



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil Engineering (Transportation Engineering)

Course / Subject Code: ME01069031

Course / Subject Name: Numerical Methods and Statistical Analysis

w. e. f. Academic Year:	2024-25
Semester:	1 st Semester
Category of the Course:	PEC

Prerequisite :	Zeal to learn the subject
Rationale:	<p>The course typically begins with an introduction to basic concepts in probability theory, including sample spaces, events, and different approaches to defining probability. Emphasis is placed on developing a solid grasp of fundamental probability rules, such as the addition and multiplication rules, as well as understanding conditional probability, independence, and Bayes theorem. As the course progresses, students delve deeper into more advanced topics, such as random variables, probability distributions, and expectation. They explore common probability distributions, including binomial, Poisson, uniform, exponential, and normal distributions, and they learn how to calculate probabilities and expected values associated with these distributions. The course equips students with a strong theoretical foundation in probability and the analytical skills necessary to tackle complex data-driven problems.</p> <p>Numerical Methods use computers to solve problems by step-wise, repeated and iterative solution methods, which would otherwise be tedious or unsolvable by hand-calculations. This course is designed to give an overview of numerical methods of interest to scientists and engineers. However, the focus being on the techniques themselves, rather than specific applications, the contents should be relevant to varied fields such as engineering, management, economics, etc.</p>

No	Program Outcomes
01	Engage in critical thinking and research to develop solutions to multifold real-world problems.
02	Communicate effectively with the engineering community at large level on complex design tasks & write and present technical reports.
03	Demonstrate a high level of professionalism in handling multidisciplinary and complex traffic engineering problems.
04	Plan, assess, create, integrate, carry out, and oversee complex transportation



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	infrastructure projects in a sustainable local and global context.
05	Address societal issues pertaining to transportation by offering technologically advanced, reasonably priced solutions while upholding high standards of ethics and professionalism.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
01	Apply basic principles and different techniques of statistics and numerical methods along with the use of different software.	R, U, A

*Revised Bloom's Taxonomy (RBT)

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Motivation, Data and Decisions, Measurement Uncertainties, Random processes. Various Statistical Measures.	03	05
2.	Basics of Probability: Sample Space, Events, Axioms of Probability, Sample space with equality likely outcomes, Conditional probability, independent events, Total probability rule, multiplication rule, Baye's theorem.	04	10
3.	Random Variable: Definition, cumulative distribution function, Type of random variables, probability mass function, probability density function, Distribution of function of random variable,	04	10
4.	Random number generation, Continuous/Discrete random variables,	04	10



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	moment generating functions. Multiple regressions, Sample statistics, empirical distributions, Goodness of fit, and sampling from normal populations.		
5.	Bernoulli distribution; Binomial distribution; Poisson Distribution; Uniform distribution; Exponential distribution; Gamma distribution; Normal distribution; Conditional distribution; Examples, Chi-square test, t-test and F-test. Interpolation And Curve Fitting	06	12
6.	Hypothesis testing, Significance Intervals.	05	10
7.	Parameter estimation, moment method, maximum likely hood, interval estimation.	03	05
8.	Numerical Methods Basic: Summary of basic concepts from Linear algebra and numerical analysis, Matrices. Operation counts, Matrix Norms, Type of Errors in Numerical computation.	04	10
9.	Numerical Integration, Gaussian Quadrature, Romberg Integration, Adaptive Quadrature.	04	10
10.	Matrix Factorization and Linear System, Cholesky Factorization, QR factorization by House holder matrices Lu- factorization and Gaussian elimination, partial pivoting, error Analysis (statement of result) solving triangular system by substitution, solving full systems by factorization. Lu-factorization for banded and sparse matrices, storage schemes, Iterative Methods, Jacobi, Gauss - Seidal and SOR Iterations, Conjugate gradient method, preconditioning.	06	13
11.	Interpolation and Curve fitting	02	5
Total		45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
30	20	30	10	10	--

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)



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(a) Books:

References/Suggested Learning Resources:

1. Numerical methods in Engineering-Salvadori & Baron
2. Numerical methods-B S Grewal
3. Numerical Methods in Finite Element Analysis-Bathe & Wilson
4. Numerical methods for scientific and engineering computations-SRK Iyengar, RK Jain and Mahinder
5. Probability and Statistics for Engineers-Miller, Freund-Hall, Prentice India Ltd.
6. Probability and Statistics for Engineers-Johnson Richard, Prentice India Ltd.
7. Introduction to Probability & Statistics for Engineers & Scientists-Ross Sheldon, Elsevier Pub
8. Sampling techniques-Cochran, Wiley Series.
9. Statistics-Concepts and Controversies-David S. Moore-Freeman Company, New York.
10. MATLAB an Introduction with Application, Gilat Amos. Willey Pub.
11. Getting Started with MATLAB-Pratap Rudra-Oxford Pub
12. Mastering MATLAB 7-Hanselman-Pearson
13. Programming in MATLAB for Engineers-Chapman S.J.- Cengage Pub.
14. Effective Technical Communication-Rizvi Ashraf-Tata McGraw Hill Pub.
15. Numerical Methods-Balagurusamy E-Tata McGraw Hill Pub.
16. Numerical Methods-Jain M.K.-New Age Pub.
17. Numerical Methods for Engineers-Chapra Steven-Tata Mc Graw Hill Pub.
18. Computer Oriented Numerical Methods- Rajaraman V.- PHI Pub

(b) Open-source software and website:

List of Open-Source Software (May not be open source but useful for the subject):

Open Office, MATLAB, ANSYS, Excel and SPSS

MOOC Course link :

- <https://nptel.ac.in/courses/111102111>
- <https://nptel.ac.in/courses/111106525>



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- <https://nptel.ac.in/courses/112104318>

Learning website:

- <http://www.scilab.org/http://nptel.ac.in>
- <http://ocw.mit.edu/>

List of Experiments/Tutorials:

Minimum 20 problems from above topics, out of which half of the problems shall be also solved using self-developed computer programs in any language.

Assignment work on

- Probability distribution
- Sampling distribution
- Correlation
- Regression analysis
- Multivariate analysis
- Hypothetical testing
