Course Title: Advanced Placement Statistics

Purpose: This course is designed to introduce students to four broad themes: 1) exploring data, 2) sampling and experimentation, 3) anticipating patterns, and 4) statistical inference. Throughout the course, students will develop strategies for collecting and analyzing data. They will be required to draw appropriate conclusions from their analysis and to communicate their conclusions in context.

Class will be structured so that students will be grouped to help communicate with each other their thought processes both orally and in written form. Class will consist of both lecture and activities that will utilize students' ability to design investigations to collect data, analyze their data, and the present their conclusions both orally and written.

Technology: Throughout the course, students are expected to use a calculator with statistical functionality, such as the TI-84 in both the classroom and at home. Will we also use a variety of online Java applets, MIMITAB software, and various other websites through use of a class room set of laptop computers. We will also use TI-emulator software and an Interactive White board daily so show various applications and power points.

Text:

Yates, Moore, & Starnes. *The Practice of Statistics.* 4 ed., W.H. Freeman & Co., 2011

Scheaffer, Gnanadesikan, Watkins, & Witmer. *Activity-Based Statistics.* 1st ed., New York, NY: Springer-Verlag., 1996

Gnanadesikan, Scheaffer, & Swift. *The Art and Techniques of Simulation.* 1 ed., Palo Alto, CA., Dale Seymour Publications 1987

Collings & Collings. *The Handbook of Statistics Review.* 1 ed., Orem, UT., CEDO Publishers 1998

Course Outline:

Unit 1: Sampling and Experimentation (4 weeks)

Objectives:

- Identify the population and sample in a sample survey
- Identify voluntary response samples and convenience samples and explain how these methods can lead to bias
- Distinguish between simple random samples, stratified random samples, and cluster samples
- Give advantages and disadvantages of each sampling method
- Explain how under coverage, nonresponse, and question wording can lead to bias in a sample survey
- Distinguish between and observational study and an experiment
- Explain how a lurking variable can lead to confounding
- Identify the experimental units, explanatory variables, treatments, and response variables in an experiment
- Describe a completely randomized design for an experiment and distinguish it from a randomized block design
- Describe how to avoid the placebo effect and explain the meaning and purpose of blinding in an experiment
- Know when a matched pairs experimental design is appropriate and how to implement such a design
- Determine the scope of inference for a statistical study

Activities:

- ✓ Activity: Random Rectangles or Jelly blubbers
  - This activity is used to compare convenience sampling and random sampling
- ✓ Technology: choosing an SRS using a calculator
- ✓ Activity: Distracted Driving
  - This activity explores the concepts of statistical significance
- ✓ Group Activity: Gummy Bear Catapult
  - Small groups are given the opportunity to design an experiment to investigate
  - Groups will collect data, make conclusions, and describe their design and conclusions to the rest of the class
- ✓ Release Open Response Items from previous exams (student presentations)
- ✓ Homework and classwork from chapter

Unit 2: Exploring Univariate Distributions

Objectives:

- Graphical Displays (dot plots, stem plots, histogram, cumulative frequency plots)
- Describe the center, shape, spread of data with noting clusters, gaps, outliers, and any other unusual features
- Summarizing data by measuring center: median and/or mean
- Measuring spread: range, interquartile range, and standard deviation
- Measuring position: quartiles, percentiles, and standardized scores (z-score)
- Using boxplots
- Determining the effect of changing units on summary measure
- Comparing univariate distributions by comparing center, shape, spread, clusters, gaps, outliers and other features of back-to-back stem plots or parallel boxplots

Activities:

- ✓ Analyzed/Compare dot plots of hypothetical data sets found by both students and teacher
- ✓ Analyze and Compare the distances based to treatments used during the Gummy Bear experiments from Unit 1.
- ✓ Matching graphical displays to statistical summaries activity
- ✓ M&M data collection activity
    - This activity will be used with measures of central tendencies and will be referred to later in the course
- ✓ Class Activity: Data Collection
    - Student survey characteristics of one another (ex. Number of phone contacts, friends on Facebook/Instagram, number of siblings, height, etc.) and create several types of displays of the data
- ✓ Technology: Histograms, boxplots on the calculator and/or other graphing software and computing numerical summaries
- ✓ Technology: Mean and Median applet
- ✓ M&M Activity for mean and standard deviation
- ✓ Homework and classwork from text
- ✓ Released Open Response Items from previous exams (student presentations)
- ✓ Unit Test

Unit 3: Probability and Simulation (4 weeks)

Objectives:

- Probability
    - Law of Large numbers
    - Addition rule, multiplication rule, conditional probability, and independence
    - Discrete random variables and their probability distributions, including binomial
    - Simulation of probability distributions, including binomial and geometric
    - Mean (expected value) and standard deviation of a random variable, and linear transformation of a random variable
- Combining Independent Random Variables
    - Notion of independence versus dependence
    - Mean and standard deviation for sums and differences of independent random variables
- The Normal Distribution
    - Properties of the normal distribution
    - Using tables of the normal distribution
    - The normal distribution as a model for measurements

Activities:

- ✓ Activity: Investigating randomness
- ✓ Activity: Law of Large Numbers
- ✓ Activity: Simulations
- ✓ Activity: Where do I stand?
    - Introduces concepts of position within a distribution and the effects of transformations on measures of center, spread, and position
- ✓ Activity: Transforming Variables
- ✓ Technology: Fathom Demonstration on the Normal Distribution
- ✓ Technology: Normal Probability plots on the calculator
- ✓ Technology: Binomial Probabilities on a calculator
- ✓ Technology: Geometric Probabilities on a calculator
- ✓ Preleased Open Response Items from previous exams (student presentations)
- ✓ Homework and classwork from chapters 5 and 6
- ✓ Unit Test

Unit 4 Sampling Distributions (3 weeks)

Objectives:

- Distinguish between a parameter and a statistic
- Distinguish between population distribution, sampling distribution, and the distribution of sample data
- Understand the relationship between sample size and the variability of an estimator
- Find the Mean and standard deviation of the sampling distribution of a sample proportion p-hat
- Find the mean and standard deviation of the sampling distribution of sample mean x-bar
- Use Normal approximation to calculate probabilities involving p-hat
- Use the sampling distribution of p-hat to evaluate a claim about a population proportion
- Calculate probabilities involving sample mean x-bar when the population distribution is Norma
- Explain how the shape of the sampling distribution of x-bar is related to the shape of the population distribution
- Use the Central Limit Theorem to help find probabilities involving a sample mean

Activities:

- ✓ Simulations of Sampling Distributions Activity
- ✓ Activity: A Penny for Your Thoughts
- ✓ Activity The Candy Machine
    - Introduces concepts related to sampling distributions of p-hat
    - Uses an applet to simulate the distribution of p-hat
- ✓ Activity: Central Limit Theorem using an Internet Applet
- ✓ Technology: Applet to Simulate the distribution of x-bar
- ✓ Technology: Fathom to simulate sampling distributions
- ✓ Released Open Response Items from previous exams (student presentations)
- ✓ Homework and classwork from Chapter 7
- ✓ Unit Test

End of1st Semester: Fall semester exam

Unit 5 Confidence Intervals (4 weeks)

Objectives:

- Properties of point estimators, including unbiasedness and variability
- Interpret a confidence level and a confidence interval in context
- Understand that a confidence interval gives a range of plausible values for the parameter

- Understand why each of the three inference conditions; random, normal, and independent are important
- Explain how practical issues like nonresponse, under coverage, and response bias can affect the interpretation of a confidence interval
- Construct and interpret a confidence interval for a population proportion and for a population mean
- Determine critical values for calculating a confidence interval using a table or a calculator
- Carry out the steps in constructing a confidence interval for a population proportion and for a population mean
    - Define parameter
    - Check conditions
    - Performs calculations
    - Interpret results in context
- Determine the sample size required to obtain a level C confidence interval for a population proportion and a population mean with specified margin of error
- Determine sample statistics from a confidence interval

Activities:

- ✓ Estimate Activity: based on an unknown population proportion of colored beans
- ✓ Estimate Activity: based on the known M&M population proportion
- ✓ Estimating Activity: based on the Random Rectangle/Jelly Blubber activity
- ✓ Estimating Activity: Mean flight distance for various treatments used during the Gummy Bear Experiment data from Unit 1
- ✓ Class Activity: Data Exploration
    - Students use chapter concepts to analyze a data set from a random sample
    - Class discussion summarizing findings
- ✓ Technology: The Confidence Interval Applet
    - Investigates the notion of confidence level and the relationship between confidence level and confidence interval
- ✓ Technology: Confidence Intervals for p on the calculator
- ✓ Technology: Confidence Intervals for population means on the calculator
- ✓ Released Open Response Items from previous exams (student presentations)
- ✓ Homework and classwork from Chapter 8
- ✓ Unit Test

Unit 6 Tests of Significance (3 weeks)

Objectives:

- State correct hypotheses for a significance test about a population proportion or mean
- Interpret P-values in context
- Interpret a Type I and a Type II error in context, and give the consequences of each
- Understand the relationship between the significance level of a test, P(Type II error) and power
- Check conditions for carrying out a test about a population mean and if met, conduct a one-sample t-test
- Use a confidence interval to draw a conclusion for a two-sided test about a population proportion and a population mean
- Recognize paired data and use one-sample t procedures to perform significance tests for such data

Activities:

- ✓ Activity: Difference in proportions between plain and peanut M&M's
- ✓ Test of Significance using the difference between two flight distance means collected from the Gummy Bear Experiment data from Unit 1
- ✓ Activity: Type I and Type II Power Activity
- ✓ Technology: Investigating power with an applet
- ✓ Technology: one-proportion z test on the calculator
- ✓ Technology: Tests and Confidence Intervals using statistical software
- ✓ Released Open Response Items from previous exams (student presentations)
- ✓ Homework and classwork from Chapter 9
- ✓ Unit Test

Unit 7 Categorical Data and Chi-Square Test (3 weeks)

Objectives:

- Exploring Categorical Data
  - Using tables and bar charts
  - Marginal and joint frequencies for two-way tables
  - Conditional relative frequencies and association
  - Comparing distributions using bar charts
- Chi-Square Test of Significance
  - Check the random, Large sample size, and independent conditions before performing a chi-square test
  - Examine goodness of fit, homogeneity of proportions, and independence (one- and two-way tables)

Activities:

- ✓ Activity: continuation of M&M data results from activity in Unit 6
- ✓ Technology: finding p-values for chi-square test on the calculator
- ✓ Technology: Chi-Square goodness-of-fitness test on the calculator
- ✓ Technology: Chi-Square tests for two-way tables with computer software and the calculator
- ✓ Released Open Response items from previous exams (student presentations)
- ✓ Homework and classwork from Chapter 11
- ✓ Unit Test

Unit 8 Linear Regressions (4 weeks)

Objectives:

- Explore bivariate data
  - Analyzing patterns in scatterplots
  - Find the correlation and linearity
  - Calculate the least-squares regression ling
  - Construct residual plots; find outliers and influential point
  - Perform transformations to achieve linearity: logarithmic and power transformations
- Confidence Interval and Test of Significance for slope associated with the LSRL

Activities:

- ✓ Investigation: The meaning of the least squares regression line
- ✓ Activity: Correlation Coefficient activity using an applet
- ✓ Technology: Calculating regression equations on calculators
- ✓ Technology: Construct residual plots on a calculator
- ✓ Technology: regression inference using calculators or computer software
- ✓ Technology: transforming to achieve linearity on the calculator
- ✓ Released Open Response items from previous exams (student presentations)
- ✓ Homework and classwork from Chapters 3 and 12
- ✓ Unit Test

Comprehensive Review (2 weeks)

- Comprehensive review for AP Statistics exam using CEDO exams
- Mock Exam grading sessions
- Practice Multiple Choice questions

AP Statistics Exam
End of 2nd Semester Exam