SRI RAMAKRISHNA MISSION VIDYALAYA
COLLEGE OF ARTS AND SCIENCE
(Autonomous)
COIMBATORE – 641 020

DEPARTMENT OF MATHEMATICS

Under Choice Based Credit System (CBCS)
2020 – 2021 Onwards

M.Sc. MATHEMATICS

SRI RAMAKRISHNA MISSION VIDYALAYA COLLEGE OF ARTS AND SCIENCE
COIMBATORE – 20.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1: The curriculum is designed to prepare the students for productive careers after the completion of this programme

PEO2: The students are trained to apply their knowledge in recent developments to continue research programs in mathematics.

PEO3: To promote the culture of interdisciplinary research among all disciplines and applied mathematics.

PEO4: Graduates will become effective collaborators and innovators, leading or participating in efforts to address social, technical and business challenges.

PEO5: The students will be able to plan, organize, lead and work in team to carryout tasks to the success of the team.

PEO6: Able to communicate mathematical ideas with clarity, identify, formulate and solve mathematical problems.

PEO7: The students will have both analytical and computational skills in mathematical sciences.

PROGRAMME OUTCOME (PO)

PO1: Demonstrate the advanced theories, theorems and coherent understanding variety of field of science, its different branches, diversified thinking and its linkage with other disciplinary areas related to specific professional subject area of physical sciences, including professional engagement in advanced research and developments.

PO2: Analyse and interpret the scientific truths / information using appropriate methods, including the specific programming skill with the use of appropriate software, and report the findings accurately with experimental results.

PO3: Demonstrate the relevant generic skills and global competencies such as problem solving, investigative skills, analytical skills, communication skills, and ICT skills.

PO4: Develop Entrepreneurship interest with ability to work individually and in a group.

PO5: Assimilate the skills and cognitive developments in explicit areas associated to current and emerging technology concerned with societal, national and global requirements. Validate the professional behaviour such as being unbiased and truthful in all aspects.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: Will provide students a strong foundation and inculcate ample knowledge to pursue higher degrees at reputed academic institutions

PSO2: Students will have a deep understanding in mathematics which provide a strong foundation to identify the thrust areas in research.

PSO3: Able to use the learned techniques, skills and modern mathematical tools suitable to the problem encountered.

PSO4: Students are well prepared to take jobs in Schools, Colleges, Software Industries and Research and Development Organizations as Teachers, Professors and Experts.

PSO5: Students will have deeper understanding and successful application of the subject knowledge to clear exams like NET, GATE, SET, etc.

Course Title : CORE 1: ALGEBRA **Course Code : 20PMA1C01**
Year : First Year **Semester : I**
Hours/Week : 6 **Credits : 5**

Course Objective

1. To study groups, rings and fields which are widely used in many research fields.
2. Understand the fundamental concepts of abstract algebra which include Sylow's theorem.
3. To know the concepts of linear transformations and its applications.

Course Outcomes (CO)

CO1	The students will remember the basic concepts of rings and fields.	K1
CO2	Will understand the significance of Sylow's theorem.	K2
CO3	Able to apply Gauss lemma, Eisenstein criterion for irreducibility of polynomials.	K3
CO4	Able to analyze Galois theory and canonical forms	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S		S	S	S	S	S
CO2	M	L	S	M	S		S	S	S	M	S
CO3	S	S	M	S	S		S	S	S	S	L
CO4	S	S	M	S	M		S	M	S	M	M

S – Strong; M – Medium; L - Low

Unit I:

Group Theory: Another counting principle – Sylow's Theorem.

Chapter 2: Sections 2.11 and 2.12

Unit II:

Ring Theory: Euclidean Rings- Particular Euclidean Ring - **Polynomial Rings*** - Polynomials over the Rational Field.

Chapter 3: Sections 3.7 to 3.10

Unit III:

Fields: Extension field – Roots of polynomials.

Chapter 5: Sections 5.1 and 5.3

Unit IV:

Fields: More about roots - Elements of Galois Theory.

Chapter 5: Sections 5.5 and 5.6

Unit V:

Linear Transformations: Trace and Transpose – Hermitian, Unitary and **Normal Transformations*.**

Chapter 6: Sections 6.8 and 6.10

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

I.N. Herstein, *Topics in Algebra*, John Wiley & Sons, Second Edition, 2006.

Books for reference:

1. M. Martin, *Algebra*, Prentice Hall of India, New Delhi, 1991.
2. J. B. Fraleigh, *A First Course in Abstract Algebra*, V Ed., Addison-Wesley Longman, Inc., Reading Massachusetts, 1999.

Course Title : CORE 2: REAL ANALYSIS **Course Code : 20PMA1C02**
Year : First Year **Semester : I**
Hours/Week : 6 **Credits : 5**

Course Objective

1. To present students the basic concepts and importance of the real analysis.
2. To define and recognize the basic properties of the field of real numbers.
3. To enable the students to the differentiability of real functions and its related theorems.

Course Outcomes (CO)

CO1	Describe fundamental properties of the real numbers.	K1
CO2	Recognize the difference between pointwise and uniform convergence of a sequence of functions.	K2
CO3	Construct various mathematical proofs of basic results in real analysis	K3
CO4	Understand the concept of Lebesgue measure which is later used in developing the theory of Lebesgue integration that gives better results as compared to the theory of Riemann integration.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	M	S	M		M	M	S	S	S
CO2	S	S	S	S	M		S	S	M	S	M
CO3	M	S	L	S	S		M	S	M	S	S
CO4	S	S	M	S	M		S	L	S	S	M

S – Strong; M – Medium; L - Low

Unit I:

Riemann Stieltjes Integral: Definition and Existence of the Integral – Properties of the Integral – **Integration and Differentiation*** – Integration of vector valued function.

Chapter: 6.(Omit: Rectifiable curves)

Unit II:

Sequences and Series of Functions: Discussion of main problem - **Uniform convergence*** - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation - Equicontinuous families of functions – The Stone-Weirstrass theorem.

Chapter: 7.

Unit III:

Function of Several Variables: Linear Transformation – Differentiation - The Contraction principle – The Inverse Function Theorem – Implicit Function Theorem – Derivatives of Higher order – **Differentiation of integrals***.

Chapter: 9. (Omit: The rank theorem and Determinants)

Unit IV:

Lebesque Measure: Outer measure – **Measurable sets and Lebesque measure*** – Measurable functions.

Chapter: 3 Section: 2, 3 and 5.

Unit V:

Lebesque Integral: The Lebesque integral of a bounded function over a set of finite measure – **The integrals of a non-negative functions*** – The General Lebesque integral.

Chapter: 4 Section: 2, 3 and 4.

*** denotes self study (Questions may be asked from these portions also)**

Books for study:

1. Walter Rudin, *Principles of Mathematical Analysis*, McGraw Hill, Third Edition, 1976. For **Units I, II and III**.
2. H.L. Royden, *Real Analysis*, 3rd edition, Macmillan, New York, 1988. For **Units IV and V**.

Book for reference:

Tom M. Apostal, *Mathematical Analysis*, Addison Wesley, 1974.

e-resources:

1. https://www.youtube.com/watch?v=qVaFEF1NpLY
2. https://www.youtube.com/watch?v=bWTmUWWZnhQ
3. https://www.youtube.com/watch?v=z7-OerO97Cs

Course Title : CORE 3: ORDINARY DIFFERENTIAL EQUATIONS

Course Code : 20PMA1C03

Year : First Year **Semester : I**

Hours/Week : 6 **Credits : 4**

Course Objective

1. This course introduces the formulation and classification of differential equations.
2. To know the existence and uniqueness of solutions for linear differential equations.
3. To understand the concepts of Picard's theorem and boundary value problems.

Course Outcomes (CO)

CO1	Able to solve a variety of first order differential equations by using various techniques.	K1
CO2	Give the existence of solutions of first order differential equations by successive approximation method.	K2
CO3	Solve a variety of oscillation of second order differential equations.	K3
CO4	Can understand the concepts Sturm Liouville problem and Green's function.	K4

K1- Remember; K2-Understand; K3-Apply; K4-Analyse

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	S	M		S	M	M	M	M
CO2	S	S	S	S	S		S	S	S	M	M
CO3	S	S	M	S	S		S	S	S	S	M
CO4	S	S	S	S	S		S	S	S	S	L

S-Strong; M-Medium; L-Low

Unit I:

System of Linear Differential Equations: Introduction - System of first order equations – Existence and Uniqueness theorem – **Fundamental Matrix*.**

Chapter 4: Section 4.1 - 4.5

Unit II:

System of Linear Differential Equations: Non – Homogeneous linear systems: Linear systems with constant co-efficient - **Linear systems with periodic co-efficient***.

Chapter 4: Section 4.6 - 4.7

Unit III:

Existence and Uniqueness of Solutions: Introduction - Preliminaries-Successive Approximation - Picard's theorem - Non-uniqueness of solutions- Continuation and dependence on initial conditions - **Existence of solutions in the large*** - Existence and Uniqueness of solution of systems.

Chapter 5: Section 5.1 - 5.8

Unit IV:

Boundary Value Problems: Introduction - Sturm Liouville problem – Green's Functions – **Non Existence of Solutions*.**

Chapter 7: Section 7.1 - 7.4

Unit V:

Oscillations of Second Order Equations: Fundamental results - Sturm's Comparision theorem - Elementary linear Oscillations - Comparision theorem of Hille – Wintner Oscillations of X'' + a(t) X=0, **Elementary nonlinear oscillations*.**

Chapter 8: Section 8.1 - 8.6

*** denotes self study (Questions may be asked from these portions also)**

Books for study:

S. G. Deo, V. Lakshmikanthan and V. Ragavendra, *Ordinary Differential Equations*, Tata McGraw-Hill Publishing Company Limited, 2010.

Books for references:

D. Somasundaram, *Ordinary Differential Equations A First Course*, Narosa Publishing House, New Delhi, Fourth Edition, 2010.

Course Title : CORE 4: MATHEMATICAL STATISTICS WITH SPSS

Course Code : 20PMA1C04

Year : First Year **Semester : I**

Hours/Week : 5 **Credits : 4**

Course Objective

1. To enable the students to learn the different aspects of statistics.
2. To provide them a systematic knowledge to analyze, organize, present and interpret any information effectively.
3. Enable to understand the concepts of probability distributions.

Course Outcomes (CO)

CO1	Demonstrate the basic concepts of statistics, probability and random variables	K1
CO2	Understand the basics of sampling distribution theory	K2
CO3	Identify the type of the distribution	K3
CO4	Knowing the applications of Limit Theorems	K3 & K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	M	M	L		S	S	S	S	S
CO2	S	S	S	S	M		S	M	S	M	M
CO3	S	S	S	S	M		S	S	S	M	S
CO4	S	S	S	M	S		S	S	M	M	S

S – Strong; M – Medium; L - Low

Unit I:

Parameters of the Distribution of a Random Variable: Expected values – Moments – The Chebyshev inequality – Absolute moments - **order of parameters***- Moments of random vectors.

Chapter 3: Sections 3.1 -3.6

Unit II:

Characteristic Functions: Properties of Characteristic functions and moments – Semi invariants – The Characteristic function of the sum of independent random variables – Determination of distribution functions by the characteristic functions- **Probability generating functions*.**

Chapter: 4: Sections 4.1 -4.5, 4.7.

Unit III:

Some Probability Distribution: One point and two point Distributions –The Binomial distribution – The Poisson distribution – Normal Distribution – Uniform Distribution – Gamma Distribution – **Beta Distribution***.

Chapter: 5 Sections 5.1, 5.2, 5.5 - 5.9.

Unit IV:

Limit Theorems: Stochastic Convergence – Bernoulli's Law of large numbers – **Levy Cramer theorem*** – De Moivre- Laplace theorem – The Lindeberg-Levy theorem.

Chapter: 6 Sections 6.2, 6.3, 6.6, 6.7, 6.8.

Unit V:

The Notion of a Sample: The notion of a statistic – The distribution of the arithmetic mean of independent normally distributed random variables – The Chi- square distribution- Distribution of the statistic ($\overline{X}, S$)- **Student's t-distributions*.**

Chapter: 9 Sections 9.1 - 9.6

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

Probability Theory and Mathematical Statistics, Marek Fisz, John Wiley, Third Edition, New York, 1963.

Book for reference:

An Introduction to Probability Theory and its Applications, W. Feller, Vol. I, John Wiley, Third Edition, 1968.

e-resources:

1. https://nptel.ac.in/courses/111/105/111105041/
2. https://www.youtube.com/watch?v=S7AqqDvnuFM
3. https://www.youtube.com/watch?v=fdlcTcY2H78

Course Title : Elective 1: NUMERICAL ANALYSIS

Course Code : 20PMA1EL1

Year : First Year **Semester : I**

Hours/Week : 5 **Credits: 4**

Course Objective

1. To solve algebraic, transcendental and nonlinear equations using numerical methods
2. To solve ordinary and partial differential equations using various numerical methods
3. To know about boundary value problems and finding the solutions numerically

Course Outcomes (CO)

CO1	Remembering various numerical methods for finding the solution of nonlinear equations.	K1
CO2	Demonstrating various numerical algorithms for solving simultaneous linear algebraic equations.	K2&K3
CO3	Applying numerical methods for solving ODE and PDE.	K3
CO4	Analyzing the boundary value problems using numerical methods.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 – Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M		S	S	S	M	S
CO2	S	S	S	M	S		S	S	S	S	S
CO3	S	S	S	M	S		S	S	S	S	S
CO4	S	S	S	M	S		S	S	S	S	S

S – Strong; M – Medium; L - Low

Unit I:

Solution of Non-Linear Equations: Method of halving the interval – Method of linear interpolation – **Newton's method*** – Use of X = G(X) form - convergence of Newton's method – Bairstow's method for Quadratic factors – Quotient-difference algorithm.

Chapter 1: Sections 1.2 -1.4, 1.6 – 1.9

Unit II:

Solution of System of Equations: Elimination method – Gauss and Gauss Jordan methods – LU Decomposition method - **Methods of iteration*** – Relaxation method – Set of Non-linear equations.

Chapter 2: Sections 2.3, 2.4, 2.5, 2.10, 2.11, 2.12

Unit III:

Solution of Ordinary Differential Equations: Taylor series method – Euler and **Euler Modified methods*** – Runge-Kutta Methods – Multistep methods – Milne's method – Adams Moulton method.

Chapter 5: Sections 6.2 – 6.7

Unit IV:

Boundary Value Problems and Characteristic Value Problems:

The shooting method – solution through a set of equations – Derivative of Boundary conditions – **Characteristic value problems*** – Eigen values of a matrix by Iteration.

Chapter 6: Sections 7.2 – 7.5

Unit V:

Types of Partial Differential Equations:

The Heat equation and the Wave equation- Solution Techniques for the Heat equation in One Dimensional – Solving the Vibrating String Problem – Parabolic Equations in Two or Three Dimensions – **The Wave Equation in Two Dimensions*.**

Chapter 8: Sections 8.1 – 8.6

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson Education, 6th Edition, 2003.

Book for reference:

M. K. Venkataraman, *Numerical Methods in Science and Engineering*, The National Publishing Company, 5th Edition, 1999.

Course Title : CORE 5: COMPLEX ANALYSIS

Course Code : 20PMA2C05

Year : First Year **Semester : II**

Hours/Week : 6 **Credits : 5**

Course Objective

1. To present students the elements and importance of the complex analysis.
2. To define and recognize the basic properties of the complex numbers.
3. To enable the students to the differentiability of complex functions and its related theorems.

Course Outcomes (CO)

CO1	Describe fundamental properties of the complex numbers.	K1
CO2	Understand the concept of limits and their uses.	K2
CO3	Analyze functions of complex variable in terms of continuity, differentiability.	K3
CO4	Apply Cauchy-Riemann equations and harmonic functions to solve problems.	K4

K1- Remember; K2-Understand; K3-Apply; K4-Analyse

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	S	M		M	M	M	M	L
CO2	S	S	S	S	S		S	S	S	M	M
CO3	S	S	M	S	S		S	S	S	S	M
CO4	S	S	S	S	S		S	S	S	S	M

S-Strong; M-Medium; L-Low

Unit I:

Complex Integration: Cauchy's integral formula – local properties of analytic functions – **the calculus of residues*.**

Chapter 4: Sections 2.1 - 2.3, 3.1, 3.2, 3.4, 5.1 - 5.2

Unit II:

Harmonic Functions: Series and product development: power series expansions.

Chapter 4: Sections 6.1- 6.3; Chapter V: Sections 1.1 - 1.3

Unit III:

Partial Fractions and Factorizations – Entire functions.

Chapter 5: Sections 2.1, 2.4, 3.1 - 3.2.

Unit IV:

Conformal Mapping, Dirichlet Problem: Conformal mapping of polygons, A closer look at harmonic functions, **The Dirichlet problem*.**

Chapter 6: Sections 2.1, 2.2, 3.1, 3.2, 4.1 and 4.2.

Unit V:

Elliptic Functions: Simply periodic functions, Doubly periodic functions.

Chapter 7: Sections 1.1 - 1.3, 2.1 - 2.4.

*** denotes self study (Questions may be asked from these portions also)**

Books for study:

Lars. V. Ahlfors, *Complex Analysis*, McGraw Hill, International Edition, Third Edition, 1979.

Books for reference:

S. Ponnusamy, *Complex Analysis*, Narosa book distributors, Second Edition, 2011.

Course Title : CORE 6: PARTIAL DIFFERENTIAL EQUATIONS

Course Code : 20PMA2C06

Year : First Year
Semester : II
Hours/Week : 6
Credits : 5

Course Objective

1. To present students the elements of the theory of partial differential equation.
2. To introduce different methods for solving partial differential equation.
3. To enable the students to find solution of partial differential equation of practical application in engineering, physics etc.

Course Outcomes (CO)

CO1	Enumerate the basic concepts of first and second order partial differential equations and different methods of solving PDE.	K1
CO2	Classifying PDEs and applying analytical methods and giving their physical interpretation.	K2
CO3	Formulate, analyze and validate mathematical models of practical problems related to other fields.	K3
CO4	Investigate boundary values problems and point out its significance.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	S	M	S		M	S	M	S	S
CO2	S	S	S	S	M		S	M	S	S	M
CO3	S	M	S	L	S		S	M	S	M	S
CO4	M	S	M	S	M		S	S	M	S	M

S – Strong; M – Medium; L - Low

Unit I:

Partial Differential Equations of the first order: Partial Differential Equations- nonlinear PDE of first order compatible system of first order equations- Charpit's method-special type of first order equation- **Jacobi method***.

Chapter 2: Sections 1, 7, 9, 10, 11 and 13.

Unit II:

Partial Differential Equations of the second order: Linear partial differential equation with constant coefficients - Equations with variable coefficients

Chapter 3: Sections 4 and 5.

Unit III:

Laplace's Equation: Occurrence of Laplace's equation in physics – Elementary solution of Laplace's equation - Boundary value problems - separation of variables - Problems with axial symmetry - Kelvin's inversion theorem - **Theory of Green's functions for Laplace's equation*** - Two-dimensional Laplace Equation – Green's function for two-dimensional equation.

Chapter 4: Sections 1, 2, 4, 5, 6, 7, 8, 11 and 13.

Unit IV:

The Wave Equation: Occurrence of wave function in Physics - Elementary solution one dimensional wave equation - vibrating membranes: Application of the calculus of variations - Three-dimensional problems - General solutions of wave equation - **Green's function for the wave equation*** – The nonhomogeneous wave equation.

Chapter 5: Sections 1, 2, 4, 5, 6, 7 and 8.

Unit V:

The Diffusion Equation: Occurrence of the Diffusion equation in Physics – Resolution of boundary value problem for the diffusion equation - Elementary solutions of the diffusion equation –**Separation of variables*** – The use of Green's functions.

Chapter 6: Sections 1, 2, 3, 4 and 6.

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

I. N. Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, 1988.

Book for reference:

K. Sankara Rao, *Introduction to Partial Differential equations*, PHI learning PVT. Ltd, 2010.

e-resources:

1. https://www.youtube.com/watch?v=zpxe5yoB0xg
2. https://www.youtube.com/watch?v=QWcXxdEMiTw&t=391s

Course Title : CORE 7: MECHANICS **Course Code : 20PMA2C07**

Year : First Year **Semester : II**

Hours/Week : 6 **Credits : 4**

Course Objective

1. To develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics.
2. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.
3. To develop skills in formulating and solving physics problems

Course Outcomes (CO)

CO1	Demonstrate the knowledge of core principles in Mechanics	K1
CO2	Interpret complex and difficult problems of classical dynamics in a systematic way	K2
CO3	Identify the existing symmetries and the corresponding integrals of motion and analyze the qualitative nature of dynamics	K3
CO4	Apply the Hamilton's principle for physical problems.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	M	M	L		S	M	S	S	M
CO2	S	M	S	S	M		S	M	S	M	M
CO3	S	S	S	S	M		S	S	S	M	S
CO4	S	S	S	M	S		S	S	M	M	S

S – Strong; M – Medium; L - Low

Unit I:

Introductory Concepts: The Mechanical System - Geometrical co-ordinates – Constraints Virtual Work – **Energy*.**

Chapter 1: Sections 1.1 – 1.5

Unit II:

Lagrange's Equations: Derivation of Lagrange's Equations – **Integral of the motion*** - Examples

Chapter 2: Sections 2.1 - 2.3

Unit III:

Hamilton's Equations:

Hamilton's Principle – Hamilton's Equations – Modified Hamilton's Principle – **Principle of least action and examples*.**

Chapter 4: Sections 4.1 - 4.3

Unit IV:

Hamilton-Jacobi Theory:

Hamilton's Principle function – The Hamilton – **Jacobi Equation*.**

Chapter 5: Sections 5.1 - 5.2.

Unit V:

Canonical Transformations:

Differential forms and generating functions – Lagrange and Poisson brackets.

Chapter 6: Sections 6.1 - 6.3

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

D. T. Greenwood, *Classical Dynamics*, Prentice Hall, 1985.

Book for reference:

Herbert Golstein, Charles Poole, and John Safko, *Classical Mechanics*, Addson Wesley, Third edition, 2000.

e-resources:

1. http://www-sp.phy.cam.ac.uk/~je102/ClassicalDynamics1B_2006-7/Handout_1_2006-7_v1.pdf
2. https://www.youtube.com/watch?v=83QCm3LkuEg
3. https://nptel.ac.in/courses/115/106/115106123/

Course Title : Core 8: Mathematical Software – Programming in C++

Course Code: 20PMA2C08

Year : First Year **Semester : II**

Hours/Week : 4 **Credits : 3**

Course Objective

1. To develop familiarity in the programming language.
2. To use the object oriented programme in Mathematics.
3. To develop software skill and interest in research.

Course Outcomes (CO)

CO1	To demonstrate the knowledge of C++ program in Mathematics	K3
CO2	Interpret complex and difficult problems of Science and Engineering in a systematic way	K1 & K2
CO3	Understand advanced features of C++ such as stream I/O templates and operator overloading.	K2 & K3
CO4	Analyzing the concepts of Object Oriented Programming to solve real world problems	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 – Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	S	S	M		M	M	S	S	M
CO2	S	S	S	M	M		S	S	S	S	S
CO3	S	S	S	M	S		S	M	S	M	M
CO4	S	S	S	M	S		S	S	S	S	M

S – Strong; M – Medium; L - Low

Unit I:

Principle of Object Oriented Programming: Object oriented programming paradigm. Basic concepts of object oriented programming structure of C++ program. Tokens – keywords – identities – Basic Data types – User-Defined Data types – Derived Data types – symbolic constants – Type compatibility – Declaration of variables – **Dynamic Initialization of variables*** – reference variables.

Section: 1.4 & 1.5, 3.2 – 3.12

Unit II:

Operators in C++ - Scope Resolution operator – Member Dereferencing operators – Memory Management operators – Type cast operator – Expressions and Implicit conversions – Operator overloading – Operator Precedence. Functions in C++ - Introduction – The main function – Function Prototyping – Call by Reference – Return by Reference – Inline functions – **Default Arguments*** – Constant Arguments.

Section: 3.13 – 3.16, 3.18 – 3.21, 4.1 – 4.8

Unit III:

Classes and Objects: Introduction – Specifying a class – Defining Members Functions – Making an outside function inline – Nesting of Member Functions – Private Member Functions – Arrays within a class – Memory Allocation for Objects – Static Data Members – Static Member Functions – **Friendly functions*** – Returning objects – Const Member Functions.

Constructors and Destructors: Introduction – Parameterized Constructors - Multiple Constructors in a class – Constructors with Default Arguments.

Section: 5.1, 5.3, 5.4, 5.6 – 5.12, 5.16 – 5.17, 6.1- 6.5.

Unit IV:

Operator Overloading and Type Conversions: Introduction – Defining operators overloading – Overloading Unary operators – Overloading Binary operators using friends – Manipulation of strings using operators. Rules for overloading operators – Type conversion.

Inheritance: Extending Classes: Introduction – Defining Derived classes – Single Inheritance - Making a private Member inheritable – Multilevel Inheritance – **Multiple Inheritance*** – Hierarchical Inheritance – Hybrid Inheritance.

Sections: 7.1 -7.8, 8.1 – 8.8.

Unit V:

Pointers, Virtual Functions and Polymorphism: Introduction – Pointers to objects – 'This' pointer – pointer to Derived classes – Virtual Functions – **Pure Virtual Functions*.**

Managing Console I / O Operations: Introduction – C++ Streams – C++ stream classes – Unformatted I / O operations – Formatted console I / O operations – Managing output with Manipulators.

Sections: 9.1 – 9.6, 10.1 – 10.6.

*** denotes self study (Questions may be asked from these portions also)**

Book for Study:

E. Balagurusamy, *Object – Oriented Programming with C ++*, Tata McGraw – Hill, New Delhi, 1998.

e-resources:

1. https://www.edx.org/course/introduction-to-c-
2. https://www.edx.org/course/intermediate-c-2
3. https://nptel.ac.in/courses/106/105/106105151/
4. https://www.edx.org/course/advanced-c
5. https://nptel.ac.in/courses/106/101/106101208/

Course Title : Elective 2: GRAPH THEORY **Course Code :20PMA2EL2**

Year : First Year **Semester : II**
Hours/Week : 5 **Credits : 4**

Course Objective

1. To present students the basic concepts of graph theory.
2. To understand the concept of colouring, connectivity of graphs
3. To enable the students to find the practical applications to the real world problems.

Course Outcomes (CO)

CO1	Understanding of network and colouring in Graph theory.	K2
CO2	Apply the concepts of connectivity, blocks and Hamilton cycles in the real life.	K3
CO3	Demonstrate the concept of colouring and to apply in day today life.	K1
CO4	Emphasis the concepts of planar graphs and directed graphs.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	M	S	S		S	S	M	S	S
CO2	S	S	M	M	M		S	S	S	S	S
CO3	S	S	S	M	S		S	S	M	S	S
CO4	S	S	S	S	S		S	S	S	S	S

S – Strong; M – Medium; L - Low

Unit-I

Graphs and Sub graphs: Graphs and simple graphs –Graph isomorphism – The incidence and adjacency matrix – sub graphs – vertex degree – path, **connection and cycles*.**
Tree: Trees – cut edges and bonds – cut vertices and Cayley's formula.

Chapter I- Section: 1.1-1.7, Chapter II- Section: 2.1-2.4

Unit -II

Connectivity and Blocks, Euler tours and Hamilton cycles: Euler tours and Hamilton cycles.

Chapter III- Section: 3.1-3.2, Chapter IV- Section: 4.1-4.2

Unit -III

Matchings: Matchings*, Matchings and coverings in bipartite graphs and perfect matchings.
Independent sets and Cliques: Independent sets.

Chapter V- Section: 5.1-5.3, Chapter VII- Section: 7.1

Unit -IV

Edge Colourings: Edge Chromatic number and Viging's theorem.

Vertex Colourings: Chromatic number, Brook's theorem, Hajo's Conjecture, Dirac's Theorem, **Chromatic polynomials*,** Girth and Chromatic number.

Chapter VI- Section: 6.1-6.2, Chapter VIII- Section: 8.1-8.5.

Unit -V

Planar graphs: Plane and planer graphs, dual graph, Euler's formula, Kuratowski's Theorem.

Directed graphs: Directed graphs, directed paths and **directed cycles*.**

Chapter IX- Section: 9.1-9.3 and 9.5, Chapter X- Section: 10.1-10.3.

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

J. A. Bondy and U. S. R. Murty, *Graph Theory with applications*, Macmillan Company, 1976.

Books for Reference:

1. R. Balahrishnan and K. Ranganathan, *A text book on Graph Theory*, Springer Verlog, Newyork 2000.
2. R. Gould, *Graph Theory*, The Benjamin/Cummings publications company Califonia, 1988.
3. N. Harlsfield and G. Ringd, *Pearls in Graph Theory*, Academic press, 1990.

Course Title : CORE 9: TOPOLOGY **Course Code : 20PMA3C09**
Year : Second Year **Semester : III**
Hours/Week : 6 **Credits : 5**

Course Objective

1. Students will learn the fundamental concepts of point-set topology.
2. Introduce students to the concepts of open and closed sets abstractly.
3. Provide the awareness of tools to students to carrying out advanced research work in pure Mathematics.

Course Outcomes (CO)

CO1	Define and illustrate the concept of topological spaces and continuous functions, concept of product topology and quotient topology	K1 & K2
CO2	Identify the concepts of distance between two sets, connectedness, denseness and compactness.	K2
CO3	Ability to determine that a given point in a topological space is either a limit point or not a limit point for a given subset of a topological space.	K3 & K4
CO4	Understanding the concepts of countability and separation axioms.	K2

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	L	S		S	S	S	S	S
CO2	M	S	M	M	S		M	S	M	S	S
CO3	S	S	S	M	S		S	S	S	M	M
CO4	M	M	S	L	S		M	S	L	M	S

S – Strong; M – Medium; L - Low

Unit I:

Topological Spaces and Continuous Functions: Topological spaces – Basis for a Topology – The Order topology – The Product topology on X × Y – The Subspace topology – **Closed sets and limit points***.

Chapter 2: Sections 12 - 17

Unit II:

Topological Spaces and Continuous Functions: Continuous functions – The Product topology – **The Metric topology*.**

Chapter 2: Sections 18 - 20

Unit III:

Connectedness and Compactness: Connected spaces – Connected Subspaces of the real line – Components and **Local Connectedness*.**

Chapter 3: Sections 23 - 25

Unit IV:

Connectedness and Compactness: Compact spaces, Compact Subspaces of the real line – **Limit point compactness*.**

Chapter 3: Sections 26 - 28

Unit V:

Countability and Separation Axioms: The Countability Axioms – The Separation Axioms – The Urysohn Lemma – The Urysohn Metrization theorem.

Chapter 4: Sections 30, 31, 33, 34

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

James R. Munkres, *Topology*, Prentice Hall of India, New Delhi, 2007.

Books for reference:

1. Sze - Tsen Hu, *Introduction to general topology*, Holdenday inc, 1966.
2. J. Dugundji, *Topology*, Prentice Hall of India, 1975.
3. G. F. Simmons, *Introduction to topology and modern analysis*, Tata McGraw Hill book company, Inc, Ninth reprint, 2004.
4. J. L. Kelly, *General Topology*, Dover Publications, Inc., New York, 2017.

e-resources:

1. https://nptel.ac.in/courses/111/106/111106054/
2. https://youtu.be/SXHHvoaSctc
3. https://ocw.mit.edu/courses/mathematics/18-901-introduction-to-topology-fall-2004/lecture-notes/

Course Title : CORE 10: Nonlinear Differential Equations

Course Code : 20PMA3C10

Year : Second Year **Semester : IV**

Hours/Week : 6 **Credits : 5**

Course Objective

1. Students will learn the fundamental concepts of linear and nonlinear systems.
2. To use different techniques to solve nonlinear problems
3. To understand the concept of stability analysis.

Course Outcomes (CO)

CO1	Able to define and understand types of nonlinear equations	K2
CO2	Identify methods to solve different types of problems	K1 & K2
CO3	Ability to give sufficient conditions for the existence of solutions	K3
CO4	To apply the stability analysis to check the stability of the solutions	K3 & K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	S	M	M	S		M	S	M	S	M
CO2	S	S	M	S	S		S	M	M	S	S
CO3	M	M	S	M	S		S	S	S	M	L
CO4	M	L	S	L	S		S	S	M	M	S

S – Strong; M – Medium; L - Low

Unit I:

First order systems in two variables and linearization: The general phase plane – some population models – linear approximation at equilibrium points – **The general solution of a linear system*.**

Chapter 2: Sections 2.1 - 2.4

Unit II:

Averaging Methods: An energy balance method for limit cycles – Amplitude and frequency estimates – Slowly varying amplitudes: Nearly periodic solutions – Periodic solutions: **Harmonic balance*** – Equivalent linear equation by harmonic.

Chapter 4: Sections 4.1 - 4.5

Unit III:

Perturbation Methods: Outline of the direct method – Forced Oscillations far from resonance – Forced oscillations near resonance with weak excitation – Amplitude equation for undamped pendulum– Lindstedt's method – **The perturbation method and Fourier series***.

Chapter 5: Sections 5.1 - 5.4, 5.8, 5.10.

Unit IV:

Stability: Poincare stability – Solutions, paths and norms – Liapunov stability. Stability of linear systems- Stability and boundedness for linear systems- **Stability of system with constant coefficients*.**

Chapter 8: Sections 8.1 – 8.4, 8.6-8.7.

Unit V:

The Existence of Periodic solutions: The Poincare - Bendixson theorem - A theorem on the existence of a centre - A theorem on the existence of a limit cycle- Van der Pol's equation with large parameter.

Chapter 11: Sections 11.1 – 11.4

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

D.W. Jordan and P. Smith, *Nonlinear Ordinary Differential Equations*, Clarendon Press, Oxford, Second Edition, 1987.

Books for reference:

1. G.F. Simmons, *Differential Equations*, Tata McGraw-Hill, New Delhi, 1979.
2. D.A. Sanchez, *Ordinary Differential Equations and Stability Theory*, Dover, New York, 1968.

e-resources:

1. https://www.youtube.com/watch?v=oOpFvkqAnG4
2. https://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/unit-iv-first-order-systems/nonlinear-systems/
3. https://ocw.mit.edu/courses/mathematics/18-385j-nonlinear-dynamics-and-chaos-fall-2004/
4. https://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/unit-iv-first-order-systems/limitations-of-the-linear-limit-cycles-and-chaos/existence-of-limit-cycles/

Course Title : CORE 11: NEURAL NETWORKS **Course Code : 20PMA3C11**

Year : Second Year **Semester : I**
Hours/Week : 6 **Credits : 4**

Course Objectives

1. To know the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications.
2. To acquire in-depth knowledge in non-linear dynamics.
3. To apply neural network to classification and generalization problems.

Course Outcomes (CO)

CO1	Understand and analyze different neural network models.	K2 & K4
CO2	Understand the basic ideas behind most common learning algorithms for multilayer perceptions.	K1 & K2
CO3	Describe Hebb rule and analyze back propagation algorithm with examples.	K3
CO4	Study convergence and generalization and implement common learning algorithm.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 – Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	M	L	M		S	M	S	M	M
CO2	S	S	S	M	S		S	M	M	M	M
CO3	S	S	S	M	S		S	S	S	M	M
CO4	S	S	S	M	S		S	S	S	S	M

S – Strong; M – Medium; L - Low

Unit - I

Neuron Model and Network Architectures: Mathematical Neuron Model- Network Architectures- Perceptron-Hamming Network - **Hopfield Network*.**

Chapter 2: Page No. 2.2 to 2.21
Chapter 3: Page No. 3.2 to 3.14

Unit – II

Perceptron Architectures and Learning Rules: Learning Rules - Perceptron Architectures and Learning Rule with Proof of Convergence.

Chapter 4: Page No. 4.2 to 4.33

Unit - III

Supervised Hebbian Learning: Supervised Hebbian Learning -Linear Associator - The Hebb Rule-Pseudo inverse Rule - **Variations of Hebbian Learning*.**

Chapter 7: Page No. 7.2 to 7.28

Unit – IV

Back Propagation: Back Propagation - Multilayer Perceptrons - Back propagation Algorithm - **Convergence and Generalization*.**

Chapter 11: Page No. 11.2 to 11.40

Unit - V

Performance Surfaces and Performance Optimizations: Taylor series* - Directional Derivatives - Minima-Necessary Conditions for Optimality- Quadratic Functions-Performance Optimizations-Steepest Descent- Newton's Method - Conjugate Gradient.

Chapter 8: Page No. 8.2 to 8.33
Chapter 9: Page No. 9.2 to 8.28

*** denotes self study (Questions may be asked from these portions also)**

Books for study:

Martin T. Hagan, Howard B. Demuth, and Mark Beale, *Neural Network Design*, Vikas Publishing House, New Delhi, 2002.

Books for reference:

1. James A. Freeman, and David M. Skapura, *Neural Networks Algorithms,* Applications and Programming Techniques, Pearson Education, 2003.
2. Robert J. Schalkoff, *Artificial Neural Network*, McGraw-Hill International Edition, 1997.

e-resources:

1. https://nptel.ac.in/courses/117/105/117105084/
2. https://nptel.ac.in/courses/106/106/106106184/

Course Title : CORE 12: Mathematical Software – MATLAB

Course Code : 20PMA3C12

Year : Second Year **Semester : III**

Hours/Week : 5 **Credits : 4**

Course Objective

1. To develop familiarity in the programming language.
2. To use the MATLAB program in Mathematics
3. To develop software skill and interest in research

Course Outcomes (CO)

CO1	To demonstrate the knowledge of MATLAB program in Mathematics	K1&K2
CO2	Interpret complex and difficult problems of Science and Engineering in a systematic way and to write program	K4
CO3	Applying the MATLAB program to solve industrial problems	K3
CO4	Solving the ODE and nonlinear equations using MATLAB	K3&K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	M	M		S	S	M	M	L
CO2	M	S	M	M	S		S	M	S	S	M
CO3	M	S	M	M	S		S	M	S	S	M
CO4	M	S	M	M	M		S	S	S	M	M

S – Strong; M – Medium; L - Low

Unit I:

Introduction: What is MATLAB? - Does MATLAB do symbolic calculations? - Will MATLAB run on my computer? - Where do I get MATLAB? - How do I use this book?-Basic of MATLAB, Input – Output - File types – **Platform dependence*** – General commands.

Chapter I: Section 1.1-1.6

Unit II:

Interactive Computation: Matrices and vectors – Matrix and Array Operations – Creating and Using Inline functions – Using Built-in Functions and On-line Help – **Saving and loading data*** – Plotting simple graphs.

Chapter III: Sections 3.1 – 3.6.

Unit III:

Programming in MATLAB: Scripts and Functions – Script files – Function files – Language specific features – **Advanced data objects*.**

Chapter IV: Sections 4.1 – 4.4.

Unit IV:

Applications: Linear Algebra – Curve fitting and Interpolation – Data analysis and Statistics – Numerical Integration – Ordinary differential equations – **Nonlinear Algebraic Equations*.**

Chapter V: Sections 5.1 – 5.6.

Unit V:

Graphics: Basic 2-D plots – Using subplot to layout multiple graphs – 3-D Plots – Handle Graphics – **Saving and Printing Graphs*** – Errors.

Chapter VI & VII: Sections 6.1 – 6.4, 6.6, 7

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

Rudra Pratap, *Getting started with MATLAB – A Quick Introduction for Scientists and Engineers*, Oxford University Press, 2010.

Books for reference:

1. A. Gilat, *MATLAB An Introduction with Application*, John Wiley & Sons, Singapore, 2004.
2. W.J. Palm, *Introduction to Matlab 7 for Engineers*, McGraw-Hill Education, New York, 2005.
3. D. M. Etter, D. C. Kuncicky and H. Moore, *Introduction to MATLAB 7*, Prentice Hall, New Jersy, 2004.

e-resource:

1. https://nptel.ac.in/courses/111/102/111102137/
2. https://nptel.ac.in/courses/103/106/103106118/

Course Title : CORE 13: FUNCTIONAL ANALYSIS **Course Code : 20PMA4C13**
Year : Second Year **Semester : IV**
Hours/Week : 6 **Credits : 5**

Course Objective

1. Students will learn the basic concepts and theorems of functional analysis and its applications.
2. The student is able to apply knowledge of functional analysis to solve mathematical problems.
3. The student to understand the spectral analysis

Course Outcomes (CO)

CO1	Describe properties of normed linear spaces and construct examples of such spaces.	K1
CO2	Apply basic theoretical techniques to analyze linear functionals and operators on Banach and Hilbert spaces.	K3 & K4
CO3	Apply orthonormality to Fourier series expansions of functions.	K3
CO4	Understand the concept of Banach Algebras.	K2

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	S	M	S		S	S	S	S	S
CO2	S	M	S	L	M		S	S	S	S	S
CO3	M	M	S	M	M		M	S	M	M	S
CO4	M	M	S	L	S		M	M	L	S	S

S – Strong; M – Medium; L - Low

Unit I:

Banach Spaces: The definition and some examples – **Continuous Linear Transformation*** – The Hahn – Banach theorem.

Chapter 9: Sections 46 – 48

Unit II:

The natural imbedding of N in N** - The Open Mapping Theorem – The conjugate of an operator. **Hilbert spaces**: The Definition and some examples – **properties*.**

Chapter 9: Sections 49 -51 and **Chapter 10: Section 52**

Unit III:

Orthogonal complements – **Orthogonal sets*** – The conjugate space H* - The Adjoint of an Operator.

Chapter 10: Sections 53 – 56

Unit IV:

Self – Adjoint operators – Normal and Unitary operators – **Projections*.**

Chapter 10: Sections 57 -59

Unit V:

Finite – dimensional Spectral Theory: Matrices – The Spectral theorem
General Preliminaries on Banach Algebras: The Definition and some examples – Regular and singular elements.

Chapter 11: Sections 60 – 62 and **Chapter 11: Sections 64, 65**

*** denotes self study (Questions may be asked from these portions also)**

Books for study:

G. F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill publication Company, 1963.

Books for reference:

1. Balmohan V Limaye, *Function Analysis*, Newage international publishers 2014.
2. J. B. Conway, *A Course in Functional Analysis*, Springer, New York, 1990.
3. G. Bachman and L. Narici, *Functional Analysis*, Dover Publications, 2nd Edition, 2012.
4. D. Somasundaram, *A first course in Functional Analysis*, Narosa Publishing House, 2018.

e- resources:

1. https://nptel.ac.in/courses/111/105/111105037/
2. https://ocw.mit.edu/courses/mathematics/18-102-introduction-to-functional-analysis-spring-2009/lecture-notes/
3. https://www.math.kit.edu/iana1/lehre/funcana2012w/media/fa-lecturenotes.pdf

Course Title : CORE 14: MATHEMATICAL METHODS **Course Code : 20PMA4C14**
Year : Second Year **Semester : IV**
Hours/Week : 6 **Credits : 4**

Course Objective

1. To give an introduction to mathematical methods for solving hard problems that arises in the sciences.
2. To understand the concepts like integral transforms, integral equations and calculus of variations in fields of Engineering.
3. To understand the application of integral equations to IVP and BVP.

Course Outcomes (CO)

CO1	Acquire knowledge of various mathematical concepts and techniques required for successful application of mathematics in physics and related sciences.	K1
CO2	Apply various transforms and integral equations to solve multidisciplinary problems.	K3
CO3	Able to solve variational problems by constructing an appropriate functional.	K2
CO4	Develop strategies using mathematical methods to solve real world problems	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	S	S		S	S	S	S	S
CO2	S	S	S	S	S		S	S	*S*	S	S
CO3	M	S	S	S	S		M	S	M	S	S
CO4	S	S	M	S	L		S	M	S	M	M

S – Strong; M – Medium; L - Low

Unit I:

Fourier Transforms, **Finite Fourier Transforms***, Applications of Fourier Transforms in Initial and Boundary value problems.

Chapter 6: Sections 6.1, 6.4 -6.12, Examples 1 – 18
Chapter 7: Sections 7.1 - 7.4, Examples 1 - 9
Chapter 8: Sections 8.1 – 8.4, Examples 1-5, 13-19.

Unit II:

Henkel Transforms and finite Hankel Transforms, Applications of Hankel Transforms in Initial and **Boundary value problems***.

Chapters: 9, 10, 11

Unit III:

Introduction: Definition – Regularity Conditions – Special kinds of Kernels – Eigenvalues and Eigen functions – Convolution Integral – The inner or scaler product of two functions.
Integral Equations with Separable Kernels: Reduction to a system of Algebraic equations – Examples – Fredholm Alternative – Examples – **An Approximate Method*.**
Method of Successive Approximations: Iterative Scheme – Examples – Volterra Integral Equation – Examples.

Chapter I: Sections 1.1 – 1.6, Chapter II: Sections 2.1 – 2.5 and Chapters III: Sections 3.1 – 3.4

Unit IV:

Application Integral Equation to Ordinary Differential Equation: Initial value problems, Boundary value problems – Examples.
Singular Integral Equation: Abel integral equation - Examples.

Chapter 5: Sections 5.1 – 5.3 and **Chapter 8: Sections 8.1 – 8.2**

Unit V:

Calculus of Variations: Variation and its properties – **Euler's equation*** – functionals of the form functional dependent on higher order derivatives - functional dependent on the functions of several independent variables variational problem in parametric form.

Chapter 6: Sections 6.1 - 6. 7.

*** denotes self study (Questions may be asked from these portions also)**

Books for study:

1. Vasistha and Gupta, Integral Transforms, Krishna Prakasam Mandir Meerut, 1993-94. **For Units I & II.**
2. Ram P. Kanwal, Linear Integral Equations, Academic Press, New York, 1971. **For Units III & IV.**
3. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, 1970. **For Unit V.**

Course Title : Core 15: DIFFERENTIAL GEOMETRY **Course Code: 20PMA4C15**
Year : Second Year **Semester : IV**
Hours/Week : 5 **Credits : 4**

Course Objective

1. To introduce the notion of surfaces and their properties.
2. To study geodesics and differential geometry of surfaces.
3. To study fundamental theorems and their applications.

Course Outcomes (CO)

CO1	Identification of important types of curves in surfaces, including principal curves, asymptotic curves and geodesics.	K1
CO2	Enumerate some standard examples in geometry, such as surfaces of constant Gaussian curvature, compact and non -compact surfaces, and surfaces of revolution.	K2
CO3	Analyze Gaussian and mean curvatures using variety of methods including patch computations, direct calculation of the shape operator	K4
CO4	Articulate connections between geometry and other disciplines, possibly including topology, algebra, analysis, or applied mathematics.	K3&K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	M	M	M		M	S	M	S	M
CO2	S	S	M	M	M		S	S	S	S	M
CO3	S	S	S	S	M		S	S	M	S	S
CO4	S	S	S	S	M		S	S	M	S	M

S – Strong; M – Medium; L - Low

Unit I:

Curves: Analytic representation, Arc Length, Tangent, Osculating plane, Curvature Torsion, **Formulas of Frenet*.**

Chapter I: Sections 1.1 - 1.6

Unit II:

Contact, Natural equations, Helices, General solutions of the Natural equations, **Evolutes and Involutes***.

Chapter I: Sections 1.7 -1.11

Unit III:

Elementary Theory of surfaces: Analytic Representation, First Fundamental form, Normal tangent plane, **Developable surfaces*.**

Chapter II: Sections 2.1 - 2.4

Unit IV:

Second fundamental form, Meusnier's theorem, **Euler's theorem*.** Dupin's indicatrix, some surfaces. The fundamental equations; the equations of Gauss – Weingarten.

Chapter II: Sections 2.5 - 2.8 and **Chapter III: Sections 3.1 - 3.2**

Unit V:

The theorem of Gauss and the equations of Codazzi, Some applications of the Gauss and Codazzi equations. The fundamental theorem of surface theory – Geodesic curvature, **Geodesics*.**

Chapter III: Sections 3.3, 3.5, 3.6 and **Chapter IV: Sections 4.1 to 4.2**

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

Dirk, J. Struik, *Lectures on Classical Differential Geometry*, Addison Wesley Publishing Company, 1961.

Books for reference:

1. D. Somasunduram, *Differential Geometry First Course*, Narosa Publishing House, 2010.
2. Nirmala Prakash *Differential Geometry An Integrated Approach*, Tata McGraw-Hill Publishing Company Ltd. Fourth Reprint, 1992.

e-resources:

1. https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-ma07/
2. https://www.youtube.com/watch?v=tKnBj7B2PSg
3. http://pages.uoregon.edu/koch/math433/Final.pdf

Course Title : Elective:4 FLUID DYNAMICS **Course Code : 20PMA4EL4**
Year : Second Year **Semester : IV**
Hours/Week : 6 **Credits : 4**

Course Objective

1. To familiarize the students with basic concepts of Fluid Dynamics.
2. To understand the applications in medical, astrophysical, geophysical, agricultural, aero dynamical and other related disciplines.
3. To develop the problem-solving skills essential to fluid dynamics in practical applications.

Course Outcomes (CO)

CO1	Understand the fundamental knowledge of fluids and its properties.	K1 & K2
CO2	Apply thermodynamic control volume concepts in fluid dynamics for applications that include momentum, mass and energy balances.	K3
CO3	To analyze the approximate solutions of the Navier-Stokes equation.	K4
CO4	Appreciate the role of fluid dynamics in day-to-day life.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	S	S	L	M		S	S	M	S	M
CO2	M	S	M	M	M		S	M	S	S	M
CO3	S	M	M	M	S		M	L	M	M	M
CO4	S	M	S	L	L		M	M	S	S	L

S – Strong; M – Medium; L - Low

Unit I:

Introductory notions – Velocity – Stream lines, and Path of the particle - Stream tubes and Filaments – Fluid body – Density - Pressure, Differentiation with respect to time – Equation of continuity - Boundary conditions (Kinematical and Physical) - **Rate of change of linear momentum*** – Equation of motion of an inviscid Fluid.

Chapter I: Sections 1.0 – 1.3
Chapter III: Sections 3.10, 3.20, 3.30, 3.31, 3.40, 3.41

Unit II:

Euler's Momentum theorem - Conservative forces – Steady motion (Bernoulli's equation) – The Energy equation – Rate of Change of Circulation (Kelvin's theorem) – **Vortex motion*** - Permanence of Verticity (Helmholtz Equation).

Chapter IIII: Sections 3.42, 3.43, 3.45, 3.50, 3.51, 3.52, 3.53

Unit III:

Two dimensional motions – Two dimensional functions – complex potential basic singularities – source vertex – doublet circle theorem – flow past a circular cylinder with circulation – **conformal transformation*** – Blasius theorem – Lift force.

Chapter 3: Sections 3.1 – 3.7.5 (omit 3.4 , 3.5 , 3.5.3 and 3.6)

Unit IV:

Viscous flows – Navier stokes equations – Vorticity and Circulation in a viscous fluid – steady flow through an arbitrary cylinder under pressure – **steady couette flow between cylinders in relative motion*** – steady flow between parallel planes.

Chapter 5: Sections 5.2 – 5.3.3

Unit V:

Laminar boundary layer in incompressible flow boundary layer concept – Boundary layer equations – Displacement thickness – Momentum thickness – Kinetic energy thickness – **Integral equation of boundary layer*** – Flow parallel to semi infinite flat plate - Blasius equation and it's solution.

Chapter 6: Sections 6.2.1, 6.2.3, 6.2.4, 6.3.1

*** denotes self study (Questions may be asked from these portions also)**

Books for study:

1. L. M. Milne Thomson, *Theoretical Hydrodynamics*, Macmillan Company, 5th Edition, 1968. **For Units I and II.**
2. N. Curle and H. J. Davies, *Modern Fluid Dynamics – Vol I*, D Van Nostrand Company Ltd; London, 1968. **For Units III, IV and V.**

Books for references:

1. F. Chorlton, *Text book of Fluid dynamics*, CBS Publishers 2004.
2. A. J. Chorin and A. Marsden, *A Mathematical Introduction to Fluid Dynamics*, SpringerVerlag, New York, 1993.
3. G. K. Batchelor, *An Introduction to Fluid Dynamics*, Cambridge Mathematical Library, 2000.
4. M. D. Raisinghania, *Fluid Dynamics*, S. Chand, 5th Edition, 2018.

e-resource:

1. https://nptel.ac.in/courses/112/105/112105218/
2. https://www.meteo.physik.uni-muenchen.de/lehre/roger/manuskripte/Fluid_Dynamics.pdf
3. https://nptel.ac.in/courses/101/103/101103004/
4. https://www.youtube.com/watch?v=djx9jlkYAt4

Course Title : ELECTIVE 5: CONTROL THEORY **Course Code : 20PMA4EL5**
Year : Second Year **Semester : IV**
Hours/Week : 5 **Credits : 4**

Course Objective

1. To know some fundamental concepts of control system including state, space techniques, optimal control, stability analysis and controllability.
2. The course is intended to provide students with confidence in own abilities to analyze and design a new control system.
3. To understand the concept of optimal control.

Course Outcomes (CO)

CO1	Describe the basic concepts and properties of differential equations, fundamental concepts of control system.	K1&K2
CO2	To know the observability and controllability of a linear system.	K2
CO3	Find the rank of matrices by using the concepts of observability and controllability	K3
CO4	Ability to analyze and design a new control system.	K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze

	PO1	PO2	PO3	PO4	PO5		PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S	M	M	L	M		S	M	M	S	S
CO2	M	M	M	L	M		S	M	S	M	S
CO3	M	M	M	L	M		S	M	M	M	S
CO4	S	S	S	S	S		S	S	S	M	M

S – Strong; M – Medium; L - Low

Unit I:

Observability: Linear systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – **Nonlinear systems*.**

Chapter 2: Sections 2.1- 2.2

Unit II:

Controllability: Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – **Steering function*** – Nonlinear systems.

Chapter 3: Sections 3.1- 3.2

Unit III:

Stability: Stability – Uniform Stability – Asymptotic Stability of Linear systems – Linear time varying systems – **Perturbed linear systems*** – Nonlinear systems.

Chapter 4: Sections 4.1- 4.3

Unit IV:

Stabilizability: Stabilization via linear feedback control – Bass method – **Controllable subspace*** – Stabilization with restricted feedback.

Chapter 5: Sections 5.1- 5.3

Unit V:

Optimal Control: Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – **Nonlinear systems*.**

Chapter 6: Sections 6.1- 6.3

*** denotes self study (Questions may be asked from these portions also)**

Book for study:

K. Balachandran and J.P.Dauer, *Elements of Control Theory*, Narosa, New Delhi, 2nd Edition, 2012.

e-resource:

1. https://en.wikipedia.org/wiki/Observability
2. https://en.wikibooks.org/wiki/Control_Systems/Controllability_and_Observability
3. https://www.youtube.com/watch?v=E_RDCFOlJx4
4. https://www.youtube.com/watch?v=UZHKsk5OnF0