CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221TCE100	PROBABILITY AND STATISTICS	DISCIPLINE CORE	3	0	0	3

Preamble: The objective of this course is to expose the students to the fundamental concepts of probability and statistics. The course aims to equip the students to find solutions for many real-world civil engineering problems and to understand basic data analysis tools by applying the principles of statistics.

Course Outcomes: After the completion of the course, the student will be able to

CO 1	To create an awareness of the concepts of statistics and probability distributions
CO 2	To formulate and test hypotheses for civil engineering problems
CO 3	To apply statistical data analysis tools such as ANOVA and experimental designs
CO 4	To build regression models for civil engineering applications and to identify the principal components
CO5	To apply the concepts of data analysis for a time series

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2		3			2
CO 2	3	2	2	3	3		2
CO 3	3	2	2	3	3		2
CO 4	3	2	2	3	3		2
CO5							

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	25
Analyse	25
Evaluate	5
Create	5

Mark distribution

Total Marks	CIA	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Micro project/Course based project	:	20 marks
Course based task/Seminar/Quiz	:	10 marks
Test paper, 1 no.	:	10 marks

The project shall be done individually. Group projects are not permitted. The project may include the implementation of theoretical computation using software packages.
The test papers hall include a minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Syllabus

Module 1- Introduction to probability distributions

Sample Space and Events, Axioms of Probability, Addition rules, Conditional Probability, Multiplication and Total Probability rules, Independence. Random Variables–discrete and continuous random variables, Probability mass functions and probability density functions. Cumulative distribution functions, Mathematical Expectations, mean and variance.

Standard discrete distributions-Binomial and Poisson distribution. Standard continuous distributions –Exponential and Normal distribution, Mean and variance (derivation is not required). Computing probability using the above distributions, Fitting of binomial and Poisson distributions.

Module 2- Statistical Inference

Populations and samples. Sampling distribution of the mean(sigma known and unknown), Sampling distribution of the variance(sigma known and unknown).Interval estimation:-Confidence interval for mean and variance.-Tests of hypotheses:-Null hypothesis and alternative hypothesis, Type I and Type II errors.-Test of significance of (i) Mean (ii) Mean of two samples (iii)Proportions (iv) Variance (v) Two variance (vi) Paired t-test (vii) Chi-square test of goodness of fit (viii) Chi-square test for independence

Module 3- Analysis of variance

Analysis of variance. Completely randomized designs and randomized block designs.- Latin square designs -Factorial experiments: Two-factor experiments (overview only)

Module 4- Correlation and regression models

Linear regression and correlation, method of least squares, normal regression analysis, normal correlation analysis, correlation coefficient- Multiple linear regression, normal equations -Principal components (brief overview only)

Module 5-Time Series Models

Components of time series. Identifying linear trend: semi averages method and least squares method. Smoothing: moving averages, weighted moving averages, exponential smoothing using one smoothing coefficient. Forecasting, measuring forecasting accuracy

Course Plan

No	Topic	No. of Lectures
1	**Introduction to probability distributions**	
1.1	Sample Space and Events, Axioms of Probability, Addition rules, Conditional Probability, Multiplication and Total Probability rules, Independence.	1
1.2	Random Variables–discrete and continuous random variables, Probability mass functions and probability density functions. Cumulative distribution functions, Mathematical Expectations, mean and variance.	2
1.3	Standard discrete distributions-Binomial and Poisson distribution. Standard continuous distributions –Exponential and Normal distribution, Mean and variance (derivation is not required). Computing probability using the above distributions, Fitting of binomial and Poisson distributions.	5
2	**Statistical Inference**	
2.1	Populations and samples. Sampling distribution of the mean(sigma known and unknown), Sampling distribution of the variance(sigma known and unknown).Interval estimation:- Confidence interval for mean and variance.	2
2.2	Tests of hypotheses:-Null hypothesis and alternative hypothesis, Type I and Type II errors.	2

2.3	Test of significance of (i) Mean (ii) Mean of two samples (iii)Proportions (iv) Variance (v) Two variance (vi) Paired t-test (vii) Chi-square test of goodness of fit (viii) Chi-square test for independence	4
3	**Analysis of variance**	
3.1	Analysis of variance. Completely randomized designs and randomized block designs.	4
3.2	Latin square designs	2
3.3	Factorial experiments: Two-factor experiments (overview only)	2
4	**Correlation and regression models**	
4.1	Linear regression and correlation, method of least squares, normal regression analysis, normal correlation analysis, correlation coefficient	4
4.2	Multiple linear regression, normal equations	2
4.3	Principal components (brief overview only)	2
5	**Time Series Models**	
5.1	Components of time series. Identifying linear trend: semi averages method and least squares method.	2
5.2	Smoothing: moving averages, weighted moving averages, exponential smoothing using one smoothing coefficient.	3
5.3	Forecasting, measuring forecasting accuracy	3
	Total hours	40

Reference Books

1. Gupta. S. C. and Kapoor. V. K, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2020
2. Benjamin, Jack.R and Comell.C, Allin, Probability, Statistics and Decision for Civil Engineers, Mc- McGraw-Hill.
3. Johnson RA , Miller I, Freund J. Miller and Freund's Probability and Statistics for Engineers (9th edition) Pearson. 2018.
4. Response Surface Methodology: Process and Product Optimization Using Designed Experiments, 4th EditionRaymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook ISBN: 978-1-118-91601-8 February 2016.
5. Introduction to Time Series Analysis and Forecasting Second Edition, DOUGLAS C. MONTGOMERY, CHERYL L. JENNINGS, MURAT KULAHCI, John Wiley & Sons, 2015.
6. Papoulis A, Pillai SU Probability, Random Variables and Stochastic Processes McGraw Hill 2022
7. Schiller J, Srinivasan RA, Spiegal M Schaum's Outline of Probability and Statistics, 2012 McGraw Hill
8. Ross S Introduction to Probability and Statistics for Engineers and Scientists Elsevier 6th Edition 2021

Model Question Paper

XXXX PROBABILITY AND STATISTICS

Time: 3 Hrs Max. Marks:60

PART A

(Answer all Questions: Each question carries 5 marks)

1. Explain the concept of mean, median and mode, and its applicability in various contexts with suitable examples.

2. Explain Type I and Type II errors with example.

3. What are the assumptions involved in Analysis of Variance (ANOVA)?

4. Obtain Karl Pearson's correlation coefficient for Stress and Performance.

Observation no.	1	2	3	4	5
Performance	75	80	85	90	95
Stress	80	75	80	60	55

5. Explain briefly the components of time series.

PART B

(Answer any five questions: Each carry 7 marks)

6. The number of products sold by a shop keeper follows Poisson distribution, with a mean of 2 per week. (i) Find the Probability that in the next 4 weeks the shop keeper sells exactly 3 products. (ii) The shop keeper monitors sales in periods of 5 weeks. Find the probability that in the next 15 of these 5-week period, there are exactly 10 periods in which more than 5 products are sold.

7. After conducting series test on ProbabilityandStatistics the following scores were obtained for Batch A and Batch B. Conduct a hypothesis testing for checking the equality of variance in scores of two batchesat a significant level corresponding to a β error probability of 0.9.

A	35	40	42	30	12	50	45	28	26	30
B	20	24	28	26	18	50	50	48	48	09

8. In order to evaluate safety performance of employees across 3 departments, 5 employees across each department were randomly monitored and their safety behaviour on a hundred scale is given below. Do the departments differ in their safety behaviour?

Department	1	2	3	4	5
A1	68	73	75	65	78
A2	85	85	78	86	79
A3	73	77	72	70	76

9. Develop a Regression Equation between A and Busing Method of Least Square. Consider B as the dependent variable. Explain the significance of estimated slope.

Observation no.	1	2	3	4	5
A	75	80	85	90	95
B	80	75	80	60	55

10. Foodgrain production (in lakh tones) is given below. Find the Trend by using 3-yearly and 4-yearly movingaverage method, tabulate the trend values and predict the production for the year 2022.

Years	Production
2008	40
2009	60
2010	45
2011	85
2012	130
2013	135
2014	150
2015	120
2016	200

11. An evaluation of teaching methods shows the following outcomes.

Method of Teaching	No of students	Average marks obtained	Population Standard Deviation
Chalk and Talk Method	32	70	5
PPT and Talk Method	29	65	8

Conduct hypothesis testing for the mean difference of the teaching methods at a significant level corresponding to a Type I error probability of 0.01.

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CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221TCE007	THEORY OF ELASTICITY	PROGRAM CORE 1	3	0	0	3

Preamble: This course advances students from the one-dimensional and linear solid mechanics problems, conventionally treated in courses of strength of materials, into more general, two and three-dimensional problems. Students will be introduced to rectangular and polar coordinate systems to describe stress and strain in an elastic continuum and also solve various 2D linear elastic problems.

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

CO 1	Apply knowledge of mechanics and mathematics to model elastic bodies as continuum.
CO 2	Formulate boundary value problems; and calculate stresses and strains.
CO 3	Comprehend constitutive relations for elastic solids and compatibility constraints.
CO 4	Solve two-dimensional problems (plane stress and plane strain) using the concept of stress function.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	3	3	1
CO 2	3	2	3	3	3	3	1
CO 3	3	2	3	3	3	3	1
CO 4	3	2	3	3	3	3	1

Assessment Pattern

Bloom's Category	Continuous Assessment test	End Semester Examination
Understand	10	15
Apply	10	15
Analyse	20	30
Evaluate	-	-
Create	-	-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222TCE100	ADVANCED NUMERICAL METHODS	DISCIPLINE CORE 2	3	0	0	3

Preamble: For solving complex problems in mechanics and engineering, a post-graduate student must be well versed in numerical methods along with skills to apply them. This course equips the student with various numerical techniques that finds applications in civil engineering, across various streams (specialisations). Special focus is given to finite element method, explaining the relevance, versatility and fundamental concepts of this numerical tool.

Course Outcomes: After the completion of the course, the student will be able to

CO 1	Obtain the solution of simultaneous Linear system of equations
CO 2	Obtain the numerical solutions of ordinary differential equations
CO 3	Obtain the numerical solutions for solving boundary value problems of partial differential equations
CO 4	Describe the terminologies, applications or procedure of finite element method
CO 5	Describe or apply the concept of finite element method

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3			3			
CO 2	3			3			
CO 3	3			3			
CO 4	1		2	2	2	2	
CO 5	3			2	2	2	

(1-Weak, 2-Medium, 3- strong)

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	25
Analyse	25
Evaluate	5
Create	5

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (Minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

Note: Enough opportunity to explore the practical examples from specialization should be given to the students. One assignment/course project should be based on the coding or use of packages

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model Question Paper

QP CODE:

Reg No.:_____

Name:_____ ___

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER M.TECH. DEGREE EXAMINATION, MONTH & YEAR

Course Code: XXXXXX

ADVANCED NUMERICAL METHODS

Max. Marks: 60 Duration: 2.5 hours

PART A

(Answer ***ALL*** questions; each question carries 5 marks)

1. Explain the procedure of solution of Tridiagonal systems
2. Explain single shooting method for solving Boundary value problems
3. Explain the parabolic and elliptic partial differential equations with examples
4. Explain any five practical applications of Finite element in the con
5. Explain Generalised coordinates and Natural coordinates in Finite Element analysis

PART B

(Answer ***any FIVE*** questions; each question carries 7 marks)

6. Solve the system of equations by Jacobi's iteration considering initial approximation as $[0.5, -0.5, 0.5]^T$

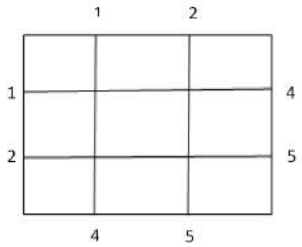
$$4x_1 + x_2 + x_3 = 2$$

$$x_1 + 5x_2 + 2x_3 = -6$$

$$x_1 + 2x_2 + 3x_3 = -4$$

7. Solve $y'=x^2+y$ for y=0.1, given that $y(0)=1$ considering h=0.05 using (i) Eulers method and (ii) Runge Kutta method

8. Solve the equation $uxx + uyy = 0$ for the square mesh with boundary value as shown in figure



9. Solve $\left(\frac{\partial u}{\partial t}\right)=\left(\frac{\partial^2 u}{\partial x^2}\right)$ subject to the conditions $u(x,0)=\sin(\pi x)$ for $0 \le x \le 1$ $u(0,t)=u(1,t)=0$. Perform the computations of two levels taking $h=1/3$ and $t=1/36$ using Crank Nicolson implicit scheme

10. Explain in detail the steps of finite element analysis

11. Explain forms of shape functions in finite element analysis

12. Explain the convergence criteria in finite element applications in detail

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Syllabus

Module 1 **(7 hours)**

Solutions of simultaneous Linear Systems of Equations- Solution of linear systems – Direct methods, Gauss-Jordan Method-Method of factorization- Solution of Tridiagonal Systems. Solution by matrix decomposition Iterative methods: Jacobi, Gauss-Siedel iteration for ordinary and sparse systems, Convergence of iterative solution schemes with examples.

Module 2 **(7 hours)**

Solving Ordinary Differential Equations- The Elementary Theory of Initial-Value Problems -Euler's Method- Higher-Order Taylor Methods. Runge-Kutta Method- Introduction to solution methods for differential algebraic equations- Single shooting method for solving ODE-BVPs.

Module 3 **(7 hours)**

Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method. Crank-Nicholson implicit method - Ellipse equations- Finite difference method-Problems with irregular boundaries.

Module 4 **(7 hours)**

Introduction to Finite Element Method – Historical Background — Mathematical Modeling of field problems in Engineering — Governing Equations — Discrete and continuous models — Boundary, Initial and Eigen Value problems– Basic concepts of the Finite Element Method- Displacement approach-Concept of Stiffness Matrix and Boundary Condition-- General procedure of FEA

Module5 **(7 hours)**

Concept of Finite Element Method- Concept of Nodes, elements, Generalised coordinates and Natural coordinates in FEA. Shape functions – Polynomials - Lagrangian and Hermitian Interpolation –- Compatibility - C0 and C1 elements - Convergence criteria - Conforming & nonconforming elements. Development of element matrices for one dimensional elements.

Text Books

1.Gupta,S.K. Numerical Methods for Engineers. Wiley Eastern, New Delhi, 1995.

2. Cook, RD. Concepts and Applications of Finite Element Analysis , Wiley.

Reference Books

1. Gilbert Strang, Linear Algebra and its Applications (4th Ed.), Wellesley Cambridge Press 2009

2. Gourdin, A. and M Boumhrat. Applied Numerical Methods.Prentice Hall India, New Delhi 2000

3. Chopra S.C. and Canale R.P. Numerical Methods for Engineers,McGraw Hill 2006

4. Krishnamoorthy C S, *Finite Element Analysis- Theory and Programming*, Tata McGraw Hill, New Delhi., 1994

5. Rao, SS. Finite Element Analysis, Elsevier Butterworth-Heinemann

6. Gerald and Wheatly, *Applied Numerical Analysis,* Pearson Education.

7. Rajasekharan S., *Numerical Methods in Science and Engineering,* S Chand & Company, 2003.

8. Bathe K J, *Finite Element Procedures in Engineering Analysis*, Prentice Hall, New Delhi. 1982

9. Chandrupatla T R and Belegundu A D, *Introduction to Finite Elements in Engineering*, Pearson Education, New Delhi 1998

10. Rajasekharan S, *Finite Element Analysis in Engineering Design*, Wheeler, New Delhi

11. Hutton D V, *Fundamentals of Finite Element Analysis*, Tata McGraw Hill Education Private Ltd, New Delhi

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