Siddaganga Institute of Technology, Tumkur – 572 103

(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belgaum)

Engineering Mathematics-I (Common to all branches)

Contact Hours/ Week	**3(L)+2(T)**	**Credits**	**4**
Total Lecture Hours	**40**	**CIE Marks**	**50**
Total Tutorial Hours	**20**	**SEE Marks**	**50**
Sub Code	**1RMAT1**	**Semester**	**I**

Prerequisites: Basics in differential calculus, Integral calculus and vectors.

Course Learning Objectives: This course will enable students to master the basic tools of differential and vector calculus, infinite series and differential equations and become skilled for solving problems in **s**cience and engineering.

Course objectives: This course will enable students to:

1. Known the behavior of the polar curve and its application.
2. Handle the indeterminate form; determine the extremities of functions of two variables.
3. Learn how the vectors govern the physical models.
4. Understand the behavior of the infinite series.
5. Known how the real word problems governed by the first order differential equations.

Course outcomes: After the completion of this course, students will be able to:

1. Apply the knowledge of calculus to solve problems related to polar curves and its applications in determining the bentness of the curve. **(L1& L2)**
2. Learn the notation of partial differentiation to calculate rates of change of multivariate functions and solve problems related to composite functions and applications. **(L1& L2)**
3. Illustrate the applications of multivariate calculus to understand the characteristics of vector field.
4. **(L1& L2)**
5. Describe the convergence and divergence of infinite series and understand how a function of single variable can be expanded as a Taylor's series. **(L1& L2)**
6. Apply the analytical methods to solve first order and first degree differential equations and solve some Engineering problems. **(L1& L2)**

UNIT-I: Differential Calculus-I: **(8+4) Hours**

Polar curves: angle between the radius vector and tangent, angle of intersection of polar curves. Pedal equation for polar curves. Curvature and radius of curvature -Cartesian and pedal forms. (Without proof)

UNIT – II: Differential Calculus –II: **(8+4) Hours**

Indeterminate forms L' Hospital Rule (without proof), Partial differentiation: Partial derivatives, Total derivatives-differentiation of composite functions. Maxima and minima for a function two variables, Method of Lagrange's Multipliers with one subsidiary condition- Applications of maxima and minima with illustrative examples.

UNIT – III: Vector Calculus: **(8+4) Hours**

Vector Differentiation: scalar and vector fields, Gradient, directional derivative, divergence, curl-physical interpretation; solenoidal and irrotational vector fields-illustrative problems.

UNIT-IV: Infinite Series: **(8+4) Hours**

Convergence and divergence of infinite series-p-series test, comparison test, Cauchy's root test and D'Alembert's ratio test, Raabe's test (without proof)-Illustrative examples. Taylor's and Maclaurin's series expansions for one variable (statement only).

UNIT-V: Differential Equations-I: **(8+4) Hours**

Solution of first order and first degree differential equations: Linear differential equations and Bernoulli's equation. Exact differential equations. Applications: Orthogonal trajectories (Cartesian form), Newton's law of cooling, flow of electricity, law of decay and growth.

Text Books:

1. Erwin Kreyzig, "Advanced Engineering Mathematics", 10th edition, Wiley Publications, 2016.
2. B. S. Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.

Reference Books:

1. Maurice D. Weir, Joel R. Hass and George B. Thomas, "Thomas' calculus**:** Early Transcendentals", 12th edition, Pearson Education, 2016
2. Ramana .B.V, **"**Higher Engineering Mathematics"**,** 11th edition**,** Tata-McGraw Hill. 2010
3. C.Ray Wylie, Louis. C. Barrett "Advanced Engineering Mathematics", 6th edition, Tata-McGraw Hill 2005.
4. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd edition, McGraw Hill, 2014.
5. Peter V.o 'Neil, "Advanced Engineering Mathematics", 7th edition, CENGAGE Learning India Pvt. Ltd. Publishers, 2012.

Siddaganga Institute of Technology, Tumkur – 572 103

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Engineering Mathematics-II (Common to all branches)

Contact Hours/ Week	**3(L)+2(T)**	**Credits**	**4**
Total Lecture Hours	**40**	**CIE Marks**	**50**
Total Tutorial Hours	**20**	**SEE Marks**	**50**
Sub Code	**2RMAT1**	**Semester**	**II**

Prerequisites: Basics in differential calculus, Integral calculus and vectors.

Course Learning Objectives: This course will facilitate the students with concrete foundation of ordinary differential equations, Laplace transforms, Integral calculus and numerical methods enabling them to acquire the knowledge of these mathematical tools.

Course objectives: This course will enable students to:

1. Solve second and higher order differential equations.
2. Find the Laplace transform of the function f(t).
3. Find the Inverse Laplace transform of the function F(s).
4. Solve the integral by using standard integrals (Beta and Gamma) and multiple integrals.
5. Apply the knowledge of numerical methods in the models of various physical and engineering phenomena.

Course outcomes: After the completion of this course, students will be able to:

1. Explain various physical models through higher order differential equations and solve such linear ordinary differential equations. **(L1& L2)**
2. Understand the concept of Laplace transform and obtain Laplace transform of periodic functions and unit step functions. **(L1& L2)**
3. Apply the concept of Laplace transform in solving Linear Differential equations. **(L1& L2)**
4. Apply the concept of change of order of integration and change of variables to evaluate multiple integrals and their usage in computing the area and volume. **(L1& L2)**
5. Apply the Numerical methods to solve Algebraic and transcendental equations and find the polynomials by finite difference method. **(L1& L2)**

UNIT-I: Linear Differential Equations: (8+4) Hours

Solution of second and higher order equations with constant coefficients by inverse differential operator method, method of variation of parameters, solution of Cauchy's and Legendre's Linear differential equations. Engineering applications: oscillation of simple pendulum and spring, LCR circuits.

UNIT – II: Laplace Transform: (8+4) Hours

Definition, Transforms of elementary functions, properties of Laplace Transform, Laplace Transform of $t^n f(t)$, $\frac{1}{t} f(t)$, derivatives and Integrals. Laplace Transform of Periodic functions, unit step function.

UNIT-III: Inverse Laplace Transform: (8+4) Hours

Inverse Laplace Transform, Convolution theorem (without proof) and problems. Applications –Solution of Linear differential equations using Laplace Transform.

UNIT-IV: Integral Calculus: **(8+4) Hours**

Reduction formulae for the integrals of $sin^n x$, $cos^n x$, $sin^m x \, cos^n x$, and evaluation of these integrals with standard limits-problems. **Beta and Gamma functions**: Definition, relation between Beta and Gamma functions and simple problems.

Multiple integrals –Evaluation of double and triple Integrals, evaluation of Double integrals- change of order of integration, Jacobians and change of variables. Applications to find area and volume.

UNIT-V: Elementary Numerical Methods **(8+4) Hours**

Finite differences. Interpolation/extrapolation using Newton's forward and backward difference formulae, Newton's divided difference and Lagrange's formulae (All formulae without proof). Solution of polynomial and transcendental equations - Newton-Raphson method (only formula) – Illustrative examples.

Text Books:

1. Erwin Kreyzig, "Advanced Engineering Mathematics", 10th edition, Wiley Publications, 2016.
2. B. S. Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.

Reference Books:

1. Maurice D. Weir, Joel R. Hass and George B. Thomas, "Thomas' calculus**:** Early Transcendentals", 12th edition, Pearson Education, 2016
2. Ramana .B.V, **"**Higher Engineering Mathematics"**,** 11th edition**,** Tata-McGraw Hill. 2010
3. C.Ray Wylie, Louis. C. Barrett "Advanced Engineering Mathematics", 6th edition, Tata-McGraw Hill 2005.
4. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd edition, McGraw Hill, 2014.
5. Peter V.o 'Neil, "Advanced Engineering Mathematics", 7th edition, CENGAGE Learning India Pvt. Ltd. Publishers, 2012.

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(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belgaum)

Engineering Mathematics– III (EC, TC, EE, IT)

Contact Hours/ Week	4 (L)	**Credits**	**4**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	3RMAT3A	**Semester**	**III**

Prerequisites: Engineering Mathematics-I and Engineering Mathematics-II.

Course objective:

1. To introduce the concept of analytic function, transformation for mapping.
2. The concept of complex variables to evaluate the integrals.
3. Introduce partial differential equations, use separation of variable method to solve wave, heat and Laplace equations.
4. Introduction of Finite difference approximation to derivatives to partial differential equations.
5. To represent a periodic signal as an infinite sum of sine wave components.

Course Outcomes:

Upon completion of this course the student will be able to:

1. Apply basic mathematical operations on complex numbers in Cartesian and polar forms. Determine continuity/differentiability/analyticity of a function and find the derivative of a function. Identify the transformation (L3,L1)
2. Evaluate a contour integral using Cauchy's integral formula. Compute singularities and also the residues(L3).
3. Formulate and solve partial differential equations. Use of separation of variable method to solve wave, heat and Laplace equations (L4).
4. Compute the numerical solution of partial differential equations (L4).
5. Represent a periodic function as a Fourier series. Compute the Fourier coefficients numerically(L3).

UNIT-I :Complex Variables **12 Hours**

Functions of complex variable, Definition of Limit, Continuity, Differentiability. Analytic functions, Cauchy's-Reimann equation in Cartesian and polar forms (Statement only), Properties of analytic functions (Statement only). Geometrical representation of $f(z)=w$, Conformal transformation: $w=e^z$, $w=z+\frac{1}{z}$, $w=z^2$, $w=\cosh z$.

UNIT-II: Complex Integration 9 **Hours**

Bilinear transformation, Properties, Complex integration, Cauchy's theorem (statement only), Converse of Cauchy's theorem, Cauchy's integral formula (statement only), zeros & singularities of an analytic function, residues, residues theorem, calculation of residues.

UNIT – III : Partial differential equations (P.D.E.) **11 Hours**

Formation of Partial Differential Equation, Solution of Langrange's Linear P.D.E. of the type Pp+Qq=R. Method of Separation of Variables. **Applications of P.D.E.:** Classification of PDE, Solution of one dimensional heat, wave and two dimensional Laplace's equations by the method of separation of variables.

UNIT-IV :Numerical Solutions to the Partial differential equations **10 Hours**

Introduction, Finite difference approximation to derivatives, Elliptic equations, Solution of Laplace's equations, Parabolic equations, Solution of heat equation, Hyperbolic equations, Solution of wave equation.

UNIT – V:Fourier Series **10 Hours**
Periodic functions, Fourier Expansions, Half Range Expansions, Complex form of Fourier series, Practical Harmonic Analysis.

Text Book:

1. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.

Reference Books:

1. Ramana .B.V, **"**Higher Engineering Mathematics"**,** latest edition, Tata-McGraw Hill, 2016
2. Erwin Kreyszig, "Advanced Engineering Mathematics" , 10th edition, Wiley Publications, 2015.
3. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics", 6th edition, Tata-McGraw Hill 2005.
4. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd edition, McGraw Hill,2014.

(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belgaum)

Engineering Mathematics– III (Civil, Mech., IEM)

Contact Hours/ Week	4 (L)	**Credits**	**4**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	3RMAT3B	**Semester**	**III**

Prerequisites: Engineering Mathematics-I and Engineering Mathematics-II.

Course objectives:

1. To introduce the concept of analytic function, transformation for mapping.
2. To introduce the concept of complex variables to evaluate the integrals
3. To introduce the concept of partial differential equations, use separation of variable method to solve wave, heat and Laplace equations.
4. To make the student to solve system of linear equations, carryout matrix operations, determine the eigen values & eigenvectors.
5. To find optimal solutions to engineering problems whose optimum may be a certain quantity, shape and function..

Course Outcomes:

Upon completion of this course the student will be able to:

1. Apply basic mathematical operations on complex numbers in Cartesian and polar forms. Determine continuity/differentiability/analyticity of a function and find the derivative of a function. Identify the transformation (L3,L1)
2. Evaluate a contour integral using Cauchy’s integral formula. Compute singularities and also the residues (L3).
3. Formulate and solve partial differential equations. Use of separation of variable method to solve wave, heat and Laplace equations(L4).
4. Represent a periodic function as a Fourier series. Determine the Fourier transform of a given function(L3).
5. Compute extreme values of a variational problems like geodesics, least time and shortest path(L3).

UNIT-I : Complex Variables **12 Hours**

Functions of complex variable, Definition of Limit, Continuity, Differentiability. Analytic functions, Cauchy’s-Reimann equation in Cartesian and polar forms (Statement only), Properties of analytic functions(Statement only). Geometrical representation $f(z)=w$, Conformal transformation: $w=e^z$, $w=z+\frac{1}{z}$, $w=z^2$, $w=\cosh z$.

UNIT-II: Complex Integration **10 Hours**

Bilinear transformation, Properties, Complex integration, Cauchy’s theorem (statement only), Converse of Cauchy’s theorem, Cauchy’s integral formula (statement only), zeros & singularities of an analytic function, residues, residues theorem, calculation of residues.

UNIT – III: Partial differential equations (P.D.E.) **10 Hours**

Formation of Partial Differential Equation, Solution of Langrange’s Linear P.D.E. of the type Pp+Qq=R. Method of Separation of Variables. **Applications of P.D.E.:** Classification of PDE, solution of one dimensional heat wave and two dimensional Laplace’s equation by the method of separation of variables.

UNIT – IV : Linear Algebra: **10 Hours**

System of linear equations, Row operations, Echelon form Reduced Echelon form, Solution of Homogeneous and Nonhomogeneous equations, vector equations, Linear combinations, Linear independent/dependent vectors, Eigen values, Eigen vectors, Diagonalizations.

UNIT-V :Calculus of Variation **10 Hours**

Variation of a function and a functional, Extremal of a functional, Variational problems, Euler's equation, Standard Variational problems including geodesics, Minimal surface of revolution, hanging chain and Brachistrochrone problem.

Text Book:

1. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.
2. David C. Lay, "Linear algebra and its applications", 5th edition, Pearson Education, 2014.

Reference Books:

1. Ramana .B.V, **"**Higher Engineering Mathematics"**,** latest edition, Tata-McGraw Hill, 2016
2. Erwin Kreyszig, "Advanced Engineering Mathematics" , 10th edition, Wiley Publications, 2015.
3. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics", 6th edition, Tata-McGraw Hill 2005.
4. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd edition, McGraw Hill, 2014.

Mathematical Concepts for Information Technology (CSE, ISE)

Contact Hours/ Week	4 (L)	**Credits**	**4**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	3RMAT3C	**Semester**	**III**

Prerequisites: Engineering Mathematics-I and Engineering Mathematics-II.

Course objectives:

1. To introduce the concept of analytic function, transformation for mapping.
2. To introduce the concept of complex variables to evaluate the integrals
3. To introduce the concept of partial differential equations, use separation of variable method to solve wave, heat and Laplace equations.
4. To develop and conduct appropriate experimentation ,analyze and interpret data and use engineering judgment to draw conclusion.
5. To introduce the basic concepts and applications of probability in engineering .

Course Outcomes:

Upon completion of this course the student will be able to:

1. Apply basic mathematical operations on complex numbers in Cartesian and polar forms. Determine continuity/differentiability/analyticity of a function and find the derivative of a function. Identify the transformation (L3,L1)
2. Evaluate a contour integral using Cauchy's integral formula. Compute singularities and also the residues (L3).
3. Formulate and solve partial differential equations. Use of separation of variable method to solve wave, heat and Laplace equations (L4).
4. Apply least square method to fit a curve for the given data and evaluate the correlation coefficient and regression lines for the data (L3)
5. Determine the nature of the events and hence calculate the appropriate probabilities of the events (L3).

UNIT-I : Complex Variables **12 Hours**

Functions of complex variable, Definition of Limit, Continuity, Differentiability. Analytic functions, Cauchy's-Reimann equation in Cartesian and polar forms (Statement only), Properties of analytic functions (Statement only). Geometrical representation $f(z)=w$, Conformal transformation: $w=e^z$, $w=z+\frac{1}{z}$, $w=z^2$, $w=\cosh z$.

UNIT-II :Complex Integration **10 Hours**

Bilinear transformation, Properties, Complex integration, Cauchy's theorem (statement only), Converse of Cauchy's theorem, Cauchy's integral formula (statement only), zeros & singularities of an analytic function, residues, residues theorem, calculation of residues.

UNIT – III : Partial differential equations (P.D.E.) **10 Hours**

Formation of Partial Differential Equation, Solution of Langrange's Linear P.D.E. of the type Pp+Qq=R. Method of Separation of Variables. **Applications of P.D.E.:** Classification of PDE, solution of one dimensional heat wave and two dimensional Laplace's equation by the method of separation of variables.

UNIT-IV : Statistics **10 Hours**

Introduction, Definitions, Curve Fitting, equation of Straight line, parabola and exponential, correlation and regression, formula for correlation coefficient, regression lines and angle between the regression lines.

UNIT-V : Probability Theory **10 Hours** Basic terminology, Definition of probability, Probability and set notations, Addition law of probability, independent events, conditional probability, multiplication law of probability, Baye's theorem.

Text Book:

1. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.

Reference Books:

1. Ramana .B.V, **"**Higher Engineering Mathematics"**,** latest edition, Tata-McGraw Hill, 2016
2. Erwin Kreyszig, "Advanced Engineering Mathematics" , 10th edition, Wiley Publications, 2015.
3. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics", 6th edition, Tata-McGraw Hill 2005.
4. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd edition, McGraw Hill 2014.

Siddaganga Institute of Technology, Tumkur – 572 103

(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belgaum)

Engineering Mathematics – III (Chem, BT)

Contact Hours/ Week	4 (L)	**Credits**	**4**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	3RMAT3D	**Semester**	**III**

Prerequisites: Engineering Mathematics-I and Engineering Mathematics-II.

Course objectives:

1. To introduce the concept of analytic function, transformation for mapping.
2. To introduce the concept of complex variables to evaluate the integrals
3. To introduce the concept of partial differential equations, use separation of variable method to solve wave, heat and Laplace equations.
4. To make the student to apply the numerical methods to solve algebraic and transcendental equations.
5. To Solve the system of equation analytically and numerically .

Course Outcomes:

Upon completion of this course the student will be able to:

1. Apply basic mathematical operations on complex numbers in Cartesian and polar forms. Determine continuity/differentiability/analyticity of a function and find the derivative of a function. Identify the transformation (L3,L1)
2. Evaluate a contour integral using Cauchy's integral formula. Compute singularities and also the residues(L3).
3. Formulate and solve partial differential equations. Use of separation of variable method to solve wave, heat and Laplace equations(L4).
4. Compute the roots of an algebraic or transcendental equations (L3).
5. Solve the system of equation analytically and numerically (L3).

UNIT-I :Complex Variables **12 Hours**

Functions of complex variable, Definition of Limit, Continuity, Differentiability. Analytic functions, Cauchy's-Reimann equation in Cartesian and polar forms (Statement only), Properties of analytic functions. Geometrical representation $f(z)=w$, Conformal transformation: $w=e^z$, $w=z+\frac{1}{z}$, $w=z^2$, $w=\cosh z$.

UNIT-II :Complex Integration 9 **Hours**

Bilinear transformation, Properties, Complex integration, Cauchy's theorem (statement only), Converse of Cauchy's theorem, Cauchy's integral formula (statement only), zeros & singularities of an analytic function, residues, residues theorem, calculation of residues.

UNIT – III :Partial differential equations (P.D.E.) **11 Hours**

Formation of Partial Differential Equation, Solution of Langrange's Linear P.D.E. of the type Pp+Qq=R. Method of Separation of Variables. **Applications of P.D.E.:** Classification of PDE, solution of one dimensional heat wave and two dimensional Laplace's equation by the method of separation of variables.

UNIT – IV :Roots of equation **10 Hours**

Introduction, Bracketing methods – Bisection & Regula-falsi methods. Open methods – Secant method, Newton-Raphson method, multiple roots, Muller's method.

UNIT – V :System of linear algebraic equations **10 Hours**

Rank of a matrix by echelon form, Consistency of a system of linear equations, Gauss elimination method, Gauss-Jordan method. Iterative methods - Jacobi, Gauss-Seidel iterative methods.

Text Books:

1. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.
2. B.S.Grewal, "Numerical Methods", 43rd edition, Khanna Publications, 2014.

Reference Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics" , 10th edition, Wiley Publications, 2015.
2. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics", 6th edition, Tata-McGraw Hill 2005.
3. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd edition, McGraw Hill, 2014.

Siddaganga Institute of Technology, Tumkur – 572 103

(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belgaum)

Discrete Mathematical Structures (CSE/ISE)

Contact Hours/ Week	3 (L)	**Credits**	**3.5**
Total Lecture Hours	**39**	**CIE Marks**	**50**
Total Tutorial Hours	**13**	**SEE Marks**	**50**
Sub Code	3RCCI01	**Semester**	**III**

Prerequisites: Set Theory.

Course objectives:

1. To identify the domain and range of a relation and its properties, use function notation and evaluate function.
2. To understand the mathematical application of symmetry to an object to obtain knowledge of its physical properties
3. To identify and apply various properties of and relating to the integers including the well-ordering principle, prime, unique factorization , the division algorithm and greatest common divisor.
4. To compute multiplication inverse, expressing the whole in parts and test of primitive.
5. To study the theory of Boolean algebra and to representation of switching functions using Boolean expressions and their minimization technique. .

Course Outcomes:

Upon completion of this course the student will be able to:

1. Derive logical implications and equivalences using laws of logic, describe use quantifiers and prove given statement in different ways (L1, L2).
2. Compute zero-one matrix, composition of relations and draw Hasse diagram (L3).
3. Explain the concept of groups, subgroup, Abelian group and derive Lagrange's theorem in groups (L2).
4. Determine gcd by different methods and represent gcd as a linear combination. Euclidean algorithm and its applications(L3).
5. Perform congruence arithmetic. Compute inverse mod p using different methods and know the existence of primitive roots (L3).

UNIT-I: Relations and Function **8 Hours**

Cartesian product and Relations, Properties of Relations, function, types of function, Computer Recognition-Zero-One Matrices and Digraphs, Partial order relation -Poset and Hasse-Diagrams, Equivalence Relation and Partitions, Extremal elements of a Poset, Lattice.

UNIT-II: Groups **8 Hours**

Binary Operations and Properties, Definition of a Group, Examples and Elementary properties, Abelian Groups, Homomorphism, Isomorphism and Cyclic Groups, Cosets and Lagrange's Thoerem, Normal subgroups.

UNIT- III: Number Theory – Divisibility Theory in Integers **8 Hours**

Introduction, The division algorithm, greatest common divisor, Euclidean Algorithm, The Diophantine equation ax + by = c, Fundamental theorem of arithmetic, The Goldbach conjecture.

UNIT-IV: The Theory of congruences **8 Hours**

Basic properties of congruences, Binary and decimal representation of integers, Chinese remainder theorem, Fermat's Theorem, Wilson Theorem, The Fermat-Kraitchik Factorization method.

UNIT-V: Boolean Algebra and Switching Functions: **7 Hours**

Switching functions: Disjunctive and conjunctive normal forms. Structure of Boolean Algebra.

Text Books:

1. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics", 5^{th} Edition, *Pearson Education*, 2012.
2. Bernard Kolman, Robert Busby and Sharon C. Ross, "Discrete Mathematical Structures", 6^{th} edition, Pearson Education, 2012.
3. David M Burton, "Elementary Number Theory", 7^{th} Edition, McGraw Hill Education, 2013.

Reference Books:

1. Kenneth H. Rosen, "Discrete Mathematical and its Applications", Tata-McGrawHill, 7^{th} Edition-2011.
2. J.P.Tremblay and R. Manohar, "Discrete Mathematical Structures with Applications to computer science", Tata-McGraw Hill, 2010.
3. M. Ram Murthy and Jody Esmonde, "Problems in Algebraic number theory", Springer, 2006.
4. Erwin Kreyszig, "Advanced Engineering Mathematics" , 10^{th} edition, Wiley Publications, 2015.

Siddaganga Institute of Technology, Tumkur – 572 103

(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belgaum)

Statistics and Probability for Engineering
(ALL BRANCHES EXCEPT CS,IS,BT)

Contact Hours/ Week	4 (L)	**Credits**	**4**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	4RMAT3	**Semester**	**IV**

Prerequisites: Engineering Mathematics-III

Course objectives:

1. To develop and conduct appropriate experimentation ,analyze and interpret data and use engineering judgment to draw conclusion.
2. To introduce the basic concepts and applications of probability in engineering .
3. To provide the knowledge about the random variable, random process and how to model the random processes in engineering.
4. To deal with multiple random variables and introduction of the most important types of stochastic processes.
5. To investigate the variability in sample statistics from sample to sample, measure of central tendency & dispersion of sample statistics and pattern of variability of sample.

Course Outcomes:

Upon completion of this course the student will be able to:

1. Apply least square method to fit a curve for the given data and evaluate the correlation coefficient and regression lines for the data (L3).
2. Analyse the nature of the events and hence determine the appropriate probabilities of the events (L3).
3. Classify the random variables to determine the appropriate probability distributions (L2).
4. Determine the joint probability distribution, its mean, variance and covariance and calculate the transition matrix and fixed probability vector for a given Markov chain (L3).
5. Estimate the parameter of a population, important role of normal distribution as a sampling distribution (L2).

UNIT-I : Statistics **10 Hours**

Introduction, Definitions, Curve Fitting: Straight line, parabola and exponential curves. Correlation and regression, formula for correlation coefficient, regression lines and angle between the regression lines.

UNIT-II :Probability **10 Hours**

Basic terminology, Definition of probability, Probability and set notations, Addition law of probability, independent events, conditional probability, multiplication law of probability, Baye's theorem.

UNIT-III :Random Variable **10 Hours**

Discrete Probability distribution, Continuous Probability distribution, expectation, Variance, Moments, Moment generating function, Probability generating function, Binomial distribution, Poisson distribution, Normal distribution and Exponential distributions.

UNIT-IV :Joint Probability **11 Hours**

Joint probability distribution, Discrete and independent random variables, Expectation, Covariance, Correlation coefficient. Probability vectors, stochastic matrices, fixed point matrices, Regular stochastic matrices, Markov chains, Higher transition-probabilities, stationary distribution of regular markov chains and absorbing states.

UNIT-V: Sampling Distribution **11 Hours**

Introduction, Objectives, sampling distribution, testing of hypothesis, level of significance, confidence limits, simple sampling of attributes, test of significance of large samples, comparison of large samples, sampling of variables, central limit theorem, confidence limits for unknown mean, test of significance for means of two large samples, Sampling of variables – small samples , Student's t-distribution.

Text Books:

1. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.
2. Ramana .B.V, **"**Higher Engineering Mathematics"**,** latest edition, Tata-McGraw Hill, 2016

Reference Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics" , 10th edition, Wiley Publications, 2015.
2. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics", 6th Edition, Tata-McGraw Hill 2005.
3. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd Edition, McGraw Hill, 2014.

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Probability and its Applications for Information Technology (CSE/ISE)

Contact Hours/ Week	4 (L)	**Credits**	**4**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	4RMAT4	**Semester**	**IV**

Prerequisites: Engineering Mathematics-III

Course objectives:

1. To provide the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.
2. To introduce the concept of a probability density function of a continuous random variable.
3. To deal with multiple random variables and introduction of the most important types of stochastic processes.
4. To investigate the variability in sample statistics from sample to sample, measure of central tendency & dispersion of sample statistics and pattern of variability of sample.
4. To understand the fundamentals of coding theory, concept of source coding and channel coding theorem.

Outcomes:

Upon completion of this course the student will be able to:

1. Identify a random variable as discrete and appropriate probability distribution, its statistical parameters(L1).
2. Identify a random variable as continuous and appropriate probability distribution, its statistical parameters (L1).
3. Determine the joint probability distribution, its mean, variance and covariance and calculate the transition matrix, fixed probability vector for a given Markov chain(L3).
4. Estimate the parameter of a population, important role of normal distribution as a sampling distribution(L2).
5. Apply concepts of probability in information theory and coding (L3).

Unit I: Analysis of Discrete Random Variables **11 Hours**

Discrete random variables, probability distribution and probability mass function, cumulative distributive functions, mean and variance of discrete random variable, discrete uniform distribution, binomial distribution, geometric distribution, negative binomial distribution and Poisson distribution.

Unit II: Analysis of Continuous Random Variables **9 Hours**

Continuous random variable, probability distribution and probability density function, cumulative distributive functions, mean and variance of continuous random variable, continuous uniform distribution, exponential distribution, normal distribution, normal approximation to the Binomial and Poisson distributions.

Unit III: Joint Probability **9 Hours**

Joint probability distribution, discrete and independent random variables, expectation, covariance, correlation coefficient, probability vectors, stochastic matrices, fixed point matrices, regular stochastic matrices, Markov chains, higher transition probabilities, stationary distribution of regular Markov chains and absorbing states.

Unit IV: Sampling Distribution **11 Hours**

Introduction, Objectives, sampling distribution, testing of hypothesis, level of significance, confidence limits, simple sampling of attributes, test of significance of large samples, comparison of large samples, sampling of variables, central limit theorem, confidence limits for unknown mean, test of significance for means of two large samples, Sampling of variables – small samples , Student's t-distribution.

Unit V: Information Theory **12 Hours**

Introduction, Entropy, Joint Entropy and Conditional Entropy, Relative Entropy and Mutual Information, Relationship Between Entropy and Mutual Information, Chain Rules for Entropy, Relative Entropy and Mutual Information, Jensen's Inequality and Its Consequences, Log Sum Inequality and Its Applications, Data-Processing Inequality, Sufficient Statistics, Fano's Inequality

Text Books:

1. Douglas C Montgomery, George C Runger, "Applied Statistics and Probability for Engineers", 5th edition, Wiley India, 2010.
2. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.
3. Thomas M. Cover, Joy A.Thomas, "Elements of Information Theory", 2nd edition, Wiley Publications, 2006.(Chapters 1 and 2)

Reference Books:

1. Ramana .B.V, **"**Higher Engineering Mathematics"**,** latest edition, Tata-McGraw Hill, 2016
2. Erwin Kreyszig, "Advanced Engineering Mathematics" , 10th edition, Wiley Publications, 2015.
3. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics", 6th Edition, Tata-McGraw Hill, 2005.
4. Louis A. Pipes and Lawrence R. Harvill, "Applied Mathematics for Engineers and Physicists", 3rd Edition, McGraw Hill, 2014.
5. Richard A Johnson, Irwin Miller and John Freund, "Probability and Statistics for Engineers", 9th edition, Pearson Publishers, 2011.
6. Robert G Gallager, "Information theory and Reliable communication", 2nd edition, Wiley Publishers, 1968.

Siddaganga Institute of Technology, Tumkur – 572 103

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BIOSTATISTICS AND BIOMODELING

Contact Hours/ Week	4 (L)	**Credits**	**4**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	4RBT05	**Semester**	**IV**

Prerequisites: Engg Mathmatics-III

Course objectives:

1. To study the scope of statistics in Biotechnology
2. To learn the laws & principles of probability distribution
3. To understand the significance of statistical inference in biological experiments
4. To learn the design of experiments
5. To study the biomodeling of microbial growth in a chemostat, growth equations of microbial populations, models for inheritance

Course outcomes:

A student who has met the objectives of the course will be able to:

1. Explain the concepts of data collection, presentation of charts, graphs & data (L2)
2. Describe different laws of probability (L2)
3. Apply concepts of analysis of variance in inferring the statistical data (L3)
4. Apply different methods in design of experiments (L3)
5. Outline the case studies of lung cancer, endangered plants species (L1)

Unit –I: Introduction **11 Hours**

Scope of biostatistics, definition, data collection, presentation of data, graphs, charts (scale diagram, histogram, frequency polygon, frequency curve, logarithmic curves). Sampling & selection bias, probability sampling, random sampling, sampling designs. Descriptive statistics: Measure of central tendency (arithmetic mean, geometric mean, harmonic mean, median, quartiles, mode); Measure of dispersion (range, quartile deviation, mean deviation and standard deviation, coefficient of variation).

Unit –II: Bi-Variate Distribution **11 Hours**

Correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential).
Probability: Axioms, models, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Forensic probability determination, Likelihood of paternity, Estimation of probabilities for multilocus/ multi-allele finger print system.

Unit –III: Statistical Inference **11 Hours**

Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, simultaneous confidence intervals, parametric and non-parametric distributions (T-test, F-test, Chi Squared distribution, goodness of fit test) analysis of variance (one-way and two-way classifications). Case studies of statistical designs of biological experiments (RCBD, RBD).

Unit –IV: Probability Distributions **09 Hours**

Discrete probability distributions - Binomial, Poisson, geometric – derivations. Central limit theorem. Continuous probability distribution – normal, exponential, gamma distributions, beta and Weibull distributions, T & F distributions.

Design of Experiments: Sample surveys, comparisons groups and randomization, random assignments, single and double blind experiments, blocking and extraneous variables, limitations of experiments.

Unit –V: Case Studies **10 Hours**

Cigarette smoking, Lung cancer, endangered plants species, epidemics.

Biomodeling: Microbial Growth in a Chemo stat, Growth Equations of Microbial populations, Models of Commensalisms, Mutualism, Predation and Mutation.Volterra's Model for n Interacting Species. Basic Models for Inheritance, Selection and Mutation Models, Genetic Inbreeding Models.

Text Book:

1. Marcello Pagano & Kimberlee Gauvreu, "Principles of Biostatistics", 2nd Edition, Thompson Learning, 2000.
2. Ronald N Forthofer and Eun Sul Lee, "Introduction to Biostatistics", 1st edition, Academic Press, 1996.
3. Norman T J Bailey, "Statistical methods in Biology", 3rd Edition, Cambridge University Press, 1995.
4. J.N.Kapur, "Mathematical Models in Biology and Medicine", Oscar Publication, 2010.
5. H Bancroft, J. Ispen and P Feigl, "Introduction to Biostatistics", 2nd edition, Harper & Row, New York,1970.
6. Dutta, Animesh, K, "Basic Biostatistics & its Applications",1st edition, New Central Book Agency, 2007.

Reference Books:

1. S I Rubinow, "Introduction to Mathematical Biology", 1st edition, Wiley Publishers, 1975.
2. P.S.S. Sundar Rao and J.Richard, "An Introduction to Biostatistics", 5th edition, Prentice Hall of India Pvt Ltd, 2006.
3. Miller, Freund's and Richard A Johnson, "Probability and Statistics for Engineers", 8th edition, Chegg Publishers, 2011.
4. Veer Bala Rastogi, "Fundamentals of Biostatistics", Ane Books India, 2009.

Foundations of Engineering Mathematics
(For Lateral Entry students only)

Contact Hours/ Week	**04**	**Credits**	**00**
Total Lecture Hours	**52**	**CIE Marks**	**50**
Total Tutorial Hours	**00**	**SEE Marks**	**50**
Sub Code	**3RMATF1**	***Semester***	***III***

Course objectives: This course will enable students to:

1. Known the behavior of the polar curve and its application, determine the derivatives of functions of two variables and to understand the behavior of the infinite series
2. Learn how the vectors govern the physical models.
3. Known how the real word problems governed by the first order differential equations.
4. Solve second and higher order differential equations.
5. Find the Laplace transform of the function f(t) and the Inverse Laplace transform of the function F(s).

Course Outcomes:
Upon completion of this course the student will be able to:

1. Find the angle between the polar curves and represent a function as a Infinite series. **(L2)**
2. Calculate the gradient of a scalar point function; divergence, curl and Laplacian of a vector point function. **(L3)**
3. Solve first order and first-degree equations and solve Engineering problems. **(L3)**
4. Solve the linear differential equations of second and higher order with constant coefficients. **(L3)**
5. Derive Laplace transform of basic functions and evaluate inverse Laplace transforms and also solve linear differential equations by the method of Laplace transform. **(L3)**

UNIT-I Differential Calculus **08 hrs**
Polar curves: angle between the radius vector and tangent, angle between the two curves.
Partial differentiation: Definition, total differentiation, Jacobians illustrative examples and problems.
Taylor's series, Maclaurin's series for functions of single variable.

UNIT-II Vector Calculus **07 hrs**
Vector Algebra: Vector addition, subtraction, multiplication (dot and cross products), scalar triple product.
Vector Differentiation: Velocity, acceleration of a vector point function, gradient, divergence and curl.

UNIT-III Differential Equations-I **08 hrs**
Solution of first order, first-degree differential equations: variable separable method, homogeneous, Linear, Bernoulli's and exact differential equations.

UNIT-IV Differential Equations-II **07 hrs**
Differential equations of second and higher orders with constant coefficients. Method of Variation of Parameters

UNIT-V Laplace Transform **09 hrs**
Definition, Laplace transform of elementary functions, properties of Laplace transforms, multiplication by t^n, division by t and derivatives. Inverse transforms, Applications of Laplace transforms to differential equation.

Text Books:

1. B.S.Grewal, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, 2015.

2. H. K. Das and Er. Rajnish Verma, Higher Engineering Mathematics, 1st edition, S. Chand Publishers, 2011

Reference Books:

1. Ramana .B.V, **"**Higher Engineering Mathematics"**,** latest edition, Tata-McGraw Hill, 2016
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley Publications, 2015.

LINEAR ALGEBRA (Open Elective)

Contact Hours/ Week	: 3	Credits:	03
Total Lecture Hours	: 39	CIE Marks:	50
Total Tutorial Hours	: 00	SEE Marks:	50
Sub. Code	: OE07		

Prerequisites: MAT1, MAT2

Course objectives: This Course will enable students to

1. To understand several important concepts in linear algebra, including systems of linear equations and their solutions; matrices and their properties; vector spaces; linear independence of vectors; subspaces, bases, and dimension of vector spaces; inner product spaces; linear transformations; and Eigen values and eigenvectors.
2. To apply these concepts to such real world phenomena as electrical networks, traffic flow, archeological dating, economic interdependencies, population movement, communication networks, and weather prediction.
3. To learn to use the computer package MATLAB to perform matrix computations and to explore and analyze linear algebra concepts.
4. To improve your ability (or to learn!) to prove mathematical theorems.
5. To improve your ability to think logically, analytically, and abstractly

UNIT-I

Linear equations:

Systems of linear equations, row reduction and Echelon form, vector equations, Matrix equation, solution sets of linear systems, Linear independence.

08 Hrs

UNIT-II

Matrix Algebra:

Introduction to linear transformations, Matrix of a linear transformation.Matrix operations, Inverse of a matrix, characterization of invertible matrices, partitioned matrices, matrix factorizations.

08 Hrs HrsUNIT-III

Vector spaces:

Vector spaces and subspaces, Null spaces, column spaces, linear transformations, linearly independent sets, bases, dimension of a vector space, rank, change of basis.

08 Hrs

UNIT-IV

Eigen values, Eigen vectors and Orthogonality:

Introduction, characteristic equation, diagonalization, Eigen vectors and linear transformations,Orthogonality-Inner product, length, and orthogonality, orthogonal sets, orthogonal projections.

08 Hrs

UNIT-V

Orthogonality and least squares:

Gram-Schmidt process, least squares problems, Inner product spaces, diagonalization of symmetric matrices, quadratic forms. **07Hrs**

Text Book:

1	David C. Lay	"Linear algebra and its applications", 4th edition, Pearson Education, 2014 ISBN: 978-0321385178

Reference Books:

1	Gilbert Strang	"Linear algebra and its applications", 4th edition, Thomson Asia Pvt. ltd., 2007 ISBN: 978-0030105678
2	Kenneth Hoffman, Ray Kunze	"Linear algebra", 2nd edition, Prentice-Hall of India Pvt. Ltd., 2002 ISBN:978-0135367971

Course Outcomes: Upon completion of this course the student will be able to:

1. Apply the numerical methods to solve Systems of linear equations, row reduction and Echelon form, vector equations, Matrix equation, solution sets of linear systems, Linear independence (L3)

2. Solve the linear transformations, Matrix of a linear transformation.Matrix operations, Inverse of a matrix, characterization of invertible matrices, partitioned matrices, matrix factorizations, Determinants: Introduction, Properties, volume and linear transformations (L2)

3. Determine the Vector spaces and subspaces, Null spaces, column spaces, linear transformations, linearly independent sets, bases, dimension of a vector space, rank, change of basis (L3)

4. Determine and Describe characteristic equation, diagonalization, Eigen vectors and linear transformations, Complex Eigen values. Orthogonality- Inner product, length, and orthogonality, orthogonal sets, orthogonal projections (L1, L3)

5. Determine and Describe Gram-Schmidt process, least squares problems, Inner product spaces, diagonalization of symmetric matrices, quadratic forms (L1, L3)

STATISTICAL COMPUTING(Open Elective)

Contact Hours/ Week	: 3	Credits:	03
Total Lecture Hours	: 39	CIE Marks:	50
Total Tutorial Hours	: 00	SEE Marks:	50
Sub. Code	: OE05		

Prerequisites: Elementary probability theory and Statistics.

Course objectives: This Course will enable students to

1. It aims to introduce the fundamental ideas of probability and Statistics and these through investigations of data and familiarize students with the statistical methods. A thorough grounding in the concept of probability allows having a better understanding of statistical inferences. Also aiming at the design of algorithm for implementing statistical methods on computers.
2. Estimating the parameters of a population, role of normal distribution as a sampling distribution. Understand the central limit theorem, point estimators, including bias, variance, and mean square error. Construct point estimators using method of moments, maximum likelihood and Bayesian approach.
3. Test hypothesis and construct confidence intervals on difference in means, ratio of the variance, difference in two population proportions of two normal distributions. Use of p-value approach for making decision in hypothesis tests. Use the relationship between confidence intervals and hypothesis tests.
4. The problems in engineering and science involve exploringthe relationship between two or morevariables. Regression analysis is a statistical technique that is very useful for these types of problems. This can also used for process optimization, such as finding the level of temperature that maximizes yield.
5. Use multiple regression techniques to build empirical models to engineering and scientific data.Assesregression model adequacy. Build regression models with polynomial terms. Stepwise regression and other model to building techniques to select the appropriate set of variables for a regression model.

UNIT-I

The Role of Statistics in Engineering(Data Summary and Presentation):

Statistical Thinking, Collecting data, Statistical Modeling Frame work, Measure of Central Tendency and Variance, Importance of Data Summary and Display, Tabular and Graphical display.

08 Hrs

UNIT-II

Point Estimation:

Sampling distributions and The Central Limit Theorem. General concept of Point Estimation-Unbiased Estimators, Variance of a Point Estimation, Standard error
(reporting a point estimate), Mean square error of an estimator. Method of Point estimators: Method of moment, method of Maximum likelihood, Bayesian Estimation of parameters.

08 Hrs

UNIT-III

Statistical Inference for a Single Sample and Two Samples:

Hypothesis testing, Inference on the mean of a population (Variance known and unknown), Inference on the variance of a normal population, Inference on a Population Proportions, Testing for goodness of Fit, Inference for a difference in Means, Variances known, Inference for a difference in means of two normal distributions, Variances unknown, Inference on the variances of two normal Populations, Inference on two population proportions. **08 Hrs**

UNIT-IV

Simple Linear Regression and Correlation:

Simple Linear Regression, Properties of Least Square Estimators and Estimation of variance, Common abuses of regression, Prediction of new observations, assessing the adequacy of regression model, Analysis of Variance.

06Hrs

UNIT-V

Multiple Linear Regression Model:
Introduction, Least Sqaures Estimation of the Parameters.Matrix approach to Multiple Linear Regression, Properties of the Least Squares Estimators.**Hypothesis Tests in Multiple Linear Regression**: Tests for significance of regression, Tests on Individual regression Coefficients and Subsets of Coefficients. **Confidence Intervals in MultipleLinear Regression**: Confidence Interval on Individual Regression Coefficients, Confidence interval on the Mean Response. Prediction of New observations.

09Hrs

Text Books

1	Douglas C Montgomery, George C Runger,	"Applied Statistics and Probability for Engineers", 5^{th} edition, Wiley India, 2010. ISBN: 9780470053041
2	R. R. Walpole and R. H. Myers	"Probability and Statistics for Engineers and Scientists", 9^{th} Edition, Pearson Publications, 2012 ISBN: 978-0-321-62911-1

Reference Books

1	Devore	"Probability and Statistics for Engineers and Sciences", 9^{th} Edition. ISBN: 978-1305251809
2	Richard A Johnson, Irwin Miller and John Freund	"Probability and Statistics for Engineers", 9^{th} edition, Pearson Publishers, 2011. ISBN: 978-0321986245

Course Outcomes: Upon completion of this course the student will be able to:

1.Apply the basic concepts of probability and statistics in engineering models, various ways of data collections, interpretations and models. (L3)

2. Apply the methods of moments, methods of maximum likelihood to make decisions or to draw conclusions about a population using the information contained in a sample from the population drawing conclusion. (L3)

3. Apply hypothesis testing on the mean of a normal distribution using either a z-test or a t-test produce and test hypothesis on the variance or standard deviation of a normal distribution. Determine the p-value approach for making decision in hypothesis test. Explain and use the relationship between confidence intervals and hypothesis tests. (L2, L3, L5)

4. Apply simple linear regression for building empirical models to engineering and scientific data. Determine the method of least square is used to estimate the parameters in a linear regression model. Derive the regression model to make a prediction of a future observation and construct an appropriate prediction interval on the future observation. Apply the correlation model. (L2, L4, L5)

5. Determine the regression model to estimate the mean response and to make predictions and to construct confidence intervals and prediction intervals. (L5)

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MATHEMATICAL MODELING(Open Elective)

Contact Hours/ Week	: 3	Credits:	03
Total Lecture Hours	: 39	CIE Marks:	50
Total Tutorial Hours	: 00	SEE Marks:	50
Sub. Code	: OE40		

Prerequisites: Differential Equations, Curve fitting.

Course objectives: This Course will enable students to

1. To make the student to identify the physical situation(s) which can be modeled as a difference equation and hence predict the future by finding its solution.
2. To introduce the systematic procedure to derive the mathematical model using the well defined physical laws.
3. To make the student to analyze the data, identify the type of curve to be fit and justify the fit through the parameters of fit.
4. To introduce the concept of probability to develop the mathematical model for the situation.
5. To make the student to apply the concept of differential equation to develop the mathematical model for the given situation.

UNIT-I

Modeling Change:

Introduction, Testing for proportionality, Modeling change with difference equations, Example 1: A savings certificate, Example 2: Mortgaging a home, Approximating Change with Difference equations, Example 1: Growth of a Yeast culture, Example 2: Growth of a Yeast culture revisited, Example 3: Decay of Digoxin in the blood stream, Solutions to Dynamical systems, Example 1: A savings certificate revisited, Example 2:Seavage treatment, Example 3: Prescription for Digoxin, Systems of Difference equations, Example1: A car rental company, Example 2: The battle of Trafalgar, Example 3: Travelers' Tendencies at a Regional Airport., Example 4: Discrete Epidemic Models. **08 Hrs**

UNIT-II

The Modeling Process, Proportionality, andGeometric Similarity:

The Modeling Process, Proportionality and Geometric similarity: Introduction, Mathematical Models, Example: Vehicular stopping distance, Modeling using proportionality, Example: Kepler's third law, Modeling using geometric similarity, Example1: Rain drops from a motionless cloud, Example 2: Modeling a bass fishing derby, Automobile Gasoline Mileage, Body weight and height strength and Agility.

08 Hrs

UNIT–III

Model fitting:

Introduction,Fitting models to data graphically - Visual Model Fitting with the Original Data, Transforming the Data.Analytic methods of model fitting - Chebyshev Approximation Criterion, Minimizing the Sum of the Absolute Deviations, Least-Squares Criterion, Relating the Criteria.Applying the least squares criterion-Fitting a Straight Line, Fitting a Power Curve, Transformed LeastSquares Fit, Choosing a best model, Example: Vehicular stopping distance. **08 Hrs**

UNIT-IV

Discrete Probabilistic Modeling:

Introduction, Probabilistic modeling with discrete systems, Example 1: Rental car company revisited, Example 2: Voting tendencies, Modeling component and system reliability, Example1: series systems, Example 2: Parallel systems, Example3: Series and Parallel combinations.Linear Regression, Example 1: Ponderosa pines, Example 2: The bass fishing derby revisited.

08 Hrs

UNIT-V

Modelingwith differential equations:

Introduction- The Derivative as a Rate of Change, the Derivative as the Slope of the Tangent Line. Population growth, Prescribing Drug Dosage,Breaking distance revisited. Graphical solutions of Autonomous differential equations, Example: Drawing a phase line and sketching solution curves, Numerical approximation methods - First-Order Initial Value Problems, Approximating Solutions to Initial Value Problems: Example 1: Using Euler's method and Modified method. Example 2: A saving certificate revisited.

07 Hrs

Text Books

1	Frank.R.Giordano, William.P.Fox, Steven B. Horton and Brooks Cole	"A First course in Mathematical modeling", 5th edition, 2013. [Chapters – 1,2,3,6 and 11] ISBN: 978-0495011590

Reference Books

1	Neil Gerschenfeld,	"The nature of Mathematical Modeling", Cambridge University press, 1999. ISBN: 0-521-57095-6
2	A.C. Fowler,	"Mathematical Models in applied sciences", Cambridge University press, 1997 ISBN: 0521467039

Course Outcomes: Upon completion of this course the student will be able to

1. Apply the solution of difference equation to given physical situation, explainthe solution and interpret the results (L2, L3)

2. Describe the steps involved in deriving the model for the given situation by selecting the suitable physical law(s). (L2, L3, L4)

3. Derive the normal equations, apply them to fit a curve and evaluate the parameters to check the goodness of fit. (L3, L4, L5)

4. Calculate the reliability of the system whose components are in series or in parallel or a combination of them. Identify the better model from the available models. (L1, L3)

5. Derive a model using differential equation and find the numerical solution, identify an autonomous differential equation and draw solution curves. (L1, L4)

COMBINATORICS(Open Elective)

Contact Hours/ Week	: 3	Credits:	03
Total Lecture Hours	: 39	CIE Marks:	50
Total Tutorial Hours	: 00	SEE Marks:	50
Sub. Code	: OE49		

Course Objectives: This Course will enable students to

1. To introduce the concept of elements of counting principles and to facilitate them to use the results in the appropriate situation.
2. To introduce the concept of systematic / formula driven counting through principle of inclusion and exclusion and its use.
3. To introduce the alternate way of counting namely, generating function and its use at the relevant place.

UNIT–I

Fundamental Principles of Counting:
The Rules of Sum and Product, Permutations(linear, circular, identical objects), Combinations – The Binomial Theorem, Combinations with Repetition, The Catalon Numbers. **08 Hrs**

UNIT–II

The Principle of Inclusion and Exclusion:
The Principle of Inclusion and Exclusion, Generalizations of the Principle. Derangements – Nothing is in its Right Place, Rook Polynomials, Arrangements with forbidden positions **08 Hrs**

UNIT -III

Generating Functions:
Introductory Examples, Definition and Examples – Calculational Techniques, Partitions of Integers. The Exponential Generating Function, The Summation Operator. **08 Hrs**

UNIT -IV

Recurrence Relations:First Order Linear Recurrence Relation
The First Order Linear Homogeneous Recurrence Relation with Constant Coefficients, The Non-homogeneous Recurrence Relation, The Method of Generating Functions. **08 Hrs**

UNIT -V

Recurrence Relations:Second Order Linear Recurrence Relation
The Second Order Linear Homogeneous Recurrence Relation with Constant Coefficients, The Non-homogeneous second order recurrence relation, The Method of Generating Functions. **07Hrs**

Text Books:

1	Ralph P. Grimaldi	"Discrete and Combinatorial Mathematics", 5th Edition, *Pearson Education*, 2012. ISBN: 978-0201726343
2	Alan Tucker	"Applied Combinatorics", 5th Edition, Wiley-India, 2011 ISBN: 978-0471735076

Reference Books:

1	Dr.D.S.Chandrasekharaiah	"Graph Theory and Combinatorics", Prism, 2005
2	Richard A. Brualdi	"Introductory Combinatorics", 5th Edition, Pearson Prentice Hall, 2014. ISBN: 978-0136020400

Course Outcomes: Upon completion of this course the student will be able to

1. Apply the techniques of counting to identify the number of ways in which a given task can be accomplished without list all the possibilities explicitly. (L3)
2. Identify the different physical situations in which principle of inclusion and exclusion can be used for counting. (L1)
3. Derive the generating function for the given situation and evaluate the required coefficient. (L3)
4. Solve the first order recurrence relation and interpret the solution. (L3,L4)
5. Solve the first order recurrence relation and interpret the solution. (L3,L4)

NUMERICAL METHODS AND PROGRAMING (Open Elective)

Contact Hours/ Week	: 3	Credits:	03
Total Lecture Hours	: 39	CIE Marks:	50
Total Tutorial Hours	: 00	SEE Marks:	50
Sub. Code	: OE56		

Course Objectives:This Course will enable students to

1. Fundamentals of creating mathematical *models* of *physical systems* and implementation on computers to analyze the *system* both to gain insight and make predictions.
2. Art of numerical computation. The theory and derivation of computational techniques, *error analysis.*
3. *Solve the equations* involving *linear* and *non-linear* system.
4. To learn about interpolation polynomials.
5. To understand the concept of piece wise and *spline* approximation.

UNIT-I

MODELLING OF PHYSICAL SYSTEMS AND MATLAB PROGRAMMING:

Mathematical modeling, modelling of ODE: Bungee jumper problem, RLC circuit, analytical solution of Bungee jumper problem. Matlab environment, assignment, mathematical operators, built-in functions, plots. Programming with Matlab: M-files, input-output, structured programming, nesting and indentation, passing functions to M-files. Implementation of physical systems using Matlab.

08 Hrs

UNIT -II

ERROR ANALYSIS AND ROOT FINDING:

Introduction to Error, definition, types of errors, round-off errors, accuracy and precision. Truncation errors and Taylor series.Total numerical error.

Definition of algebraic and transcendental equations, root, geometrical interpretation, root finding methods.Bracketing methods: Bisection and Regula-Falsi methods, problems and implementation using Matalb. Open Methods: Newton-Raphson and Secant methods, problems and implementation using Matlab.

08 Hrs

UNIT-III

SOLUTION OF LINEAR AND NON-LINEAR SYSTEMS:

Matrix representation of linear algebraic system. Iterative methods: Jacobi method, Gauss-Seidel method, problems, implementation using Matlab. Non-linear Systems: Successive substitution method and Newton-Raphson method. **08 Hrs**

UNIT-IV

POLYNOMIAL INTERPOLATION:

Introduction to interpolation, Newton's interpolation, Lagrange's interpolation, Inverse interpolation, Its merits and demerits, Implementation using Matlab.

08 Hrs

UNIT-V

PIECEWISE INTERPOLATION AND SPLINES:

Introduction to piecewise interpolation and splines, linear splines , quadratic splines, cubic splines with all three types of end conditions. Implementation using Matalb.

07 Hrs

Text Books:

1	Steven C Chapra	Applied Numerical Methods With MATLAB for Engineers and Scientists, 2nd Edition, By Tata McGraw Hill Company ISBN: 978-1259027437

Reference Books:

1.	John H.Mathews andKurtisD.Fink	Numerical Methods Using MATLAB, Pearson Education, 4th Edition, 2010,ISBN - 9780130652485
2.	Brian D. Hahn and Daniel T. Valentine	Essential MATLAB® for Engineers and Scientists, Elsevier Publishers, 4th Edition,2010, ISBN - 9781305253667
3.	Richard L. Burden, J. Douglas Faires and Annette M. Burden	Numerical Analysis, Cengage Learning, 10th Edition, 2016, ISBN - 9781305253674.

Course Outcomes: Upon the successful completion of the course, students will be able to:

1. Become familiar with *modeling* and *simulation* as an engineering design process; Learn to *program* in *MATLAB* *(L2,L3)*
2. Apply numerical methods to find solution of algebraic equations using different methods Underdifferent conditions, (L2,L3,L4)
3. S*olve linear and non-linear equations* using algebra and MATLAB Code. (L3,L4)
4. Apply the interpolation and inverse interpolation to estimate solution. Implement them inMATLAB (L3)
5. Apply *piecewise and spline interpolation*. Implement them in MATLAB (L4)

OE 18: Fuzzy Logic and Engineering Applications

Credits: 3		Total Hours: 39
Lecture Hours/week: 3		SEE marks: 50
		CIE marks: 50

Prerequisites:

- A course in Mathematics preferably discrete mathematics.

Course Learning Objectives:

- To get a overall view of fuzzy logic by going through basic concepts
- To study about developing fuzzy sets / membership functions.
- To understand principles of fuzzy relations and operations on fuzzy relations.
- To get clear idea about the development of membership functions
- To study the concepts and steps of developing fuzzy inference system
- To understand modeling of natural processes and engineering systems with fuzzy automated methods.
- To go through fuzzy clustering algorithm.

Course outcomes:

At the end of the course, students should be able to:

- Analyze uncertainty in data / information available to them.
- Realize the importance of fuzzy sets, to decide on type of membership function be developed for given set of data, get clear understanding of linguistic variables.
- Develop fuzzy rules connecting antecedents and consequents.
- Develop a suitable fuzzy inference system for the given domain/ or their domain of interest.
- Develop predictive models using automated fuzzy systems.
- Form clusters within the given data set using FCM and to be able to analyze the clusters.

UNIT-1 **09 Hrs**

INTRODUCTION: Historical perspective, utility of fuzzy systems, limitations of fuzzy systems, statistics and random processes, uncertainty in information, fuzzy sets and membership, chance versus fuzziness, sets as points in Hypercube.

CLASSICAL SETS AND FUZZY SETS: classical sets, operations on them, mapping of classical sets to functions, fuzzy sets, fuzzy set operations, properties of fuzzy sets, non interactive fuzzy sets.

UNIT-2 **07 Hrs**

CLASSICAL RELATIONS AND FUZZY RELATIONS: Cartesian Product, Crisp Relations - Cardinality of Crisp Relations, Operations on Crisp Relations, and Properties of Crisp Relations, Composition. Fuzzy Relations - Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition, Non interactive Fuzzy Sets. Tolerance and Equivalence Relations – Crisp Equivalence Relation, Crisp Tolerance Relation, Fuzzy Tolerance and Equivalence Relations. Value Assignments - Cosine Amplitude, Max-min Method, Other Similarity methods.
Development of membership Functions: Membership value assignments, intuition, inference, rank ordering, neural networks, and genetic algorithms, inductive reasoning

UNIT-3 **09Hrs**

MEMBERSHIP FUNCTIONS: Features of the Membership Functions, Standard Forms and Boundaries, Fuzzification, defuzzification to crisp sets, Lambda-Cuts for Fuzzy Sets, Lambda-Cuts for Fuzzy Relations, Defuzzification Methods. Problems on defuzzification.

UNIT- 4 **8Hrs**

FUZZY ARITHMETIC AND THE EXTENSION PRINCIPLE - Crisp Functions, Mapping and Relations, Functions of fuzzy Sets – Extension Principle, Fuzzy Transform (Mapping), Practical Considerations. Fuzzy Numbers Interval Analysis in Arithmetic, Approximate Methods of Extension - Vertex method, DSW Algorithm, Restricted DSW Algorithm, Comparisons. Fuzzy Vectors.

FUZZY SYSTEMS: Natural Language, Linguistic Hedges, Rule-Based Systems, Graphical Techniques of Inference.

UNIT-5 **06 Hrs**

FUZZY CLASSIFICATION: Classification by equivalence relations, fuzzy relations, cluster analysis, cluster validity, C-means clustering, hard-c means(HCM), fuzzy c-means(FCM), fuzzy c-means algorithm, classification metric, hardening the fuzzy partition and similarity relations from clustering.

Text Book:

1. Timothy J. Ross, Fuzzy Logic with Engineering Applications, III edition, John Wiley & Sons, 2015.

Reference Books:

1. John Yen, Reza Langari, Fuzzy Logic- Intelligence, Control, and information, Pearson Education, 2004.
2. George J.Klir , Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications, Prentice Hall of India, 2000.