DSE2.1 Mathematical Modeling

Total Marks: 100, Theory: 60, IA: 20, Practical: 20

Credit: 4+2=6;

(L=4, P=4, T=0)

Objectives:: After going through this course the students will be able to solve differential equations and linear programming problems used in mathematical modelling

Unit-1 Marks: 25, Contact hrs: 30

Power series solution of a differential equation about an ordinary point, solution about a regular singular point, Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order.

Unit-2 Marks: 35, Contact hrs: 30

Monte Carlo Simulation Modeling: simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence, Queuing Models: harbor system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis

List of Practical (using any software) Marks: 20 Contact hrs: 30

(i) Plotting of Legendre polynomial for n = 1 to 5 in the interval [0,1]. Verifying graphically that all the roots of Pn (x) lie in the interval [0,1].

(ii) Automatic computation of coefficients in the series solution near ordinary points.

(iii) Plotting of the Bessel's function of first kind of order 0 to3.

(iv) Automating the Frobenius Series Method.

(v) Random number generation and then use it for one of the following (a) Simulate area under a curve (b) Simulate volume under asurface.

(vi) Programming of either one of the queuing model (a) Single server queue (e.g. Harbor system) (b) Multiple server queue (e.g. Rushhour).

(vii) Programming of the Simplex method for 2/3variables.

Books Recommended

- TMyint-U and LokenathDebnath, *Linear Partial Differential Equation for Scientists and Engineers*, Springer, Indian reprint,2006.
- FR. Giordano, MD. Weir and WP. Fox, *A First Course in Mathematical Modeling*, Thomson Learning, London and New York,2003.

DSE2.2 Mechanics

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Describe Moment of a force and couple, general equation of equilibrium
- Solve Problems of translation and rotation of rigid bodies

Unit-1 Marks: 20: Contact hrs: 30

Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections, general equations of equilibrium, two point equivalent loading, problems arising from structures, static indeterminacy.

Unit-2 Marks: 25: Contact hrs: 30

Laws of Coulomb friction, application to simple and complex surface contact friction problems, transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centers, Theorem of Pappus-Guldinus, second moments and the product of area of a plane area, transfer theorems, relation between second moments and products of area, polar moment of area, principal axes.

Unit-3 Marks: 35: Contact hrs: 30

Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass, moment of momentum equation for a single particle and a system of particles, translation and rotation of rigid bodies, Chasles′ theorem, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references.

Books Recommended

1. I.H. Shames and G. Krishna Mohan Rao, *Engineering Mechanics: Statics and Dynamics,* (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and A. Gupta, *Engineering Mechanics: Statics and Dynamics,* 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education),Delhi.

DSE2.3 Number Theory

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- obtain solutions of Diophantine equations
- define number theoretic functions

Unit-1 Marks: 20: Contact hrs: 30

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat′s Little theorem, Wilson′s theorem.

Unit-2 Marks: 30: Contact hrs:30

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi- function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

Unit-3 Marks: 30: Contact hrs: 30

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler′s criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat′s Last theorem.

Books Recommended

1. D. M. Burton, *Elementary Number Theory,* 6th Ed., Tata McGraw- Hill, Indian reprint, 2007.
2. N. Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi,2007.

DSE2.4 Bio-Mathematics
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to discuss various models and techniques to study Bio-mathematical real life problems.

Unit-1 Marks: 15, Contact hrs:20

Mathematical Biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, Bacterial growth in a Chemostat, Harvesting a single natural population, Prey predator systems and LotkaVolterra equations,

Unit-2 Marks: 15, Contact hrs:15

Populations in competitions, Epidemic Models (SI, SIR, SIRS, SIC), Activator-Inhibitor system, Insect Outbreak Model: Spruce Budworm, Numerical solution of the models and its graphical representation.

Unit-3 Marks: 15, Contact hrs:15

Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria, Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario.

Unit-4 Marks: 15, Contact hrs:20

Spatial Models: One species model with diffusion, Two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population. Discrete Models: Overview of difference equations, steady state solution and linear stabilityanalysis,

Unit-5 Marks: 20, Contact hrs:20

Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting, Host-Parasitoid systems (Nicholson-Bailey model), Numerical solution of the models and its graphical representation. Case Studies: Optimal Exploitation models, Models in Genetics, Stage Structure Models, Age Structure Models.

Books Recommended

1. L.E. Keshet, *Mathematical Models in Biology*, SIAM,1988.
2. J. D. Murray, *Mathematical Biology*, Springer,1993.
3. Y.C. Fung, *Biomechanics*, Springer-Verlag,1990.
4. F. Brauer, P.V.D. Driessche and J. Wu, *Mathematical Epidemiology*, Springer,2008.
5. M. Kot, *Elements of Mathematical Ecology*, Cambridge University Press,2001.

DSE2.5 Industrial Mathematics
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Use various type of numerical methods to model problems and use simulation to solve problem
- Apply different methods to solve financial problems

Unit-1 Marks: 15, Contact hrs:15

Medical Imaging and Inverse Problems. The content X-ray is based on Mathematics of and CT scan based on the knowledge of equations, complexcalculus, elementary differential numbers and matrices.

Unit-2 Marks: 25, Contact hrs:15

Introduction to Inverse problems: Why should we teach Inverse Problems? Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations. Geological anomalies in Earth's interior from measurements at its surface (Inverse problems for Natural disaster) and Tomography.

Unit-3 Marks: 10, Contact hrs:15

X-ray: Introduction, X-ray behavior and Beers Law (The fundament question of image construction) Lines in the place.

Unit-4 Marks: 10, Contact hrs:15

Radon Transform: Definition and Examples, Linearity, Phantom (Shepp - Logan Phantom - Mathematical phantoms).

Unit-5 Marks: 10, Contact hrs:15

Back Projection: Definition, properties and examples.

Unit-6 Marks: 10, Contact hrs:15

CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan.

Books Recommended

1. T. G. Feeman, *The Mathematics of Medical Imaging, A Beginners Guide*, Springer Under graduate Text in Mathematics and Technology, Springer,2010.
2. C.W. Groetsch, *Inverse Problems*, Activities for Undergraduates, The Mathematical Association of America,1999.
3. A. Kirsch, *An Introduction to the Mathematical Theory of Inverse Problems*, 2nd Ed., Springer,2011

DSE 3.1 Hydro-Mechanics
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objective: After going through this course the students will be able to describe the basic properties of Fluid Mechanics.

Unit 1: **Marks: 15, Contact hrs:15**

Kinematics: Real and ideal fluid, velocity of a fluid at a point, Eulerian and Lagrangian method, stream lines and path lines, steady and unsteady flows, velocity potential, rotational and irrotational motions, local and particle rate of change, equation of continuity, examples, acceleration of a fluid at a point, General analysis of fluid motion

Unit 2: **Marks: 12, Contact hrs:15**

Equation of Motion: Euler's equation of motion, Bernoullis equation, steady motion under conservative forces, impulsive motion, circulation, Kelvin's circulation theorem.

Unit :3 **Marks: 8, Contact hrs:15**

General theory of irrotationalmotion : Potential flow, deductions from Green's theorem, kinetic energy of a liquid, uniqueness theorems, Kelvin's minimum energy theorem, Mean value of velocity potential.).

Unit 4: **Marks: 17, Contact hrs:15**

Fluid Pressure**:** Introduction, Fluid Pressure and related theorems, Density and specific gravity, Theorems on fluid pressure under gravity, Rate of variation of pressure, Differential equation of pressure, Condition of equilibrium, Equi-pressure surfaces and lines of force, Curves of equi-pressure and equi-density, Examples.

Unit 5: **Marks: 16, Contact hrs:15**

Resultant Pressure and Centre of Pressure: Resultant fluid pressure and related theorems, Centre of pressure, Determination of centre of pressure of parallelogram, triangle, circle under different conditions, Examples, Thrust on curved surfaces, Examples.

Unit 6: **Marks: 12, Contact hrs:15**

Equilibrium and Stability of Floating Bodies: Condition of equilibrium of floating bodies, Examples, Unstable and Neutral equilibrium, Determination of Meta centre, Examples.

Books Recommended

1. F. Chorlton, Text Books of Fluid Dynamics; CBS Publishers & Distributors, 2005.
2. M. D. Raisinghania, Fluid Dynamics; S. Chand & Company Ltd, 1995.
3. M. Ray and H.S. Sharma, A Text Book of Hydrostatics; S. Chand & Company Ltd, New Delhi, 1989.

Reference Books :1. M. Thomson, Theoretical Hydrodynamics; Macmillan & Co.

DSE3.2 Linear Programming

Total Marks: 100, Theory: 80, IA: 20,

Credit: 5+1=6;

(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- describe various optimization techniques pertaining to linear programming.
- apply linear programming to problems arising out of real life problems.

Unit-1 Marks: 25, Contact hrs: 35

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two- phase method, Big- M method and their comparison.

Unit-2 Marks: 15, Contact hrs: 15

Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual.

Unit-3 Marks: 20, Contact hrs: 20

Transportation problem and its mathematical formulation, northwest- corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit-4 Marks: 20, Contact hrs: 20

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Books Recommended

1. M. S. Bazaraa, J. J. Jarvis and H. D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India,2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore,2009.
3. H. A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice- Hall India, 2006.
4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi,2002.

DSE 3.3 Discrete Mathematics
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course, the students should be able to

- Explain various discrete structures.
- Design graph theoretic models of real life problems.

Unit-1 Marks: 25, Contact hrs:30

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

Unit-2 Marks: 25, Contact hrs: 30

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn- McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Unit-3 Marks: 30, Contact hrs: 30

Definitions, examples and basic properties of graph, pseudographs, cpmplete graphs, bipartite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman′s problem, shortest path, Dijkstra′s algorithm, Floyd-Warshall algorithm

Books Recommended

1. B. A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge,1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory (2^{nd}Edition), Pearson Education (Singapore), Pte. Ltd., Indian Reprint2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra (2^{nd}Edition), Undergraduate Texts in Mathematics, Springer (SIE), Indian Reprint,2004.

DSE3.4 Theory of Equations
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to discuss various properties of algebraic equations, symmetric properties of roots and determination of roots.

Unit-1 Marks: 20, Contact hrs: 25

General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte′s rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

Unit-2 Marks: 20, Contact hrs: 25

Symmetric functions, Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

Unit-3 Marks: 20, Contact hrs: 20

Symmetric functions of the roots, Newton′s theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

Unit-4 Marks: 20, Contact hrs: 20

Separation of the roots of equations, Strums theorem, Applications of Strum′s theorem, Conditions for reality of the roots of an equation and biquadratic. Solution of numerical equations.

Books Recommended

1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press,1954.
2. C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc.,1954.

DSE 3.5 Dynamical Systems
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=3, P=0, T=1)

Objectives: After going through this course the students will be able to

- Discuss the qualitative properties of difference/differential equations.

Unit – 1 Marks : 16, Contact hrs:20

Introduction, A Geometrical way of Thinking, Fixed Points and Stability, Population Growth, Linear Stability Analysis, Existence and Uniqueness Theorem (Statement only), Examples.

Bifurcations, Saddle-Node Bifurcation, Transcritical Bifurcation.

Unit – 2 Marks : 16, Contact hrs:20

Introduction, Investigation of Differential Equations via its Direction Field, Linear Systems, Phase Plane, Classification of Fixed Points of Non-linear Systems by Linearization, Examples.

Unit – 3 Marks : 16, Contact hrs: 20

Limit Cycles, Gradient System, Liapunov Functions, Dulac's Criteria, Poincare-Bendixon Theorem, Lorenz System and its Properties, Chaos, Necessary Condition for Chaos, Examples.

Unit – 4 Marks : 16, Contact hrs:15

Maps and Flow, Composition of Maps, Orbits, Fixed Points, Stable and Unstable Fixed Points, Basin of Attraction and Basin Boundary, Linear Stability Analysis, Cobweb Diagram, Examples.

Unit – 5 Marks : 16, Contact hrs:15

Periodic Point, Periodic Cycles, Stability of Periodic Points and Periodic Cycles, Tent Map, Logistic Map. Properties of Logistic Map. Examples.

Books Recommended

1. Steven H. Strogatz :*Nonlinear Dynamics and Chaos*, Sarat Book Dist, Kolkata, ISBN : 81-87169–85–0
2. G.C. Layek :*An Introduction to Dynamical Systems and Chaos*, Springer, ISBN : 978-81-322-2555-2
3. J. Berry :*Introduction to Non-Linear Systems*, Arnold, Great Britain, ISBN : 0-340-67700-7
4. D. Kaplan and L. Gloss : *Understanding Nonlinear Dynamics*, Springer.

DSE 4.1 Mathematical Methods
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Construct mathematical models or real world problems.
- Solve real world problems through the studied theories.

Unit- 1: **Marks 10,** Contact hrs: 20

Fourier Series : Fourier Series, Dirichlet conditions, Fourier series for even and odd functions Half range Fourier series.

Unit – 2 **Marks 20,** Contact hrs: 15

Laplace Transform: Definition of Laplace transform, Existence theorem for Laplace transform. Linearity property of Laplace transform, Laplace transform of some elementary functions. (algebraic functions, trigonometric functions, exponential functions, hyperbolic functions). First Shifting theorem, Second shifting theorem, Change of scale property, Laplace transform of derivatives, Laplace transform of Integrals.

Unit – 3 **Marks 10,** Contact hrs: 20

Inverse Laplace Transform: Definition of Inverse Laplace Transform, Linearity property, first and second shifting theorems, change of scale, Convolution theorem.

Unit – 4 **Marks 25,** Contact hrs: 20

Fourier Transform, and Inverse Fourier transform: Dirichlet conditions, Definition of Fourier transform, Inverse theorem for Fourier transform, Fourier Sine and Fourier cosine transforms and their inversion formula, Linearity property, change of scale property , shifting property, modulation theorem, convolution theorem.

Unit- 5 **Marks 15,** Contact hrs: 15

Applications of Fourier and Laplace transform: Solution of Boundary value problems and initial value problems in 1-D and 2-D cases. Solution of Laplace and Poisson equations in 2-D cases**.**

Text Book:

1. S Sreennadh, S Ranganatham, M V S S N Prasad, V Ramesh Babu, Fourier series and Integral transform,S. Chand, New Delhi, 2008.

Reference Book :

2. M R Spigel, Theory and Problems of Laplace Transform, Schaum Outline Series. 2018.

DSE 4.2 Boolean Algebra and Automata Theory
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Define a lattice
- identify various lattice properties and apply them to describe switching circuits.

Unit-1 Marks: 15, Contact hrs:15

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

Unit-2 Marks: 15, Contact hrs:15

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn- McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Unit-3 Marks: 15, Contact hrs:15

Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

Unit-4 Marks: 15, Contact hrs:15

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

Unit-5 Marks: 10, Contact hrs: 15

Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence.

Unit-6 Marks: 10, Contact hrs: 15

Undecidability: Recursively enumerable and recursive languages, undecidable problems about Turing machines: halting problem, Post Correspondence Problem, and undecidability problems About CFGs.

Books Recommended

1. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge,1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* (2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint,2004.
4. J. E. Hopcroft, R. Motwani and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation,* 2nd Ed., Addison-Wesley,2001.
5. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, *Elements of the Theory of Computation*, 2nd Ed., Prentice-Hall, NJ,1997.
6. J.A. Anderson, *Automata Theory with Modern Applications*, Cambridge University Press, 2006.

DSE4.3 Probability and Statistics
Total Marks: 100, Theory: 80, IA: 20,
Credit:5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Characterize the statistical techniques.
- Define various statistical distributions and obtain their related properties
- Describe the mathematical theory of probability

Unit-1 Marks: 30, Contact hrs:30

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Unit-2 Marks: 30, Contact hrs:30

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for twovariables.

Unit-3 Marks: 20, Contact hrs:30

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification ofstates.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia,2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia,2006.
3. Sheldon Ross, *Introduction to Probability Models,* 9th Ed., Academic Press, Indian Reprint,2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007

DSE 4.4 Differential Geometry
Total Marks: 100, Theory: 80, IA: 20,
Credit: 5+1=6;
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Describe various properties of space curves, surfaces and Geodesics
- Discuss the properties of algebra and calculus of tensors.

Unit-1 Marks: 15, Contact hrs: 15

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

Unit-2 Marks: 20, Contact hrs:20

Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler′s theorem. Rodrigue′s formula, Conjugate and Asymptotic lines.

Unit-3 Marks: 10, Contact hrs: 15

Developables: Developable associated with space curves and curveson surfaces, Minimal surfaces.

Unit-4 Marks: 15, Contact hrs: 20

Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut′s theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem. Surfaces of constant curvature. Conformal mapping. Geodesic mapping. Tissot′s theorem.

Unit-5 Marks: 20, Contact hrs:20

Tensors: Summation convention and indicial notation, Coordinate transformation and Jacobian, Contra-variant and Covariant vectors, Tensors of different type, Algebra of tensors and contraction, Metric tensor and 3-index Christoffel symbols, Parallel propagation of vectors, Covariant and intrinsic derivatives, Curvature tensor and its properties, Curl, Divergence and Laplacian operators in tensor form, Physical components.

Books Recommended

1. T.J. Willmore, *An Introduction to Differential Geometry*, Dover Publications,2012.
2. B. O'Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press,2006.
3. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Cambridge University Press2003.
4. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications,1988.
5. S. Lang, *Fundamentals of Differential Geometry*, Springer,1999.
6. B. Spain, *Tensor Calculus: A Concise Course*, Dover Publications,2003

SEC-1.1 Logic and Sets

Total Marks: 50, Theory: 40, IA: 10,

Credit: 2;

(L=2, P=0, T=0)

Objectives: After going through this course the students will be able to describe

- Analyze the truth and falsity of a logical statement
- Differentiate between a logical statement and an ordinary statement
- Define and describe various properties ofsets.

Unit-1 Marks: 16, Contact hrs:10

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Unit-2 Marks: 12, Contact hrs: 10

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Unit-3 Marks: 12, Contact hrs: 10

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n-ary relations.

Books Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education,1998.
2. P.R. Halmos, *Naive Set Theory*, Springer,1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers,1950.

SEC-1.2 Computer Graphics
Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: The students will be able to

- Indentify the core concepts of computergraphics
- Apply graphics programming techniques to create and design computer graphics scans

Marks:40, Contact hrs: 30

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices. Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti aliasing. Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended

1. D. Hearn and M.P. Baker, *Computer Graphics,* 2nd Ed., Prentice–Hall of India,2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, *Computer Graphics: Principals and Practices,* 2nd Ed., Addison-Wesley, MA,1990.
3. D.F. Rogers, *Procedural Elements in Computer Graphics,* 2nd Ed., McGraw Hill Book Company,2001.
4. D.F. Rogers and A.J. Admas, *Mathematical Elements in Computer Graphics,* 2nd Ed., McGraw Hill Book Company,1990.

SEC-2.1 Graph Theory
Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: Students should be able to

- Describe the fundamental properties of Graph Theory
- Identify different representations of a Graph for practical applications.

Marks:40, Contact hrs: 30

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi- partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd- Warshall algorithm.

Books Recommended

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge,1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint,2004.

SEC-2.2 Operating System: Linux
Total Marks: 50, Theory: 40, IA: 10,
Credit: 2;
(L=2, P=0, T=0)

Objectives: The students will be able to

- test the linux process model and explain how linux schedule processes and provide inter- process communication
- explore how linux implements files systems and manages input output devices.

Unit-1 Marks: 20, Contact hrs:15

Linux – The Operating System: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, Overview of Linux architecture, Installation, Start up scripts, system processes (an overview), Linux Security, The Ext2 and Ext3 File systems: General Characteristics of, The Ext3 File system, file permissions. User Management: Types of users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools.

Unit-2 Marks: 20, Contact hrs:15

Resource Management in Linux: file and directory management, system calls for files Process Management, Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls for processes, Memory Management, library and system calls for memory.

Books Recommended

1. Arnold Robbins, *Linux Programming by Examples The Fundamentals*, 2nd Ed., Pearson Education,2008.
2. Cox K, *Red Hat Linux Administrator's Guide*, PHI,2009.
3. R. Stevens, *UNIX Network Programming*, 3rd Ed., PHI,2008.
4. Sumitabha Das, *Unix Concepts and Applications*, 4th Ed., TMH,2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, *Linux in a Nutshell*, 6th Ed., O'Reilly Media,2009.
6. Neil Matthew, Richard Stones, Alan Cox, *Beginning Linux Programming*, 3rd Ed.,2004.

GE-1.1 Differential Calculus
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6 (5+1);
(L=5, P=0, T=1)

Objectives: Students will be able to

- differentiate functions
- find tangent normal, curvature, asymptotes etc.

Unit-1 Marks: 30, Contact hrs:30

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz′s theorem, Partial differentiation, Euler′s theorem on homogeneous functions.

Unit-2 Marks: 20, Contact hrs:30

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

Unit-3 Marks: 30, Contact hrs: 30

Rolle′s theorem, Mean Value theorems, Taylor′s theorem with Lagrange′s and Cauchy′s forms of remainder, Taylor′s series, Maclaurin′s series of sin x, cos x, e^x, log(l+x), $(l+x)^m$, Maxima and Minima, Indeterminate forms.

Books Recommended

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc.,2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education,2007.

GE-1.2 Object Oriented Programming in C++
Total Marks: 100, Theory: 60, IA: 20, Prac:20
Credit:6 (4+2);
(L=4, P=4, T=0)

Objectives: After going through this course the students will be able to

- Write C-programmes to solve Mathematical problems.
- Design algorithms to solve problems.

Unit-1 Marks:25, Contact hrs:20

OOP Paradigm: Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Object-based programming languages C++: Brief History of C++,Structure of a C++ program, Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers. Enumeration, Arrays and Pointer.

Unit-2 Marks:10, Contact hrs:20

Implementing oops concepts in C++ Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value, Using Reference variables withFunctions.

Unit-3 Marks: 25, Contact hrs:20

Abstract data types, Class Component, Object & Class, Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers – private, publicand protected. Implementing Class Functions within Class declaration or outside the Class declaration. instantiation of objects, Scope resolution operator, Working with Friend Functions, Using Static Class members. Understanding Compile Time Polymorphism function overloading Rules of Operator Overloading (Unary and Binary) as member function/friend function, Implementation of operator overloading of Arithmetic Operators, Overloading Output/Input,Prefix/ Postfix Increment and decrement Operators, Overloading comparison operators, Assignment, subscript and function call Operator, concepts of namespaces.

Practical to be performed in lab. Books Recommended Marks: 20, Contact hrs:30

1. A. R. Venugopal, Rajkumar, and T. Ravishanker, M*astering C++*, TMH,1997.
2. S. B. Lippman and J. Lajoie, *C++ Primer,* 3rd Ed., Addison Wesley,2000.
3. Bruce Eckel, *Thinking in C++*, 2nd Ed., President, Mindview Inc., Prentice Hall.
4. D. Parasons, *Object Oriented Programming with C++*, BPBPublication.
5. Bjarne Stroustrup ,*The C++ Programming Language*, 3rd Ed., AddisonWelsley.

GE-1.3 Finite Element Methods
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives: Students will be able to

- Describe finite element methods
- Differential equations using finite element methods

Unit-1 Marks: 20, Contact hrs:15

Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares and Galerkin′smethod.Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.

Unit-2 Marks: 12, Contacthrs:15

Applications to solving simple problems of ordinary differential equations.

Unit-3 Marks: 12, Contact hrs:15

Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.

Unit-4 Marks: 12, Contact hrs:15

Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries.

Unit-5 Marks: 12, Contact hrs:15

Interpolation functions, numerical integration, and modeling considerations**.**

Unit-6 Marks: 12,Contact hrs:15

Solution of two dimensional partial differential equations under different Geometric conditions.

Books Recommended

1. J.N. Reddy, *Introduction to the Finite Element Methods*, Tata McGraw-Hill,2003.
2. K.J. Bathe, *Finite Element Procedures*, Prentice-Hall,2001**.**
3. R.D. Cook, D.S. Malkus and M.E. Plesha, *Concepts and Applications of Finite Element Analysis*, John Wiley and Sons,2002.
4. Thomas J.R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover Publication,2000.
5. George R. Buchanan, *Finite Element Analysis*, McGraw Hill,1994.

GE-2.1 Differential Equation
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives: students will be able to describe various methods for solving differential equations.

Unit-1 Marks: 16, Contact hrs:15
First order exact differential equations. Integrating factors, rules to find an integrating factor.

Unit-2 Marks: 20, Contact hrs:20
First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.

Unit-3 Marks: 16, Contact hrs:20
Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Unit-4 Marks: 16, Contact hrs: 20
Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange′s method, Charpit′s method.

Unit-5 Marks: 12, Contact hrs:15
Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Books Recommended

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons,1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition,1967.

GE-2.2 Econometrics
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives: After going through this course the students should be able to design models and solve problems related to Economic issues.

Unit-1 Marks: 16, Contact hrs: 20

Statistical Concepts Normal distribution; chi-square, t and F-distributions; estimation of parameters; properties of estimators; testing of hypotheses: defining statistical hypotheses; distributions of test statistics; testing hypotheses related to population parameters; Type I and Type II errors; power of a test; tests for comparing parameters from two samples.

Unit-2 Marks: 16, Contact hrs: 20

Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem;forecasting.

Unit-3 Marks: 16, Contact hrs: 20

Multiple Linear Regression Model Estimation of parameters; properties of OLS estimators; goodness of fit - R2 and adjusted R2 ; partial regression coefficients; testing hypotheses – individual and joint; functional forms of regression models; qualitative (dummy) independent variables.

Unit-4 Marks: 16, Contact hrs:15

Violations of Classical Assumptions: Consequences, Detection and Remedies Multicollinearity; heteroscedasticity; serial correlation.

Unit-5 Marks: 16, Contact hrs:15

Specification Analysis Omission of a relevant variable; inclusion of irrelevant variable; tests of specification errors.

Books Recommended

1. Jay L. Devore, *Probability and Statistics for Engineers*, Cengage Learning,2010.
2. John E. Freund, *Mathematical Statistics*, Prentice Hall,1992.
3. Richard J. Larsen and Morris L. Marx, *An Introduction to Mathematical Statistics and its Applications,* Prentice Hall,2011.
4. D. N. Gujarati and D.C. Porter, *Essentials of Econometrics*, McGraw Hill, 4th Ed., International Edition,2009.
5. Christopher Dougherty, *Introduction to Econometrics*, Oxford University Press, 3rd Ed., Indian edition,2007.

GE-3.1 Real Analysis
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Analyse the properties of the number line
- Describe various analytical properties of the real number system

Unit-1 Marks: 20, Contact hrs:30

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Unit-2 Marks: 20, Contact hrs:20

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy′s theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Unit-3 Marks: 20, Contact hrs:20

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz′s test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

Unit-4 Marks: 20, Contact hrs:20

Sequences and series of functions, Pointwise and uniform convergence. Mn-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

Books Recommended

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd.,2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis,* John Wiley and Sons (Asia) P.Ltd.,2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag,1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series*- Undergraduate Texts in Mathematics, Springer Verlag,2003.

GE3.2 Cryptography and Network Security
Total Marks:100, Theory: 80, IA: 20,
Credit: 6(5+1)
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Discuss the principles of Cryptography
- Explain various ways of attacks in complex networks.
- Explain the structure and organization of the complex network.

Unit-1 Marks: 24, Contact hrs: 30

Public Key Cryptography Principles & Applications, Algorithms: RSA, Message Authentication: One way Hash Functions: Message Digest, MD5, SHA1. Public Key Infrastructure: Digital Signatures, Digital Certificates, Certificate Authorities.

Unit-2 Marks: 24, Contact hrs: 30

Network Attacks: Buffer Overflow, IP Spoofing, TCP Session Hijacking, Sequence Guessing, Network Scanning: ICMP, TCP sweeps, Basic Port Scans; Denial of Service Attacks: SYN Flood, Teardrop attacks, land, Smurf Attacks.IP security Architecture: Overview, Authentication header, Encapsulating Security Pay Load, combining Security Associations, Key Management. Virtual Private Network Technology: Tunneling using IPSEC.

Unit-3 Marks: 32, Contact hrs: 30

Requirements, Secure Socket Layer, and Secure Electronic Transactions, Network Management Security: Overview of SNMP Architecture- SNMPV1, SNMPV3.Firewall Characteristics & Design Principles, Types of Firewalls: Packet Filtering Router, Application Level Gateway or Proxy, Content Filters, Bastion Host.

Books Recommended

1. W. Stallings, *Networks Security Essentials: Application & Standards,* Pearson Education, 2000.
2. Behrouz A. Forouzan, *Data Communication and Networking*, Tata McGrawHill, 2007.
3. W. Stallings, *Cryptography and Network Security, Principles and Practice*, Pearson Education,2000.

GE 3.3 Information Security
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives: After going through this course the students will be able to

- Describe security issues and data integrity

Unit-1 Marks: 16, Contact hrs:15

Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication, Orange Book.

Unit-2 Marks: 20, Contact hrs:20

Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats- intruders; communication threats- tapping and piracy.

Unit-3 Marks: 16, Contact hrs:20

Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie- Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.

Unit-4 Marks: 16, Contact hrs:20

Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures.

Unit-5 Marks: 12, Contact hrs:15

Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

Books Recommended

1. W. Stallings, *Cryptography and Network Security Principles and Practices,* 4th Ed., Prentice-Hall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing ,*3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security*, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security,* Springer- Verlag Berlin, 2003.
5. J.M. Kizza, *Computer Network Security*, Springer,2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices,* Pearson Education,2006.

GE-4.1 Algebra
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives:: After going through this course the students will be able to

- Describe various algebraic structures onsets
- Identify the algebraic structures present in different branches ofSciences

Unit-1 Marks: 28, Contact hrs:30

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn ofintegers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn(n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.

Unit-2 Marks: 28, Contact hrs:30

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange′s theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Unit-3 Marks: 24, Contact hrs: 30

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rationalfunctions.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson,2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson,2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa,1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation,1984.

GE-4.2 Applications of Algebra
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives: After going through this course you will be able to

- Explain various algebraic structure
- Solve system of linear equations.

Unit-1 Marks: 16, Contact hrs: 15

Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields.

Unit-2 Marks: 16, Contact hrs:15

Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.

Unit-3 Marks:16, Contact hrs:20

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphicgraphs.

Unit-4 Marks: 16, Contact hrs:20

Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius-König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of apositive semi- definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

Unit-5 Marks: 16, Contact hrs:20

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an m×n matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

Books Recommended

1. I. N. Herstein and D. J. Winter, *Primer on Linear Algebra*, Macmillan Publishing Company, New York,1990.
2. S. R. Nagpaul and S. K. Jain, *Topics in Applied Abstract Algebra*, Thomson Brooks and Cole, Belmont,2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press LLC, Boca Raton,2000.
4. David C. Lay, *Linear Algebra and its Applications.* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang, *Matrix theory*, Springer-Verlag New York, Inc., New York,1999.

GE4.3 Combinatorial Mathematics
Total Marks: 100, Theory: 80, IA: 20,
Credit: 6(5+1);
(L=5, P=0, T=1)

Objectives: After going through this course you will be able to

- Use combinatorial approach in solving algebraic problems
- Explain counting principles.

Unit-1 Marks: 12, Contact hrs:15

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers

Unit-2 Marks:10, Contact hrs:15

Principle of Inclusion and Exclusion, Derangements, Inversion formulae

Unit-3 Marks: 12, Contact hrs:15

Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.

Unit-4 Marks: 10, Contact hrs:15

Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.

Unit-5 Marks: 12,, Contact hrs:10

Integer partitions, Systems of distinct representatives.

Unit-6 Marks: 12, Contact hrs:10

Polya theory of counting: Necklace problem and Burnside′s lemma, Cyclic index of a permutation group, Polya′s theorems and their immediate applications.

Unit-7 Marks: 12, Contact hrs:10

Latin squares, Hadamard matrices, Combinatorial designs: *t* designs, BIBDs, Symmetric designs.

Books Recommended

1. J.H. van Lint and R.M. Wilson, *A Course in Combinatorics*, 2nd Ed., Cambridge University Press,2001.
2. V. Krishnamurthy, *Combinatorics, Theory and Application*, Affiliated East-West Press 1985.
3. P.J. Cameron, *Combinatorics, Topics, Techniques, Algorithms*, Cambridge University Press, 1995.
4. M. Jr. Hall, *Combinatorial Theory*, 2nd Ed., John Wiley & Sons, 1986.
5. S.S. Sane, *Combinatorial Techniques*, Hindustan Book Agency, 2013.
6. R.A. Brualdi, *Introductory Combinatorics*, 5th Ed., Pearson Education Inc., 2009.