Ghulam Ishaq Khan Institute of Engineering Sciences and Technology (GIKI)

Faculty of Engineering Sciences (FES)

EE 111 Applied Statistics (3 Credit Hours) – Spring 2024

Pre-Requisite: MT 101 Calculus I

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Office Hours: Tuesday, Wednesday, Thursday 10:30 – 11:30. Or by appointment.

Course Introduction

This course introduces the students to the fundamentals of probability theory, engineering statistics, and data analysis. The first one half of the course develops necessary "Probability Theory" that is used to analyze the random processes occurring in natural sciences and engineering. The second half of the course is about "Inferential Statistics" where the students learn the techniques of analyzing the statistical data and making inferences about population using sample data. Statistical tests are developed using the probability theory learned in first half of the course. The emphasis is on using statistical methods to the problems of applied science and engineering. Students are expected to have good background of analytical skills for this course. On completion of this course, the students will be trained enough to appreciate the power of statistical techniques and apply these tools to analyze problems in their areas.

Course Contents

- **Introduction to Probability:** Basic definitions, axioms of probability, addition and multiplication rules, conditional probabilities, independence, and Bayes' rule, revision of permutations and combinations.
- **Probability Distributions:** Random variables and probability distributions, discrete and continuous RVs, probability mass function, density function, and cumulative distribution function, mean, variance, higher moments, and their calculation.
- **Discrete Distributions:** Binomial, Poisson, and hyper geometric distributions, mean and variance of standard discrete distributions.
- **Continuous Distributions:** Uniform, exponential, and normal distributions, standard normal distribution and calculation of normal probabilities using tables, mean and variance of standard continuous distributions.
- **Joint Distributions:** Joint distributions of two random variables, discrete and continuous joint probability distributions, marginal probability distributions, independence and covariance of joint probability distributions.
- **Descriptive Statistics and Random Sampling:** Data arrangement, measures of central tendency, spread and variability, frequency distributions and histograms, plots of data, random sampling, distribution of sample mean and variance.
- **Estimation Theory:** Estimation of unknown parameters of a population distribution, point estimation, interval estimation, standard error of estimation and margin of error, confidence intervals of mean and proportion, calculation of sample size, small sample theory and t-distribution, chi-square.
- **Hypothesis Testing:** Statistical hypotheses, one and two tail tests, significance and confidence levels, relationship with interval estimation, critical regions, type I and type II errors, chi-square test.
- **Regression Analysis:** Simple linear regression, the method of least squares, inferences based on least-square estimators.
- **Design of Experiments:** One-factor experiments, response variable, pairwise comparisons in one-factor experiments.

Mapping of CLOs & PLOs

By the end of the course, the student will be able to:			
CLOs	**Course Learning Outcomes**	**PLOs**	**Blooms Taxonomy**
CLO-1	**Calculate** probabilities of events, joint probabilities, conditional probabilities using set operations and definition of probability. Justify valid and invalid probability assignments and independence of events.	PLO-2 (Problem analysis)	Cognitive Level-3 (Applying)
CLO-2	**Calculate** probability mass/density function parameters, moments and functions of random variables.	PLO-2 (Problem analysis)	Cognitive Level-3 (Applying)
CLO-3	**Draw** inferences about population and sample data using techniques of "Inferential Statistics".	PLO-2 (Problem analysis)	Cognitive Level-4 (Analyzing)

CLO-4	**Solve** problems related to basic estimators and design of experiments	PLO-2 (Problem analysis)	Cognitive Level-3 (Applying)
CLO-5	**Demonstrate** ability to implement learned concepts in a modern tool (such as R, Python)	PLO-2 (Problem analysis)	Cognitive Level-3 (Applying)

CLOs Direct Assessment Mechanism

CLO #	Assessment Tools
CLO1	Quizzes, Assignments, Midterm Exam, Final Exam
CLO2	Quizzes, Assignments, Midterm Exam, Final Exam
CLO3	Quizzes, Assignments, Final Exam
CLO4	Quizzes, Assignments, CEP, Final Exam
CLO 5	Assignments, CEP

Overall Grading Policy

Assessment Tools	Percentage
Quizzes (Surprise + Scheduled)	15%
Assignments + Python Certification	(8+2) %
Software Tool Evaluation	5%
Midterm Examination	30%
Final Examination	40%

Text and Reference Books

Text Book:

1. **Probability and Statistics for Engineers & Scientists** by R. E. Walpole (9th Ed., Prentice-Hall, 2012).

Reference Books:

1. **Probability and Statistics for Engineers (Miller & Freund's)** by Richard A. Johnson (9th Ed., Pearson USA, 2017).
2. **Probability and Statistics for Engineering and Sciences** by Jay L. Devore, (8th Ed., Brooks/Cole USA, 2012).

Administrative Instructions

- According to institute policy, 80% attendance is mandatory to appear in the final examination.
- Assignments must be submitted as per instructions given for each assignment.
- In any case, there will be no retake of (scheduled/surprise) quizzes.
- Mobile phones are not allowed during quizzes and exams.
- Bring calculator/statistical tables in lecture classes.

Computer Usage

Students are encouraged to solve some assigned homework problems using the available statistical software.

Lecture Breakdown (subject to change)

Lecture	Topics	CLO
1	Overview of Probability and Statistics	1, 5
2	Revision of set algebra and simple combinatorics	
3	Basic definitions and axioms of probability	
4	Addition and multiplication rules of probability	
5	Conditional probabilities and independence	
6	Law of total probability and Baye's rule	
7	Joint probability distributions	
8	Marginal distributions	

9	Independence and covariance in joint distributions	
10	Random Variables and Probability Distributions	2, 5
11	Discrete and continuous RVs	
12	Probability mass function, density function	
13	Cumulative distribution function	
14	Expected value of a random variable and its calculation	
15	Variance of a random variable and its calculation	
16-17	Binomial distribution and its mean and variance	
18-19	Poisson distribution and its mean and variance	
20	Hypergeometric distribution and its mean and variance	
21	Uniform distribution and its mean and variance	
22	Exponential distribution and its mean and variance	
23-24	Normal distribution and its mean and variance	
25	Data arrangement and central tendency	3, 5
26	Spread and variability	
27	Frequency distributions and histograms, plots of data	
28	Random sampling, distribution of sample mean and variance	
29	Point estimation, standard error and MSE	
30	Problems on point estimation	
31-32	Confidence intervals of mean and variance in different situations	
33	Sample size, small sample theory and t-distribution	
34	Confidence interval of population proportion	
35	Statistical hypotheses and one and two tail tests	
36	Type I and type II errors, critical regions	
37	Hypothesis testing on mean, variance and population proportion	
38	Simple linear regression, the method of least squares	4, 5
39	Inferences based on least-square estimators	
40	Curvilinear regression, adequacy of the regression model, correlation	
41	One-factor experiments, response variable	
42	Pairwise comparisons in one-factor experiments	
43	Two-factor experiments, error correction	
44-45	Revision	

All the Best