INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION

Course Title	**:**	**PROBABILITY AND STATISTICS**			
Course Code	**:**	**A30008**			
Course Structure	**:**	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	:	4	1	-	4
Course Coordinator	**:**	Mrs. L. Indira, Associate Professor			
Team of Instructors	**:**	Mrs. L. Indira, Associate Professor Mr. Ganesh Kumar, Assistant Professor.			

I. COURSE OVERVIEW

The course matter is divided into five chapters covering duly-recognized areas of theory and study. This course develops abstract and critical reasoning by studying logical proofs and the axiomatic method as applied to basic probability and to make connections between probability and other branches of mathematics. The topics covered include probability, random variables and distributions, correlation and regression, sampling distribution, testing of hypothesis for large samples and small samples, queuing theory and stochastic process. The course helps students gain an appreciation for the diverse applications of statistics and its relevance to their lives and fields of study.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	5	Basic Statistics and Algebra

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective test. The subjective test is for 20 marks, with duration of 2 hours. Subjective test of each semester shall contain 5 one mark compulsory questions in part-A and part-B contains 5 questions, the student has to answer 3 questions, each carrying 5 marks. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

IV. EVALUATION SCHEME

S.No	Component	Duration	Marks
1	I Mid examination	90 minutes	20
2	I Assignment	--	05
3	II Mid examination	90 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES

I. Expose students to the elements of probability, probability distributions and statistical inference.
II. Provide an introduction to probability and statistics with applications.
III. Develop an understanding about the role of statistics in engineering.
IV. Develop an understanding about the application of statistical analysis to solve real-life problems.

VI. COURSE OUTCOMES

After completing this course the student must demonstrate the knowledge and ability to:

1. **Recall** the basics of permutation and combination.
2. **Demonstrate** an understanding of the basic concepts of probability and random variables.
3. **Classify** the types of random variables and calculate mean and variance.
4. **Recognize** where the Binomial Distribution and Poisson distribution could be appropriate model and find mean & variance of the distributions.
5. **Apply** the inferential methods relating to the means of Normal Distributions.
6. **Explain** multiple random variables and covariance of two random variables.
7. **Calculate** the correlation and regression to the given data.
8. **Understand** the concept of sampling distribution of statistics and in particular describe the behavior of the sample mean.
9. **Understand** the foundation for classical inference involving confidence interval and hypothesis testing.
10. **Apply** testing of hypothesis for large samples and small samples.
11. **Describe** the queuing system, mean arrival and service rates.
12. **Calculate** expected queue length and waiting lines
13. **Define** random process, Markov chain and stochastic matrix and limiting probabilities.
14. **Calculate** the gambler ruin for the given data.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an Engineering. specialization to the solution of complex engineering problems.	H	Assignments, Tutorials
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	H	Assignments
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	S	Assignments
PO4	**Conduct investigations of complex problems**: Use research- based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	S	Assignments

PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	N	-
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	N	-
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	N	-
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	N	-
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	N	-
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	N	-
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	N	-
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	N	-

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.	S	**Lectures, Assignments**
PSO 2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	S	Assignments
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.	S	**Guest Lectures**

N - None **S - Supportive** **H – Highly Related**

IX. SYLLABUS

UNIT-I

Single Random variable and probability distribution: Random Variable-Discrete and continuous. probability distributions, mass function/density function of a probability distribution. mathematical expectation, moments about origin, central moments. Moment generating function of probability distribution. Binomial, passion & normal distributions and their properties. Moment generating functions of the above three distributions and hence find the mean and variance

UNIT-II

Multiple Random variables, Correlation & Regression: Joint probability distribution-joint probability mass/density function, marginal probability mass/density function, covariance of two random variables, correlation-coefficient of correlation, the rank correlation Regression-Regression coefficient. The lines of regression and multiple correlation & regression.

UNIT-III

Sampling Distribution and Testing of Hypothesis:

Sampling: Definition of population, sampling, statistic, parameter. Types of sampling, expected values of sample mean and variance, sampling distribution, standard error, sampling distribution of means and sampling distribution of variance.

Parameter estimation-likelihood estimation, interval estimation.

Testing of Hypothesis: Null hypothesis, alternative hypothesis, type-I &type II errors-critical region, confidence interval, level of significance, one sided test, two sided test.

Large sample tests:

i) Test of equality of means of two samples equality of sample mean and population mean(cases of known variance & unknown variance, equal and unequal variances)
ii) Tests of significance difference between sample S.D and population S.D
iii) Tests of significance difference between sample proportion and population proportion & difference between two samples proportions.

Small sample tests:

Student t-distribution, its properties; test of significance difference between sample mean and population mean; difference between means of two small samples. Snedecor's F-distribution and its properties. Test equality of two population variances, Chi-square distribution and its properties, Chi-square test of goodness of fit

UNIT-IV

Queuing Theory: Structure of a queuing system, operating characteristics of queuing syatem.Transient and steady states, terminology of queuing system, arrival and service processes-pure birth-death process-deteministic queuing models-M/M/1 model of infinite queue, M/M/1 model finite queue.

UNIT-V

Stochastic processes: Introduction to stochastic process-classification of random processes,methods of description of random processes,stationary and non-stationary random process,average values of single random process and two or more random process.Markov process,Markov chain,classification of states-examples of Markov chains,Stochastic matrix.

Textbooks:

1. 1. Dr. B. S. Grewal, "Higher Engineering Mathematics", Khanna publishers.
2. 2. Sheldon M Ross, "Probability and Statistics for Engineering and Scientists", Academic press.
3. S. D. Sarma, "Operation Research".

Referencebooks:

1. K. B. Datta and M.A.S.Srinivas, "Mathematics for Engineering", Cengage Publications.
2. T. K. V. Iyengar, B. Krishna, "Probability and Statistics", Gandhi Et.
3. S. C. Gupta and V. K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons.
4. Jay I Devore, "Probability and Statistics for Engineers and Scientists", California, 2004.

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1	**Demonstrate** an understanding of the basic concept of probability and random variables	Single random variables and probability distributions: Introduction to probability	T1,R2

2	**Describe** the concept of random variables	Definition of random variable	T1,R2
3	**Contrast** discrete random variables and calculate the mean and variance of discrete random variables	Discrete probability distributions	T1,R2
4	**Contrast** continuous Random variables and calculate the mean and variance of continuous Random variables	Continuous probability Distributions	T1,R2
5	**Recall** the continuous probability function	Density function of a probability Distribution	T1,R2
6	**Identify** mathematical mean and find moment about origin	Mathematical expectation, moment about origin	T1,R2
7	**Generalize** central moments and moment generating functions of a probability distribution	Central moments, moment generating function of a probability distribution	T1,R2
8-9	**Recall** characteristics of the Binomial Distribution and find mean , variance	Binomial distribution	T1,R2
10-11	**Recognize** cases where Poisson Distribution could be appropriate model to find mean and variance	Poisson distribution	T1,R2
12-14	**Apply** Normal Distributions find the probability over a set of values, mean and variance	Normal distribution and their properties	T1,R2
15	**Apply** probability distribution to find moment generating functions	Moment generating functions of three distributions	T1,R2
16	**Recall** the properties of sample correlation and identify which variable in Regression Analysis	Multiple random variables, correlation and regression: Introduction joint probability Distribution	T1,R2
17	**Apply** probability distribution	Joint probability mass or density function	T1,R2
18-19	**Apply** marginal probability density function	Marginal probability mass or density function	T1,R2
20	**Identify** the covariance of two random variables	Covariance of two random Variables	T1,R2
21	**Recognize** the limitation of correlation as a summary of bivariate data.	Coefficient of correlation	T1,R2
22	**Interpret** the correlation between the bivariate data by allotting ranks.	Rank correlation	T1,R2
23-24	**Define** the concept of least squares estimation in linear regression	Regression coefficient	T1,R2
25-26	**Estimate** the linear model to a bivariate data	The lines of regression	T1,R2
27-28	**Recognize** the multiple correlation of bivariate data	Multiple correlation and regression	T1,R2
29	**Recall** the sampling distribution of the sample mean in general situation	Sampling distribution and testing of hypothesis: definitions of sampling distributions	T1,R2

30-31	**Distinguish** between a population and a sample and between parameters & statistics	Types of sampling, expected values of sample mean and Variance	T1,R2
32-33	**Recall** the sampling distribution of the sample mean in general situation	Sampling distributions of means and variance	T1,R2
34-35	**Interpret** the confidence interval and confidence level	Estimations	T1,R2
36	**Understand** the foundation for classical inference involving hypothesis testing	Testing of hypothesis	T1,R2
37	**Explain** the procedure and two types of errors possible	Procedure for testing of hypothesis	T1,R2
38	Identify the confidence interval with single mean	Testing of hypothesis with single mean	T1,R2
39-40	Identify the confidence interval with difference between the mean	Testing of hypothesis with difference of means	T1,R2
41-42	Identify the confidence interval with difference between the proportions	Testing of hypothesis with single Proportion	T1,R2
43-44	Identify the confidence interval with difference between the proportions	Testing of hypothesis with difference of proportions	T1,R2
45-46	Recall the definition of a t-statistics in terms of statistics of sample from a normal distribution	Student's t-tests and its properties	T1,R2
47-48	State and apply the definition of F-distribution	F-test	T1,R2
49-50	State and apply the definition of-distribution	F-test	T1,R2
51	Apply Poisson process in finding arrival and departure rates.	Queuing theory: Introduction to queuing theory	T3,R2
52	Define and explain basic concepts in the theory Markov processes, M/M/1 queuing systems	Structure of queuing system	T3,R2
53	Derive and apply main formulas for some properties (such as stationary probabilities, average waiting and system time, expected number of customers in the queue, etc.) of M/M/1 queuing systems.	Characteristics of queuing system	T3,R2
54	Analyseand solve problems	Transient and steady state	T3,R2
55	Calculate the traffic intensity, blocked traffic and the utilization of some queuing systems	Pure birth and death process	T3,R2
56	Define and explain basic concepts in the theory Markov processes, M/M/1 queuing systems	M/M/1-model -1	T3,R2
57	Define and explain basic concepts in the theory Markov processes, M/M/1 queuing systems	M/M/1-model -2	T3,R2
58	Understand the theory of multivariate data	Stochastic process: introduction to stochastic	T3,R2

		processes	
59	Classify different types of randomprocesses	Classification of random processes	T3,R2
60	Define and explain basic concepts in the theory Markov processes	Markov process	T3,R2
61	Classify different states of Markov process	Classification of state	T3,R2
62	Understand the concept of Markov chain	Markov chains	T3,R2
63	Define stochastic matrix and apply the process to practical problems	Stochastic matrix	T3,R2

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I	H	H											S	S	
II	S	H											S	S	
III	H												S		
IV		S												S	

N = None **S = Supportive** **H = Highly related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF TSHE PROGRAM OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	H	H											S	S	
2	H	S											S		
3	S	S		S										S	
4	H												S		
5	S												S		
6	H													S	
7		H											S		
8	H													S	
9		S											S		
10		S											S		
11	S													S	
12	H		S										S		
13	S	S												S	S
14	H												S		

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Prepared by:
Mrs. L. Indira, Associate Professor

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