General Education Statistics 3-4 semester hours

Prerequisites: A student in this course should be college-ready in mathematics as assessed by local institutions (for example: Intermediate Algebra with a C or better, placement, co-requisite course, multiple measures, transitional mathematics competencies, PMGE, or professional organization recommendations, etc.).

Note: See Technology Statement in the Introduction

Focuses on statistical reasoning and the solving of problems using real-world data rather than on computational skills. The use of technology-based computations (more advanced than a basic scientific calculator, such as graphing calculators with a statistical package, spreadsheets, or statistical computing software) is required with an emphasis on interpretation and evaluation of statistical results. Topics must include data collection processes (observational studies, experimental design, sampling techniques, bias), descriptive methods using quantitative and qualitative data, bivariate data, correlation, and least squares regression, basic probability theory, probability distributions (normal distributions and normal curve, binomial distribution), confidence intervals and hypothesis tests using p-values.

Course Content

The following three major areas are to be considered. These, along with a listing of topics for each, are:

1. Collection, Presentation and Description of Quantitative and Qualitative Data
   A. Data Collection and Experimental Design
      1. Terminology of Experimental Design – measurement level, qualitative/quantitative, discrete/continuous, observational study, designed experiment
      2. Sampling – simple random sample, stratified sample, systematic sample, cluster sample, convenience sample
   B. Graphical Methods
      1. Univariate Techniques - histograms, box plots
      2. Bivariate Techniques - scatterplots (including estimation of best fit line)
   C. Numerical Methods
      1. Measures of Location - means, medians, modes
      2. Measure of Variability - standard deviations, ranges, interquartile ranges, outliers
      3. Measures of Association - correlation coefficients: examples and properties
2. Probability and Probability Distributions
   A. Probabilities of events as relative frequencies from observed data
   B. "Theoretical" probability as limit of relative frequencies
      1. The "addition rule," conditional probability, "multiplication rule," independence of events
      2. The Law of Large Numbers
   C. The Central Limit Theorem
   D. Random variables, means and variances
3. Sampling and Statistical Inference
   A. Population and Samples: random sampling, sample survey methods, errors in sampling, bias, sampling distributions
   B. Point estimation: estimators for proportions, means, and correlation coefficients; properties
   C. Interval estimation (confidence intervals): proportions and means
   D. Hypothesis Testing: testing H_0: $p = p_0$ and H_0: $\mu = \mu_0$ (including p-value method)

Course Objectives—The student will be able to:

1. Collection, Presentation and Description of Quantitative Data
   A. apply and interpret basic terminology of experimental design and primary random sampling strategies.
   B. organize and graph quantitative and qualitative data.
   C. apply the definitions, properties, and functions of the following descriptive statistics and calculate their values from small data sets: means, medians, variances, standard deviations, correlation coefficients.
2. Probability and Probability Distributions
   A. recognize certain data sets as being the result of random experiments, determine the relative frequency of certain events related to these experiments and use probability language to express those determinations.
   B. express and provide examples of the interpretation of the probability of an event as the limit of the relative frequency of that event in repeated experiments; express and provide examples of alternative interpretations of probability.
   C. determine probabilities of events through the application of the standard ideas in elementary probability (e.g. the

"addition rule," the "multiplication rule," independence of events, conditional probability,...).

D. given a random experiment with a random variable defined on its sample space, construct the probability function of the random variable and determine probabilities of events described in terms of random variables.

E. give examples of continuous random variables, their probability density functions, the determination of probabilities of events described in terms of random variables, and, for certain simple distributions (e.g. the normal distribution), find probabilities of events, given the mean and standard deviation of the random variable.

F. establish the parameters and properties of a sampling distribution comprised of both sample means and sample proportions.

3. Sampling and Statistical Inference

A. state the Central Limit Theorem as it applies to sample means and state the properties of the distribution of the sample proportions.

B. list properties of estimators of population proportions and means and find corresponding estimates from sample data.

C. list properties of interval estimates of means and proportions and construct confidence intervals from sample data.

D. state appropriate hypotheses and alternatives concerning population means and proportions and test these using sample data.

Notes

The general education statistics course provides students with an opportunity to acquire a reasonable level of statistical literacy and thus expand their base for understanding a variety of work-related, societal, and personal problems and statistical approaches to solutions of these problems. The main objective of the course is the development of statistical reasoning. Detailed techniques of statistical analysis and the mathematical development of statistical procedures are not emphasized. The course is intended to meet the general education requirement. It is not intended to be a prerequisite to nor a replacement for courses in statistical methods (for business or social science) nor for courses in mathematical statistics.

While some latitude in choice of topics and their position in the course is allowable, it is necessary that each of the major areas receive significant attention.

This course is intended to align with M1-902 of the Illinois Articulation Initiative. Be sure to check the appropriate course description with the Illinois Articulation Initiative to ensure proper alignment.

Statistics 3-4 semester hours (4 hours is recommended)

Prerequisite: College Algebra with a grade of "C" or better

Note: See Technology Statement in the Introduction

This is a course designed to provide students with the ability to:

- Determine appropriate mathematical techniques and statistical tests required to evaluate data in order to make informed decisions.
- Identify and use statistical tools and quantitative reasoning to extract information from data, interpret the findings, and demonstrate the ability to make and communicate informed decisions.
- Determine and execute appropriate statistical tests using data to evaluate and infer population parameters.
- Analyze and solve basic statistical problems involving: descriptive measures of populations and samples, central tendency and variability, probability theory, interval estimation, hypothesis tests of means and proportions, simple linear regression, chi square tests, F-test, and one-way analysis of variation.

Course Content

1. Descriptive Methods
 A. Frequency distributions and graphing
 B. Measures of location--mean, median, quartiles, percentiles
 C. Measures of variation--variance, standard deviation

2. Basic Probability Theory
 A. Sample spaces and probability as relative frequency
 B. Probability Laws

3. Probability Distributions
 A. Normal distribution and normal curve
 B. Binomial distribution
 C. Random samples and sampling techniques
  1. Distribution of sample means and variance
  2. Applications in fields such as quality control

4. Statistical Inference
 A. Interval Estimation
 B. Hypothesis Testing
  1. Means, Proportions, and Variances (both 1- and 2-sample)
  2. Chi-Square goodness-of-fit and independence tests
  3. Analysis of Variance
  4. Type I and II Errors

5. Correlation and Regression
 A. Coefficient of correlation
 B. Regression line; line of best fit

Course Objectives—The student will be able to:

1. Collection, Presentation and Description of Quantitative Data
 A. apply and interpret basic terminology of experimental design and primary random sampling strategies.
 B. organize and graph quantitative and qualitative data for univariate and bivariate data.
 C. apply the definitions, properties, and functions of the following descriptive statistics and calculate their values from small data sets: means, medians, variances, standard deviations, correlation coefficients.
2. Probability and Probability Distributions
 A. recognize certain data sets as being the result of random experiments, determine the relative frequency of certain events related to these experiments and use probability language to express those determinations.
 B. express and provide examples of the interpretation of the probability of an event as the limit of the relative frequency of that event in repeated experiments; express and provide examples of alternative interpretations of probability.
 C. determine probabilities of events through the application of the standard ideas in elementary probability (e.g. the

"addition rule," the "multiplication rule," independence of events, conditional probability,...).

D. given a random experiment with a random variable defined on its sample space, construct the probability function of the random variable and determine probabilities of events described in terms of random variables.

E. give examples of continuous random variables, their probability density functions, the determination of probabilities of events described in terms of random variables, and, for certain simple distributions (e.g. the normal distribution), find probabilities of events, given the mean and standard deviation of the random variable.

F. establish the parameters and properties of a sampling distribution comprised of both sample means and sample proportions.

3. Sampling and Statistical Inference

A. state the Central Limit Theorem as it applies to sample means and state the properties of the distribution of the sample proportions.

B. list properties of estimators of population proportions, means, and standard deviations, and find corresponding estimates from sample data.

C. list properties of interval estimates of means, proportions, and standard deviations and construct confidence intervals from sample data.

D. state appropriate hypotheses and alternatives concerning population means, proportions, and standard deviations and test these using sample data.

E. state appropriate hypotheses and alternatives concerning goodness-of-fit test, independence test, and analysis of variance.

Notes

1. If it is desired to align this course with BUS 901 (Business Statistics as defined by the Business Majors Panel of IAI), applications to business and economics should be a fundamental part of the course. The Business Majors panel strongly recommends but does not require the pre-requisite of College Algebra. The full description and requirements of the IAI Business Statistics course are as follows:

At the conclusion of this course, students will be able to:

- Determine appropriate mathematical techniques and statistical tests required to evaluate data in order to answer questions related to business situations.
- Identify and use statistical tools and quantitative reasoning to extract information from data, interpret the findings, and demonstrate the ability to make and communicate informed business-decisions.
- Determine and execute appropriate statistical tests using historical business data to evaluate current climate and infer population parameters.
- Analyze and solve basic statistical problems involving: descriptive measures of populations and samples, central tendency and variability, probability theory, interval estimation, hypothesis tests of means and proportions, simple linear regression, chi square tests, and one-way analysis of variation.

2. This course can also be aligned with the Illinois Articulation Initiative Mathematics General Education Panel description for General Education Statistics (M1 902), though generally the course above will include more topics. See the course description for General Education Statistics in this guide to ensure proper alignment.