

GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17) NUMERICAL TECHNIQUES & STATISTICAL METHODS FOR IC ENGINEERING SUBJECT CODE: 2141703 B.E. 4th Semester

Type of course: Engineering Mathematics and Statistics

Prerequisite:

- (1) Solution of quadratic equations and conditions for types of roots.
- (2) Basic factorization.

Rationale: This subject deals with common numerical techniques widely used in engineering applications and some of the statistical methods

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
		PA	ALA		ESE	OEP				
3	2	0	5	70	20	10	30	0	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	ERROR ANALYSIS: Round-off errors and truncation errors in numerical computation, error propagation, and numerical instability.	2	4
2	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS Linear interpolation (method of false position) – Newton’s method - Statement of fixed point theorem – Fixed point iteration: $x=g(x)$ method – Solution of linear system by Gaussian elimination and Gauss-Jordon method – Iterative methods: Gauss Jacobi and Gauss-Seidel methods – Inverse of matrix by Gauss Jordon method – Eigen value of matrix by power method	5	10
3	INTERPOLATION AND APPROXIMATION Lagrangian Polynomials – Divided differences – Interpolating with a cubic spline – Newton’s forward difference formulas.	5	12
4	NUMERICAL DIFFERENTIATION AND INTEGRATION Derivatives from difference tables – Divided differences and finite differences – numerical integration by trapezoidal and Simpson’s 1/3 and 3/8 rules – Romberg’s method – Two and Three point Gaussian quadrature formulas – Double integrals using trapezoidal and Simpson’s rules	5	12

5	<p>INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS</p> <p>Single step methods: Taylor series method – Euler and modified Euler methods – Fourth order Runge-Kutta method for solving first and second order equations – Multistep methods: Milne’s and Adam’s predictor and corrector methods.</p>	5	12
6	<p>INTRODUCTION TO STATISTICAL PARAMETERS</p> <p>Significant figures, scientific notations, average- Mean, Mode, Median, geometric mean, harmonic mean, root-mean-square and root-sum-squares average, Logarithmic representation of signal levels, Data classes, Variation – Gaussian curve, standard deviation, variance</p>	2	4
7	<p>PROBABILITY AND PROBABILITY DISTRIBUTIONS</p> <p>Introduction to probability; Random Experiments, Sample Space, Events and their probabilities; Some basic results of probability, Conditional probability, Random variables: Probability distributions; Expected value & variance of a probability distribution; Discrete probability distributions: Binomial, Poisson. Continuous probability distributions: Exponential, Normal.</p>	6	12
8	<p>SAMPLING, SAMPLING DISTRIBUTION & INTERVAL ESTIMATION</p> <p>Simple random sampling, point estimation, introduction to sampling distributions, sampling distributions of \bar{x}, Sampling distribution of sample proportion \bar{p}, Properties of point estimation, Other sampling methods, Interval estimation: Population mean: σ known, σ unknown, Determining the sample size. Sampling distribution of variance.</p>	6	10
9	<p>STATISTICAL INFERENCES, TESTING OF HYPOTHESES, χ^2-TEST</p> <p>Introduction, Test of significance for large samples: Difference between small & large samples, Two-tailed test for difference between the means of two samples, Standard error of the difference between two standard deviations, Test of significance for small samples: The assumption of normality, Students’-distribution; properties and application of t-distribution, testing difference between means of two samples (Independent samples; Dependent samples) Definition of chi-square, degrees of freedom; chi-square distribution, Conditions for applying chi-square test, Uses of chi-square test, Misuse of chi-square test.</p>	8	14
10	<p>NETWORK ANALYSIS</p> <p>Network definition, Minimal spanning tree problem, Shortest route problem, Maximum flow problem concepts and solution algorithm as applied to problems. Project planning and control by CPM network, Probability assessment in PERT network.</p> <p>PROJECT MANAGEMENT AND SCHEDULING</p> <p>Project management (CPM & PERT)</p> <p>Network concepts, components, rules for network construction, critical path method (CPM) and Project</p>	4	10

	evaluation and review Techniques (PERT)		
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Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
21	21	14	7	7

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Reference Books:

1. Richard A. Johnson, "Miller & Freund's Probability and Statistics for Engineers", eighth edition, PHI
2. Gerald, C.F, and Wheatley, P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
3. Balagurusamy, E., "Numerical Methods", Tata McGraw- Hill Publishing Company, New Delhi 1999.
4. Joe D. Hoffman: "Numerical Methods for Engineers and Scientists", Second edition, Taylor and Francis (2001).
5. Anderson, Sweeney, Williams, "Statistics for business and economics", 9th edition, Thomson Publication.
6. S P Gupta, "Statistical Methods", 30th edition S Chand
7. Operational Research -An Introduction -Fifth edition by Hamdy A Taha -PHI New Delhi
8. J. K. Sharma, "Operations Research - Theory and Applications" by 4th Edition, Macmillan Publishers India ltd.
9. Kandasamy, P., Thilagavathy, K. and Gunavathy, K., "Numeric Methods", S. Chand Co.Ltd., New Delhi, 2003.
10. Burden, R.L and Faires, T.D., "Numeric Analysis", Seventh Edition, Thomson Asia Pvt. Ltd., Singapore, 2002
11. Saumyen Guha and Rajesh Srivastava: "Numerical Methods for Engineering and Science". Oxford Higher Education (2010)

Course Outcomes:

After learning the course, student should be able to decide which numerical method is appropriate to resolve his/her technical problems and how to interpret solution obtained.

- One must be able to understand which probability distribution is applicable to the set-up of field of interest or to the design of experiment.
- Students must be able to realize goodness of fit of various distributions.
- Students must be able to check various research claims.
- Student must be able to have vision about utility & necessity of Numerical Methods and Statistical Methods in field work.

Tutorials

- (1) Examples based on various numerical methods to solve transcendental equations.
(with an aim: student must be able to understand which method is appropriate to which type of example)
- (2) Examples based on numerical integration and differentiation.
- (3) Examples based on solution of various differential equations.
- (4) Examples based on solution of various partial differential equations.
- (5) Examples based on Fundamental concepts of Statistics like, Mean, Median, Mode, classifications, frequency distribution, Variance, Standard Deviation.
- (6) Examples based on probability, conditional probability, independent events.
- (7) Examples based on Binomial, Poisson distributions
- (8) Examples based on exponential, Normal distributions.
- (9) Examples based on Interval Estimation
- (10) Examples based on hypotheses Testing
- (11) Examples based on chi-square distributions

List of Open Source Software/learning website: scilab, SPSS / SAS software / Matlab Statistical Tool Box.

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.