2,K3,K4,K5,K6)
1.4 Computational issues in the revised simplex method(K1,K2,K3,K4,K5,K6)
1.5 Bounded –variable algorithm (K1,K2,K3,K4,K5,K6)
1.6 Duality (K1,K2,K3,K4,K5,K6)
(Chapter 7: Sections 7.1-7. 4)

Unit II: Queuing System (18 Hours)

2.1 Introduction(K1,K2,K3,K4,K5,K6)
2.2 Elements of a Queuing model (K1,K2,K3,K4,K5,K6)
2.3 Role of exponential distribution (K1,K2,K3,K4,K5,K6)
2.4 Pure Birth and Death models (Relationship between the Exponential and Poisson distributions) (K1,K2,K3,K4,K5,K6)
2.5 Generalized Poisson Queuing Model (K1,K2,K3,K4,K5,K6)
2.6 Specialized Poisson Queues. (K1,K2,K3,K4,K5,K6)
(Chapter 18: Sections 18.1 - 18.6)

Unit III: Inventory Models (18 Hours)

3.1 Inventory problem : A supply chain perspective(K1,K2,K3,K4,K5,K6)
3.2 Role of demand in the development of Inventory models (K1,K2,K3,K4,K5,K6)
3.3 Static Economic-Order-Quantity (EOQ) models (K1,K2,K3,K4,K5,K6)
3.4 EOQ with price breaks (K1,K2,K3,K4,K5,K6)
3.5 Multi – item EOQ with shortage limitation (K1,K2,K3,K4,K5,K6)
3.6 Dynamic EOQ Models (K1,K2,K3,K4,K5,K6)
(Chapter 13: Sections 13.1 - 13.4)

Unit IV: Dynamic Programming (18 Hours)

4.1 Recursive Nature of Dynamic Programming Computation (K1,K2,K3,K4,K5,K6)
4.2 Forward and Backward Recursion (K1,K2,K3,K4,K5,K6)
4.3 Selected Dynamic Programming Applications (K1,K2,K3,K4,K5,K6)
4.4 Equipment Replacement model(K1,K2,K3,K4,K5,K6)
4.5 Investment model(K1,K2,K3,K4,K5,K6)
4.6 Problem of dimensionality(K1,K2,K3,K4,K5,K6)
(Chapter 12: 12.1 – 12.4)

Unit V: Non Linear Programming (18 Hours)

5.1 Basic concepts (K1,K2,K3,K4,K5,K6)
5.2 constrained Optimization –Direct search method(K1,K2,K3,K4,K5,K6)
5.3 Gradient method(K1,K2,K3,K4,K5,K6)
5.4 Constrained Optimization Problems – Separable programming(K1,K2,K3,K4,K5,K6)

5.5 Quadratic programming(K1,K2,K3,K4,K5,K6)
5.6 Chance constrained programming(K1,K2,K3,K4,K5,K6)
(Chapter21:21.1- 21.2.3**)**

Books for study and reference:

Text Book:

1. Hamdy A. Taha - Operations Research an Introduction, 10thEdition – Pearson-2017.

Books for Reference:

1. Hiller F.S. and Liberman G.J. - Introduction to Operations Research, 2ndEdition - CBS Publishers and Distributors, 1999.
2. S.D. Sharma - Operations Research, 15th Edition Kedarnath and Ramnath and Co. Publishers, 2003.
3. Ravindran A. Phillips D.T and Solberg J. - Operations Research: Principles and Practice, 2ndEdition - John Wiley and Sons Private Limited, 1987.

E- Resources:

1. https://www.scribd.com/document/490106553/Operations-Research-Kanti-swarup-pdf#
2. http://zalamsyah.staff.unja.ac.id/wp-content/uploads/sites/286/2019/11/9-Operations-Research-An-Introduction-10th-Ed.-Hamdy-A-Taha.pdf
3. https://www.amirajcollege.in/wp-content/uploads/2020/10/3151910-operations-research-theory-and-applications-by-j.-k.-sharma-z-lib.org_.pdf
4. https://nptel.ac.in
5. www.coursera.org
6. https://swayam.gov.in

SEMESTER – III

PEMAE20 – ELECTIVE III A: PROGRAMMING WITH JAVA

Year: II **SEM:** III	**Course Code:** PEMAE20	**Title of the Course:** Elective III A: Programming With Java	**Course Type:** Theory	**Course Category:** Elective	**H/W** 4	**CREDITS** 3	**MARKS** 100

Course Objectives

1. To learn a new platform independent language
2. To utilize Java in a variety of technologies and on different platforms.

Course Outcomes (CO)

The Learners will be able to

1. Understand the benefits and applications of OOP and distinguish C++ and JAVA.
2. Gain knowledge about operators and its types.
3. Define decision making statements and solve problems based on it.
4. Develop the program by manipulating classes and methods in the Java programming language.
5. Explore the Java programming by using arrays.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	H	H	H	L	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Fundamentals of Object - Oriented Programming (12 Hours)

1.1 Basic Concepts of Object Oriented Programming – Benefits of OOP (K1, K2, K3, K4,K5, K6)

1.2 Applications of OOP - Features of Java (K1, K2, K3, K4, K5, K6)

1.3 Java Differs from C and C++ - Java environment (K1, K2, K3, K4, K5, K6)
1.4 Java program structure (K1, K2, K3, K4, K5, K6)
1.5 Tokens – Statements (K1, K2, K3, K4, K5, K6)
1.6 Java programming style(K1, K2, K3, K4, K5, K6)
(Chapter 1:1.3 – 1.5, Chapter 2: 2.2-2.3 and 2.9, Chapter 3:3.5 – 3.7 and 3.12)

Unit II: Constants, Variables and Data Types, Operators and Expressions (12 Hours)

2.1 Constants – Variables – Data types – Declaration of variables (K1, K2, K3, K4, K5, K6)
2.2 Giving values to variables – Scope of variables – Symbolic constants (K1,K2,K3,K4,K5,K6)
2.3 Type casting – Getting values of variables – Standard default values (K1,K2,K3,K4,K5,K6)
2.4 Operators: Arithmetic, relational, logical, assignment, increment and decrement, conditional bitwise and special – Arithmetic expressions (K1, K2, K3, K4, K5, K6)
2.5 Evaluation of expressions – Operator precedence and associativity (K1, K2, K3, K4,K5,K6)
2.6 Mathematical functions (K1, K2, K3, K4, K5,K6)
(Chapter 4: 4.2 – 4.11, Chapter 5: 5.2 – 5.11, 5.14 – 5.15)

Unit III: Decision Making, Branching, Looping (12 Hours)

3.1 Decision making statements: if, simple if, if … else (K1, K2, K3, K4, K5,K6)
3.2 Nesting of if … else, else if ladder (K1, K2, K3, K4, K5,K6)
3.3 Switch statements and conditional operator (K1, K2, K3, K4, K5,K6)
3.4 Loop statements: while, do, for loops (K1, K2, K3, K4, K5,K6)
3.5 Jumps in loops (K1, K2, K3, K4, K5,K6)
3.6 Labeled loops.(K1, K2, K3, K4, K5,K6)
(Chapter 6: 6.2 – 6.8, Chapter 7: 7.2 – 7.6)

Unit IV: Classes, Objects and Methods (12 Hours)

4.1 Defining a class – Fields declaration – Methods declaration (K1, K2, K3, K4, K5,K6)
4.2 Creating objects – Accessing class members – Constructors (K1, K2, K3, K4, K5,K6)
4.3 Methods overloading – Static members – Nesting of methods (K1, K2, K3, K4, K5,K6)
4.4 Inheritance – overriding methods (K1, K2, K3, K4, K5,K6)
4.5 Final variables, methods and classes, Finalizer methods (K1, K2, K3, K4, K5,K6)
4.6 Abstract methods and classes - Methods with varargs – Visibility control.(K1, K2, K3, K4, K5,K6)
(Chapter 8: 8.2 – 8.18)

Unit V: Arrays, Strings and Vectors and Interfaces (12 Hours)

5.1 One and two dimensional arrays (K1, K2, K3, K4, K5,K6)
5.2 Strings – Vectors (K1, K2, K3, K4, K5,K6)
5.3 Wrapper classes – Enumerated types (K1, K2, K3, K4, K5,K6)
5.4 Annotations – Defining interfaces (K1, K2, K3, K4, K5,K6)
5.5 Extending interfaces – Implementing interfaces (K1, K2, K3, K4, K5,K6)
5.6 Accessing interface variables (K1, K2, K3, K4, K5,K6)
(Chapter 9: 9.2 – 9.9, Chapter 10: 10.2 – 10.5)

Books for study and reference:

Text Book:

1. E. Balagurusamy – Programming with Java – Tata McGraw Hill Publication, 5rd Edition, 2014.

Books for Reference:

1. K. Arnold and J. Gosling – The Java Programming Language – Ed. 2, Publication 2000.
2. Cays Horstmann and Gary Cornell – Core Java Volume II, Publications 2001.
3. Phil Hanna – JSP 2.0: The Complete Reference – TMH, Edition 2, Publications 2003.

E- Resources:

1. https://www.acs.ase.ro/Media/Default/documents/java/ClaudiuVinte/books/ArnoldGoslingHolmes06.pdf
2. https://ptgmedia.pearsoncmg.com/images/9780137081608/samplepages/013708160X.pdf
3. https://nitikesh.yolasite.com/resources/JSP%20complete%20reference.pdf
4. https://mu.ac.in/wp-content/uploads/2022/09/Core-JAVA.pdf
5. https://nptel.ac.in/
6. https://swayam.gov.in/nc_details/NPTEL
7. https://www.coursera.org/

SEMESTER – III

PEMAG20– ELECTIVE III B: PROGRAMMING WITH R

Year : II SEM : III	Course Code : PEMAG20	Title Of The Course : Elective III B:Programming with R	Course Type : Theory& Practical	Course Category : Elective	H/W 4	CREDITS 3	MARKS 100

Course Objectives

1. To master the use of R interactive environment with an understanding of the use of R documentation.
2. To use R for descriptive statistics and write multivariate models in R.

Course Outcomes (CO)

The Learners will be able to

1. Familiarize with basics of R software and built in function of R.
2. Identify the characteristics of datasets and plot the datasets in R using graphical methods.
3. Demonstrate understanding and use of for loop, if statement and break.
4. Implement the learning techniques and computing environment that are suitable for the applications under consideration.
5. Compute vectors and matrices, matrix inverse, eigen values and eigen vectors.

CO	PSO					
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	M	H	H	L	M	H

(L-Low, M-Moderate, H-High)

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	H	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit 1: Introduction to R language **(12 Hours)**

1.1.Starting and quitting in R, Basic features in R(K1,K2,K3,K4,K5,K6)
1.2.Built in functions and online help(K1,K2,K3,K4,K5,K6)
1.3.Logical vectors (K1,K2,K3,K4,K5,K6)
1.4. Rational operators.(K1,K2,K3,K4,K5,K6)
1.5.Changing Directories, redirecting R output, Lists(K1,K2,K3,K4,K5,K6)
1.6.Data frames (K1,K2,K3,K4,K5,K6)

Unit II: Programming Statistical Graph **(12 Hours)**

2.1 Plotting bar charts, dot charts(K1,K2,K3,K4,K5,K6)
2.2 Plotting Pie charts (K1,K2,K3,K4,K5,K6)
2.3 Plotting Histograms (K1,K2,K3,K4,K5,K6)
2.4 Plotting Box plot(K1,K2,K3,K4,K5,K6)
2.5 Plotting scatter plot (K1,K2,K3,K4,K5,K6)
2.6 Plotting QQ plots(K1,K2,K3,K4,K5,K6)

Unit III: Programming with R **(12 Hours)**

3.1 For loop(K1,K2,K3,K4,K5,K6)
3.2 If statement(K1,K2,K3,K4,K5,K6)
3.3 while loop(K1,K2,K3,K4,K5,K6)
3.4 Newton's method for finding root(K1,K2,K3,K4,K5,K6)
3.5 Repeat loop, break and next statements(K1,K2,K3,K4,K5,K6)
3.6 Problems and Exercises(K1,K2,K3,K4,K5,K6)

Unit IV: Simulation in R **(12 Hours)**

4.1 Monte Carlo simulation(K1,K2,K3,K4,K5,K6)
4.2 Generation of pseudo random numbers(K1,K2,K3,K4,K5,K6)
4.3 Bernoulli random variables(K1,K2,K3,K4,K5,K6)
4.4 Binomial random variables(K1,K2,K3,K4,K5,K6)
4.5 Poisson random variables(K1,K2,K3,K4,K5,K6)
4.6 Exponential random numbers(K1,K2,K3,K4,K5,K6)

Unit V: Computational Linear Algebra in R **(12 Hours)**

5.1 Vectors and matrices in R(K1,K2,K3,K4,K5,K6)
5.2 Constructing matrix objects(K1,K2,K3,K4,K5,K6)
5.3 Accessing matrix elements(K1,K2,K3,K4,K5,K6)
5.4 Row and column names(K1,K2,K3,K4,K5,K6)
5.5 Matrix properties, Matrix multiplication and inversion(K1,K2,K3,K4,K5,K6)
5.6 Eigen values and Eigen vectors.(K1,K2,K3,K4,K5,K6)

Books for study and reference:

Text Book:

1. W. John Braun, Duncan J. Murdoch, A first course in statistical programming with R, Cambridge University Press, 2007.

Books for Reference:

1. Gardener, M. Beginning R: The statistical programming language, John Wiley & Sons 2012.
2. Martin, T. The Undergraduate Guide to R. A beginner's introduction to R programming Language, 2009.
3. Chambers, J. Software for data analysis: programming with R. Springer Science & Business Media, 2008.

E- Resources:

1. http://assets.cambridge.org/97805218/72652/frontmatter/9780521872652_frontmatter.pdf
2. http://students.aiu.edu/submissions/profiles/resources/onlineBook/A7E7d8_Beginning%20R%20statistics.pdf
3. https://www.cs.upc.edu/~robert/teaching/estadistica/rprogramming.pdf
4. https://www.cs.upc.edu/~robert/teaching/estadistica/TheRBook.pdf
5. https://nptel.ac.in/
6. https://swayam.gov.in/nc_details/NPTEL
7. https://www.coursera.org/
8. https://spoken-tutorial.org/

SEMESTER – III

PEMAF20 – ELECTIVE PRACTICAL: JAVA

Year: II **SEM:** III	**Course Code:** PEMAF20	**Title of the Course:** Elective Practical: Java	**Course Type:** Practical	**Course Category:** Elective	**H/W** 2	**CREDITS** 1	**MARKS** 100

Course Objectives

1. To gain knowledge of object-oriented paradigm in the Java programming language.
2. To design & program stand-alone Java applications.

Course Outcomes (CO)

The Learners will be able to

1. Implement programs with classes.
2. Write programs that perform operations using arrays.
3. Develop the program by decision making statements and solve problems based on it.
4. Illustrate basic programming concepts such as program flow and syntax of a high-level general purpose language.
5. Take a problem, figure out the algorithm to solve it and write the code.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	H	H	H	L	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

PROGRAMS:

1. Solution of linear equations.(K1,K2,K3,K4,K5,K6)
2. Number and sum of integers between two given integers which are divisible by a

number. (K1,K2,K3,K4,K5,K6)

3. Multiplication table. (K1,K2,K3,K4,K5,K6)
4. Verifying whether a given number is a palindrome. (K1,K2,K3,K4,K5,K6)
5. Generation of Fibonacci sequence. (K1,K2,K3,K4,K5,K6)
6. Sorting an array. (K1,K2,K3,K4,K5,K6)
7. Merging two sorted arrays. (K1,K2,K3,K4,K5,K6)
8. Product of two matrices. (K1,K2,K3,K4,K5,K6)
9. Transpose of a matrix. (K1,K2,K3,K4,K5,K6)
10. Replacing a substring with another. (K1,K2,K3,K4,K5,K6)

Books for study and reference:

Text Book:

1. E. Balagurusamy – Programming with Java – Tata McGraw Hill Publication 5th Edition, 2014.

Books for Reference:

1. K. Arnold and J. Gosling – The Java Programming Language – Ed. 2, Publication, 2000.
2. Cays Horstmann and Gary Cornell – Core Java Volume II, Publications, 2001.
3. Phil Hanna – JSP 2.0: The Complete Reference – TMH, Edition 2, Publications, 2003.

E- Resources:

1. https://www.acs.ase.ro/Media/Default/documents/java/ClaudiuVinte/books/ArnoldGoslingHolmes06.pdf
2. https://ptgmedia.pearsoncmg.com/images/9780137081608/samplepages/013708160X.pdf
3. https://nitikesh.yolasite.com/resources/JSP%20complete%20reference.pdf
4. https://nptel.ac.in/
5. https://swayam.gov.in/nc_details/NPTEL
6. https://www.coursera.org/

SEMESTER – III

PEMAH20 - ELECTIVE PRACTICAL: R

Year : II **SEM :** III	**Course Code:** PEMAH20	**Title Of The Course :** Elective Practical: R	**Course Type :** Theory & Practical	**Course Category :** Elective	**H/W** 2	**CREDITS** 1	**MARKS** 100

Course Objectives

1. To master the use of R interactive environment with an understanding of the use of R documentation.
2. To use R for descriptive statistics and write simple programs in R.

Course Outcomes (CO)

The Learners will be able to

1. Familiarize with basics of R software and built in function of R.
2. Identify the characteristics of datasets and plot the datasets in R using graphical methods.
3. Demonstrate understanding and use data frames.
4. Implement the learning techniques and computing environment that are suitable for the applications under consideration.
5. Compute vectors and matrices, matrix inverse, eigen values and eigen vectors.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	M	H	H	L	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

PROGRAMS:

1. Create a sequence and find the mean of numbers.(K1,K2,K3,K4,K5,K6)

2. Find the first 10 Fibonacci Numbers. (K1,K2,K3,K4,K5,K6)
3. Find the factors of a given number. (K1,K2,K3,K4,K5,K6)
4. Find the maximum and minimum of a given vector.(K1,K2,K3,K4,K5,K6)
5. Read the CSV file and display the content.(K1,K2,K3,K4,K5,K6)
6. Create m x n matrix and perform matrix operations.(K1,K2,K3,K4,K5,K6)
7. Create a bar plot of five subject marks.(K1,K2,K3,K4,K5,K6)
8. Create a data frame and display the details.(K1,K2,K3,K4,K5,K6)
9. Extract rows and columns from data frame(K1,K2,K3,K4,K5,K6)
10. Create a list containing strings, numbers and vectors(K1,K2,K3,K4,K5,K6)

Books for study and reference:

Text Book:

1. W. John Braun, Duncan J. Murdoch, A first course in statistical programming with R, Cambridge University Press, 2007.

Books for Reference:

1. Gardener, M. Beginning R: The statistical programming language, John Wiley & Sons, 2012.
2. Martin, T. The Undergraduate Guide to R. A beginner's introduction to R programming Language, 2009.
3. Chambers, J. Software for data analysis: programming with R. Springer Science & Business Media, 2008.

E- Resources:

1. http://assets.cambridge.org/97805218/72652/frontmatter/9780521872652_frontmatter.pdf
2. http://students.aiu.edu/submissions/profiles/resources/onlineBook/A7E7d8_Beginning%20R%20statistics.pdf
3. https://www.cs.upc.edu/~robert/teaching/estadistica/rprogramming.pdf
4. https://www.cs.upc.edu/~robert/teaching/estadistica/TheRBook.pdf
5. https://nptel.ac.in/
6. https://swayam.gov.in/nc_details/NPTEL
7. https://www.coursera.org/
8. https://spoken-tutorial.org/

SEMESTER – III

PIMAE20 - INDEPENDENT ELECTIVE 3 A: SKILL ENHANCEMENT IN REAL AND COMPLEX ANALYSIS -I

Year: II **SEM:**III	**Course Code:** PIMAE20	**Title of the Course:** Independent Elective 3 A: Skill Enhancement in Real and Complex Analysis -I	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**CREDITS** 2	**MARKS** 100

Course Objectives

1. To develop the in-depth knowledge in Analysis and problem solving skills.
2. To engage them in self independent study of the Lecture notes and to enable the students to workout unsolved problems using various tricks.

Course Outcomes (CO)

The Learners will be able to

1. Utilize the basics of set theory and number system.
2. Acquire the knowledge of Sequences and Series.
3. Compute the Limit, Continuity and Differentiation of functions.
4. Analyze the Transcendental functions such as Exponential, Trigonometric and Hyperbolic Functions.
5. Evaluate the integral by Cauchy's Integral formula.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	L	M
CO2	H	H	M	H	L	M
CO3	H	H	M	H	L	M
CO4	H	H	M	H	H	M
CO5	H	H	M	H	H	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	H
CO2	H	H	H	M	L	H
CO3	H	H	H	M	L	H
CO4	H	H	H	M	H	H
CO5	H	H	H	M	H	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Set theory and Real Number System

Elementary Set Theory – Finite Countable and Uncountable Sets – Real Number System as a Complete Ordered Field – Archimedean Property – Supremum – Infimum. (K1,K2,K3,K4,K5,K6)
(Chapter 1: 1.1- 1.6)

Unit II: Sequences and Series

Sequences and Series – Convergence – lim sup – liminf – Bolzano Weierstrass Theorem – Heine Boral Theorem.(K1,K2,K3,K4,K5,K6)
(Chapter 2: 2.1-2.5)

Unit III: Limit, Continuity and Differentiability and Mean Value Theorem

Continuity – Uniform Continuity – Discontinuity – Types of Discontinuity – Differentiability– Mean Value Theorem.(K1,K2,K3,K4,K5,K6)
(Chapter 3: 3.1-3.4)

Unit IV: Complex Numbers and Analytic Function

Algebra of Complex Number – The Complex Plane – Polynomials – Power Series – Transcendental Functions Such as Exponential, Trigonometric and HyperbolicFunctions-Analytic Function.(K1,K2,K3,K4,K5,K6)
(Chapter 11: 11.1-11.5)

Unit V: Complex Integration and Calculus of Residues

Contour integral – Cauchy's Theorem – Cauchy's Integral Formulae – Liouville's Theorem – Maximum Modulus Principle. (K1,K2,K3,K4,K5,K6)
(Chapter 12: 12.1-12.4)

Books for study and reference:

Text Book:

1. Pawan Sharma, Neha Sharma, Suraj Singh, Mathematical Sciences, UGC CSIR NET/SET (JRF & LS), Arihant Publications (India) Ltd, 2016.

Books for Reference:

1. Dr. A. P. Singh - Modern Algebra – Infostudy Publication, 2018.
2. R. Gupta's - Joint CSIR - UGC-NET Mathematical Sciences Previous Year's Solved Paper, 2014.
3. Dr. A . Kumar - CSIR-UGC NET/JRF/SLET Mathematical Sciences (Paper I & II) – UPKAR Prakashan Publications, 2010.

4. S.K. Shrivastava & M.K. Malik - CSIR-UGC NET/JRF MATHEMATICAL SCIENCES Previous Years Solved Papers Including Model Papers with Explanation – JBC Press, 20

E-Resources:

1. https://r.search.yahoo.com/_ylt=Awr1Td7ugLVkU4YA5ADnHgx.;_ylu=Y29sbwMEcG9zAzgEdnRpZAMEc2VjA3Ny/RV=2/RE=1689645423/RO=10/RU=https%3a%2f%2fdrive.google.com%2ffile%2fd%2f1dPIW3INU5shOVzs-XNO0oKENEZlIE4gR%2fview/RK=2/RS=OnsX9HtilpGstujshULBSKrgEKY-
2. https://r.search.yahoo.com/_ylt=Awr1QQutgrVkW1Q_AUnnHgx.;_ylu=Y29sbwMEcG9zAzQEdnRpZAMEc2VjA3Ny/RV=2/RE=1689645869/RO=10/RU=https%3a%2f%2fuobabylon.edu.iq%2feprints%2fpublication_2_24266_1569.pdf/RK=2/RS=HlnOYl4vos37u6WUo_j0uuo57AE-
3. https://nptel.ac.in
4. www.coursera.org
5. https://swayam.gov.in

SEMESTER – III

PIMAF20 - INDEPENDENT ELECTIVE 3 B: FUNDAMENTALS OF RESEARCH METHODOLOGY AND STATISTICS - I

Year: II **SEM:** III	**Course Code:** PIMAF20	**Title of the Course:** Independent Elective 3 B: Fundamentals of Research Methodology and Statistics – I	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**CREDITS** 2	**MARKS** 100

Course Objectives

1. To provide a clear understanding of basic concepts of the research methodology.
2. To motivate them in self- independent study of the Lecture notes and online materials and to analyse the real life problems using Statistics concepts.

Course Outcomes (CO)

The Learners will be able to

1. Utilize the basic concepts of Research.
2. Prepare the review of literature.
3. Plan the various types of survey studies and sampling design.
4. Study the case of Historical methods and Philosophical methods.
5. Classify the experimental procedure and case study of various groups.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	L	H
CO2	H	H	M	H	L	H
CO3	H	H	M	H	L	H
CO4	H	H	M	H	L	H
CO5	H	H	M	H	L	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	H
CO2	H	H	H	M	L	H
CO3	H	H	H	M	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Perception of Research and Assortment of Problem

Meaning of Research – General Characteristics of Research – Specific Characteristics of Research – Objectives of Research – Classification of Research – Types of Research – Reflective Thinking – Scientific Thinking – Characteristic of a Good Researcher – Characteristic of a Problem.(K1,K2,K3,K4,K5,K6)
(Chapter 1 and 2)

Unit II: Appraise of related literature and foundation of hypothesis

Meaning of review of Literature – Objective of review of literature – Sources of review of Literature – How to conduct of the review of the literature – Meaning of hypothesis – Observation versus specific Land general hypothesis – Variables in a hypothesis – Formal conditions for testing hypothesis.(K1,K2,K3,K4,K5,K6)
(Chapter 3 and 4)

Unit III: Research Planning and Sampling, Survey Method

Meaning of Research plan/ Design – Meaning and definitions of Sampling – Functions of Population and sampling – Types of sampling design – Scientific Method – Types of Survey Studies.(K1,K2,K3,K4,K5,K6)
(Chapter 5, 6 and 7)

Unit IV: Historical Method and Philosophical Method

Approaches of Historical Research – Functional History of Education – Writing the Report – Meaning of Philosophy – Philosophy of education – Procedure of Philososphy research in social sciences. (K1,K2,K3,K4,K5,K6)
(Chapter 8 and 9)

Unit V: Experimental method and Case study

Meaning and definition of experiment– the basic assumptions behind the experiment – Types of variables – Classification of experiment or experimental procedures – definition of case study – Types of Case study – Case study of group. (K1,K2,K3,K4,K5,K6)
(Chapter 9 and 10)

Books for study and reference:

Text Book:

1. Yogesh Kumar Singh - Fundamental of Research of Methodology and Statistics - New Age International Publishers, 2007.

Books for Reference:

1. Bernard Beins and Maureen A. McCarthy - Research Methods and Statistics- Cambridge University Press Publications, 2017.
2. C. R. Kothari - Research Methodology: Methods and Techniques - New Delhi: New Age International (P) Ltd., ©2004, 1985.
3. Ian Walker - Research Methods and Statistics - Palgrave Macmillan Publisher, 2010.
4. Sherri L. Jackson - Research Methods and Statistics: A Critical Thinking Approach - Thomson Learning EMEA, Limited, 2008.

E-Resources:

1. https://r.search.yahoo.com/_ylt=AwrKAnTbybVkMwADhQLnHgx.;_ylu=Y29sbwMEcG9zAzIEdnRpZAMEc2VjA3Ny/RV=2/RE=1689664091/RO=10/RU=https%3a%2f%2fmfs.mkcl.org%2fimages%2febook%2fFundamental%2520of%2520Research%2520Methodology%2520and%2520Statistics%2520by%2520Yogesh%2520Kumar%2520Singh.pdf/RK=2/RS=34nLQrRAfg3K6OC0qscqOhl3HLM-
2. https://r.search.yahoo.com/_ylt=Awr1Td55z7VkTLMCEAznHgx.;_ylu=Y29sbwMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1689665529/RO=10/RU=https%3a%2f%2fdrive.google.com%2ffile%2fd%2f1XBslFv864x-k2kG-gGxlc35IlDL8_3Z1%2fview%3fusp%3dsharing/RK=2/RS=NIJctXhwacALzFiAfbxuc2xubrA-
3. https://nptel.ac.in/
4. https://swayam.gov.in/nc_details/NPTEL
5. https://www.coursera.org/

SEMESTER – IV

PCMAM20 -FUNCTIONAL ANALYSIS

Year:II **SEM**: IV	**Course Code :** PCMAM20	**Title of the Course:** Functional Analysis	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 5	**MARKS** 100

Course Objectives

1. To introduce the main structure theorems of functional analysis and to study the concepts of Banach and Hilbert spaces.
2. To instigate the concept of Banach algebra and the structure of commutative Banach algebra.

Course Outcomes (CO)

The Learners will be able to

1. Gain the knowledge of complete normed linear space and the Hahn Banach theorem.
2. Understand the open mapping theorem, closed graph theorem, and uniform boundedness theorem and determine the concept of complete inner product space and its properties.
3. Classify the operators into adjoint, self-adjoint, unitary and normal.
4. Know the basic properties of Banach Algebra and the spectrum of an element in a Banach algebra.
5. Represent commutative Banach algebras as algebras of continuous functions.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Banach Spaces (18 Hours)

1.1 The Definition (K1,K2,K3,K4,K5,K6)
1.2 Some examples (K1,K2,K3,K4,K5,K6)
1.3 Continuous Linear Transformations (K1,K2,K3,K4,K5,K6)
1.4 The Hahn Banach theorem (K1,K2,K3,K4,K5,K6)
1.5 The Natural imbedding of N in N^{**}(K1,K2,K3,K4,K5,K6)
1.6 The Natural imbedding of N in N^{**} (continued) (K1,K2,K3,K4,K5,K6)
(Chapter 9: Sections 46 - 49)

Unit II: Banach Spaces and Hilbert Spaces (18 Hours)

2.1 The Open Mapping Theorem (K1,K2,K3,K4,K5,K6)
2.2 The Conjugate of an Operator (K1,K2,K3,K4,K5,K6)
2.3 Definition of Hilbert Space (K1,K2,K3,K4,K5,K6)
2.4 Some simple properties (K!,K2,K3,K4,K5,K6)
2.5 Orthogonal complements (K1,K2,K3,K4,K5,K6)
2.6 Orthonormal Sets (K1,K2,K3,K4,K5,K6)
(Chapter 9: Sections 50 and 51 and Chapter 10: Sections 52-54)

Unit III: Hilbert Spaces (18 Hours)

3.1 The Conjugate spaces H* (K1,K2,K3,K4,K5,K6)
3.2 The Adjoint of an operator (K1,K2,K3,K4,K5,K6)
3.3 Self adjoint operators (K1,K2,K3,K4,K5,K6)
3.4 Normal operator (K1,K2,K3,K4,K5,K6)
3.5 Unitary operator (K1,K2,K3,K4,K5,K6)
3.6 Projections (K1,K2,K3,K4,K5,K6)
(Chapter 10: Sections 55-59)

Unit IV: Banach Algebras (18 Hours)

4.1 The definition and some examples (K1,K2,K3,K4,K5,K6)
4.2 Regular and singular elements (K1,K2,K3,K4,K5,K6)
4.3 Topological divisors of zero (K1,K2,K3,K4,K5,K6)
4.4 The spectrum (K1,K2,K3,K4,K5,K6)
4.5 The formula for the spectral radius (K1,K2,K3,K4,K5,K6)
4.6 The radical and semi-simplicity (K1,K2,K3,K4,K5,K6)
(Chapter 12: Sections 64-69)

Unit V: The Structure of Commutative Banach Algebras (18 Hours)

5.1 The Gelfand Mapping (K1,K2,K3,K4,K5,K6)
5.2 The Gelfand Mapping (continued) (K1,K2,K3,K4,K5,K6)
5.3 Applications of the formula $\boldsymbol{r(x) = \lim_{n\to\infty} \|x^n\|^{\frac{1}{n}}}$(K1,K2,K3,K4,K5,K6)
5.4 Applications of the formula $\boldsymbol{r(x) = \lim_{n\to\infty} \|x^n\|^{\frac{1}{n}}}$(continued) (K1,K2,K3,K4,K5,K6)

5.5 Involutions in Banach Algebras (K1,K2,K3,K4,K5,K6)
5.6 The Gelfand Neumark theorem (K1,K2,K3,K4,K5,K6)
(Chapter 13: Sections 70-73)

Books for study and reference:

Text Book:

1. George F. Simmons - Introduction to Topology and Modern Analysis – McGraw Hill Education (India) Private Limited, New Delhi, 2004 (26th Reprint 2016).

Books for Reference:

1. Somasundaram D. – A first course in Functional Analysis –Narosa Publishing House Pvt. Ltd., 2006, Reprint 2008.
2. Ovchinnikov S. – Functional Analysis, 1st Edition – Springer, 2018.
3. Kumar S. – Functional Analysis, 1stEdition - CBS, 2005.

E-Resources:

1. https://people.math.ethz.ch/~salamon/PREPRINTS/funcana.pdf
2. https://docs.ufpr.br/~eidam/2019/2/CM075/Kreyszig.pdf
3. https://59clc.files.wordpress.com/2012/08/functional-analysis-_-rudin-2th.pdf
4. http://mathforum.org
5. http://ocw.mit.edu/ocwweb/Mathematics
6. http://www.opensource.org
7. http://en.wikiepedia.org
8. https://nptel.ac.in
9. www.coursera.org
10. https://swayam.gov.in

SEMESTER – IV

PCMAN20 – CALCULUS OF VARIATIONS

Year: II **SEM:** IV	**Course Code:** PCMAN20	**Title of the Course:** Calculus of Variations	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**CREDITS** 5	**MARKS** 100

Course Objectives

1. To find the maxima and minima of functions.
2. To develop an understanding of variational problems with fixed boundaries and moving boundaries.

Course Outcomes (CO)

The Learners will be able to

1. Understand the functional and its applications. Also use the Euler-Lagrange equation to find the differential equations for stationary paths.
2. Describe Du Bois-Reymond problem and solve it.
3. Solve differential equations for stationary paths subject to boundary conditions
4. Give an account of the foundations of calculus of variations and its applications in Mathematics and Physics.
5. Apply direct methods to solve variational problems.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	M	H	H	M	L
CO2	H	M	H	H	M	L
CO3	H	M	H	H	M	L
CO4	H	M	H	H	M	L
CO5	H	M	H	H	M	L

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

(L-Low, M-Moderate, H-High

Course Syllabus

Unit I: **Variational Problems with Fixed Boundaries** **(18 Hours)**

1.1 The Concept of Variation and Its Properties.(K1,K2,K3,K4,K5,K6)
1.2 Euler's Equation.(K1,K2,,K3,K4,K5,K6)

1.3 Variational Problems for Functionals of the Form $\int_a^b F\big(x, y_1(x), y_2(x), \dots, y_1'(x), y_1'(x), \dots, y_n'(x)\big)dx$ (K1,K2,K3,K4,K5,K6)
1.4 Functionals Dependent On Higher-Order Derivatives.(K1,K2,K3,K4,K5,K6)
1.5 Functionals Dependent on Functions of Several Independent Variables. (K1,K2,K3,K4,K5,K6)
1.6 Variational Problems in Parametric Form.(K1,K2,K3,K4,K5,K6)
(Chapter 1: Sections1.1-1.6)

Unit II: Variational Problems with Fixed Boundaries (Continued) (18 Hours)

2.1 Some Applications to Problems of Mechanics.(K1,K2,K3,K4,K5,K6)
2.2 Variational Problems Leading to an Integral Equation or a Differential-Difference Equation. (K1,K2,K3,K4,K5,K6)
2.3 Theorem of du Bois-Reymond. (K1,K2,K3,K4,K5,K6)
2.4 Stochastic Calculus of Variations. (K1,K2,K3,K4,K5,K6)
2.5 Supplementary Remarks. (K1,K2,K3,K4,K5,K6)
2.6 Problems. (K1,K2,K3,K4,K5,K5)
(Chapter 1: Sections 1.7-1.11)

Unit III: Variational Problems with Moving Boundaries (18 Hours)

3.1 Functional of the form $I\,[y(x)] = \int_{x_1}^{x_2} F(x, y, y')dx$. (K1,K2,K3,K4,K5,K6)
3.2 Variational Problem with a Movable Boundary for a Functional Dependent on Two Functions. (K1,K2,K3,K4,K5,K6)
3.3 One-Sided Variations.(K1,K2,K3,K4,K5,K6)
3.4 Reflection and Refraction of Extremals. (K1,K2,K3,K4,K5,K6)
3.5 Diffraction of Light Rays.(K1,K2,,K3,K4,K5,K6)
3.6 Problems. (K1,K2,K3,K4,K5,K6)
(Chapter 2: Sections2.1-2.5)

Unit IV: Sufficient Conditions for an Extremum (18 Hours)

4.1 Field of Extremals. (K1,K2,K3,K4,K5,K6)
4.2 Jacobi Condition. (K1,K2,K3,K4,K5,K6)
4.3 Weirstrass Function. (K1,K2,K3,K4,K5,K6)
4.4 Legendre Condition. (K1,K2,K3,K4,K5,K6)
4.5 Second Variation. (K1,K2,K3,K4,K5,K6)
4.6 Canonical Equations and Variational Principles. (K1,K2,K3,K4,K5,K6)
(Chapter 3: Sections 3.1-3.6)

Unit V: Sufficient Conditions for an Extremum (Continued) (18 Hours)

5.1 Complementary Variational Principles.(K1,K2,,K3,K4,K5,K6)
5.2 Poisson Bracket .(K1,K2,,K3,K4,K5,K6)
5.3 Contact Transformations.(K1,K2,,K3,K4,K5,K6)
5.4 The Hamilton-Jacobi Equation.(K1,K2,,K3,K4,K5,K6)
5.5 Clairaut's Theorem.(K1,K2,,K3,K4,K5,K6)
5.6 Noether's Theorem.(K1,K2,,K3,K4,K5,K6)
(Chapter 3: Sections 3.7 – 3.12)

Books for study and reference:

Text Book:

1. A.S. Gupta- Calculus of Variations with Applications-10th Printing –PHI Learning Private Limited,1997.

Books for Reference:

1. Gelfand, J.M. and Fomin S.V.- Calculus of Varians - Prentice hall - New Jessy- 1963.
2. Weinstock - Calculus of Variation - McGraw Hall. 1952.
3. Bernard Dacorogna – Introduction to the calculus of variations – 3rd edition, Imperial college press, Switzerland, 2004.

E- Resources:

1. https://books.google.co.in/books/about/CALCULUS_OF_VARIATIONS_WITH_APPLICATIONS.html?id=90UvngEACAAJ&redir_esc=y
2. https://efaidnbmnnnibpcajpcglclefindmkaj/http://users.uoa.gr/~pjioannou/mech2/READING/Gelfand_Fomin_Calculus_of_Variations.pdf
3. https://emineter.files.wordpress.com/2014/02/mathematics-calculus-of-variations-with-applications-to-physics-engineering-robert-weinstock-dover-publications-djvu.pdf
4. https://efaidnbmnnnibpcajpcglclefindmkaj/http://kgut.ac.ir/useruploads/1569312462937qai.pdf
5. https://nptel.ac.in/
6. https://swayam.gov.in/nc_details/NPTEL
7. https://www.coursera.org/

SEMESTER – IV

PCMAO20 - MATHEMATICAL STATISTICS

Year : II **SEM :** IV	**Course Code :** PCMAO20	**Title Of The Course :** Mathematical Statistics	**Course Type :** Theory	**Course Category :** Core	**H/W** 6	**CREDITS** 5	**MARKS** 100

Course Objectives

1. To know about Statistics, its scope and importance in various areas such as Medical, Engineering, Agricultural etc.
2. To apply problem solving technique to solve real world event and acquire knowledge about hypothesis testing and the significance test.

Course Outcomes (CO)

The Learners will be able to

1. Understand the sample moments and their functions and analyze chi-square, Student-t, Fishers-Z distributions.
2. Demonstrate the knowledge of the properties of parametric testing procedures.
3. Construct tests and estimators, and derive their properties. Estimate population parameters from data sets and use the sampling distributions to compute confidence intervals for these population parameters.
4. Learn the basic components of hypothesis testing and perform hypothesis test on population means.
5. Understand the basic terms used in design of experiments and use appropriate experimental designs to analyze the experimental data.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	L	H	M	L
CO4	H	H	L	H	H	M
CO5	H	H	H	H	H	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

(L-Low, M-Moderate, H-High

Course Syllabus

Unit I: Sample moments and their functions (18 Hours)

1.1 The notion of a sample (K1,K2,K3,K4,K5,K6)
1.2 The notion of a statistic (K1,K2,K3,K4,K5,K6)
1.3 The distribution of the arithmetic mean of independent normally distributed random variables(K1,K2,K3,K4,K5,K6)
1.4 The chi-square distribution (K1,K2,K3,K4,K5,K6)
1.5 The distribution of the statistic (K1,K2,K3,K4,K5,K6)
1.6 Student's t-distribution –Fisher's Z-distribution (K1,K2,K3,K4,K5,K6)
(Chapter 9: Sections 9.1 to 9.7)

Unit II: Significance Test (18 Hours)

2.1 The concept of a statistical test (K1,K2,K3,K4,K5,K6)
2.2 Parametric test for small samples (K1,K2,K3,K4,K5,K6)
2.3 Parametric tests for large samples (K1,K2,K3,K4,K5,K6)
2.3 Examples based on Small and large samples(K1,K2,K3,K4,K5,K6)
2.5 The chi – square test (K1,K2,K3,K4,K5,K6)
2.6 Independence tests by contingency tables. (K1,K2,K3,K4,K5,K6)
(Chapter 12: Sections 12.1 to 12.4 and 12.7)

Unit III: Theory of Estimation (18 Hours)

3.1 Preliminary notions (K1,K2,K3,K4,K5,K6)
3.2 Consistent estimate (K1,K2,K3,K4,K5,K6)
3.2 Unbiased estimate (K1,K2,K3,K4,K5,K6)
3.4 Sufficiency – efficiency (K1,K2,K3,K4,K5,K6)
3.5 Asymptotically most efficient estimate.(K1,K2,K3,K4,K5,K6)
3.6 Methods of finding estimates. (K1,K2,K3,K4,K5,K6)
(Chapter 13: Sections 13.1 to 13.7)

Unit IV: Theory of Hypotheses testing (18 Hours)

4.1 Preliminary remarks (K1,K2,K3,K4,K5,K6)
4.2 The Power function and the OC. (K1,K2,K3,K4,K5,K6)
4.3 Most Powerful tests (K1,K2,K3,K4,K5,K6)
4.4 Uniformly most powerful test (K1,K2,K3,K4,K5,K6)
4.5 Unbiased tests (K1,K2,K3,K4,K5,K6)
4.6 The power and consistency of nonparametric test. (K1,K2,K3,K4,K5,K6)
(Chapter 16: 16.1 to 16.6)

Unit V: Design of Experiments (18 Hours)

5.1 Aim of the Design of experiments. (K1,K2,K3,K4,K5,K6)
5.2 Basic Principles of Experimental Design.(K1,K2,K3,K4,K5,K6)
5.3 Some Basic Designs of Experiment. (K1,K2,K3,K4,K5,K6)
5.4 Analysis of variance (K1,K2,K3,K4,K5,K6)

5.5 Comparison of RBD and LSD. (K1,K2,K3,K4,K5,K6)
5.6 Examples based on analysis of variance (K1,K2,K3,K4,K5,K6)
(Chapter 10: 10.1 to 10.11)

Books for study and reference:

Text Books:

1. Marek Fisz - Probability Theory and Mathematical Statistics, 3rdEdition – John Wiley and Sons Inc, 1963. (Unit I to IV)
2. Veerarajan T – Probability, Statistics and Random Processes , 2nd Edition – Tata McGraw-Hill, 2006.(Unit V)

Books for Reference:

1. Suddhenda Biswas and G. L. Sriwastav – Mathematical Statistics – Narosa Publishing House, 2011.
2. Alexander M. Mood, Franklin A.Graybill and Duane C.Bose – Introduction to Theory of Statistics, 3rd Edition - Tata McGraw Hill, 1974.
3. P. Kandasamy, K. Thilagavathy and K. Gunavathy - Probability, Statistics and Queuing Theory, 2nd Edition - Sultan Chand and Sons, 2005.

E- Resources:

1. https://www.scribd.com/document/294762054/Probability-Theory-and-Mathematical
2. https://r.search.yahoo.com/_ylt=AwrKAnSkarVk9P8.IiPnHgx.;_ylu=Y29sbwMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1689639716/RO=10/RU=https%3a%2f%2fdrive.google.com%2ffile%2fd%2f0B3ouU3Ur4aahVy13TzBfYjdUN3c%2fedit%3fusp%3dsharing/RK=2/RS=cZtZhaJAGtGLVB_.TFsHTeJhluc-
3. http://mathforum.org
4. http://ocw.mit.edu/ocwweb/Mathematics
5. http://www.opensource.org
6. https://nptel.ac.in
7. https://www.probability.net
8. www.coursera.org
9. https://swayam.gov.in

SEMESTER – IV

PCMAP20 - PROJECT

Year: II **SEM:** IV	**Course Code:** PCMAP20	**Title of the Course:** Project	**Course Type:** -	**Course Category:** -	**H/W** 6	**CREDITS** 4	**MARKS** 100

It should be done individually under the guidance of one of the Faculty members. The Dissertation should be submitted before 31st March. The students should present their research work during the viva-voce.

SEMESTER – IV

PEMAI20 - ELECTIVE IV A: GRAPH THEORY

Year : II **SEM :** IV	**Course Code :** PEMAI20	**Title Of The Course :** Elective IV A:Graph Theory	**Course Type :** Theory	**Course Category :** Elective	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To introduce the fundamental concepts of graph theory
2. To understand the concepts of graph theory and apply it in practical situations.

Course Outcomes (CO)

The Learners will be able to

1. Identify subgraphs, cycles, paths and connection in graphs.
2. Analyse the cut vertices, cut edges and bonds in trees.
3. Distinguish between the Hamiltonian and Eulerian graph.
4. Explain the concepts of matchings and coverings in bipartite graphs.
5. Understand the concepts of colouring and planar graphs.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	H	H	L	M
CO2	H	H	H	H	M	H
CO3	H	H	H	H	L	M
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Graphs and Subgraphs **(18 Hours)**

1.1 Graphs and Simple Graphs (K1, K2, K3, K4, K5, K6)
1.2 Graph Isomorphism (K1, K2, K3, K4, K5,K6)
1.3 Incidence and adjacency Matrices (K1, K2, K3, K4, K5,K6)
1.4 Subgraphs - Vertex degrees (K1, K2, K3, K4, K5, K6)
1.5 Paths and connection - Cycles (K1, K2, K3, K4, K5, K6)
1.6 The shortest path problem. (K1, K2, K3, K4, K5, K6)
(Chapter1: Sections 1.1 – 1.8)

Unit II: Trees and Connectivity **(18 Hours)**

2.1 Trees (K1,K2,K3,K4,K5,K6)
2.2 Cut Edges and Bonds (K1, K2, K3, K4, K5, K6)
2.3 Cut Vertices (K1, K2, K3, K4, K5, K6)
2.4 Cayley's Formula (K1, K2, K3, K4, K5, K6)
2.5 Connectivity (K1, K2, K3, K4, K5, K6)
2.6 Blocks (K1, K2, K3, K4, K5, K6)
(Chapter2: Sections 2.1 - 2.5 and Chapter3: Sections 3.1- 3.2)

Unit III: Euler Tours and Hamilton Cycles **(18 Hours)**

3.1 Euler Tours (K1, K2, K3, K4, K5, K6)
3.2 Theorems on Euler Tours (K1, K2, K3, K4, K5, K6)
3.3 Hamilton Cycles (K1, K2, K3, K4, K5, K6)
3.4 Theorems on Hamilton Cycles (K1, K2, K3, K4, K5, K6)
3.5 The Chinese postman problem (K1, K2, K3, K4, K5, K6)
3.6 The travelling salesman problem (K1, K2, K3, K4, K5, K6)
(Chapter 4: Sections 4.1 - 4.4)

Unit IV: Matchings, Independent sets and Cliques **(18 Hours)**

4.1 Matchings (K1, K2, K3, K4, K5, K6)
4.2 Theorems on Matchings. (K1, K2, K3, K4, K5, K6)
4.3 Coverings in bipartite graphs (K1, K2, K3, K4, K5, K6)
4.4 Perfect matching (K1, K2, K3, K4, K5, K6)
4.5 The personnel problem (K1, K2, K3, K4, K5, K6)
4.6 Independent Sets (K1, K2, K3, K4, K5, K6)
(Chapter5: Sections 5.1 - 5.4 and Chapter7: Section7.1)

Unit V: Vertex colouring and Planar graphs **(18 Hours)**

5.1 Chromatic Number- Brook’s theorem (K1, K2, K3, K4, K5, K6)
5.2 Chromatic Polynomials (K1, K2, K3, K4, K5, K6)
5.3 Plane and planar graphs (K1, K2, K3, K4, K5, K6)
5.4 Dual graphs (K1, K2, K3, K4, K5, K6)

5.5 Euler's formula (K1, K2, K3, K4, K5, K6)
5.6 The Five Colour theorem and the Four-Colour Conjecture (K1, K2, K3, K4, K5, K6)
(Chapter 8: Section 8.1, 8.2 and 8.4, Chapter 9: Sections 9.1 - 9.3 and 9.6)

Books for study and reference:

Text Book:

1. J. A. Bondy and U.S.R.Murty - Graph theory and Applications, Macmillan 5th edition 1982.

Books for Reference:

1. Douglas B. West - Introduction to Graph Theory, 2nd Edition – Urbana, 2006.
2. Harary - Graph Theory, 1st Edition – Narosa Publising House,1988.
3. S.Arumugam and S. Ramachandran - Invitation to Graph Theory – SciTech Publications Pt. Ltd.,2001.

E-Resources:

1. https://www.zib.de/groetschel/teaching/WS1314/BondyMurtyGTWA.pdf
2. https://www.researchgate.net/publication/336915761_APPLICATIONS_OF_GRAPH_THEORY_IN_HUMAN_LIFE
3. https://www.hamilton.ie/ollie/Downloads/Graph.pdf
4. https://nptel.ac.in
5. www.coursera.org
6. https://swayam.gov.in

SEMESTER – IV

PEMAJ20 –ELECTIVE IV B: FUZZY SET THEORY

Year :II **SEM** : IV	**Course Code :** PEMAJ20	**Title Of The Course :** Elective IV B:Fuzzy Set Theory	**Course Type :** Theory	**Course Category :** Elective	**H/W** 6	**CREDITS** 4	**MARKS** 100

Course Objectives

1. To develop a research approach that can deal with problems relating to ambiguous situations.
2. To make use of a special fuzzy set to model reality better than traditional theories.

Course Outcomes (CO)

The Learners will be able to

1. Distinguish between crisp set and fuzzy set through bi-valued logic and infinite-valued logic.
2. Know about the most widely used standard fuzzy set operations.
3. Formulate the fuzzy number which is a special case of a convex, normalized fuzzy set of the real line.
4. Explore the fuzzy relation and its operations which is the generalization of crisp relation.
5. Analyze the methods of decision making in fuzzy environment and their applications in LPP.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	H	H	L	M
CO2	H	M	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	H	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Crisp Sets and Fuzzy Sets **(18 Hours)**

1.1 Crisp sets: An Overview (K1,K2,K3,K4,K5,K6)
1.2 Fuzzy sets: Basic Types (K1,K2,K3,K4,K5,K6)
1.3 Fuzzy sets: Basic Concepts (K1,K2,K3,K4,K5,K6)
1.4 Additional properties of alpha cuts (K1,K2,K3,K4,K5,K6)
1.5 Representations of fuzzy sets (K1,K2,K3,K4,K5,K6)
1.6 Extension Principle for fuzzy sets (K1,K2,K3,K4,K5,K6)
(Chapter 1: 1.2-1.4 and Chapter 2: 2.1-2.3)

Unit II: Operations on Fuzzy Sets **(18 Hours)**

2.1 Types of operations (K1,K2,K3,K4,K5,K6)
2.2 Fuzzy Complements (K1,K2,K3,K4,K5,K6)
2.3 Fuzzy Intersection: t-Norms (K1,K2,K3,K4,K5,K6)
2.4 Fuzzy Union: t-Conorms (K1,K2,K3,K4,K5,K6)
2.5 Combinations of operations (K1,K2,K3,K4,K5,K6)
2.6 Aggregation Operations (K1,K2,K3,K4,K5,K6)
(Chapter 3: 3.1-3.6)

Unit III: Fuzzy Arithmetic **(18 Hours)**

3.1 Fuzzy numbers(K1,K2,K3,K4,K5,K6)
3.2 Linguistic variables (K1,K2,K3,K4,K5,K6)
3.3 Arithmetic operations on intervals (K1,K2,K3,K4,K5,K6)
3.4 Arithmetic operations on fuzzy numbers (K1,K2,K3,K4,K5,K6)
3.5 Lattice of fuzzy numbers (K1,K2,K3,K4,K5,K6)
3.6 Fuzzy equations (K1,K2,K3,K4,K5,K6)
(Chapter 4: 4.1-4.6)

Unit IV: Fuzzy Relations **(18 Hours)**

4.1 Crisp versus Fuzzy Relations (K1,K2,K3,K4,K5,K6)
4.2 Projections and Cylindric extensions (K1,K2,K3,K4,K5,K6)
4.3 Binary fuzzy relations. (K1,K2,K3,K4,K5,K6)
4.4 Binary relations on a single set (K1,K2,K3,K4,K5,K6)
4.5 Fuzzy equivalence relations (K1,K2,K3,K4,K5,K6)
4.6 Fuzzy compatibility relations, Fuzzy ordering relations (K1,K2,K3,K4,K5,K6)
(Chapter 5: 5.1 - 5.7)

Unit V: Fuzzy Decision Making **(18 Hours)**

5.1 Individual Decision Making (K1,K2,K3,K4,K5,K6)
5.2 Multi-person Decision Making (K1,K2,K3,K4,K5,K6)
5.3 Multi criteria Decision Making (K1,K2,K3,K4,K5,K6)
5.4 Multi-stage Decision Making (K1,K2,K3,K4,K5,K6)

5.5 Fuzzy Ranking Methods (K1,K2,K3,K4,K5,K6)
5.6 Fuzzy linear programming (K1,K2,K3,K4,K5,K6)
(Chapter 15: 15.2-15.7)

Books for study and reference:

Text Book:

1. George J. Klir and Bo Yuan, Fuzzy sets and fuzzy logic – Theory and Applications, Prentice Hall of India Private limited, New Delhi, 2005.

Books for Reference:

1. Kwang H. Lee – First Course on Fuzzy Theory and Applications – Springer, 2005.
2. Sudhir K. Pundir and Rimple Pundir - Fuzzy Sets and their Applications –Pragati Prakashan Educational Publisher, First Edition, 2006.
3. S. Nanda and N. R. Das – Fuzzy Mathematical Concepts– Narosa Publishing House, 2010.

E-Resources:

1. http://www.pzs.dstu.dp.ua/logic/bibl/yuan.pdf
2. https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf
3. https://nptel.ac.in
4. www.coursera.org
5. https://swayam.gov.in

SEMESTER – IV

PIMAG20 - INDEPENDENT ELECTIVE 4 A: SKILL ENHANCEMENT IN REAL AND COMPLEX ANALYSIS – II

Year: II **SEM:**IV	**Course Code:** PIMAG20	**Title of the Course:** Independent Elective 4 A: Skill Enhancement in Real and Complex Analysis – II	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**CREDITS** 2	**MARKS** 100

Course Objectives

1. To develop the in-depth knowledge in real and complex analysis problem solving skills.
2. To enhance the knowledge of the students to workout unsolved problems using various tricks and to encourage them to clear CSIR NET, SET, JRF and GATE examinations.

Course Outcomes (CO)

The Learners will be able to

1. Analyze the theory of Partial derivatives.
2. Compute Riemann Sum and Riemann integral.
3. Evaluate the concepts of Lebesgue measure and Lebesgue integral.
4. Identify the Connectedness and Compactness.
5. Calculate the Residues of functions and improve the knowledge of conformal mappings

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	L	M
CO2	H	H	M	H	L	M
CO3	H	H	M	H	L	M
CO4	H	H	M	H	H	M
CO5	H	H	M	H	H	M

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	H
CO2	H	H	H	M	L	H
CO3	H	H	H	M	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Functions of Several Variables

Functions of Several Variables – Directional Derivative – Partial Derivative – Derivative as a Linear Transformation. (K1,K2,K3,K4,K5,K6)
(Chapter 4: 4.1- 4.4)

Unit II: The Riemann Integral and Improper Integral

Riemann Sum and Riemann Integral - Improper Integral – Sequences and Series of Function-Uniform Convergence. (K1,K2,K3,K4,K5,K6)
(Chapter 5: 5.1-5.2)

Unit III: Function of Bounded Variation, Lebesgue Measure and Metric Space

Function of Bounded Variation – Lebesgue Measure – Lebesgue Integral – Metric Space – Connectedness – Compactness – Normal Linear Space.(K1,K2,K3,K4,K5,K6)
(Chapter 7: 7.1-7.6)

Unit IV: Complex Integration and Calculus of Residues

Schwartz Lemma – Open Mapping Theorem – Taylor Series – Laurents Theorem Calculus of Residues.(K1,K2,K3,K4,K5,K6)
(Chapter 12: 12.5-12.7)

Unit V: Conformal Mapping

Conformal Mapping – Mobious Transformation. (K1,K2,K3,K4,K5,K6)
(Chapter 13: 13.1-13.2)

Books for study and reference:

Text Book:

1. Pawan Sharma, Neha Sharma, Suraj Singh, Mathematical Sciences, UGC CSIR NET/SET (JRF & LS), Arihant Publications (India) Ltd, 2016.

Books for Reference:

1. Dr. A. P. Singh - Modern Algebra - Infostudy Publication, 2018.
2. R. Gupta's - Joint CSIR - UGC-NET Mathematical Sciences Previous Year's Solved Paper, 2014.
3. Dr. A. Kumar - CSIR-UGC NET/JRF/SLET Mathematical Sciences (Paper I & II) – UPKAR Prakashan Publications, 2010.

4. S.K. Shrivastava & M.K. Malik - CSIR-UGC NET/JRF MATHEMATICAL SCIENCES Previous Years Solved Papers Including Model Papers With Explanation – JBC Press, 2019.

E- Resources:

1. https://r.search.yahoo.com/_ylt=Awr1Td7ugLVkU4YA5ADnHgx.;_ylu=Y29sbwMEcG9zAzgEdnRpZAMEc2VjA3Ny/RV=2/RE=1689645423/RO=10/RU=https%3a%2f%2fdrive.google.com%2ffile%2fd%2f1dPIW3INU5shOVzs-XNO0oKENEZlIE4gR%2fview/RK=2/RS=OnsX9HtilpGstujshULBSKrgEKY-
2. https://books.google.co.in/books/publisher/content?id=nz6iBQAAQBAJ&pg=PP30&img=1&zoom=3&hl=en&bul=1&sig=ACfU3U2qb9AhU7l9M44MtGUoDAcM-UY6Q&w=1280
3. https://nptel.ac.in
4. www.coursera.org
5. https://swayam.gov.in

SEMESTER – IV

PIMAH20 - INDEPENDENT ELECTIVE 4 B: FUNDAMENTALS OF RESEARCH METHODOLOGY AND STATISTICS – I

Year: II **SEM:**IV	**Course Code:** PIMAH20	**Title of the Course:** Independent Elective 4 B: Fundamentals of Research Methodology and Statistics - II	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**CREDITS** 2	**MARKS** 100

Course Objectives

1. To provide a clear understanding of basic concepts of the research methodology.
2. To plan the Questionnaire in research and survive works.

Course Outcomes (CO)

The Learners will be able to

1. Analyze the needs and purpose of Experimental design.
2. Prepare and Analyze the Questionnaire and compute the Statistical analysis of data.
3. Analyze the statistical data and research report.
4. Acquire the knowledge of Action research and Educational research.
5. Understand the basic measures of variability, dispersion and correlation.

CO	**PSO**					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	L	H
CO2	H	H	M	H	L	H
CO3	H	H	M	H	L	H
CO4	H	H	M	H	H	H
CO5	H	H	M	H	H	H

(L-Low, M-Moderate, H-High)

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	H
CO2	H	H	H	M	L	H
CO3	H	H	H	M	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Genetic method and Design of Experiments

Meaning of Genetic Research – Types of Genetic research – Problems of Genetic research– Diagnosis and Prognosis– Needs and Purpose of Experimental design– Types of basic experimental design. (K1,K2,K3,K4,K5,K6)
(Chapter 11 and 12)

Unit II: Tools of Research and collection of Data

Questionnaire – Preparing and administering the questionnaire – Characteristics of a Good questionnaire – Characteristic of a Good schedule – Need for data collection – Difference between facts and data – Characteristics of quantitative data.(K1,K2,K3,K4,K5,K6)
(Chapter 13 and 14)

Unit III: Analysis of data and Research report

Need for analysis of data or Treatment of data – Statistical analysis of data – Planning for data analysis – Level of significance – The research report – General format of research report.(K1,K2,K3,K4,K5,K6)
(Chapter 15 and 16)

Unit IV: Action Research and Presentation of Statistical data

Meaning of Action Research – Objective of educational research – Types of education research – Steps of research – Method of organizing and presenting data - The graphical presenting of ungrouped data. (K1,K2,K3,K4,K5,K6)
(Chapter 17 and 18)

Unit V: Measurement of central Tendency and measures of variability

Arithmetic Mean – Median – Mode – Different measures of variability of dispersion – Standard deviation – Correlation. (K1,K2,K3,K4,K5,K6)
(Chapter 19 and 20)

Books for study and reference:

Text Book:

1. Yogesh Kumar Singh - Fundamental of Research of Methodology and Statistics - New Age International Publishers, 2007.

Books for Reference:

1. Bernard Beins and Maureen A. McCarthy - Research Methods and Statistics- Cambridge University Press Publications, 2017.
2. C. R. Kothari - Research Methodology: Methods and Techniques - New Delhi: New Age International (P) Ltd., ©2004, 1985.
3. Ian Walker - Research Methods and Statistics - Palgrave Macmillan Publisher, 2010.
4. Sherri L. Jackson - Research Methods and Statistics: A Critical Thinking Approach - Thomson Learning EMEA, Limited, 2008.

E- Resources:

1. https://r.search.yahoo.com/_ylt=AwrKAnTbybVkMwADhQLnHgx.;_ylu=Y29sbwMEcG9zAzIEdnRpZAMEc2VjA3Ny/RV=2/RE=1689664091/RO=10/RU=https%3a%2f%2fmfs.mkcl.org%2fimages%2febook%2fFundamental%2520of%2520Research%2520Methodology%2520and%2520Statistics%2520by%2520Yogesh%2520Kumar%2520Singh.pdf/RK=2/RS=34nLQrRAfg3K6OC0qscqOhl3HLM-
2. https://r.search.yahoo.com/_ylt=Awr1Td55z7VkTLMCEAznHgx.;_ylu=Y29sbwMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1689665529/RO=10/RU=https%3a%2f%2fdrive.google.com%2ffile%2fd%2f1XBslFv864x-k2kG-gGxlc35IlDL8_3Z1%2fview%3fusp%3dsharing/RK=2/RS=NIJctXhwacALzFiAfbxuc2xubrA-
3. https://nptel.ac.in
4. www.coursera.org
5. https://swayam.gov.in

For MBA Programme
SEMESTER –I

PCBAD20- STATISTICAL METHODS FOR RESEARCH

Year: I SEM: I	Course Code: PCBAD20	Title Of The Course : Statistical Methods for Research	Course Type: Theory	Course Category: Allied	H/W 6	Credits 3	Marks 100

Course Objectives

1. To introduce the basic concepts of research in business.
2. To make decisions based on scientific methods.

Course Outcomes (CO)

The Learners will be able to

1. Understand the basic concepts in statistics.
2. Solve different statistical concepts related to management.
3. Acquire wide knowledge of different statistical analysis.
4. Understand and apply different ethics in business research.
5. Get a basic knowledge about data collection and report writing.

CO	PSO					
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	M	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	M	H	M	H

(L-Low, M-Moderate, H-High)

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO 6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Introduction and Ethics in Business Research (18 Hours)

1.1 Business Research – Definition and Significance (K1, K2,K3, K4,K5,K6)
1.2 Ethics in Research- Ethical Behavior of Research- Subjectivity and Objectivity in Research (K1, K2,K3, K4,K5,K6)
1.3 Research Process- Types of Research (K1, K2,K3, K4,K5,K6)
1.4 Research Design- Definition – Types of Research Design(K1, K2,K3, K4,K5,K6)
1.5 Validity of Findings- Variables in Research- Measurement and Scaling (K1, K2,K3, K4,K5,K6)
1.6 Different Scales-Construction of Instruments- Validity and Reliability of Instruments(K1, K2,K3, K4,K5,K6)

Unit II: Data Collection and Report Writing (18 Hours)

2.1 Types of Data- Primary and Secondary Data- Methods of Data Collection (K1, K2,K3, K4,K5,K6)
2.2 Sampling Plan – Sampling Size – Sampling Techniques and Methods (K1, K2,K3, K4,K5,K6)
2.3 Data Preparation- Validity of Data –Qualitative Vs Quantitative Data Analysis (K1, K2,K3, K4,K5,K6)
2.4 Bivariate and Multivariate Statistical Techniques - Factor Analysis- Discriminant Analysis – Cluster Analysis (K1, K2,K3, K4,K5,K6)
2.5 Multidimensional Scaling- Application of Statistical Software for Data Analysis (K1,K2, K3, K4,K5,K6)
2.6 Research report – Different types – Contents of reports – need of executive summary – Chapterization – contents of chapter – report writing(K1, K2,K3, K4,K5,K6)

Unit III: Statistics- Sampling Distribution and Testing of Hypothesis (18 Hours)

3.1 Statistics- Definition- Sampling Distributions, Mean, Median, Mode (K1, K2,K3, K4,K5,K6)
3.2 Standard Deviation and Proportion(K1, K2,K3, K4,K5,K6)
3.3 Sampling Techniques- Hypothesis Testing : Single Sample and Double Sample Test for Means and Proportions of Large Samples (Z- Test) (K1,K2, K3, K4, K5, K6)
3.4 Single Sample and Double Sample Tests for Means of Small (T- Test) (K1,K2, K3, K4, K5,K6)
3.5 F-Test for Two Sample Standard Deviation (K1,K2, K3, K4, K5, K6)
3.6 ANOVA One and Two Way – Design of Experiments(K1,K2, K3, K4, K5, K6)

Unit IV: Non Parametric Methods, Correlation and Regression Analysis (18 Hours)

4.1 Chi- Square Tests – Sign Test for Paried Data (K1,K2, K3, K4, K5, K6)
4.2 Rank Sum Test (K1,K2, K3, K4, K5, K6)
4.3 Mann-Whitney U Test and Kruskal Wallis Test (K1,K2, K3, K4, K5, K6)
4.4 One Sample Run Test (K1,K2, K3, K4, K5, K6)
4.5 Rank Correlation- Correlation Analysis (K1,K2, K3, K4, K5, K6)

4.6 Estimation of Regression Line. (K1,K2, K3, K4, K5, K6)

Unit V: Time Series Analysis **(18 Hours)**

5.1 Time Series Analysis – Introduction (K1, K2,K3, K4,K5,K6)
5.2 Variation in Time Series(K1,K2, K3, K4, K5, K6)
5.3 Trend Analysis(K1,K2, K3, K4, K5, K6)
5.4 Cyclical Variations(K1,K2, K3, K4, K5, K6)
5.5Seasonal Variations (K1,K2, K3, K4, K5, K6)
5.6 Irregular Variations(K1,K2, K3, K4, K5, K6)

Books for study and reference:

Text Books:

1. Donald R. Cooper and Pamela S. Schindler – Business Research Methods – Tata McGraw Hill, 2006.
2. Srivatsav TN, Shailajarago - Statistics for Management - Tata McGraw Hill, 2008.

Books for Reference:

1. S.P. Gupta – Statistical Methods – Sultan Chand & Sons, 2011.
2. Gupta S. C. and Kapoor V.K – Fundamentals of Mathematical Statistics – Sultan Chand & Sons, 2020.
3. Uma Sekaran – Research Methods of Business – Wiley India limited, 2006.
4. Levin R.I and Rubin D.s – Statistics for Management – 7th edition, Prentice Hall of India Pvt, Ltd., Delhi, 2001.
5. K.N. Krishnamoorthy, AppaIyerSivakumar and M. Mathirajan –Management Research Methodology – Pearson Education, 2006.

E- Resources:

1. https://ccsuniversity.ac.in/bridge-library/pdf/Research-Methodology-CR-Kothari.pdf
2. https://theengineeringmaths.com/wp-content/uploads/2018/03/sampling.pdf
3. https://influentialpoints.com/Training/nonparametric_correlation_and_regression-principles-properties-assumptions.htm
4. http://www.mim.ac.mw/books/Donald%20R%20Cooper's%20Business%20Research%20Methods,%2012th%20Edition.pdf
5. http://mathforum.org
6. http://ocw.mit.edu/ocwweb/Mathematics
7. http://www.opensource.org
8. www.coursera.org
9. https://swayam.gov.in

For MBA Programme
SEMESTER –II

PCBAK20 - RESOURCE MANAGEMENT TECHNIQUES

Year : I SEM : II	Course Code :PCBAK20	Title Of The Course : Resource Management Techniques	Course Type : Theory	Course Category : Allied	H/W 6	Credits 3	Marks 100

Course Objectives

1. To learn and understand the methodical approach of solving problem in the field of industries, marketing, finance and so on
2. To create awareness about optimization in utilization of resources.

Course Outcomes (CO)

The Learners will be able to

1. Understand the basic Operation Research concepts related to management.
2. Analyse the real life situation using Transportation and Assignment problems.
3. Acquire wide knowledge in Game Theory and replacement models that are used in management.
4. Solve any practical issues using Queuing Theory and decision making.
5. Impart the knowledge in Network Analysis that are used in Management.

CO	PSO					
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	M	H	M	H
CO5	H	H	M	H	M	H

(L-Low, M-Moderate, H-High)

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	M	H
CO2	H	H	H	M	M	H
CO3	H	H	H	M	M	H
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

(L-Low, M-Moderate, H-High)

Course Syllabus

Unit I: Introduction to Linear Programming (18 Hours)

1.1 Introduction to applications of OR in functional areas of management (K1,K2, K3, K4,K5,K6)
1.2 Linear Programming – formulation(K1,K2, K3, K4,K5,K6)
1.3 Solution by graphical Method (K1,K2, K3, K4,K5,K6)
1.4 Solution by Simplex method (K1,K2, K3, K4,K5,K6)
1.5 Artificial variable techniques (Big M method only) (K1,K2, K3, K4,K5,K6)
1.6 Dual simplex method (K1,K2, K3, K4,K5,K6)

Unit II: Liner Programming Extensions (18 Hours)

2.1 Transportation Models (Minimizing and Maximizing cases) – Balanced and unbalance cases(K1,K2, K3, K4,K5,K6)
2.2 Initial Basic feasible solution by N-W Corner Rule, Least cost Method (K1,K2, K3, K4,K5,K6)
2.3 Vogel's approximation methods (K1,K2, K3, K4,K5,K6)
2.4 Check for optimality, solution by MODI / stepping stone method(K1,K2, K3, K4,K5,K6)
2.5 Causes of degeneracy (K1, K2, K3, K4, K5, K6)
2.6 Assignment Models (Minimizing and Maximizing Cases) – Balanced and Unbalanced causes, solution by Hungarian(K1,K2, K3, K4,K5,K6)

Unit III: Game Theory and Replacement Models (18 Hours)

3.1 Game Theory – Two person Zero sum games – Saddle point (K1,K2, K3, K4,K5,K6)
3.2 Dominance Properties (K1,K2, K3, K4,K5,K6)
3.3 Matrix Methods (K1,K2, K3, K4,K5,K6)
3.4 Graphical Method (K1,K2, K3, K4,K5,K6)
3.5 LPP Solutions (K1,K2, K3, K4,K5,K6)
3.6 Replacement models- Individuals replacement models (With and without time value of money) (K1,K2, K3, K4,K5,K6)

Unit IV: Queuing Theory, Decision Theory and Decision Trees (18 Hours)

4.1 Queuing Theory – introduction (K1, K2, K3, K4, K5, K6)
4.2 Single and multi channel models I single server system(K1,K2, K3, K4,K5,K6)
4.3 Decision making under risk (Expected value criterion, Expected value combined with variance criterion) (K1,K2, K3, K4,K5,K6)
4.4 Decision making under risk(EMV, EOL models) (K1,K2, K3, K4,K5,K6)
4.5 Decision trees (K1,K2, K3, K4,K5,K6)
4.6 Decision making under uncertainty(K1,K2, K3, K4,K5,K6)

Unit V: Network analysis: CPM and PERT Computations(18 Hours)

5.1 CPM-construction(K1,K2, K3, K4,K5,K6)
5.2 Different time calculation (K1,K2, K3, K4,K5,K6)
5.3 Calculation of critical path and project duration (K1,K2, K3, K4,K5,K6)

5.4 PERT (K1, K2, K3, K4, K5, K6)
5.5 Difference between CPM and PERT (K1,K2, K3, K4,K5,K6)
5.6 Probability of meeting the scheduled dates(K1,K2, K3, K4,K5,K6)

Note: 80% problems and 20% Theory

Books for study and reference:

Text Book:

1. Prem Kumar Gupta, Hira D.S., "Operations Research" S. Chand & Company Pvt. Limited: New Delhi, Seventh Revised Edition, 2014.

Books for Reference:

1. Kanti Swarup, P.K. Gupta and Man Mohan, Introduction to Management Science - Operations Research, Sultan Chand and Sons, 2014.
2. P.R.Vittal, Introduction to Operations Research, Margham Publications,2008.
3. V. Sundaresan, K.S. Ganapathy Subramanian,and K. Ganesan, Resource Management Techniques, A.R. Publications, 2009.
4. Pannerselvam, R. Operations Research, Prentice Hall of India, 4th Edition, 2008.
5. SankaraIyer .P, Operations Research, Tata McGraw Hill, 2008.

E-Resources:

1. https://www.shivajicollege.ac.in/sPanel/uploads/econtent/33dfc039a8d88fa01d763d5abcd1df20.pdf
2. https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/1585041316993_Module-4.pdf
3. https://kanchiuniv.ac.in/coursematerials/Game%20theory.pdf
4. https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/MODULE-4-Queueing-Theory.pdf
5. https://www.srividyaengg.ac.in/coursematerial/CSE/104745.pdf
6. https://nptel.ac.in
7. www.coursera.org
8. https://swayam.gov.in