M.Sc. MATHEMATICS

SEM.	COURSE CODE	COURSE	COURSE TITLE	HRS/ WEEK	CREDIT	CIA MARKS	SE MARKS	TOTAL MARKS
I	14PMA1C1	CORE I	Algebra	6	5	40	60	100
	14PMA1C2	CORE II	Real Analysis	6	5	40	60	100
	14PMA 1C3	CORE III	Ordinary and Partial Differential Equations	6	5	40	60	100
	14PMA1C4	CORE IV	Programming in C++	3	3	20	30	50
	14PMA1C4 P	CORE IV	C++ Programming Lab	3	2	20	30	50
	14PMA1CE1	CORE BASED ELECTIVE I#		6	5	40	60	100
TOTAL				**30**	**25**	**200**	**300**	**500**
II	14PMA2C5	CORE V	Linear Algebra	6	5	40	60	100
	14PMA2C6	CORE VI	Fuzzy Sets and their Applications	6	5	40	60	100
	14PMA2C7	CORE VII	Integral Equations and Calculus of Variations	6	5	40	60	100
	14PMA2C8	CORE VIII	Complex Analysis	6	5	40	60	100
	14PMA2CE2	CORE BASED ELECTIVE II#		6	5	40	60	100
TOTAL				**30**	**25**	**200**	**300**	**500**
III	14PMA3C9	CORE IX	Topology	6	5	40	60	100
	14PMA3C10	CORE X	Measure Theory and Integration	6	5	40	60	100
	14PMA3C11	CORE XI	Functional Analysis	6	5	40	60	100
	14PMA3C12	CORE XII	Graph Theory	6	5	40	60	100
	14PMA3CE3	CORE BASED ELECTIVE III#		6	5	40	60	100
	14PMA3EC1	EXTRA CREDIT-I	Discrete Mathematics	-	5*	-	100*	100*
TOTAL				**30**	**25**	**200**	**300**	**500**
IV	14PMA4C13	CORE XIII	Fluid Dynamics	6	5	40	60	100
	14PMA4C14	CORE XIV	Advanced Operations Research	6	5	40	60	100
	14PMA4C15	CORE XV	Advanced Differential Equations	6	5	40	60	100
	14PMA4CE4	CORE BASED ELECTIVE IV#		6	5	40	60	100
	14PMA4EC2	EXTRA CREDIT-II	Differential Geometry	-	5*	-	100*	100*
	14PMA4PW	PROJECT WORK		6	5	40	60	100
TOTAL				**30**	**25**	**200**	**300**	**500**
GRAND TOTAL				**120**	**100**	**800**	**1200**	**2000**

Core Based Elective:

SEMESTER	CORE BASED ELECTIVE
I	Classical Mechanics
	Control Theory
II	Numerical Analysis
	Mathematical Methods in Biology
III	Mathematical Statistics
	Computer Algorithms
IV	Stochastic Processes
	Queuing Theory and Non-Linear Programming

* Not Considered for Grand Total and CGPA

SEMESTER I: CORE - I
ALGEBRA

Course Code	**: 14PMA1C1**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To provide foundation in group and to enhance the power of ideas for solving the problems in algebra.

UNIT I **18 hours**

#Homomorphism on groups# - Cayley's Theorem- Permutation Groups.

UNIT II **18 hours**

#Normalizer and centre of group# - Another Counting Principle – Sylow's theorem.

UNIT III **18 hours**

Ideals and quotient rings - More Ideals and quotient rings – Euclidean rings - A particular Euclidean ring.

UNIT IV **18 hours**

Polynomial Rings – Polynomials over the Rational Field - Polynomial Rings over commutative rings.

UNIT V **18 hours**

Field Extension – Extension fields, Roots of Polynomials more about roots.

 # # Self-study portion.

Text Book:

I. N. Herstein, Topics in Algebra, Second Edition, John Wiley & Sons, Pvt., Ltd. (2000).

UNIT I	Chapter II	Section 2.9 and 2.10
UNIT II	Chapter II	Section 2.11 and 2.12
UNIT III	Chapter III	Section 3.4, 3.5, 3.7 and 3.8
UNIT IV	Chapter III	Section 3.9 – 3.11
UNIT V	Chapter V	Section 5.1, 5.3 and 5.5

Books for Reference:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press (1995).
2. John B. Fraleigh, A First Course in Abstract Algebra, Addison Wesley Publishing Company (1970).

SEMESTER I: CORE – II
REAL ANALYSIS

Course Code	**: 14PMA1C2**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To test the convergence of sequences and series of functions and to study the concepts in integration and multivariable calculus.

UNIT I **18 hours**

Basic topology - #Metric spaces# - Compact sets - Perfect sets.

UNIT II **18 hours**

Riemann - Stieltjes integral - Definition and existence of the integral - #Properties of the integral# - Integration and differentiation - Rectifiable Curves.

UNIT III **18 hours**

Sequences and series of functions - #Uniform convergence# - Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation – Stone - Weierstrass theorem.

UNIT IV **18 hours**

Multivariable differential calculus – Directional derivatives - Total derivative - Matrix of linear function - #Jacobian matrix# - Chain rule - Mean value theorem - Sufficient condition for differentiability - Equality of partial derivatives - Taylor's formula.

UNIT V **18 hours**

Functions with non-zero Jacobian determinant - Inverse function theorem - Implicit function theorem.

 # # Self-study portion.

Text Books:

T.B-1. Walter Rudin, Principles of Mathematical Analysis, McGraw-Hill International Editions, Third Edition (1987).

T.B-2. Tom M. Apostol, Mathematical Analysis, Addison-Wesley Publishing Company, Second Edition (1974).

UNIT I	Chapter 2	Sections 2.15 - 2.43	**T.B-1**
UNIT II	Chapter 6	Sections 6.1 - 6.22, 6.26, 6.27	**T.B-1**
UNIT III	Chapter 7	Sections 7.1 - 7.18, 7.26, 7.27	**T.B-1**
UNIT IV	Chapter 12		**T.B-2**
UNIT V	Chapter 13	Sections 13.1 - 13.4	**T.B-2**

Books for Reference:

1. V. Ganapathy Iyer, Mathematical analysis, Tata McGraw-Hill Publishing Company, Ltd, (1977).
2. Gabriel Klambauer, Real Analysis, American Elsevier Publishing Company, INC, (1973).

SEMESTER I: CORE – III
ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Course Code	**: 14PMA1C3**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To understand the concepts of differential equations and to know the applications of ordinary differential equations and to present the basic theory of PDE which will enable the students to find the practical applications.

UNIT I **18 hours**

General solution of the homogeneous equation – Use of known solution to find another - Method of Variation of Parameters - Series solutions of first order equations.

UNIT II **18 hours**

Second order linear equations - Ordinary points - Regular Singular points – Regular Singular points (continued).

UNIT III **18 hours**

Gauss's hyper geometric equation – #Point at infinity# - Legendre polynomials - Properties of Legendre polynomials.

UNIT IV **18 hours**

Genesis of First Order P.D.E – Classification of Integrals – Linear equations of the First Order – Pfaffian Differential Equations – Compatible Systems.

UNIT V **18 hours**

Charpits's method - Jacobi's Method – Integral Surfaces Through a given Curve – Quasi-Linear Equations.

 # # Self-study portion.

Text Book:

T.B-1. G.F. Simmons, Differential Equations with applications and Historical notes, Tata McGraw Hill Publishing Company Ltd, New Delhi, Second Edition (2003).

T.B-2. T. Amarnath, An Elementary Course in Partial differential Equations, Narosa Publishing House, Second Edition (2003).

UNIT I	Chapter 3	Sections 15, 16, 19 and Chapter 5 Section 27	**T.B-1**
UNIT II	Chapter 5	Sections 28, 29, 30	**T.B-1**
UNIT III	Chapter 5	Sections 31, 32 and Chapter 8 Sections 44, 45	**T.B-1**
UNIT IV	Chapter 1	Sections 1.2–1.6	**T.B-2**
UNIT V	Chapter 1	Sections 1.7–1.10	**T.B-2**

Books for Reference:

1. Earl. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, (1961).
2. M.D. Raisinghania, Advanced Differential Equations, S. Chand and Company Ltd, New Delhi, Seventh Revised Edition (2000).
3. N. Sneddon, Elements of Partial Differential Equations, McGraw Hill (1985).

SEMESTER I: CORE – IV
PROGRAMMING IN C++

Course Code : 14PMA1C4 **Max. Marks : 50**
Hours /Week : 3 **Internal Marks : 20**
Credits : 3 **External Marks: 30**

Objective:

To introduce the benefits of using C++ and object-oriented programming techniques for application development and write programs for a wide variety problems in mathematics.

UNIT I **12 hours**

Object-Oriented Programming Paradigm – Basic concepts of Object-oriented Programming – What is C++ – A simple C++ program – More C++ statements – An example with class – Structure of C++ program – **#**Keywords – Identifiers and Constants – Basic Data types – User defined data types – Derived data types – Symbolic constants – Declaration of variables – Reference variables**#** – Operators in C++ - Scope resolution operators – Expressions and their types – Control structures.

UNIT II **12 hours**

Functions in C++ - The main function – **#**Function prototyping – Call by reference – Return by reference**#**– Inline functions – Function overloading – Specifying a class – Defining member functions – Nesting of member functions – Private member functions – Arrays within a class – Arrays of Objects – Objects as function arguments – Friendly functions – Returning Objects – Pointers to members.

UNIT III **12 hours**

Constructors – Parameterized constructors – Multiple constructors in a class – constructors with default arguments – Copy constructor – constructing two-dimensional arrays – Destructors – Defining operator overloading – Overloading unary operators - Overloading binary operators - **#**Overloading binary operators using friends**#**.

UNIT IV **12 hours**

Inheritance – Defining derived classes – Single inheritance – Making a private member inheritable – Multilevel inheritance – Multiple inheritance – Hierarchical inheritance – Hybrid inheritance – **#**Virtual base classes**#**.

UNIT V **12 hours**

Working with files – Introduction – classes for file stream operations – Opening and closing a file – Detecting End-of-File – File pointers and their manipulations – Sequential input and output operations – Updating a file: Random access – Error handling during file operations – **#**Command-Line-Arguments**#**.

 # # Self-study portion.

Text Book:

E. Balagurusamy, Object Oriented Programming with C++, Second Edition, TMH, 2008.

UNIT I Chapter 1 - 1.4, 1.5; Chapter 2 – 2.1, 2.3, 2.4, 2.5, 2.6
Chapter 3 – 3.3 to 3.8; 3.10, 3.12, 3.13, 3.14, 3.19, 3.24
UNIT II Chapter 4 – 4.2 to 4.6; 4.9; Chapter 5 – 5.3, 5.4, 5.7, 5.8, 5.9, 5.13 to 5.16; 5.18
UNIT III Chapter 6 – 6.2 to 6.5; 6.7, 6.9, 6.11, Chapter 7 – 7.2 to 7.5
UNIT IV Chapter 8 – 8.2 to 8.9
UNIT V Chapter 11 – 11.1 to 11.4; 11.6 to 11.10

Books for Reference:

1. Herbert Schildt, The Complete Reference C++, Fourth Edition, TMH, 2003.
2. K. R. Venugopal, Raj Kumar and T. Ravi Shankar, Mastering C++, TMH, 2005.

SEMESTER I: CORE – IV P
C++ PROGRAMMING LAB

Course Code : 14PMA1C4 P **Max. Marks : 50**
Hours /Week : 3 **Internal Marks : 20**
Credits : 2 **External Marks : 30**

Objective:

To enable the students to acquire programming skills by applying various features of C++ Language.

List of Practicals:

1. Simple programs using functions.
2. Simple programs using classes and objects
3. Develop a C++ Program to implement the following:
   a) Friend Function b) In-line Function c) Virtual Function
4. Develop a C++ Program using Operator Overloading
   a) to add complex numbers
   b) to multiply two matrices
5. Develop a C++ Program using pointers for String Manipulations
6. Develop a C++ Program to illustrate the use of Arrays of Objects.
7. Develop a C++ Program to implement Pay Bill application by using Inheritance
8. Develop a C++ Program to implement Mark List Application by using Files.

SEMESTER I: CORE BASED ELECTIVE – I
CLASSICAL MECHANICS

Course Code : 14PMA1CE1 **Max. Mark : 100**
Hours/Week : 6 **Internal Mark: 40**
Credit : 5 **External Mark: 60**

Objective:

To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum, to study mechanics developed by Newton, Lagrange and Hamilton Jacobi concepts.

UNIT I **18 hours**

Mechanical system – Generalized Co-ordinates – Constraints – Virtual work – #Energy and Momentum#.

UNIT II **18 hours**

Derivation of Lagrange's Equation – Examples – Integrals of the motion - #Simple Problems#.

UNIT III **18 hours**

Rayleigh's Dissipation Function – Impulsive motion - #Velocity dependent potentials#.

UNIT IV **18 hours**

Hamilton`s principle – Hamilton's equation - #Other variational principles#.

UNIT V **18 hours**

Hamilton`s principal function – The Hamilton's – Jacobi equation – separability - #Simple Problems#.

 # # Self-study portion.

Text Book:

Donald. T. Green wood, Classical Dynamics, Prentice Hall of India, (1985).

UNIT I Sections 1.1 - 1.5
UNIT II Sections 2.1 - 2.3
UNIT III Sections 3.1, 3.2 and 3.4
UNIT IV Sections 4.1, 4.2, 4.3
UNIT V Sections 5.1, 5.2 and 5.3

Books for Reference:

1. C.R. Mondal, Classical Mechanics, Revised Edition, Prentice Hall of India, (2008).
2. S.G. Venkatachalapathy, Classical Mechanics, Margham Publications, (2006).

SEMESTER I: CORE BASED ELECTIVE – I
CONTROL THEORY

Course Code : 14PMA1CE1 **Max. Mark : 100**
Hours/Week : 6 **Internal Mark: 40**
Credit : 5 **External Mark: 60**

Objective:

To study observability, controllability, stability and optimal control of linear systems.

UNIT I **18 hours**

Observability: Linear Systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems

UNIT II **18 hours**

Controllability: Linear systems – Controllability Grammian – Adjoint systems – Constant coefficientsystems – steering function – Nonlinear systems

UNIT III **18 hours**

Stability: Stability – Uniform Stability – Asymptotic Stability of Linear Systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems

UNIT IV **18 hours**

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

UNIT V **18 hours**

Optimalcontrol: Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems

Text Book:

Elements of Control Theory by K. Balachandran and J.P.Dauer, Narosa, New Delhi, 1999.

UNIT I Chapter 2
UNIT II Chapter 3 Sections 3.1 - 3.3
UNIT III Chapter 4
UNIT IV Chapter 5
UNIT V Chapter 6

Books for Reference:

1. Linear Differential Equations and Control by R.Conti, Academic Press,London, 1976.
2. Functional Analysis and Modern Applied Mathematics by R.F.Curtain andA.J.Pritchard, Academic Press, New York, 1977.
3. Controllability of Dynamical Systems by J.Klamka, Kluwer AcademicPublisher, Dordrecht, 1991.
4. Mathematics of Finite Dimensional Control Systems by D.L.Russell, MarcelDekker, New York, 1979.
5. E.B. Lee and L. Markus, Foundations of optimal Control Theory, John Wiley,New York, 1967

SEMESTER II: CORE – V
LINEAR ALGEBRA

Course Code	**: 14PMA2C5**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To understand the various aspects of Linear Algebra and to train in problem-solving skill.

UNIT I **18 hours**

#Systems of linear Equations# – Matrices and Elementary Row operations – Row-Reduced echelon Matrices – Vector spaces – Subspaces – Bases and Dimension.

UNIT II **18 hours**

#Linear transformations# - Algebra of linear transformations – Isomorphism of Vector Spaces – Representations of Linear Transformations by Matrices - Linear Functionals - Double Dual – Transpose of a Linear Transformation.

UNIT III **18 hours**

#Polynomials# - Algebra of polynomials – Lagrange Interpolation – Polynomial Ideals – Prime factorization of a polynomial – Determinant functions – Permutations and uniqueness of determinants – Classical Adjoint of a (Square) matrix – Inverse of an invertible matrix using determinants.

UNIT IV **18 hours**

Characteristic values – Annihilating polynomials – Invariant subspaces - Simultaneous triangulation and simultaneous Diagonalization.

UNIT V **18 hours**

Direct - Sum Decompositions – Invariant Direct sums – Primary Decomposition theorem.

 # # Self- study portion.

Text Book:

Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, Prentice Hall of India Private Limited, New Delhi, Second Edition (2010).

UNIT I	Chapter I	Sections 1.2 - 1.4	and	Chapter II	Sections 2.1 – 2.3
UNIT II	Chapter III	Sections 3.1 - 3.7			
UNIT III	Chapter IV	Sections 4.2 - 4.5	and	Chapter V	Sections 5.2 - 5.4
UNIT IV	Chapter VI	Sections 6.1 - 6.5			
UNIT V	Chapter VI	Sections 6.6 - 6.8			

Books for Reference:

1. I. N. Herstein, Topics in Algebra, John Wiley & Sons Pvt. Ltd., Second Edition (2000).
2. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice Hall of India Ltd. (2004).

SEMESTER II: CORE - VI
FUZZY SETS AND THEIR APPLICATIONS

Course Code	**: 14PMA2C6**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To study the uncertainty environment, the fuzzy sets incorporates imprecision and subjectivity into the model formulation and solution process. The fuzzy set theory is to make the final crisp values

UNIT I **18 hours**

From Classical Sets to Fuzzy sets – Fuzzy set: Basic types – Fuzzy sets Versus Crisp sets- Extension Principle for fuzzy sets – Operations on Fuzzy sets – #Types of operations# – Fuzzy complements.

UNIT II **18 hours**

Fuzzy Arithmetic – Fuzzy numbers - Linguistic variables – Arithmetic operations on intervals – Arithmetic operations on Fuzzy numbers – #Lattice of Fuzzy numbers# – Fuzzy equations.

UNIT III **18 hours**

Fuzzy Logic – Multi-valued Logics – Fuzzy Propositions – Unconditional and Unqualified Fuzzy propositions – Unconditional and qualified Propositions – Conditional and Unqualified propositions – Conditional and Qualified propositions – Linguistic Hedges – Inference from conditional Fuzzy propositions- #Inference from conditional and qualified propositions#.

UNIT IV **18 hours**

Fuzzy Decision making – #Individual decision making# – Fuzzy Ranking methods – Fuzzy Linear programming.

UNIT V **18 hours**

Fuzzy Relations – Composition of fuzzy relations – Properties of fuzzy relations.

 # # Self-study portion.

Text Books:

T.B-1. George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, Prentice Hall of India, (2004).

T.B-2. A. Nagoor Gani and V.J. Chandrasekaran, A first look at Fuzzy Graph Theory, Allied Publishers Pvt. Ltd., (2010).

UNIT I	Chapter 1 Sections 1.3, 2.3 and Chapter 3 Sections 3.1&3.2	**T.B-1**
UNIT II	Chapter 4 Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6	**T.B-1**
UNIT III	Chapter 8 Sections 8.2, 8.3, 8.5, 8.6, 8.7	**T.B-1**
UNIT IV	Chapter 15 Sections 15.2, 15.6, 15.7	**T.B-1**
UNIT V	Chapter 1 Sections 1.3, 1.4, 1. 5	**T.B-2**

Books for Reference:

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited (1991).

2. M. Ganesh, Introduction to Fuzzy sets and Fuzzy logic, Prentice Hall of India, New Delhi (2006).

SEMESTER II: CORE - VII
INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS

Course Code	**: 14PMA2C7**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

The aim of the course is to introduce to the students various types of integral equations and how to solve these equations and second to introduce the concept of calculus of variation and its applications.

UNIT I **18 hours**

Regularity conditions - Special kinds of kernels – Eigen values and Eigen functions – Convolution Integral – Inner or Scalar product of two functions. Integral equations with separable kernels - Reduction to a system of Algebraic Equations - #Examples# - Fredholm Alternative - #Examples#.

UNIT II **18 hours**

Method of successive approximations - Iterative scheme - #Examples# - Volterra Integral Equations - #Examples# - Some results about the resolvent Kernel.

UNIT III **18 hours**

Applications to ordinary differential equations - Initial value problems – Boundary value Problems - #Examples# - Singular integral equations - Abel Integral Equation - #Examples#.

UNIT IV **18 hours**

Calculus of variations and applications - Maxima and Minima – Simplest case - #Illustrative examples#.

UNIT V **18 hours**

Natural Boundary conditions and transition conditions – Variational notation - #More general case # - Constraints and Lagrange multipliers.

 # # Self-study portion.

Text Books:

T.B-1. Ram P. Kanwal, Linear Integral Equations Theory and Technique, Academic Press, Birkhäuser, New York (2013).

T.B-2. Francis B. Hildebrand, Methods of Applied Mathematics, Dover, Prentice Hall of India, New York, Dover, Second Edition (1992).

UNIT I	Sections 1.1 - 1.6, 2.1 - 2.4	**T.B-1**
UNIT II	Sections 3.1 - 3.5	**T.B-1**
UNIT III	Sections 5.1, 5.2, 5.3, 8.1, 8.2	**T.B-1**
UNIT IV	Sections 2.1, 2.2, 2.3	**T.B-2**
UNIT V	Sections 2.4 - 2.7	**T.B-2**

Books for Reference:

1. Sudir K. Pundir and Rimple Pundir, Integral Equations and Boundary Value Problems, Pragati Prakasam, Meerut (2005).
2. M. D. Raisinghania, Integral Equations and Boundary Value Problems, S. Chand & Co., New Delhi (2007).

SEMESTER II: CORE -VIII
COMPLEX ANALYSIS

Course Code	**: 14PMA2C8**	**Max. Marks:**	**100**
Hours/Week	**: 6**	**Internal Marks:**	**40**
Credit	**: 5**	**External Marks:**	**60**

Objective:

To introduce advanced concepts of complex analysis.

UNIT I **18 hours**

Fundamental theorems – Line integrals - Rectifiable arcs - Line integrals as functions of arcs - Cauchy's theorem for a rectangle - Cauchy's theorem in a disk. Cauchy's integral formula – Index of a point with respect to a closed curve - Integral formula for higher derivatives.

UNIT II **18 hours**

Local properties of analytical functions – Removable singularities - Taylor's theorem - Zeros and poles. Local mapping - Maximum principle. General form of Cauchy theorem – Chains and cycles - Simple connectivity - Homology.

UNIT III **18 hours**

General statement of Cauchy's theorem - Proof of Cauchy's theorem - Locally exact differentials. Calculus of residue - Residue theorem - Argument principle - Evaluation of definite integrals.

UNIT IV **18 hours**

Harmonic functions – Definition and basic properties – Mean-value property - Poisson's formula - Schwarz's theorem - Reflection principle. Power series expansions – Weierstrass's theorem - Taylor series - Laurent series.

UNIT V **18 hours**

Partial fractions and factorization – Partial fractions - Infinite products - Canonical products - Gamma functions.

Text Book:

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

UNIT I Chapter 4 Sections 1.1 - 1.5, 2.1 - 2.3.
UNIT II Chapter 4 Sections 3.1 - 3.4, 4.1 - 4.3.
UNIT III Chapter 4 Sections 4.4 - 4.6, 5.1 - 5.3
UNIT IV Chapter 4 Sections 6.1 - 6.5
Chapter 5 Sections 1.1 - 1.3
UNIT V Chapter 5 Sections 2.1 - 2.4

Books for Reference:

1. Jacob Sonnenschein and Simon Green, Elements of Complex analysis, Dickenson Publishing Company, INC. (1977).
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Pvt. Ltd., Second Edition (2008).

SEMESTER II: CORE BASED ELECTIVE - II
NUMERICAL ANALYSIS

Course Code	**: 14PMA2CE2**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To develop a sound knowledge and appreciation of the ideas and concepts related to polynomials, interpolation, and to give a strong foundation to take up advanced level courses in analysis.

UNIT I **18 hours**

Iteration method based on Second degree equations - Chebyshev Method – Multipoint Iteration Methods – Bridge Vieta Method – Baristow Method – Graeffe's root Squaring Method.

UNIT II **18 hours**

Iteration Methods - Jacobi Method - Guass Seidel Method - Successive Over Relaxation Method – Iterative Method for A^{-1} – #Eigen Values and Eigen Vectors# – Jacobi Method for symmetric Matrices - Power Method.

UNIT III **18 hours**

Interpolation and Approximation – Hermite Interpolation – Piecewise cubic Interpolation and cubic Spline interpolation – Bivariate interpolation – Lagrange and Newton's Bivariate interpolation – #Least Square approximation# – Gram-Schmidt Orthogonalizing Process.

UNIT IV **18 hours**

Differentiation and Integration; Numerical Differentiation – Methods Based on Interpolation – Partial Differentiation – Numerical Integration – Methods Based on Interpolation – Methods Based on Undetermined Coefficients – Gauss Quadrature methods - Gauss Legendre and Gauss Chebyshev Integration Methods – Double Integration – Trapezoidal and Simpson's Rule – Simple Problems.

UNIT V **18 hours**

Ordinary Differential Equations: Numerical Methods – Euler Method – #Backward Euler Method# – Mid-Point Method – Runge-kutta Methods – Implicit Runge-Kutta Methods – Predictor – Corrector Methods.

 # # Self-study portion.

Text Book:

M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, Fourth Edition (2004).

UNIT I	Chapter II	Sections 2.4, 2.9
UNIT II	Chapter III	Sections 3.4, 3.7, 3.11
UNIT III	Chapter IV	Sections 4.5, 4.6, 4.7, 4.9
UNIT IV	Chapter V	Sections 5.2, 5.5, 5.6, 5.7, 5.8, 5.11
UNIT V	Chapter VI	Sections 6.3, 6.4, 6.7

Books for Reference:

1. Samuel. D. Conte and Carl De Boor, Elementary Numerical Analysis, Third Edition (1965).
2. F.B. Hildebrand, Introduction to Numerical Analysis, Tata McGraw Hill (1979).

SEMESTER II: CORE BASED ELECTIVE - II
MATHEMATICAL METHODS IN BIOLOGY

Course Code	**: 14PMA2CE2**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To introduce Mathematics as a tool in the study of Biology.

UNIT I **18 hours**

Sequence alignments, Basic string definitions, The importance of sequence comparison in Molecular Biology, The edit distance between two strings, String alignment, Edit graphs, String similarity, Alignment graphs, Local alignment, Introduction to Gaps, CDNA matching, A concrete illustration, Choices for gap weights, Time analysis.

UNIT II **18 hours**

Overview of RDBMS, Advantages of DBNS, Normalization, Oracle data types, Introduction to SQL, DDL, DML, & TLC commands. Data definition Language, Data Manipulation Language, Transaction Control & data, Control language Grant & Revoke Privilege Command.

UNIT III **18 hours**

Multiple sequence alignments, the morphological to the molecular, Common multiple alignment methods, multiple sequence alignments, Local alignment gaps, parametric sequence alignments, suboptimal alignments, Multifunction tools for sequence analysis.

UNIT IV **18 hours**

Phylogenetic analysis, Evolutionary Trees and Phylogeny, Ultrasonic trees, Parsimony, Ultrametric problem, Perfect phylogeny, Phylogenetic alignment, Connection between multiple alignment and tree construction, Methods in Phylogeneic Analysis, Profiles and Motifs

UNIT V **18 hours**

Tools in Bioinformatics, Tools for database search using search engines, Finding scientific articles, Finding public data bases, Depositing data into public data bases, Tools for Sequence Analysis, Algorithms issues in data base search, FASTA, BLAST, Amino acid substitution matrices PAM and BLOSSUM

Text Books:

1. George Koch and Kevin Loney; ORACLE 8-THE COMPLETE REFERENCE, Tata McGraw – Hill Edition, 1988.
2. Michael Abbey andMichael J. Correy; ORACLE 8 – A BEGINNERS GUIDE, 1997.
3. Eddy, S.R., Durbin et al; Computational Molecular Biology, 2002.
4. Cynthia Gibas& Per Jampeck, Developing Bioinformatics ComputerSkills; Shroff Publishers and Distributors Private Limited, Calcutta, 2001.
5. Waterman,Michael S, Introduction to Computational Biology, Chapman and Hall, CRC Press, 2000.

Books for Reference:

1. Baxevanis, A.D., and Ouellette, Francis, B.F., Bioinformatics – A practical Guide to theAnalysis of genes and Proteins, JohnWiley and Sons Inc. Publishing, New York, 1998.
2. Dan Gusfield, Algorithms on Strings, trees and sequences, Cambridge University Press, USA.

SEMESTER III: CORE – IX
TOPOLOGY

Course Code	**: 14PMA3C9**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms and complete metric spaces.

UNIT I **18 hours**

Topological spaces - Basis for a topology- Order topology, product topology- Subspace topology- Closed sets and limit points - Continuous functions - #Product Topology#.

UNIT II **18 hours**

Metric topology - Metric topology (continued) - Connected spaces.

UNIT III **18 hours**

Compact spaces - Limit point compactness - Tychonoff theorem.

UNIT IV **18 hours**

Countability Axioms - Separation axioms - Urysohn Lemma - Urysohn Metrization theorem - Completely regular spaces.

UNIT V **18 hours**

Complete Metric Spaces - Compactness in metric spaces - Baire Spaces.

 # # Self-study portion.

Text Book:

James R. Munkres, Topology A First Course, Prentice Hall of India, (1998).

UNIT I	Sections 2.1 - 2.8
UNIT II	Sections 2.9, 2.10, 3.1
UNIT III	Sections 3.5, 3.7, 5.1
UNIT IV	Sections 4.1 - 4.4, 5.2
UNIT V	Sections 7.1, 7.3, 7.7

Books for Reference:

1. Sze-Tsen Hu, Elements of General Topology, Holden Day, INC. (1964).
2. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. (1983).

SEMESTER III: CORE – X
MEASURE THEORY AND INTEGRATION

Course Code	**: 14PMA3C10**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To understand measure on a real line, Borel measure, Lebesgue measure, measure on measurable space, L^p space and product measure.

UNIT I **18 hours**

#Set function and properties on sets in real line# - Measure on a real line – Lebesgue Outer measure – Measurable sets – Regularity – Measurable functions.

UNIT II **18 hours**

#Borel set# - Continuous function and integral function - Borel and Lebesgue measurability – Integration of Functions of a real variable – Integration of non-negative functions – General Integral.

UNIT III **18 hours**

#Measure on measurable space# - Abstract Measure Space – Measure and Outer measure – Uniqueness of the extension – Completion of a measure.

UNIT IV **18 hours**

#Countable and additive# - Convergence in measure – Almost uniform convergence - Signed measure and their derivatives – Hahn Decomposition – Jordan Decomposition.

UNIT V **18 hours**

#Product space# - Radon – Nikodym theorem – Measure and Integration in a Product space – Measurability in a Product Space – Product Measure and Fubini's theorem.

 # # Self-study portion.

Text Book:

Measure Theory and Integration, G. De Barra, New Age International (P) Limited, Publishers (1997).

UNIT I	Sections 2.1 – 2.4
UNIT II	Sections 2.5, 3.1 – 3.2
UNIT III	Sections 5.1 - 5.6
UNIT IV	Sections 7.1,7.2,8.1,8.2
UNIT V	Sections 8.3, 10.1, 10.2

Books for Reference:

1. M. C. Munroe, Measure and Integration, Addison, Wesley Publishing Company, Second Edition (1971).
2. H.L. Roydon and P.M. Fitzpatrick, Real Analysis, Prentice Hall of India**,** Learning Pvt. Ltd., New Delhi, Four Edition (2011).

SEMESTER III: CORE – XI
FUNCTIONAL ANALYSIS

Course Code	**: 14PMA3C11**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To study the theorems of Functional Analysis viz., Hahn-Banach theorem, open mapping theorem and Uniform boundedness principle.

UNIT I **18 hours**

Banach Space: Definition and some examples - Continuous linear transformations - Hahn-Banach theorem.

UNIT II **18 hours**

Banach space (continued): Natural imbedding of N IN N**- Open mapping theorem - Conjugate of an operator.

UNIT III **18 hours**

Hilbert spaces: Definition and some simple properties - Orthogonal complements - Orthonormal sets - Conjugate space H*.

UNIT IV **18 hours**

Hilbert spaces (Continued): Adjoint of an operator - Self-adjoint operators - Normal and unitary operators - #Projections#.

UNIT V **18 hours**

Finite Dimensional spectral theory: Matrices - Determinants and the spectrum of an operator - Spectral theorem.

 # # Self-study portion.

Text Book:

G.F Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, International Book Company, (1963).

UNIT I	Sections 46 - 48
UNIT II	Sections 49 - 51
UNIT III	Sections 52 - 55
UNIT IV	Sections 56 - 59
UNIT V	Sections 60 - 62

Books for Reference:

1. Balmohan V. Limaye, Functional Analysis, New Age International Pvt. Ltd., Second Edition (2005).
2. M. Thamban Nair, Functional Analysis, A First Course, Prentice Hall of India (2002).

SEMESTER III: CORE – XII
GRAPH THEORY

Course Code	**: 14PMA3C12**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To introduce the notion of graph theory and its applications and the techniques of combinatorics in Graph Theory.

UNIT I **18 hours**

Connectivity and edge-connectivity – 2-connected graphs – Menger's theorem.

UNIT II **18 hours**

Matching – System of Distinct Representatives and Marriage problem – Covering – 1-factor – Stable Matching.

UNIT III **18 hours**

Independent sets – Edge-colourings – Vizing's Theorem – Vertex Colourings – Uniquely Colourable graphs – Critical graphs.

UNIT IV **18 hours**

Predecessor and Successor – Algorithm – Graceful Labeling – Sequential functions – Magic graphs – Conservative graphs.

UNIT V **18 hours**

Perfect Graphs – Perfect Graph Theorem – Chordal Graphs – Interval Graphs – Comparability Graphs.

Text Book:

M. Murugan, Topics in Graph theory and Algorithms**,** Muthali Publishing House, Annanagar, Chennai, First Edition (2003).

UNIT I	Chapter 3	Sections 3.1 - 3.3
UNIT II	Chapter 6	Sections 6.1 - 6.5
UNIT III	Chapter 7	Sections 7.1, 7.2, 7.4 - 7.7
UNIT IV	Chapter 10	Sections 10.1 - 10.4, 10.6, 10.7
UNIT V	Chapter 12	Sections 12.1 - 12.5

Books for Reference:

1. S. Arumugam and S. Ramachandran, Invitation to Graph Theory, New Gamma Publishing House, Palayamkottai, 2006.
2. S.A. Choudum, First Course in Graph Theory, Macmillan India Limited, New Delhi (2009).
3. F. Harary, Graph Theory, Addison-Wesley Publishing Company, INC. (1969).

SEMESTER III: CORE BASED ELECTIVE-III
MATHEMATICAL STATISTICS

Course Code : 14PMA3CE3 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 40**
Credit : 5 **External Marks: 60**

Objective:

To impart the knowledge in Mathematical Statistics.

UNIT I **18 hours**

#Concepts of Probability, Mathematical and Classical definition of Probability# - Probability - Sample space - Probability Axioms - Addition Rule - Bonferroni's inequality - Conditional probability - Baye's theorem - Independence of Events - Problems.

UNIT II **18 hours**

#Random variables - Types of random variables# - Two dimensional Random variables - Distribution function - Marginal and Conditional density functions - Independent random variables - Expected value - Moment generating function - Holder's inequality - Cauchy-Schwarz inequality - Conditional expectations – Moments - Chebychev's inequality - Lyapunov's inequality.

UNIT III **18 hours**

#Theoretical Continuous distribution# - Theoretical distribution - Discrete distribution - Binomial, Negative Binomial, Hyper geometric, Poisson distribution. Continuous distribution: Uniform distribution, Gamma, Beta, Cauchy and normal distribution.

UNIT IV **18 hours**

#Convergence in probability# - Weaklaw of large numbers - Strong law of large number - Borel-Cantelli lemma - Kalmogorov inequality- Kroneceker lemma - Kalmogorov strong law of large numbers - Cauchy criterion - Borel's strong law of large numbers.

UNIT V **18 hours**

Central limit theorem - Lindeberg Levy – Problems - Comparison between Central limit theorems and law of large numbers.

 # # Self-study portion.

Text Book:

V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, John Wiley & Sons, Third Edition (1998).

UNIT I Chapter 1 Sections 1.1, 1.2, 1.3, 1.5, 1.6
UNIT II Chapter 4 Sections 4.1, 4.2, 4.3, 4.6, 4.7, 3.2, 3.4
UNIT III Chapter 5 Sections 5.2(d, e, f, g), 5.3(a, b, c, d, e)
UNIT IV Chapter 6 Sections 6.2, 6.3, 6.4
UNIT V Chapter 6 Sections 6.6

Books for Reference:

1. Mark Fisz, Probability theory and Mathematical Statistical John Wiley & Sons, Third Edition (1963).
2. B.R Bhat, Modern Probability Theory, NewAge International, Revised Third Edition (2005).

SEMESTER III: CORE BASED ELECTIVE-III
COMPUTER ALGORITHMS

Course Code : 14PMA3CE3 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 40**
Credit : 5 **External Marks: 60**

Objective:

To motivate the students to Computational Mathematics, a recent trend in both educational and industrial fields.

UNIT I **18 hours**

Algorithm – Definition, Time Complexity. Elementary Data Structures – Stacks, Queues, Trees, Priority Queues, Heaps, Heapsort, Graphs.

UNIT II **18 hours**

Divide and Conquer – General method, Binary search, Merge sort, Quick sort.

UNIT III **18 hours**

The Greedy Method – Knapsack problem, Job sequencing with dead lines, Optimal storage on tapes, Optimal merge patterns.

UNIT IV **18 hours**

Basic traversal – Inorder, preorder, postorder traversals, Breadth first search and traversal, Depth first search and traversal Backtracking – Sum of subsets, *n*-Queens problem (*n* = 4, 8).

UNIT V **18 hours**

NP – Hard and *NP* – complete problems – Basic Concepts, Cook's Theorem(Statement only), Conjunctive Normal Form(CNF) – satisfiability reduces to Clique Decision Problem(CDP), The Clique Decision Problem(CDP) reduces to The Node Cover Decision Problem.

Text Book:

Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, 'Fundamentals of Computer Algorithms', Galgotia Publications, 1998.

UNIT I Chapter I Section 1.1 and Chapter II Sections 2.1 - 2.5
UNIT II Chapter III Sections 3.1 - 3.5
UNIT III Chapter IV Sections 4.1 - 4.5
UNIT IV Chapter VI Section 6.1 and Chapter VII Sections 7.1 - 7.3
UNIT V Chapter XI Sections 11.1 - 11.3

Books for Reference:

1. Thomas H.Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 'Introduction to Algorithms', Second Edition, Prentice Hall of India, 2004.
2. Alfred V.Aho, John E.Hopcroft and Jeffrey D.Ullman, 'Data Structures and Algorithms', Addison-Wesley, 1983.
3. M. Gary and S. Johnson, 'Computers and Interactability: A guide to theory of *NP* Completeness',W. H. Freeman & Company, 1979.

SEMESTER III: EXTRA CREDIT - I
DISCRETE MATHEMATICS

Course Code	**: 14PMA3EC1**	**Max. Marks**	**: 100***
Hours/Week	**: -**	**Internal Marks**	**: -**
Credit	**: 5***	**External Marks**	**: 100***

Objective:

To introduce topics and techniques of discrete methods and combinatorial analysis and to demonstrate the understanding of Discrete Mathematics by being able to apply logical reasoning to solve a variety of problems.

UNIT I

Distributions of Distinct Objects – Distributions of Nondistinct Objects – Stirling's Formula.

UNIT II

Generating Functions for Combinations – Enumerators for Permutations – Distributions of Distinct Objects into Nondistinct Cells – Partitions of Integers.

UNIT III

Linear Recurrence Relations with Constant Coefficients – Solution by the Technique of Generating Functions – Recurrence Relations with Two Indices.

UNIT IV

Principle of Inclusion and Exclusion – General Formula – Derangements – Permutations with Restrictions on Relative Positions.

UNIT V

Equivalence Classes under a Permutation Group – Equivalence Classes of Functions – Weights and Inventories of Functions – Polya's Fundamental Theorem – Generalization of Polya's Theorem.

Text Book:

C. L. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill, New York (1968).

Unit I Chapter 1 Sections 1.2 – 1.6
Unit II Chapter 2 Sections 2.2 – 2.5
Unit III Chapter 3 Sections 3.2, 3.3, 3.5
Unit IV Chapter 4 Sections 4.2- 4.5
Unit V Chapter 5 Sections 5.3 – 5.7

Books for Reference:

1. C. L. Liu, Elements of Discrete Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second reprint (2000).
2. Bernard Kolman, Robert C. Busby and Sharon Cutler Ross, Discrete Mathematical Structures, Prentice Hall of India Learning Private Ltd, New Delhi, Sixth Edition (2009).
3. T. Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw-Hill Publishing Company Limited, New Delhi (2007).

SEMESTER IV: CORE – XIII
FLUID DYNAMICS

Course Code	**: 14PMA4C13**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To give an introduction to the behaviour of fluids in motion and the applications of Complex integration in the analysis of the flow of liquids.

UNIT I **18 hours**

Real fluids and ideal fluids - Velocity of a fluid at a point - Streamlines and pathlines - Steady and unsteady flows. Velocity potential - Vorticity vector - #Local and particle rates of change# - Equation of continuity - Worked examples - #Acceleration of a point of a fluid#.

UNIT II **18 hours**

Pressure at a point in a fluid at rest - Pressure at a point in a moving fluid - #Conditions at a boundary of two inviscid Immissible fluids# - Euler's equations of motion - Bernoulli's equation - Worked examples - Some flows involving axial symmetry - Some special two dimensional flows - #Impulsive motion#.

UNIT III **18 hours**

Some three dimensional flows - Sources, sinks and doublets - #Images in a rigid infinite plane# - Axis-symmetric flows - Stokes stream function - Some special forms of the stream function for Axis-symmetric irrotational motions.

UNIT IV **18 hours**

Two dimensional flow - Use of cylindrical polar coordinates - Stream function. #Complex potential for two-dimensional irrotational - Incompressible flow# - Complex velocity potential for standard two-dimensional flows - Uniform stream, line sources and line sinks, line doublets, line vortices - Worked examples.

UNIT V **18 hours**

Two dimensional image systems – Milne-Thomson circle theorem - Some applications of the circle theorem - Extension of the circle theorem - Theorem of Blasius - #Use of conformal transformation – Some hydro dynamical aspects of conformal transformation# - Worked example.

 # # Self-study portion.

Text Book:

F. Chorlton, Textbook of Fluid Dynamics, CBS Publication and Distribution (2004).

UNIT I	Chapter 2 Sections 2.1 to 2.9
UNIT II	Chapter 3 Sections 3.1 to 3.6, 3.9 to 3.11
UNIT III	Chapter 4 Sections 4.1 to 4.3, 4.5, 4.5.1
UNIT IV	Chapter 5 Sections 5.1 to 5.6
UNIT V	Chapter 5 Sections 5.7 to 5.10.2

Books for Reference:

1. M.D. Raisinghania, Fluid Dynamics, S. Chand, (2008).
2. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, (1984).

SEMESTER IV: CORE – XIV
ADVANCED OPERATIONS RESEARCH

Course Code	**: 14PMA4C14**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credit	**: 5**	**External Marks**	**: 60**

Objective:

To understand and apply various Operations Research tools to real life applications.

UNIT I **18 hours**

Integer Linear Programming – Types of Integer Programming Problems – Gomory's All Integer Cutting Plane Method - #Gomory's Mixed Integer Cutting Plane Method#. Sensitivity Analysis – Change in Objective Function Coefficient – Addition of New Variable – Addition of New Constraint.

UNIT II **18 hours**

Goal Programming – Difference between LP and GP approach – #Concept of Goal Programming# - Goal Programming model formulation – Single Goal with Multiple sub Goals – Equally ranked Multiple Goals – Ranking and Weighting of Unequal Multiple Goals - General GP Model – Graphical Solution method of GP – Modified Simplex Method of GP.

UNIT III **18 hours**

Decision Theory – #Steps of Decision making process# – Types of Decision Making Environments – Decision Making Under Uncertainty - Decision Making Under Risk - Expected Monetary Value. Theory of Games – Two Person Zero Sum Games – Games with Saddle Point – Rules to determine Saddle point - Games without Saddle Point - Related problems – Principles of Dominance – Graphical Method.

UNIT IV **18 hours**

Deterministic Inventory Control models – #Meaning of inventory control – Reasons for carrying inventory – Factors involved in inventory problem analysis# - Inventory cost components – Demand for inventory items - Replenishment lead time - Length of planning period – Inventory model building – Single item inventory control modes without shortages – Model I(a): EOQ model with constant rate of demand , Model I(c): Economic production Quantity model when supply is gradual. Single item inventory control models with shortages – Model II (a): EOQ model with constant rate of demand and variable order cycle time.

UNIT V **18 hours**

Dynamic Programming – Dynamic Programming Terminology – Developing Optimal Decision Policy – #General Algorithm# - Dynamic Programming Under Certainty – Model-I: Shortest Route Problem – Model-II: Multiple Separable Return Function and Single Additive Constraint - Dynamic Programming Approach for Solving Linear Programming Problems.

 # # Self-study portion.

Text Book:

J.K. Sharma, Operations Research Theory and Applications, Macmillan India Ltd., Fourth Edition, (2010).

UNIT I	Sections 7.1, 7.2, 7.4, 7.5, 6.1 and 6.2 (6.2.1, 6.2.4, 6.2.5)
UNIT II	Sections 8.1 - 8.6
UNIT III	Sections 11.1, 11.2, 11.3, 11.4(11.4.1 - 11.4.5), 11.5(11.5.1) 12.1, 12.2, 12.3(12.3.1), 12.4, 12.5, 12.6.4
UNIT IV	Sections 14.1, 14.2, 14.4, 14.5(14.5.1–14.5.4), 14.6(14.6.1-14.6.3), 14.7, 14.8(Part)
UNIT V	Sections 22.1, 22.2, 22.3, 22.4(Model - I and Model - II), 22.5

Books for Reference:

1. Prem Kumar Gupta and D.S. Hira, Operations research, S. Chand, (2000).
2. Kantiswarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons, (2009).

SEMESTER IV: CORE-XV
ADVANCED DIFFERENTIAL EQUATIONS

Course Code : 14PMA4C15 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 40**
Credits : 5 **External Marks : 60**

Objective:

To enable the students to solve the linear system of ordinary differential equation and acquire the knowledge of solving second order partial differential equations.

UNIT I **18 hours**

Sturm-Liouville Problems - Bessel functions – #The Gamma function# - Properties of Bessel functions.

UNIT II **18 hours**

Linear systems – Homogeneous linear systems with constant coefficients – The Method of Successive approximations – Picard's Theorem.

UNIT III **18 hours**

Genesis of Second Order P.D.E – Classification of Second order P.D.E. – One Dimensional Wave Equations – Vibrations of an Infinite String – Vibrations of a Semi-infinite String – Vibrations of a String of Finite length: Riemann's Method.

UNIT IV **18 hours**

Vibrations of a String of finite length: Method of Separation of variables - Laplace Equation – Boundary Value Problems – Maximum and Minimum Principles – The Cauchy Problem – The Dirichlet Problem for the Upper Half Plane – #The Neumann Problem for the Upper Half Plane# – The Dirichlet Problem for a Circle.

UNIT V **18 hours**

The Neumann Problem for a Circle – The Dirichlet Problem for a Rectangle- Laplace Equation- Green's function- The Dirichlet Problem for a Half Plane – #The Dirichlet Problem for a Circle# – Heat Conduction Problem – Heat Conduction-Infinite rod Case – Heat Conduction-Finite Rod Case – Duhamel's Principle – Wave Equation – Heat Conduction Equation.

 # # Self-study portion

Text Book:

T.B-1. G.F. Simmons, Differential Equations with applications and Historical notes, Second edition, Tata McGraw- Hill Publishing Company Ltd, New Delhi, 2006.

T.B-2. T. Amaranath, An Elementary Course in Partial differential Equations, 2nd edition, Narosa Publishing House, 2003.

UNIT I	Chapter 7	Section 43 and Chapter 8 Sections 46, 47	**T.B-1**
UNIT II	Chapter 10	Sections 55, 56 and Chapter 13 Sections 68, 69	**T.B-1**
UNIT III	Chapter 2	Sections 2.1–2.3.4	**T.B-2**
UNIT IV	Chapter 2	Sections 2.3.5, 2.4 –2.4.6	**T.B-2**
UNIT V	Chapter 2	Sections 2.4.8, 2.4.9 and 2.4.11–2.6.2	**T.B-2**

Books for Reference:

1. Earl. A. Coddington, An Introduction to Ordinary Differential Equations, PHI (1961).
2. N. Sneddon, Elements of Partial Differential Equations, McGraw Hill (1985).
3. M.D. Raisinghania, Advanced Differential Equations, Seventh Revised Edition S. Chand and Company Ltd, New Delhi (2000).

CORE BASED ELECTIVE - IV
STOCHASTIC PROCESSES

Course Code : 14PMA4CE4 **Max. Marks : 100**
Hours/Week : 6 **Internal Marks : 40**
Credits : 5 **External Marks : 60**

Objective:

To study the Markov systems, Poisson Processes, Renewal Processes and Renewal Theorems.

UNIT I **18 hours**

Introduction – Specification of Stochastic Processes – Stationary Processes – Second-Order Processes – Stationarity – Gaussian Processes - Markov Chains – Definition and examples – Transition matrix – Probability distribution – Order of a Markov chain – Markov chains as graphs – Higher transition probabilities .

UNIT II **18 Hours**

Classification of States and Chains – Communication Relations – Class Propety – Classifications of Chains – Classification of States: First Passage Time Distribution - Determination of Higher transition probabilities – Aperoidic Chain: Limiting Behaviour - Stability of a Markov System – Limiting Behaviour - #Graph theoretic approach#.

UNIT III **18 Hours**

Poisson Processes - Introduction – Postulates for Poisson process – Properties of Poisson process– Poisson process and related distributions – Interarrival Time – Further Properties of Poisson Process.

UNIT IV **18 Hours**

Renewal Process - Renewal Processes in discrete time – Relation between F(s) and P(s) – Renewal interval – Generalised Form: Delayed Recurrent Event - Renewal Theory in Discrete Time – Renewal Processes in Continuous Time – Renewal Function and Renewal Density - Renewal Equation.

UNIT V **18 Hours**

Stopping time – Wald's Equation – Renewal Theorems - Elementary Renewal Theorem – Definitions - Renewal Theorems.

 # # Selfstudy Portion

Text Book

Medhi, J, "Stochastic Processes", Second Edition(Reprint), New Age International Publishers, New Delhi, 2002

UNIT I	Chapter 2	Sections 2.1 - 2.3 and Chapter 3 Sections 3.1, 3.2
UNIT II	Chapter 3	Sections 3.4 - 3.7
UNIT III	Chapter 4	Sections 4.1 - 4.2
UNIT IV	Chapter 6	Sections 6.1- 6.3
UNIT V	Chapter 6	Sections 6.4 and 6.5, 6.5.1, 6.5.3, 6.5.4

Books for Reference:

1. Basu, A. K., “Introduction to Stochastic Process”, Narosa Publishing House, New Delhi, 2007.
2. Chung,K.L. and Sahlia, F.A., “Elementary Probability Theory with Stochastic Processes and an introduction to Mathematical Finance”, Springer (India) Pvt. Ltd., New Delhi, 2005.
3. Srinivasan, S. K. and Mehatha, K.M., “Stochastic Processes”, Tata McGraw–Hill Publishing Co. Ltd., New Delhi, 1988.

CORE BASED ELECTIVE - IV
QUEUING THEORY AND NON-LINEAR PROGRAMMING

Course Code	**: 14PMA4CE4**	**Max. Marks**	**: 100**
Hours/Week	**: 6**	**Internal Marks**	**: 40**
Credits	**: 5**	**External Marks**	**: 60**

Objective:

To study the optimization, Non linear programming and Queuing Models

UNIT I **18 Hours**

The Structure of a Queuing System - Performance Measure of a Queuing system - Probability Distributions in Queuing System - Classification of Queuing Models-Single Server Queuing Models.

UNIT II **18 Hours**

Multi-Server Queuing Models - Finite Calling Population Queuing Models - Multi-Phase Service Queuing Models.

UNIT III **18 hours**

Unconstrained Optimization - Constrained Multivariable Optimization with Equality Constraints - Constrained Multivariable Optimization with inequality Constraints.

UNIT IV **18 Hours**

The general Non-linear Programming Problem - #Graphical Solution Method# - Quadratic Programming - Applications of Quadratic Programming.

UNIT V **18 Hours**

Separable Programming - Geometric Programming - Stochastic Programming.

 # # Self-study portion.

Text Book

J K Sharma, Operations Research Theory and Applications, 4th Edition, Macmillan Publishers Ltd, 2010.

UNIT I	Chapter 16	Sections 16.1 - 16.6
UNIT II	Chapter 16	Sections 16.7 - 16.9
UNIT III	Chapter 23	Sections 23.1 - 23.4
UNIT IV	Chapter 24	Sections 24.2 - 24.5
UNIT V	Chapter 24	Sections 24.6 - 24.8

Books for Reference:

1. Prem Kumar Gupta and D.S. Hira, Operations research, S. Chand (2000).
2. Kantiswarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons (2009).

SEMESTER IV: EXTRA CREDIT – II
DIFFERENTIAL GEOMETRY

Course Code : 14PMA4EC2 **Max. Marks : 100***
Hours /Week : - **Internal Marks : -**
Credits : 5* **External Marks : 100***

Objective:

To understand the curvature and torsion of a space curve, Geodesics and the first and second fundamental forms of a surface.

UNIT I **18 hours**

Theory of Space Curve – Arc length –Tangent, Normal, and Binormal – Curvature and torsion of a curve given as the intersection of two surfaces – contact between curves and surfaces – Tangent surfaces, involutes and evolutes – Intrinsic equations – fundamental existence theorem for space curves – Helices

UNIT II **18 hours**

The Metric- Local Intrinsic properties of a surface – Curves on a surface – Surface of revolution – Helicoids – Metric – Direction coefficients – Families of curves – Isometric correspondence – Intrinsic properties

UNIT III **18 hours**

Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence theorems – Geodesic parallels – Geodesic curvature – Gauss-Bonnet theorem – Gaussian curvature – Surface of constant curvature

UNIT IV **18 hours**

The Second fundamental form – Local non-intrinsic properties of a surface – Principal curvatures – Lines of curvatures – Developables – Developables associated with space curves

UNIT V **18 hours**

Developables associated with curves on surfaces – Minimal surfaces – Ruled surfaces – The fundamental equations of surface theory – Parallel Surfaces.

Text Book:

T.J.Willmore, An Introduction to Differential Geometry, Oxford University Press, 1969.

UNIT I Chapter I Sections 3 - 9
UNIT II Chapter II Sections 1-9
UNIT III Chapter II Sections 10 -18
UNIT IV Chapter III Sections 1- 5
UNIT V Chapter III Sections 6 - 10

References Books:

1. D.Somasundaram, Differential Geometry A First Course, Narosa Publishing House, 2005.
2. Dirk J.Struik, Classical Differential Geometry, Second Edition, Addison Wesley Publishing Company, Inc., 1950.