

**Catalog Description:** Descriptive statistics, experimental design, introduction to probability, common probability distributions, random variables, sampling distributions, hypothesis testing and confidence intervals for means using one and two samples, simple linear regression.

**Course Objectives:** After completing this course, students will be able to

1. Describe patterns and departures from patterns in data.
2. Use probability rules and distributions, including the binomial and normal distributions, to solve problems.
3. Perform statistical inference.
4. Draw an appropriate conclusion based on the results of statistical analysis and the study design.

### Learning Outcomes and Performance Criteria

1. Identify and describe elements of experimental and observational design.

Core Criteria:

- (a) Describe the importance of randomization and its effect on both variation and bias of data.
- (b) Describe sampling techniques within an observational design, including but not limited to: Simple Random, Stratified Sampling, and Cluster Sampling.
- (c) Identify experimental units and variables within a study, classifying the variable type as continuous numerical, discrete numerical, ordinal categorical, nominal categorical, or binary.
- (d) Classify what role variables have within a sampling design: explanatory, response, and potential confounding effects (strata, blocking, or covariates).
- (e) Identify categorical variables and their levels for a statistical experiment.
- (f) Distinguish between experimental and observational statistical sampling procedures.
- (g) Identify potential sources of bias within a design and recommend sampling procedure to minimize bias.
- (h) Identify population, sample, and the level of generalizability of the results of a given statistical sampling strategy.
- (i) Recognize statistical ethical considerations including recognition of the need for IRB, informed consent, and data security requirements within statistical sampling and storage protocol.

Additional Criteria:

- (a) Classify variables according to mediation and moderation effect within a statistical experiment.
- (b) Describe or identify systematic sampling as a statistical procedure.

2. Organize and describe data with numerical measures.

Core Criteria:

- (a) Calculate the mean.
- (b) Compare and contrast two data sets in terms of their means, variances, and standard deviations.
- (c) Calculate the five number summary.
- (d) Answer questions about a data set based on the five number summary.
- (e) Calculate the linear correlation coefficient.
- (f) Calculate the least squares regression line.
- (g) Compare and contrast the correlation coefficient for two data sets (strength and direction).
- (h) Interpret the slope of a least squares regression line in terms of the variables.
- (i) Interpret the coefficient of determination as the percentage of variation in the response variable explained by the linear model.

Additional Criteria:

- (a) Calculate the coefficient of determination.
- (b) Calculate the mode.
- (c) Interpret the  $y$ -intercept of a least squares regression line.

3. Organize and describe data graphically.

Core Criteria:

- (a) Create and interpret a box-plot.
- (b) Create and interpret a histogram.
- (c) Create and interpret a scatter-plot.
- (d) Compare multiple graphs for different data sets.
- (e) Determine if data is skewed or symmetric.
- (f) Create and interpret a bar-plot and stacked or side-by-side bar-plot.

Additional Criteria:

- (a) Create and interpret a dot-plot.
- (b) Create and interpret a stem and leaf diagram.
- (c) Create and interpret a pie chart.
- (d) Create and interpret a cumulative frequency plot.
- (e) Create and interpret side-by-side box plots.

4. Calculate and interpret probabilities with discrete distributions using one or more of the following:

Core Criteria:

- (a) Addition rule.
- (b) Multiplication rule.
- (c) Conditional probability.
- (d) Marginal probability.
- (e) Independent events.
- (f) Dependent events
- (g) Compliment.
- (h) Combination.
- (i) Permutation.
- (j) Multiplication law.
- (k) Binomial distribution.
- (l) Mean and standard deviation of the binomial distribution.
- (m) Tree diagram.
- (n) Expected Value

Additional Criteria:

- (a) Probability distribution.
- (b) Law of large numbers.
- (c) Standard deviation of a probability distribution.

5. Calculate and interpret probabilities with continuous distributions using one or more of the following distributions or concepts:

Core Criteria:

- (a) Normal Distribution.
- (b) Sampling Distribution of the mean.
- (c) Central limit theorem.
- (d) T-Distribution.

Additional Criteria:

- (a) Proportions.

6. Make inferences about population mean(s) using a confidence interval:

Core Criteria:

- (a) Compute confidence intervals for the mean of a large sample ( $z$ -value).
- (b) Compute confidence intervals for the mean of a small sample ( $t$ -value).
- (c) Compute confidence intervals for the difference of two means. (dependant and independent)
- (d) Interpret a confidence interval.

Additional Criteria:

- (a) Compute confidence intervals for the mean for a proportion.
- (b) Test hypothesis for one or two proportion(s).

7. Make inferences about population mean(s) by hypothesis testing:

Core Criteria:

- (a) Test hypothesis for one or two mean(s).
- (b) Conduct a one-sample, two-sample or paired  $t$ -test:
  - Write the null and alternative hypotheses.
  - Determine the test statistic  $t$  and the degrees of freedom  $df$ .
  - Determine the  $P$ -value using technology or give an appropriate interval that includes the  $P$ -value.
  - Decide whether or not to reject the null hypothesis and write a conclusion.
- (c) Determine whether a  $t$ -test is one or two-tailed.
- (d) Determine when a paired  $t$ -test should be used.
- (e) Quantitative evidence from a hypothesis test is conveyed, and explained in such a way that a competent non-expert reader can follow along.