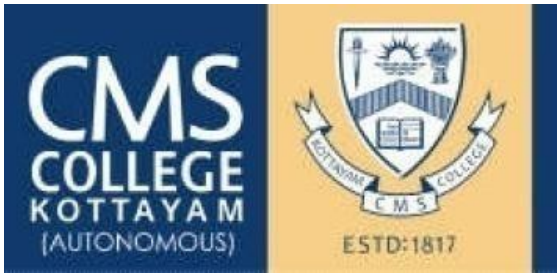

CMS COLLEGE KOTTAYAM

(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University, Kottayam, Kerala

CURRICULUM FOR POSTGRADUATE PROGRAMME

MASTER OF SCIENCE IN MATHEMATICS

UNDER CHOICE BASED CREDIT SYSTEM 2016
(With effect from 2016)

Semester - 1

PC 1 **MT21101**

LINEAR ALGEBRA

Text Book: **Kenneth Hoffman / Ray Kunze (Second Edition), *Linear Algebra*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1992.**

Module 1: Vector spaces, subspaces, basis and dimension
(Chapter 2, 2.1, 2.2, 2.3 of the text)
(Proof of theorems excluded)

Co-ordinates, summary of row-equivalence

(Chapter 2- 2.4 & 2.5 of the text) (15 hours.)

Module 2: Linear transformations, the algebra of linear transformations, isomorphism, representation of transformations by matrices, linear functionals, double dual, transpose of a linear transformation.

(Chapter 3 - 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 & 3.7 of the text) (30 hours.)

Module 3: Determinants: Commutative Rings, Determinant functions, Permutation and uniqueness of determinants, Additional properties of determinants.

(Chapter 5 - 5.1, 5.2, 5.3 & 5.4 of the text) (18 hours.)

Module 4: Introduction to elementary canonical forms, characteristic values, annihilatory polynomials, invariant subspaces, simultaneous triangulations, simultaneous diagonalisation, direct sum decompositions, invariant direct sums

(Chapter 6 - 6.1, 6.2, 6.3, 6.4, 6.5 & 6.6 of the text) (27 hours.)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	1	1
Module II	2	3	2
Module III	2	1	1
Module IV	2	3	2
Total	8	8	6

References:

1. Klaus Jonich. Linear Algebra, Springer Verlag.
2. Paul R. Halmos, Linear Algebra Problem Book, The Mathematical Association of America.
3. S. Lang, Algebra, 3rd edition, Addison-Wesley, 1993.
4. K.B. Datta, Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
5. S. Kumaresan, Linear Algebra A Geometrical Approach, Prentice Hall of India, 2000.

BASIC TOPOLOGY

Text Book: **K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd,1984.**

Module 1: Definition of a topological space – examples of topological spaces, bases and sub bases – sub spaces.

Basic concepts: closed sets and closure – neighborhood, interior and accumulation points

(Chapter 4 Section – 1, 2, 3, 4 - Chapter 5 Section -. 1 and 2 of the text.

5.2.11 & 5.2.12 excluded.) (24 hours)

Module 2: Continuity and related concepts: making functions continuous, quotient spaces.

Spaces with special properties: Smallness condition on a space

(Chapter 5. Section. 3 and 4 of the text, 5.3.2(4) excluded)

(Chapter 6 Sec. 1 of the text) (22 hours)

Module 3: Connectedness: Local connectedness and paths

(Chapter 6 Section. 2 & 3 of the text) (22 hours)

Module 4: Separation axioms: Hierarchy of separation axioms – compactness and separation axioms

(Chapter – 7 Section 1 & 2 of the text)

(2.13 to 2.16 of section.2 excluded) (22 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1
Module III	2	2	1	
Module IV	2	2	1	1
Total	8	8	6	

References:-

1. Munkres J.R, Topology-A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

2. J.L Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
3. Stephen Willard, General Topology, Addison-Wesley.
4. Dugundji, Topology, Universal Book Stall, New Delhi.
5. George F Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

PC 3 **MT21103**

MEASURE THEORY AND INTEGRATION

Text 1: **H.L. Royden, Real Analysis, Third edition, Prentice Hall of India Private Limited.**

Text 2: **G. de Barra, Measure Theory and Integration, New Age International (P) Linnilect Publishers.**

Pre-requisites: Algebras of sets, the axiom of choice and infinite direct products, open and closed sets of real numbers.

(Chapter 1 - section 4, 5

Chapter 2 - section 5 of Text 1). (5 hours)

(No questions shall be asked from this section)

Module 1: Lebesgue measure: introduction, outer measure, measurable sets and Lebesgue measure, & non-measurable sets, measurable functions.

(Chapter 3 - Sec. 1 to 5. of Text 1) (20 hours)

Module 2: Lebesgue integral: the Riemann integral, he Lebesgue integral of a bounded function over a set of finite measures, the integral of a non-negative function, the general Lebesgue integral, differentiation of monotone functions.

(Chapter 4 - Sec. 1 – 4. of Text 1

Chapter 5 - Sec. 1. of Text 1) (20 hours)

Module 3: Measure and integration: measure spaces, measurable functions, Integration, general convergence theorems, signed measures, the Radon-Nikodym theorem, outer measure and measurability, the extension theorem.

(Chapter 11 - Sec. 1 to 6 of Text 1

Chapter 12 - Sec. 1& 2 of Text 1) (20 hours)

Module 4: Convergence: convergence in measure, almost uniform convergence, measurability in a product space, the product measure and Fubini's theorem.

(Chapter 8 - Sec. 7.1 & 7.2 of Text 2

Chapter 10 - Sec. 10.1& 10.2 of Text 2) (25 hours)

Question paper pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	2	2
Module III	2	2	2
Module IV	2	2	1
Total	8	8	6

References:-

1. Halmos P.R, Measure Theory, D.van Nostrand Co.
2. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age International (P) Ltd., New Delhi, 1986(Reprint 2000).
3. R.G. Bartle, The Elements of Integration, John Wiley & Sons, Inc New York, 1966.
4. Inder K Rana, An Introduction to Measure and Integration, Narosa Publishing House, 1997.

PC 4 **MT21104**

GRAPH THEORY

Text : R.Balakrishnan and K. Ranganathan, A Text book of Graph Theory, Springer

Module: -1 Basic results and directed graphs

Basic concepts. sub graphs. degrees of vertices. Paths and connectedness

automorphism of a simple graph, line graphs, basic concepts and tournaments.

Connectivity

Vertex cuts and edge cuts. connectivity and edge connectivity, blocks.

(Chapter 1 Sections 1.1 to 1.5 and 1.6 (Up to 1.6.3)

Chapter 2 Sections 2.1 and 2.2

Chapter 3 Sections 3.1 to 3.3 of the text) (20 hours)

Module:- 2 Trees:

Definition, characterization and simple properties, centres and cenroids, counting the number of spanning trees, Cayley's formula, applications

(Chapter 4 Sections 4.1 to 4.4

Chapter 10 Sections 10.1 to 10.4 of the text) (20 hours)

Module:- 3

Independent Sets, Eulerian Graphs; Hamiltonian Graphs and Vertex Colouring, Vertex independent sets and vertex coverings. edge independent sets, Eulerian graphs, Hamiltonian graphs, vertex colourings, critical graphs, triangle free graphs.

(Chapter 5 Sections 5.1 and 5.2

Chapter 6 Sections 6.1 and 6.2

Chapter 7 Sections 7.1 to 7.3 of the text) (25 hours)

Module:- 4 :

Edge colouring and planarity- Edge colouring of graphs, planar and non planar graphs, Euler formula and its consequences, K5 and K3,3 are non planar graphs, dual of a plane graph. the four colour theorem and Heawood five colour theorem.

(Chapter 7 Section 7.4

Chapter 8 Sections 8.1 to 8.5 of the text) (25 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1
Module III	2	2	1	
Module IV	2	2	1	1
Total	8	8	6	

References:

1. John Clark and Derek Allan Holton, A First Look at Graph Theory, Allied Publishers.
2. Douglas B West, Introduction to Graph Theory, Prentice Hall of India
3. F.Harary, Graph Theory, Addison-Wesley, 1969.

PC 5 **MT21105**

COMPLEX ANALYSIS

Text: **Lars V. Ahlfors, Complex Analysis, Third edition, McGraw Hill Internationals**

Module 1: Analytic functions as mappings.

Conformality: arcs and closed curves, analytic functions in regions, conformal mapping, length and area.

Linear transformations: linear group, the cross ratio, symmetry, oriented circles, family of circles.

Elementary conformal mappings: the use of level curves, a survey of elementary mappings, elementary Riemann surfaces.

(Chapter 3 – sections 2, 3 and 4. of the text) (20 hours.)

Module 2: Complex Integration

Fundamental theorem: line integrals, rectifiable arcs, line integrals as functions of arcs, Cauchy's theorem for a rectangle, Cauchy's theorem in a disk

Cauchy's integral formula: the index of a point with respect to a cloud curve, the integral formula, higher derivatives.

(Chapter 4 – Sections 1 and 2. of the text.) (20 hours.)

Module 3: Local properties of analytical functions: removable singularities, Taylor's theorem, zeroes and poles, the local mapping, the maximum principle.

The general form of Cauchy's theorem: chains and cycles, simple connectivity, homology, general statement of Cauchy's theorem, proof ofCauchy's theorem, locally exact differentiation, multiply connected regions.

(Chapter 4 – Sections 3 and 4. of the text) (25 hours.)

Module 4: Calculus of Residues: the residue theorem, the argument principle, evaluation of definite integrals.

Harmonic functions: definition and basic properties, the mean value property, Poisson's formula, Schwarz theorem, the reflection principle.

(Chapter 4 – Sections 5 and 6 of the text) (25 hours.)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	

Module II	2	2	1	1
Module III	2	2	1	1
Module IV	2	2	1	
Total	8	8	6	

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References:

1. Chaudhary. B, The elements of Complex Analysis, Wiley Eastern.
2. Cartan. H (1973), Elementary theory of Analytic functions of one or several variable, Addison Wesley.
3. Conway .J.B, Functions of one Complex variable, Narosa publishing.
4. Lang. S, Complex Analysis, Springer.
5. H.A. Priestly, Introduction to Complex Analysis, Clarendon press, Oxford, 1990.

Semester 2

PC 6 **MT22106**

ABSTRACT ALGEBRA

Text Book: **John B. Fraleigh, A First Course in Abstract Algebra, 7th edition, Pearson Education.**

Module 1: Direct products and finitely generated Abelian groups, fundamental theorem (without proof), Applications

Rings of polynomials, factorisation of polynomials over a field.

(Part II – Section 11) & (Part IV – Sections 22 & 23) (25 hours)

Module 2: Introduction to extension fields, algebraic extensions, Geometric constructions. Finite fields.

(Part VI – Section 29, 31 – 31.1 to 31.18, 32, 33) (25 hours)

Module 3: Sylow's theorems (without proof), Applications of sylow theory

Automorphism of fields, the isomorphism extension theorem

(proof of the theorem excluded)

(Part VII Sections 36 & 37) (Part X – Sections 48 & 49, (49.1 to 49.5)

(20 hours)

Module 4: Splitting fields, separable extensions, Galois theory
(Part X – Sections 50, 51, 53 -53.1 to 53.6) (20 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	2
Module II	2	2	2
Module III	2	2	1
Module IV	2	2	1
Total	8	8	6

References:-

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. Hungerford, Algebra, Springer
3. M. Artin, Algebra, Prentice -Hall of India, 1991
4. N. Jacobson, Basic Algebra Vol. I, Hindustan Publishing Corporation
5. P.B. Bhattacharya, S.K. Jain, S.R. Nagapaul, Basic Abstract Algebra, 2nd edition, Cambridge University Press, Indian Edition, 1997.

PC 7 **MT22107**

ADVANCED TOPOLOGY

Text Book: **K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd**.

Module 1: – Urysohn Characterisation of Normality – Tietze Characterisation of Normality.
(Chapter 7 Section-.3 and 4 of the text.)
(Proof of 3.4, 4.4, and 4.5 excluded)
Products and co-products: Cartesian products of families of sets – Product Topology – Productive properties.

(Chapter 8 Section. 1, 2 & 3 of the text) (proof of 1.6 &1.7 excluded)

(25 hours)

Module 2: Embedding and Metrisation – Evaluation Functions in to Products, Embedding Lemma and Tychnoff Embedding, The Urysohn Metrisation Theorem.

(Chapter 9. Sec. 1, 2 & 3 of the text) (15 hours)

Module 3: Nets and Filters: Definition and Convergence of Nets, Topology and Convergence of Nets, Filters and their Convergence, Ultra filters and Compactness.

(Chapter – 10 Sections -1, 2, 3 & 4 of the text) (25 hours)

Module 4: Compactness: Variations of compactness – local compactness – compactification.

Chapter 11. Section 1 (Proof of theorem 1.4 & 1.12 excluded),

Section 3

Section 4(from 4.1 to 4.7) of the text (25 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	3	2	2
Module II	1	1	1
Module III	2	3	2
Module IV	2	2	1
Total	8	8	6

References:-

1. Munkres J.R, Topology-A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. J.L Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
3. Stephen Willard, General Topology, Addison-Wesley.
4. Dugundji, Topology, Universal Book Stall, New Delhi.
5. George F Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

PC 8 **MT22108**

ADVANCED COMPLEX ANALYSIS

Text Book: **Lars V. Ahlfors, Complex Analysis, Third edition, McGraw Hill Internationals**

Module 1: Elementary theory of power series: sequences, series, uniform convergence, power series, Abel's limit theorem.

Power series expansions: Weierstrass' theorem, the Taylor's series, the Laurent's series

Partial fractions and factorisation: partial fractions, infinite products, canonical products, the gamma functions.

(Chapter 2, Section 2 - Chapter 5, Sections 1, 2.1 to 2.4 of the text)

(25 hours)

Module 2: Entire functions: Jenson's formula, Hadamard's theorem (without proof)

the Riemann zeta function: the product development, extension of ξ to the whole plane, the functional equation, the zeroes of zeta function.

Normal families: Equi continuity, normality and compactness, Arzela's theorem (without proof)

(Chapter 5 - Sections 3, 4, 5.1,5.2, and 5.3 of the text) (25 hours)

Module 3: The Riemann mapping theorem: statement and proof, boundary behavior, use of reflection principle, analytic arcs.

Conformal mappings of polygons: the behavior of an angle, the Schwarz-Christoffel formulaI (Statement only).

A closer look at harmonic functions: functions with mean value property, Harnack's principle.

The Dirichlet problem: sub harmonic functions, solution of Dirichlet problem (statement only)

(Chapter 6 Section 1, 2.1, 2.2, 3, 4.1 & 4.2 of the text) (20 hours)

Module 4: Elliptic functions: simply periodic functions, representation of exponentials, the Fourier development, functions of finite order

Doubly periodic functions: The period module, unimodular transformations, the canonical basis, general properties of elliptic functions.

The Weirstrass theory: the Weierstrass function, the functions ξ (y) and σ (y), the differential equation.

Analytic continuation: the Weierstrass theorem, Germs and Sheaves, sections and Riemann surfaces, analytic continuation along arcs, homotopic curves.

(Chapter 7 Sections 1, 2, 3.1, 3.2, 3.3

Chapter 8 Sections 1.1 to 1.5 of the text) (20 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	2	1
Module III	2	2	2
Module IV	2	2	2
Total	8	8	6

References:

1. Chaudhary. B, The elements of Complex Analysis, Wiley Eastern.
2. Cartan. H (1973), Elementary theory of Analytic functions of one or several variable, Addison Wesley.
3. Conway .J.B, Functions of one Complex variable, Narosa publishing.
4. Lang. S, Complex Analysis, Springer.
5. H.A. Priestly, Introduction to Complex Analysis, Clarendon press, Oxford, 1990

PC 9 **MT22109**

PARTIAL DIFFERENTIAL EQUATIONS

Text Book:-Ian Sneddon, Elements of partial differential equations, Mc Graw Hill Book Company.

Module:-1. Methods of solutions of $dx/p = dy/Q = dz/R$. Orthogonal trajectories of a system of curves on a surface. Pfaffian differential forms and equations. Solution of Pfaffian differential equations in three variables Partial differential equations. Orgins of first order partial differential equation . Cauchy's problem for first order equation. Linear equations of first order. Integral surfaces passing through a given curve. Surfaces orthogonal to a given system of surfaces. (Sections 1.3 to 1.6 & 2.1 to 2.6 of the text) (25 hours)

Module:-2. Nonlinear partial differential equation of the first order . Cauchy's method of characteristics. Compatible systems of first order equations . Charpits

Method. Special types of first order equations. Solutions satisfying given conditions
. Jacobi's method.
(Section 2.7 to 2.13 of the text) (25 hours)

Module:-3 The origin of second order equations. Linear partial differential equations with constant coefficients. Equations with variable coefficients., Characteristic curves of second order equations .
(Section 3.1, 3.4, 3.5, 3.6 of the text) (20 hours)

Module:-4. The solution of linear Hyperbolic equations. Separation of variables. Non linear equations of the second order . Elementary solutions of Laplace equation. Familiesof equipotential surfaces. Boundary value problems.
(Section 3.8, 3.9 ,3.11 ,4.2, 4.3,4.4 of the text) (20 hours)

Question paper pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	2
Module II	2	2	2
Module III	2	2	1
Module IV	2	2	1
Total	8	8	6

References:-

1 . Phoolan Prasad and Renuka Ravindran, Partial differential Equations, New Age International (p) Limited
2 K Sankara Rao, Introduction to Partial Differential Equations, Prentice-Hall of India
3 E.T Copson , Partial differential equations , S .Chand & Co

PC 10 **MT22110**

REAL ANALYSIS

Text 1: **Tom Apostol, Mathematical Analysis (second edition), Narosa Publishing House.**

Text 2: **Walter Rudin, Principles of Mathematical Analysis (Third edition), International Student Edition.**

Pre-requisites

A quick review on continuity, uniform continuity, convergence of sequence and series. (5 hours.)

(No question shall be asked from this section.)

Module 1: Functions of bounded variation and rectifiable curves

Introduction, properties of monotonic functions, functions of bounded variation, total variation, additive property of total variation, total variation on (a, x) as a functions of x, functions of bounded variation expressed as the difference of increasing functions, continuous functions of bounded variation, curves and paths, rectifiable path and arc length, additive and continuity properties of arc length, equivalence of paths, change of parameter.

(Chapter 6, Section: 6.1 - 6.12. of Text 1) (20 hours.)

Module 2: The Riemann-Stielljes Integral

Definition and existence of the integral, properties of the integral, integration and differentiation, integration of vector valued functions.

(Chapter 6 - Section 6.1 to 6.25 of Text 2) (20 hours.)

Module 3: Sequence and Series of Functions

Discussion of main problem, uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation, the Stone-Weierstrass theorem (without proof).

(Chapter 7 Section. 7.7 to 7.18 of Text 2) (25 hours.)

Module 4: Some Special Functions

Power series, the exponential and logarithmic functions, the trigonometric functions, the algebraic completeness of complex field, Fourier series.

(Chapter 8 - Section 8.1 to 8.16 of Text 2) (20 hours.)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	2	2
Module III	2	2	2
Module IV	2	2	1
Total	8	8	6

References:-

1. Royden H.L, Real Analysis, 2nd edition, Macmillan, New York.
2. Bartle R.G, The Elements of Real Analysis, John Wiley and Sons.
3. S.C. Malik, Savitha Arora, Mathematical Analysis, New Age International Ltd.
4. Edwin Hewitt, Karl Stromberg, Real and Abstract Analysis, Springer International, 1978.

Semester – 3

PC 11 **MT23111**

MULTIVARIATE CALCULUS AND INTEGRAL TRANSFORMS

Text 1: **Tom APOSTOL, Mathematical Analysis, Second edition, Narosa Publishing House.**

Text 2: **WALTER RUDIN, Principles of Mathematical Analysis, Third edition – International Student Edition.**

Module 1: The Weirstrass theorem, other forms of Fourier series, the Fourier integral theorem, the exponential form of the Fourier integral theorem, integral transforms and convolutions, the convolution theorem for Fourier transforms.

(Chapter 11 Sections 11.15 to 11.21 of Text 1) (20 hours.)

Module 2: Multivariable Differential Calculus

The directional derivative, directional derivatives and continuity, the total derivative, the total derivative expressed in terms of partial derivatives, An application of complex- valued functions, the matrix of a linear function, the Jacobian matrix, the chain rate matrix form of the chain rule.

(Chapter 12 Sections. 12.1 to 12.10 of Text 1) (20 hours.)

Module 3: Implicit functions and extremum problems, the mean value theorem for differentiable functions, a sufficient condition for differentiability, a sufficient condition for equality of mixed partial derivatives, functions with non-zero Jacobian determinant, the inverse function theorem (without proof), the implicit function theorem (without proof), extrema of real- valued functions of one variable, extrema of real- valued functions of several variables.

Chapter 12 Sections-. 12.11 to 12.13. of Text 1

Chapter 13 Sections-. 13.1 to 13.6 of Text 1 (25 hours.)

Module 4: Integration of Differential Forms

Integration, primitive mappings, partitions of unity, change of variables, differential forms, Stokes theorem (without proof)

Chapter 10 Sections. 10.1 to 10.25, 10.33 of Text 2 (25 hours.)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	2	2
Module III	2	2	2
Module IV	2	2	1
Total	8	8	6

References:-

1. Limaye Balmohan Vishnu, Multivariate Analysis, Springer.
2. Satish Shirali and Harikrishnan, Multivariable Analysis, Springer.

PC 12 **MT23112**

FUNCTIONAL ANALYSIS

Text Book: Erwin Kreyszig, Introductory Functional Analysis with applications, John Wiley and sons, New York

Module 1

Vector Space, normed space. Banach space, further properties of normed spaces, finite dimensional normed spaces and subspaces, compactness and finite dimension, linear Operators, bounded and continuous linear operators.

(Chapter 2 - Sections 2.1 – 2.7 of the text) (20 hours)

Module 2

Linear functionals, linear operators and functionals on finite dimensional spaces, normed spaces of operators. dual space, inner product space. Hilbert space, further properties of inner product space.

(Chapter 2 - Section 2.8 to 2.10, chapter 3 - Sections 3.1 to 3.2 of the text) (20 hours)

Module 3

Orthogonal complements and direct sums, orthonormal sets and sequences, series related to orthonormal sequences and sets, total orthonormal sets and sequences. representation of functionals on Hilbert spaces, Hilbert adjoint operators, Self adjoint, unitary and normal operators.

(Chapter 3 - Sections 3.3 to 3.6, 3.8 to 3.10 of the text) (25 hours)

Module 4

Zorn's lemma, Hahn- Banach theorem, Hahn- Banach theorem for complex vector spaces and normed spaces, adjoint operators, reflexive spaces, category theorem (Statement only), uniform boundedness theorem
(Chapter 4 – Sections 4.1 to 4.3, 4.5 to 4.7 of the text) (25 hours)

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Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	3	1
Module II	2	1	2
Module III	2	1	2
Module IV	2	3	1
Total	8	8	6

References

1. Simmons, G.F, Introduction to Topology and Modern Analysis, McGraw –Hill, New York 1963.
2. Siddiqi, A.H, Functional Analysis with Applications, Tata McGraw –Hill, New Delhi : 1989
3. Somasundaram. D, Functional Analysis, S.Viswanathan Pvt. Ltd, Madras, 1994
4. Vasistha, A.R and Sharma I.N, Functional analysis, Krishnan Prakasan Media (P) Ltd, Meerut: 1995-96
5. M. Thamban Nair, Functional Analysis, A First Course, Prentice – Hall of India Pvt. Ltd, . 2008
6. Walter Rudin, Functional Analysis, TMH Edition, 1974.

PC 13 **MT23113**

DIFFERENTIAL GEOMETRY

Text Book: John A. Thorpe, Elementary Topics in Differential Geometry

Module 1: Graphs and level sets, vector fields, the tangent space, surfaces, vector fields on surfaces, orientation.

(Chapters 1 to 5 of the text) (15 hours)

Module 2: The Gauss map, geodesics, Parallel transport,

(Chapters 6, 7 & 8 of the text) (20 hours)

Module 3: The Weingarten map, curvature of plane curves, Arc length and line integrals

(Chapters 9, 10 & 11 of the text) (25 hours)

Module 4: Curvature of surfaces, Parametrized surfaces, local equivalence of surfaces and Parametrized surfaces.

(Chapters 12, 14 & 15 of the text). (30 hours)

Question paper pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	2	1
Module III	2	2	2
Module IV	2	2	2
Total	8	8	6

References:-

1. Serge Lang, Differential Manifolds
2. I.M. Siger, J.A Thorpe, Lecture notes on Elementary topology and Geometry, Springer – Verlag, 1967.
3. S. Sternberg, Lectures on Differential Geometry, Prentice-Hall, 1964.
4. M. DoCarmo, Differential Geometry of curves and surfaces.
5. Goursat, Mathematical Analysis, Vol – 1(last two chapters)

PC 14 **MT23114**

NUMBER THEORY AND CRYPTOGRAPHY

Text Book: Neal Koblitz, A **Course in Number Theory and Cryptography, 2nd edition, Springer Verlag.**

Module 1: Some topics in Elementary Number Theory:-Time estimates for doing arithmetic, divisibility and the Euclidean algorithm, congruences, Some applications to factoring.

(Chapter – I Sections 1, 2, 3 & 4 of the text) (28 hours)

Module 2: Finite Fields and Quadratic Residues:-Finite fields, quadratic residues and reciprocity

(Chapter – II Sections 1 & 2 of the text) (14 hours)

Module 3: Public Key: - The idea of public key cryptography, **RSA,** Discrete log.

(Chapter – IV Sections 1, 2 & 3 of the text) (25 hours)

Module 4: Primality and Factoring: - Pseudo primes, The rho method, Fermat factorization and factor bases, the quadratic sieve method.

(chapter – V Sections 1, 2, 3 & 5 of the text) (23 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	3	3	2
Module II	1	1	1
Module III	2	2	2
Module IV	2	2	1
Total	8	8	6

Reference Books:

1. **Niven, H.S. Zuckerman and H.L. Montgomery**, *An introduction to the theory of numbers*, John Wiley, 5th Edition.
2. **Ireland and Rosen**, *A Classical Introduction to Modern Number Theory*. Springer, 2nd edition, 1990.
3. **David Burton**, *Elementary Number Theory and its applications,* Mc Graw-Hill Education (India) Pvt. Ltd, 2006.
4. **Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone**, *Handbook of Applied*

Cryptography, CRC Press, 1996
5. **Douglas R. Stinson,** *Cryptography Theory and Practice*, Chapman & Hall, 2nd edition
6. **Victor Shoup**, A computation Introduction to Number Theory and Algebra, , Cambridge University Press, 2005
7. **William Stallings**, *Cryptography and Network Security Principles and Practice*, Third edition, Prentice-hall, India.

PC 15 **MT23115**

OPTIMIZATION TECHNIQUES

Text – 1 K.V. Mital and C. Mohan, Optimization Methods in Operation Research and Systems Analysis, 3rd edition.

Text -2- **Ravindran, Philips and Solberg. Operations Research Principle and Practice, 2nd edition, John Wiley and Sons.**

Module I: INTEGER PROGRAMMING

I.L.P in two dimensional space – General I.L.P. and M.I.L.P problems – cutting planes – remarks on cutting plane methods – branch and bound method – examples – general description – the 0 – 1 variable.
(Chapter 6; sections: 6.1 – 6.10 of text – 1) (20 hours)

Module II: SENSITIVITY ANALYSIS; FLOW AND POTENTIALS IN NETWORKS

. Introduction – changes in b_i – changes in c_j – Changes in a_{ij} – introduction of new variables – introduction of new constraints – deletion of variables - deletion of constraints –Goal programming.
Graphs- definitions and notation – minimum path problem – spanning tree of minimum length – problem of minimum potential difference – scheduling of sequential activities – maximum flow problem – duality in the maximum flow problem – generalized problem of maximum flow.
(Chapter – 5 & 7 Sections 5.1 to 5.9 & 7.1 to 7.9, 7.15 of text - 1) (25 hours)

Module III: THEORY OF GAMES

Matrix (or rectangular) games – problem of games – minimax theorem, saddle point – strategies and pay off – theorems of matrix games – graphical solution – notion of dominance – rectangular game as an L.P. problem.
(Chapter 12; Sections: 12.1 – 12.9 of text – 1) (20 hours)

Module IV: NON- LINEAR PROGRAMMING

; Basic concepts – Taylor's series expansion – Fibonacci Search - golden section search – Hooke and Jeeves search algorithm – gradient projection search – Lagrange multipliers – equality constraint optimization, constrained derivatives – project gradient methods with equality constraints – non-linear optimization: Kuhn-Tucker conditions – complimentary Pivot algorithms.
(Chapter 8; Sections: 8.1 – 8.14 of text – 2) (25 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	2	2
Module III	2	2	1
Module IV	2	2	2
Total	8	8	6

Reference:-

1. S.S. Rao, Optimization Theory and Applications, 2nd edition, New Age International Pvt.
2. J.K. Sharma, Operations Research: Theory and Applications, Third edition, Macmillan India Ltd.
3. Hamdy A. Thaha, Operations Research – An Introduction, 6th edition, Prentice Hall of India Pvt. Ltd.

Semester – 4

PC 16 **MT24116**

SPECTRAL THEORY

Text Book: Erwin Kreyszig, Introductory Functional Analysis with applications, John Wiley and sons, New York

Module I

Strong and weak convergence, convergence of sequence of operators and functionals, open mapping theorem, closed linear operators, closed graph theorem, Banach fixed point theorem

(Chapter 4 - Sections 4.8, 4.9, 4.12 & 4.13 - Chapter 5 – Section 5.1 of the text)

(25 hours)

Module 2

Spectral theory in finite dimensional normed space, basic concepts, spectral properties of bounded linear operators, further properties of resolvant and spectrum, use of complex analysis in spectral theory, Banach algebras, further properties of Banach algebras.
(Chapter 7 - Sections 71. to 7.7 of the text) (25 hours)

Module 3

Compact linear operators on normed spaces, further properties of compact linear operators, spectral properties of compact linear operators on normed spaces, further spectral properties of compact linear operators, unbounded linear operators and their Hilbert adjoint operators, Hilbert adjoint operators, symmetric and self adjoint linear operators
(Chapter 8 - Sections 8.1 to 8.4 - Chapter 10 Sections 10.1 & 10.2 of the text)
(20 hours)

Module 4

Spectral properties of bounded self adjoint linear operators, further spectral properties of bounded self adjoint linear operators, positive operators, projection operators,further properties of projections
(Chapter 9 - Sections 9.1, 9.2, 9.3, 9.5, 9.6 of the text) (20 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	3	1
Module II	2	3	1
Module III	2	1	2
Module IV	2	1	2
Total	8	8	6

References:-

1. Simmons, G.F, Introduction to Topology and Modern Analysis, McGraw –Hill, New York 1963.
2. Siddiqi, A.H, Functional Analysis with Applications, Tata McGraw –Hill, New Delhi : 1989
3. Somasundaram. D, Functional Analysis, S.Viswanathan Pvt Ltd, Madras, 1994
4. Vasistha, A.R and Sharma I.N, Functional analysis, Krishnan Prakasan Media (P) Ltd, Meerut: 1995-96
5. M. Thamban Nair, Functional Analysis, A First Course, Prentice – Hall of India Pvt. Ltd, . 2008

6. Walter Rudin, Functional Analysis, TMH Edition, 1974.

ELECTIVE COURSES

PE 1 **MT24317**

ANALYTIC NUMBER THEORY

Text: Tom M Apostol, *Introduction to Analytic Number Theory,* Springer International Student Edition, Narosa Publishing House

Module 1 Arithmetic Functions Dirichlet Multiplication and Averages of Arithmetical functions

Introduction to Chapter1 of the text, the Mobius function $\mu(n)$ the Euler totient function $\varphi(n)$, a relation connecting $\mu(n)$ and $\varphi(n)$, the Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius inversion formula, theMangoldt function $\Lambda(n)$, multiplicative e functions and Dirichlet multiplication, the inverse of completely multiplicative functions, the Liovillie's function $\lambda(n)$, the divisor function $\sigma_\alpha(n)$, generalized convolutions, formal power series, the Bell series of an arithmetical function, Bell series and Dirichlet multiplication.

Introduction to Chapter2 of the text, the big oh notation, asymptotic equality of functions, Euler's summation formula, some elementary asymptotic formulas, the average order of $d(n)$, The average order of the divisor function $\sigma_\alpha(n)$, average order of $\varphi(n)$, an application of distribution of lattice points visible from the origin, average order of $\mu(n)$ and $\Lambda(n)$,,the partial sums of a Dirichlet product, application to $\mu(n)$ and $\Lambda(n)$.

(Chapter 2 sections 2.1 to 2.17 and Chapter 3 sections 3.1 to 3.11 of the text) (30 hours)

Module 2 Some Elementary Theorems on the Distribution of Prime Numbers

Introduction to Chapter4, Chebyshev's functions $\psi(x)$ and $\vartheta(x)$, relation connecting $\vartheta(x)$ and $\pi(x)$, some equivalent forms of prime number theorem, inequalities of $\pi(n)$ and p_n Shapiro's Tauberian theorem, applications of Shapiro's theorem, an asymptotic formula for the partial sum $\sum_{p\leq x}\left(\frac{1}{p}\right)$.

(Chapter 4 sections 4.1 to 4.8 of the text) (15 hours)

Module 3 Congruences

Definition and basic properties of congruences, residue classes and complete residue systems, liner congruences , reduced residue systems and Euler – Fermat theorem, Polynomial congruences modulo p , Lagrange's theorem, applications of Lagrange's theorem, simultaneous linear congruences, the Chinese reminder theorem, applications of Chinese reminder theorem, polynomial congruences with prime powermoduli

(Chapter 5 sections 5.1 to 5.9 of the text) (30 hours)

Module 4 Primitive roots and partitions

The exponent of a number mod m. Primitive roots, Primitive roots and reduced systems, The non existence of Primitive roots mod 2^{α} for $\alpha \geq 3$, The existence of

Primitive roots mod p for odd primes p, Primitive roots and quadratic residues.
Partitions – Introduction, Geometric representation of partitions, Generating functions for partitions, Euler's pentagonal-number theorem.

(Chapter 10 sections 10.1 to 10.5 &
Chapter 14 sections 14.1 to 14.4 of the text) (15 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	3	3	2
Module II	2	1	1
Module III	2	3	2
Module IV	1	1	1
Total	8	8	6

References:

1. Hardy G.H and Wright E.M , Introduction to the Theory of numbers, Oxford, 1981
2. Leveque W.J, Topics in Number Theory, Addison Wesley, 1961.
3. J.P Serre, A Course in Arithmetic, GTM Vol. 7, Springer-Verlag, 1973

PE 2 **MT24318**

COMBINATORICS

Text Book: Chen Chuan -Chong, Koh Khee Meng, Principles and Techniques in Combinatorics, World Scientific,1999.

Module I Permutations and Combinations

Two basic counting principles, Permutations, Circular permutations, Combinations, The injection and bijection principles, Arrangements and selection with repetitions ,Distribution problems
(Chapter I of the text) (20 hours)

Module II The Piegeonhole Principle and Ramsey Numbers

Introduction, The piegeonhole principle, More examples, Ramsey type problems and Ramsey numbers, Bounds for Ramsey numbers
(Chapter 3 of the text) (20 hours)

Module III Principle of Inclusion and Exclusion

Introduction, The principle, A generalization, Integer solutions and shortest routes Surjective mappings and Sterling numbers of the second kind, Derangements and a generalization, The Sieve of Eratosathenes and Euler φ -function.
(Chapter -4 Sections 4.1 to 4.7 of the text) (25 hours)

Module IV Generating Functions

Ordinary generating functions, Some modelling problems, Partitions of integer, Exponential generating functions

Recurrence Relations

Introduction, Two examples, Linear homogeneous recurrence relations, General linear recurrence relations, Two applications
(Chapter 5, 6 Sections 6.1 to 6.5) (25 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1
Module III	2	2	1	
Module IV	2	2	1	1
Total	8	8	6	

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References:-

1. V Krishnamoorthy, Combinatorics theory and applications, E. Hoewood, 1986
2. Hall,Jr, Combinatorial Theory, Wiley- Interscinice, 1998.
3. Brualdi, R A, Introductory Combinatorics, Prentice Hall,1992

PE 3 **MT04E03**

CLASSICAL MECHANICS

Text: L. D. Landau and E. M. Lifshitz - MECHANICS, (Third Edition)
(Butter worth – Heinenann)

Module 1: Generalized coordinates, the Principle of least action, Galileo's relativity principle, the Legrangian for a free particle, Legrangian for a system of particle, energy, momentum, centre of mass, angular momentum, motion in one dimension, determination of the potential energy from the period of oscillation, the reduced mass, motion in a central field.
(Section 1 to 9, 11 to 14 of the text)

Module 2: Free oscillation in one dimension, angular velocity, the inertia tensor, angular momentum of a rigid body, the equation of motion of a rigid body, Eulerian angle, Euler's equation.
(Section 21, 31 to 36 of the text)

Module 3: The Hamilton's equation, the Routhian, Poisson brackets, the action as a function of the co ordinates, Maupertui's principle.
(Section 40 to 44 of the text)

Module 4: The Canonical transformation, Liouville's theorem, the Hamiltonian – Jacobi equation, separation of the variables, adiabatic invariants, canonical Variables
(Section 45 – 50 of the text)

References

1. M. G. Calkin, Lagrangian and Hamiltonian Mechanics, Allied
2. Herbert Goldstein, Classical mechanics, Narosa
3. K C Gupta, Classical mechanics of particles and Rigid Bodies, Wiley Eastern

PE 4 **MT04E04**

PROBABILITY THEORY

All questions shall be based on the relevant portions of the reference books given in the end of each module

Module - 1

Discrete Probability (Empirical, Classical and Axiomatic approaches), Independent events, Bayes theorem, Random variables, and distribution functions (univariate and multivariate), Expectation and moments, marginal and conditional distributions. Probability Inequalities (Chebychev, Markov). Modes of convergence, Weak and Strong laws of large numbers (Khintchine's Weak Law , Kolmogrov Strong Law, Bernaulli's Strong Law) Central Limit theorem (Lindeberg-Levy theorem).

References.

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand & Sons, 2011.
2. V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, 2nd Ed. Wiley Eastern Ltd., 1986.

Module – 2

Standard discrete and continuous univariate distributions (Binomial, Poisson,Negative binomial, Geometric, Exponential, Hypergeometric, Normal, Rectangular, Cauchy's, Gamma, Beta,), Multivariate normal distribution, Wishart distribution and their properties.

References.

For univariate distributions, refer the book

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand & Sons, 2011.

For Multivariate distributions, refer the book

2. T.W. Anderson, An Introduction to Multivariate Statistical Analysis, 3rd Ed., Wiley Interscience, 2003.

Module – 3

Methods of estimation, properties of estimators, Cramer-Rao inequality, Fisher-Neyman criterion for sufficiency, Rao-Blackwell theorem, completeness ,method of maximum likelihood, properties of maximum likelihood estimators , method of moments. Tests of hypothesis: most powerful and uniformly most powerful tests (Neyman – Pearson Lemma).

References.

For Estimation, refer the book

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand & Sons, 2011.

For Tests of Hypothesis, refer the book

2. V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, 2nd Ed. Wiley Eastern Ltd., 1986.

Module- 4

Gauss-Markov models, estimability of parameters, best linear unbiased estimators, Analysis of variance and covariance. One way and two way classification with one observation per cell.

References.

1. D.D. Joshi, Linear Estimation and Design of Experiments, Wiley Eastern Ltd., 1990.
2. C.R. Rao, Linear Statistical Inference and its Applications, John Wiely, New York. ,1965.
3. W.G.Cochran and G.M. Cox , Experimental Designs, 2nd Ed., John Wiely, New York. , 1957.

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	3	3	1
Module II	3	3	2
Module III	1	1	2
Module IV	1	1	1
Total	8	8	6

PE 5 **MT24319**

MATHEMATICAL ECONOMICS

Text – 1:- Singh S.P, Anil K.Parashar, Singh H.P, Econometrics and Mathematical Economics, S. Chand & Company, 2002.

Text – 2:- JEAN E. WEBER, MATHEMATICAL ANALYSIS Business and Economic Applications, Fourth edition, HARPER & ROW PUBLISHERS, New York.

Module:-1 The theory of consumer behaviour- Introductory, Maximization of utility, Indifference cure approach, Marginal rate of substitution, Consumer's equilibrium, Demand curve, Relative preference theory of demand, Numerical problems related to these theory part.
(Chaper – 13 .Sections 13.1, 13.2, 13.3, 13.4, 13.5, 13.6 & 13.13 of text - 1)(20 hours)

Module:-2 The production function:- Meaning and nature of production function, The law of variable proportion, Isoquants, Marginal technical rate of substitution, Producer's equilibrium, expansion path, The elasticity of substitution, Ridge lines and economic region of production,
Euler's theorem, Cobb Douglas production function, The CES Production function, Numerical problems related to these theory parts.
(Chapter – 14. Sections 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, 14.9, 14.10 & 14.11 of text - 1) (30 hours)

Module:-3 Input – Output Analysis:- Meaning of input – output, main features of analysis, Assumptions, Leontief's static and dynamic model, limations, Importance and Applications of analysis, Numerical problems related to these theory parts..
(Chapter – 15. Sectios 15.1, 15.2, 15.3, 15.4, 15.5,15.6, 15.7, 15.8 & 15.9 of text - 1)
(20 hours)

Module:- 4 Difference equations –Introduction, Definition and Classification of Difference equations, Linear Difference equations, Solution of Difference equations, Linear First-Order Difference equations with constant coefficients, Behaviour of the solution sequence, Equilibrium and Stability, Applications of Difference equations in Economic Models, The Harrod Model, The General Cobweb Model, Consumption Model, Income – Consumption – Investment Model.

(Chapter 6 Sections 6.1 to 6.5 of text 2) (20 hours)

Question paper pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	3	2
Module III	2	1	2
Module IV	2	2	1
Total	8	8	6

References:-

1. Allen.R.G..D, Mathematical Economics, 1959.
2. Alpha C Chiang, Fundamental methods of Mathematical Economics.
3. Koutsoyiannis. A, Modern Microeconomics, Macmillen.
4. Samuelson. P.A, Foundation of Economic Analysis.
5. Josef Hadar, Mathematical theory of economic behaviour, Addison-Wesley

PE 6 **MT04E06**

COMPUTING FOR MATHEMATICS

Textbooks

Text 1: E. Balagurusamy, Object Oriented Programming With C++, 4th Edition, Tata Mc Graw Hill, 2008.

Text 2: Leslie Lamport, LaTeX: A document preparation system, 2nd Edition, Addison-Wesley, 1994.

Module 1. Principles of Object Oriented Programming, Beginning with C++, Tokens, expressions and control structures, Functions in C++.

(Chapters 1-4 of text 1) (25 hours)

Module 2. Classes and Objects, Constructors and Destructors, Operator overloading and type conversions

(Chapters 5-7 of text 1) (25 hours)

Module 3. Inheritance: Extending classes, Managing console I/O operatio

(Chapters 8 and 10 of text 1) (20 hours)

Module 4. Introduction to LaTeX: Getting started-Preparing an input file-The input Changing the type style-Symbols from other languages -Mathematical formulas Defining commands and environments. Other document classes-Books-Slides-Letter

(Chapter 2,3,and 5 of Text 2) (20 hours)

For this course a record book of the practical work is to be kept. A maximum of 3 weightage is to be awarded for the record and it is to be awarded by a committee of the HOD and the teacher in charge of the course. These 3 weightage is the weightages of the assignment, seminar and the internal viva.

If this paper is offered by the SDE or for private candidates the same is to be maintained and shall be produced before the viva board. The viva board can reserve a maximum of 10 marks for this record book.

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	2
Module II	2	2	2
Module III	2	2	1
Module IV	2	2	1
Total	8	8	6

References

1. Stephen Prata, C++ Primer Plus, 5th Edition, Sams, 2004.
2. R. LaFore, Object Oriented Programming in C++, 4th Edition, Sams, 2011.
3. Deitel, and Deitel, C++ How to Program, 6th Edition, Prentice-Hall, 2008.
4. F. Mittelbach, M. Goossens The LaTeX Companion: 2nd Edition, *et.al.*, 2004.
5. Stroustup ,The C++ Programming Language, 3rd Edition, Addison-Wesley, 1997.

PE 7 **MT04E07**

OPRRATIONS RESEARCH

Text -1- **Ravindran. A, Don T Philips and James J Solberg., Operations Research Principle and Practice, 2nd edition, John Wiley and Sons.**

Text – 2- Hamdy A. Thaha, Operations Research – An Introduction, 6th edition, Prentice Hall of India Pvt. Ltd.

Text – 3- K.V. Mital and C. Mohan, Optimization Methods in Operation Research and Systems Analysis, 3rd edition, New Age International Pvt. Ltd..

Text – 4 -Man Mohan, P.K. Gupta and Kanti Swarup, Operations Research, Sultan Chand and Sons.

Module I: INVENTORY MODELS

Introduction – Variables in an inventory problem – Objectives of inventory control – The classical E.O.Q. without shortages – The classical E.O.Q. with shortages – The Production Lot size (P.L.S) models – Nonzero Lead time – The Newsboy Problem (a single period model) – Lot size reorder point model – Variable lead times – The importance of selecting the right model.

(Chapter 8; Sections: 8.1 – 8.14 of text 1) (20 hours)

Module 2: QYEUEING SYSTEMS

Why study queues? – Elements of a queueing model – Role of exponential distribution (Derivation of exponential distribution; forgetfulness property) – Pure Birth and Death models – Relationship between the exponential and Poisson distributions – Generalized Queueing Models – Kendall notation – Poisson Queueing Models – Single server models and multiple server models – Machine servicing models – (M/M/R) : (GD/K/K) Model – (M/G/1) : (GD/) model – Pollaczek- Khintchine (P - K) formula.

(Chapter 17; Sections: 17.1 – 17. 9 of text – 2) (25 hours)

Module 3: DYNAMIC PROGRAMMING

Introduction - Minimum path problem – Single additive constraint, additively separable return – Single multiplicative constraints, additively separable return - Single additive constraint, multiplicatively separable return – Computational economy in DP – Serial multistage models – Examples of failure – Decomposition – backward and forward recursions – Systems with more than one constraint – Applications of D.P to continuous systems.

(Chapter: 10; Sections: 10.1 – 10.12 of text – 3) (20 hours)

Module 4: NETWORK SEQUENCING; SIMULATION MODELING

Problem of sequencing – Basic assumptions – Processing n jobs through two machines – OptimumSequence (Johnson Bellman) Algorithm - Processing n jobs through k machines – Processing of two jobs through k machines – Maintenance crew s cheduling.

Simulation – Generation of random variables – Monte Carlo simulation – Sampling from probability distributions: 1. Inverse method, 2. Convolution method (&Box-Muller method), 3. Acceptance-Rejection method – Generic definition of events.

(Chapter: 12; Sections: 12.1 – 12.7 of text – 4

Chapter: 18- Sections: 18.1 – 18.6 of text – 2) (25 hours)

Question Paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	1
Module II	2	2	2
Module III	2	2	1
Module IV	2	2	2
Total	8	8	6

References:-

1. Thomas L Satty, Elementary Queuing Theory, McGraw Hill Publishing Company.
2. Narasingh Deo, System Simulationwirh digital Computers, 7th edition, Prentice Hall India Pvt. Ltd., 1997.
3. Geoffrey Gordon, System Simulation, 2nd edition Prentice Hall India Pvt. Ltd, 1998.

PE 8 **MT04E08**

SPECIAL FUNCTIONS

Text Book:- Earl. D. Rainville, Special functions, Chelsa Publishing Company, New York, 1960.

Module – 1

Infinite products:- Introduction, definition of an infinite product, a necessary condition for convergence, the associated series of logarithms, absolute convergence, uniform convergence.

The Gamma and Beta functions:- The Euler and Mascheroni constant γ , the Gamma function, a series for $\Gamma^{1}(z) / \Gamma(z)$, evaluation of $\Gamma(1)$ and $\Gamma^{1}(1)$, the Euler product for $\Gamma(z)$, the difference equation $\Gamma(z+1) = z\,\Gamma(z)$the order symbols o and 0, evaluation of certain infinite products, Euler's integral for $\Gamma(z)$, the Beta function, the value of $\Gamma(z)\,\Gamma(1-z)$, the factorial function, Legendre's duplication formulae, Gauss' multiplication theorem, a summation formula due to Euler, the behavior of log $\Gamma(z)$ for large $|z|$

(Chapter 1 & 2 of text – Sections 1 to 22)

Module – 2

The hypergeometric function:- The function F(a,b,c,z), a simple integral form, F(a,b,c,1) as a function of the parameters, evaluation of F(a,b,c,1), the contiguous function relations, the hypergeometric differential equation, logarithmic solution of the hypergeometric equation, F(a,b,c,z) as a function of its parameters, elementary series multiplications, simple transformations, relation between functions of z and 1 –z.

(Chapter 4 of the text – Sections 29 to 39)

Module – 3

Generalized Hypergeometric Functions: The function ${}_pF_q$, the exponential and binomial functions, a differential equation, other solutions of the differential equation, the contiguous function relations, a simple integral, the ${}_pF_q$ with unit argument.

The Confluent Hypergeometric Functions: Basic properties of the ${}_1F_1$, Kummer's first formula, Kummer's second formula.

(Chapter 5 – Sections 44 to 50, Chapter 7 - Sections – 68, 69, 70)

Module – 4

Legendre Polynomials: A generating function, Differential recurrence relations, the pure recurrence relation, Legendre's differential equation, the Rodrigue's formula, Bateman's generating function, additional generating functions, Hypergeometric forms of $p_n(x)$, Brafman's generating function, special properties of $p_n(x)$.

Hermite Polynomials: Definition of $H_n(x)$, recurrence relations, the Rodrigue's formula, other generating functions, integrals.

Question paper pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	1
Module II	2	2	1	
Module III	2	2	1	1
Module IV	2	2	1	
Total	8	8	6	

References:-

1. M.A. Pathan, V.B.L.Chaurasia, P.K.Banerji, M.C.Goyal ,Special Functions and Calculus of Variations, Ramesh Book Depot, New Delhi, 2007.

2. Z.X. Wang, D.R. Guo, Special Functions, World Scientific Publishing Company, London, 1989.

3. N.M. Temme, Special Functions – An Introduction to the Classical Functions of Mathematical Physics, John Wiley & Sons, New York, 1996.

4. A.M. Mathai, H.J. Haubold, Special Functions for Applied Scientist, Springer, New York, 2008.

5. G.E. Andrews, R. Askey, R. Roy, Special .Functions, Encyclopedia of Mathematics and its Applications 71, Cambridge University Press, Cambridge.1999.

PE 9 **MT04E09**

THEORY OF WAVELETS

Text Book:- Michael W. Frazier, An introduction to Wavelets through Linear Algebra, Springer- verlag, 2000.

Pre-requisites:- Linear Algebra, Discrete Fourier Transforms, Elementary Hilbert Space theorem. (No questions shall be asked from these sections.)

Module – 1:- Construction of Wavelets on $\mathbf{Z}_N$: The First Stage.
(Chapter – 3 Section 3.1 of the text) (20 hours)

Module – 2:-Construction of Wavelets on $\mathbf{Z}_N$: The Iteration Step, Examples – Haar, Shannon and Daubechies).
(Chapter – 3 Section 3.2 & 3.3 of the text) (20 hours)

Module – 3:- $l^2(\mathbf{Z})$, Complete Orthonormal sets in Hilbert Spaces, $L^2[-\pi , \pi]$ and Fourier Series.
(Chapter – 4 Section 4.1, 4.2 & 4.3 of the text) (20 hours)

Module – 4:- The Fourier Transform and Convolution on $l^2(\mathbf{Z})$, First-stage Wavelets on **Z**, The Iteration step for Wave lets on Z, Examples- Haar and Daubechies.
(Chapter – 4 Section 4.4, 4.5, 4.6 & 4.7 of the text) (30 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1
Module III	2	2	1	
Module IV	2	2	1	1
Total	8	8	6	

References:-

1. Mayer, Wavelets and Operators, Cambridge University Press, 1993.
2. Chui, An Introduction to Wavelets, Academic Press, Boston, 1992.

PE 10 **MT04E10**

SIGNAL THEORY

Text Book:- Athanasios Papoulis and S. Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes, Fourth edition, Tata McGraw-Hill, New Delhi.

Module – 1 General Concepts:

Definitions, Systems with Stochastic Inputs, The Power Spectrum, Discrete-Time Processes, Simple problems

(Chapter – 9, Sections 9.1 to 9.4 of the text) (22 hours)

Module – 2 Random Walks and Other Applications.

Random Walks, Poisson points and Shot Noise, Modulation.

(Chapter –10, Sections 10.1 to 10.3 of the text) (22 hours)

Module – 3 Spectral Representation

Factorizations and Innovations, Finite-Order Systems and State Variables, Fourier Series and Karhunen-Loeve Expansions, Spectral representation of Random Processes, Simple problems.

(Chapter – 11, Sections 11.1 to11.4 of the text) (24 hours)

Module – 4 Entropy

Introduction, Basic Concepts, Coding, Channel Capacity, Simple Problems.

(Proof of the channel Capacity theorem excluded)

(Chapter – 14, Sections 14.1, 14.2, 14.5 & 14.6 of the text) (22 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1
Module III	2	2	1	
Module IV	2	2	1	1
Total	8	8	6	

References:-

1. Meldhi.J, Stochastic Process, Wiley Eastern, 1987
2. Srinivasan. C.K, Stochastic Processes, 2nd edition, Tata McGraw-Hill.
3. Karlin and Taylor, A First Course in Stochastic Processes.
4. Karlin and Taylor, A Second Course in Stochastic Processes.

PE 11 **MT04E11**

COMMUTATIVE ALGEBRA

Text Book :- Gregor Kemper, A Course in Commutative Algebra, Springer, ISSN0072-5285, ISBN978-3-642-03544-6

Module :- 1 The Algebra-Geometry Lexicon – Hilbert's Nullstellensatz

Maximal ideals, Jacobson Rings, Coordinate Rings, Simple problems.
(Chapter1 Sections 1.1, 1.2 & 1.3 of the text) (25 hours)

Module: -2 Noetherian and Artinian Rings.

The Noether and Artin Properties for Rings and Modules, Notherian Rings and Modules, Simple problems
(Chapter2 Sections 2.1 & 2.2, of the text) (20 hours)

Module: - 3 The Zariski Topology

Affine Varieties, Spectra, Noetherian and Irreducible Spaces, Simple problems.
(Chapter3 Sections 3.1, 3.2 & 3.3 of the text) (25 hours)

Module: -4 A Summary of the Lexicon

True Geometry: Affine Varieties, Abstract Geometry : Spectra , Simple problems
(Chapter4 Sections 4.1 & 4.2, of the text). (20 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1
Module III	2	2	1	
Module IV	2	2	1	1
Total	8	8	6	

References: -

1. William W. Adams, Phillippe Loustaunau, An Introduction to Grobner bases, Graduate Studies in Mathematics 3, American Mathematical Society, 1994, [117]
2. Michael F Attiyah, Ian Grant Macdonald, Introduction to Commutative Algebra, Addison- Wesley, Reading, 1969[174]
3. Nicolas Bourbaki, General Topology, Chapters – 1 – 4, Springer, Berlin, 1993, [117, 118, 161].

PE 12 **MT04E12**

FRACTIONAL CALCULUS

Text Book: Mathai A.M., Saxena R.K., H.J. Houbold, The H-Function: Theory and Applications, Springer, 2010.

Module-1

Introduction

A Brief Historical Background

Fractional Integrals: Riemann-Liouville Fractional Integrals, Basic properties of Fractional Integrals, Illustrative Examples.

Riemann-Liouville Fractional Derivatives, Illustrative Examples.

(3.1, 3.2, 3.3 -3.3.1, 3.3.2, 3.3.3 - 3.4 - 3.4.1 of the text)

Module-2

The Weyl Integral: Basic properties of Weyl Integrals, Illustrative examples.

Laplace Transform: Laplace Transform of Fractional Integrals, Laplace Transform of Fractional Derivatives, Laplace Transform of Caputo Derivative.

(3.5 - 3.5.1, 3.5.2, 3.6 - 3.6.1, 3.6.2, 3.6.3 of the text)

Module-3

Mellin Transforms: Mellin Transform of the n^{th} Derivative, Illustrative Examples

Kober Operators: Erdelyl-Kober Operators

Generalized Kober Operators

(3.7 - 3.7.1, 3.7.2, 3.8 - 3.8.1, 3.9 of the text)

Module-4

Saigo Operators: Relations among the Operators, Power Function Formulae, Mellin Transform of Saigo Operators, Representation of Saigo Operators.

(3.10 - 3.10.1, 3.10.2, 3.10.3, 3.10.4 of the text)

Question paper pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	3	2
Module II	2	2	2
Module III	2	1	1
Module IV	2	2	1
Total	8	8	6

References:-

(1) Dold.A, Eckmann. B, Fractional Calculus and its Applications, Springer Verlag, 1975.

(2) Miller.K.S, Rose.B, An Introduction to Fractional Calculus and Fractional Differential Equation, John Wiley and Sons, 1993.

(3) Nishimoto k, Fractional Calculus Integration and Differentiation of arbitrary order, Descartes press, Koriyama, 1991.

(4) Oldham K.B, Spanier .J, Fractional Calculus theory and Applications of Differentiation and Integration to arbitrary order, Academic press, 1974.
(5) Ian N Sneddon, The use of operators of Fractional Integration in Applied Mathematics,(Applied mechanic series), Polish Scientific publishers, 1979.
(6) Lecture notes on Multivariable and Matrix variable calculus and Applications, Stochastic models, Edited by A.M. Mathai, Publication number – 40, SERC School notes, CMS, pala, Kerala.(phone- 04822-216317)

PE 13 **MT24320**

ALGORITHMIC GRAPH THEORY

Text Book:- Gray Chartrand and O.R Oellermann , Applied and Algorithmic Graph Theory, **Tata McGraw- Hill Companies Inc**

Module 1 : Introduction to Graphs and Algorithms

What is graph? The degree of a vertex. isomorphic graphs. subgraphs, degree sequences. connected graphs. cutvertices and blocks. special graphs. digraphs. algorithmic complexity. Search algorithms, sorting algorithms. greedy algorithms., representing graphs in a computer.

(Capter 1 Sections 1.1 to 1.9, Chapter 2 Sections 2.1, 2.2 , 2.3, 2.5 and 2.6 of the text) (24 hours)

Module 2: Trees, paths and distances

Properties of trees, rooted trees. Depth-first search: a tool for finding blocks,. breadth – first search, . the minimum spanning tree problem

Distance in a graphs, distance in weighted graphs, .the centre and median of a graph. activity digraphs and critical paths.

(Chapter 3 sections 3.1 to 3.6 , Chapter 4 sections 4.1 to 4.4 of the text) (22 hours)

Module 3: Networks

An introduction to networks. the max-flow min-cut theorem. the max-flow min-cut algorithm . connectivity and edge connectivity . Mengers theorem.

(Chapter 5 sections 5.1 , 5.2 , 5.3 , 5.5 and 5.6 of the text) (22 hours)

Module 4 : Matchings and Factorizations

An introduction to matchings . maximum matchings in a bipartite graph,. Factorizations. Block Designs.

(Chapter 6 sections 6.1 , 6.2 , 6.4 and 6.5 of the text) (22 hours)

Question paper pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1

Module III	2	2	1	
Module IV	2	2	1	1
Total	8	8	6	

Reference:-

1. Alan Gibbons, Algorithmic Graph Theory, Cambridge University Press, 1985
2. Mchugh. J.A, Algorithmic Graph Theory, Prentice-Hall, 1990
3. Golumbic. M, Algorithmic Graph Theory and Perfect Graphs, Academic press.

PE 14 **MT04E14**

CODING THEORY

Text :- Vera Pless 3rd Edition , Introduction to the theory of error coding codes, Wiley Inter Science

Module:-1 Introduction Basic Definitions Weight, Maximum Likelihood decoding Synarome decoding, Perfect Codes, Hamming codes, Sphere packing bound, more general facts.

(chapter 1 & Chapter 2 Sections 2.1, 2.2, 2.3 of the text) (25 hours)

Module:-2 Self dual codes, The Golay codes, A double error correction BCH code and a field of 16 elements.

(Chapter 2 Section 2.4 & Chapter 3 of the text) (20 hours)

Module:- 3 Finite fields

(Chapter 4 of the text) (20 hours)

Module:- 4 Cyclic Codes, BCH codes)

(Chapter 5 & Chapter 7 of the text) (25 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	2	2	2
Module II	2	2	1
Module III	2	2	1
Module IV	2	2	2
Total	8	8	6

References:-

1. R-Lidi, G. Pliz, Applied Abstract Algebra, Springer Verlag.
2. J.H.Van Lint, Introduction to Coding Theory, Springer Verlag
3. R.E.Blahut, Error- Control Codes, Addison Wesley.

PE 15 **MT04E15**

COMPLEX ALGEBRAIC CURVES

Text:- Frances Kirwan, Complex Algebraic Curves, London Mathematical Society Student Texts 23, Cambridge University Press, Cambridge.

Module:- 1 Introduction and background - Relationship with other parts of Mathematics – Number theory, Singularities and the theory of knots, Complex analysis, Abelian Integrals – Real Algebraic Curves – Hilbert's Nullstellensatz, Techniques for drawing real algebraic curves, Real algebraic curves inside complex real algebraic curves, Important examples of real algebraic curves.
(Chapter 1 of the text) (25 hours)

Module:- 2 Foundations - Complex real algebraic curves in $\mathbf{C}^2$, Complex projective spaces, Complex projective curves inP_2 , Affine and Projective curves , Exercises (Simple problems.).
(Chapter 2 of the text) (20 hours)

Module:- 3 Algebraic Properties – Bezout's theorem, Points of inflection and cubic curves, Exercises(simple problems)
(Chapter 3 of the text) (25 hours)

Module:- 4 Topological Properties –The degree – genes formula, Branched curves of P_1, Proof of degree-genus formula, Exercises (Simple problems)
(Chapter 4 of the text – 4.1.1 & 4.1.2 excluded) (20 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	1
Module II	2	2	1	
Module III	2	2	1	1
Module IV	2	2	1	
Total	8	8	6	

References:-

1. E.Arbarello, M.Cornalba, P.Griffiths and J.Harris, Topics in the theory of algebraic curves, Springer-Verlag(1985)
2. E.Brieskorn and H.Knorrer, Plane Algebraic curves, Birkhauser-Verlag(1986)
3. C.H. Clemens, A scrapbook of Complex curve theory, plenum(1980)
4. J.L.Coolidge, A treatise on algebraic plane curves, Dover(1959)

PE 16 **MT04E16**

ALGEBRAIC GEOMETRY

Text:- Brendan Hassett, Intoduction to Algebraic Geometry, Cambridge University Press, 2007.

Module:- 1 Guiding problems

Implicitization, Ideal membership, Interpolation

Division algorithm and Grobner bases

3and chain coditions, Buchberger's Criterion.

(Chapter 1 – Sections 1.1 to 1.3, Chapter – 2 Sections 2.1 to 2.5) (30 hours)

Module:- 2 Affine varieties

Ideals and varieties, Closed sets and the Zariski topology, Coordinate rings and morphisms, Rational maps, Resolving rational maps, Rational and unirational varities.

(Chapter – 3 Sections 3.1 to 3.6) (22 hours)

Module:- 3 Elimination

Projections and graphs, Images of rational maps, Secant varieties, joins, and scrolls.

Resultants

Common roots of univariate polynomials, The resultant as a function of the roots, Resultants and elimination theory.

(Chapter – 4 Sections 4.1 to 4.3 Chapter – 5 Sections 5.1 to 5.3)

(23 hours)

Module:- 4 Irreducible varieties

Existence of the decomposition, Irreducibility and domains, Doeminant morphisms.

Nullstellensatz

Statement of the Nullstellensatz, Classification of maximal ideals, Transcendence bases, Integral elements.

Primary decomposition

Irreducible

ideals, Quotient ideals, Primary ideals.

(Chapter:- 6 Sections 6.1 to 6.3) Chapter – 7 Sections 7.1 to 7.4 Chapter – 8 Sections 8.1 to 8.3) (15 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	3	3	1	
Module II	2	2	1	1
Module III	2	2	1	
Module IV	1	1	1	1
Total	8	8	6	

References:-

1. William Fulton, Algebraic Curves: An Introduction to Algebraic Geometry, Advanced Book Program, Redwood City, CA: Addison-Wesley, 1989.
2. Phillip Griffiths and Joseph Harris, Principles of Algebraic Geometry, New York: Wiley-Interscience, 1978.
3. Joe Harris, Algebraic Geometry, Graduate Texts in Mathematics, 133. New York: Springer-Verlag, 1992.

PE 17 **MT04E17**

FRACTAL GEOMETRY

Text:- Kenneth Falconer, FRACTAL GEOMETRY Mathematical Foundations and Applications, John Wiley & Sons, New York.

Pre-requisites – Mathematical background – A quick revision
(Chapter 1 of the text).
No questions shall be asked from this section. (5 hours)

Module:- 1 Hausdorff measure and dimension

Hausdorff measure, Hausdorff dimension, Calculation of Hausdorff dimension- Simple examples, Equivalent definitions of Hausdorff dimension, Finer definitions of dimension.

Alternative definitions of dimension

Box counting dimension, Properties and problems of box counting dimension, Modified box counting dimension, Packing measures and dimension.
(Chapter 2 , 3 Sections 3.1 to 3.4 of the text.) (30 hours)

Module: 2 Techniques for calculating dimensions

Basic methods, Subsets of finite measure, Potential theoretic methods, Fourier transform methods.

Local structure of fractals

Densities, Structure of 1-sets, Tangents to s-sets.
(Chapter 4 & 5 of the text.) (25 hours)

Module:- 3 Projections of fractals

Projections of arbitrary sets, Projections of s-sets of integral dimension,
Products of fractals – Product formulae
(Chapter 6 & 7 of the text) (18 hours)

Module:- 4 Intersections of fractals

Intersection formulae for fractals, Sets with large intersection.
(chapter 8 of the text) (12 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays
Module I	3	3	2
Module II	2	2	2
Module III	2	2	1
Module IV	1	1	1
Total	8	8	6

Reference:-

1. Falconer K.J, The Geometry of Fractal sets, Cambridge University Press, Cambridge.
2. Barnsley M.F, (1988), Fractals every where, Academic press, Orlando, FL.
3. Mandelbrot B.B, (1982), The Fractal Geometry of Nature, Freeman, San Francisco.
4. Peitgen H.O and Richter P.H, (1986), The Beauty of Fractals, Springer, Berlin.
5. Tamas Vicsek, Fractal Growth Phenomena, Second edition, World Scientific.

PE 18 **MT04E18**

LIE ALGEBRAS

Text:- James E. Humphreys, Introduction to Lie Algebras and Representation Theory, Springer

Module:- 1 Basic Concepts

Definition and first examples, Ideals and homomorphisms, Solvable and nilpotent Lie Algebras.
(Chapter I Sections 1, 2, & 3 of the text) (25 hours)

Module:- 2 Semi simple Lie Algebras

Theorems of Lie and Cartan, Killing form, Complete reducibility of representations.
(Chapter II Sections 4, 5, & 6 of the text) (20 hours)

Module:- 3 Root Systems

Axiomatics, Simple roots and Weyl group, Classification.(proof of Classification theorem excluded)
(Chapter III Sections 9, 10 & 11 of the text) (25 hours)

Module:- 4 Isomorphism and Conjugacy Theorems

Isomorphism theorem, Cartan Algebras, Conjugacy theorems
(Chapter IV Sections 14, 15, & 16 – 16.1 to 16.3 of the text) (20 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	3	2	1	1
Module III	2	3	1	
Module IV	1	1	1	1
Total	8	8	6	

References:-

1. J.G.F. Belinfante and B. Kolman, Asurvey of Lie Groups and Lie Algebras with computational methods and Applications, .Philadelphia : SIAM, 1972.
2. N. Jacobson, Lie Algebras, New York – London, Wiley interscience, 1962.

3. H. Samuelson, Notes on Lie Algebras, Van Nostrand Reinhold Mathematical studies No. 23, New York: Van Nostrand Reinhold, 1969.

PE 19 **MT04E19**

ALGEBRAIC TOPOLOGY

Text :-Fred H.Croom-Basic concepts of Algebraic Topology (Springer verlag) ISBN 0-387-90288-0 Newyork and ISBN 3-540-90288-0 Berlin . Heidelberg

Chapters 1-5 (All sections and Theorems)

Module 1

Geometric complexes and Polyhedra-Introduction-Examples-Orientations of geometric complexes-Chains-Cycles-boundaries and Homology groups-Examples of Homology groups-The structure of Homology groups-The Euler-Poincare Theorem-Pseudomanifolds and the Homology groups of Sp.

Module 2

Simplicial approximations-Induced homomorphisms on the Homology groups-The Brouwer fixed point Theorem and related results.

Module 3

The Fundamental group-The covering homotopy property for S'-Examples of fundamental groups-the relation between $H_1(K)$ and $\pi_1(|K|)$.

Module 4

Covering spaces -Definition and some examples-Basic properties of covering spaces-Classification of covering spaces-Universal covering spaces.

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	
Module II	2	2	1	1

Module III	2	2	1	1
Module IV	2	2	1	
Total	8	8	6	

References

1. B.K.Lahiri-A first Course in Algebraic Topology (Second Edition)-Narosa Publications-ISBN 81-7319-635-4

2. Glen E.Bredon-Topology and Geometry (Springer)- ISBN 81-8128-266-3.

3. Joseph J.Rotman-An Introduction to Algebraic Topology (Springer) –ISBN 81-8128-179-9.

PE 20 **MT04E20**

FINANCIAL MATHEMATICS

Text:- Robert J Elliott, P.Ekkehardkopp, Mathematics of Financial Markets, Second edition, Springer

Module:-1 Pricing of Arbitrage

Introduction: Pricing and Hedging, Single-Period Option Pricing Models, A General Single- Period Model, A Single- Period Binomial Model, Multi-Period Binomial Models, Bounds on Option Prices

(Chapter:- 1 Section 1.1 to 1.6 of the text) (24 hours)

Module:- 2 Martingale Measures

A General Discrete-Time Market Model, Trading Strategies, Martingales and Risk-Neutral Pricing, Arbitrage Pricing: Martingale Measures, Strategies Using Contingent Claims, Example: The Binomial Model, From CRR to Black-Scholes

(Chapter:- 2 Section 2.1 to 2.7 of the text) (22 hours)

Module:-3 The First Fundamental Theorem

The Separating Hyper Plane Theorem in $\mathbf{R}^n$, Construction of Martingale Measures, Path wise Description, Examples, General Discrete Models.

(Chapter:- 3 Section 3.1 to 3.5 of the text) (22 hours)

Module:- 4 Complete Markets

Completeness and Matringake Representation, Completeness for Finite Market Models, The CRR Model, The Splitting Index and Completeness, Incomplete Models: The Arbitrage Interval, Characterisation of Complete Models.

(Chapter:- 4 Section 4.1 to 4.6 of the text) (22 hours)

Question paper Pattern

	Part A Short questions	Part B Short essays	Part C Long essays	
Module I	2	2	1	1
Module II	3	2	1	
Module III	2	3	1	1
Module IV	1	1	1	
Total	8	8	6	

References:-

1. L.U. Dothan, Prices in Financial Markets, Oxford University Press, New York, 1990
2. D.Duffle, Future markets, Prentice-Hall, Englewood cliffs, N.J, 1989.

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