**Curriculum**

**Advanced Placement Statistics**

**Course Overview**

This is a full-year, introductory, non-calculus based, college-level course in statistics. The course meets the requirements for introductory statistics courses in fields such as psychology, sociology and health sciences, and it also prepares students for higher level calculus-based statistics courses in fields such as engineering, business, and mathematics. Students are exposed to four broad conceptual themes: exploring data, sampling and experimentation, anticipating patterns, and statistical inference. The course prepares students for the Advanced Placement Examination in May

**Department Standards**

Students will be able to comprehend mathematical concepts.

Students will apply mathematical procedures accurately, efficiently, and appropriately.

Students will be able to formulate, represent, and solve mathematical problems.

Students will develop logical mathematical thought and precise mathematical communication.

**Benchmarks**:

Students will be able to:

explore Data to describe patterns and departures from patterns;

plan and conduct a study using sampling and experimentation:

anticipate Patterns by exploring random phenomena using probability and simulation; and

use statistical inference to estimate population parameters and testing hypotheses.

**Performance Indicators**

First Quarter

Students will be able to:

when given a scenario, describe the variables of interest, the sample used, and the population;

understand completely the idea of the “distribution” of a variable;

know what is meant by a variable’s “distribution”;

describe the distribution of a specific variable and know the context of the real world situation it describes;

support their conclusions with numerical evidence;

make relevant comparisons between two different variables;

construct and interpret by hand AND on the TI: box plots, dot plots, histograms, time plots, and stem-leaf plots;

choose an appropriate variable to analyze and answer a given real-world situation;

construct an accurate and appropriate visual display for analysis;

construct a coherent, relevant real-world conclusion;

compare the distribution of two different samples of data and describe the relevant differences in their distributions, and substantiate those differences;

use both numerical and visual evidence, and make appropriate real-world conclusions based on their observations;

understand the difference between a measure of center, a measure of location, and a measure of spread;

tell which numerical tools are measures of center, spread, and relative location;

make conclusions and solve problems involving numerical measures of data: mean, median, pth percentile, quartiles, range, std. deviation, variance, and inter-quartile range;

understand the mathematical properties of these measures, and reach conclusions to problems based on them;

understand how to change units to a set of data; understand how changing units (or performing other linear transformations) affects measures of center and spread;

use the graphic calculator to enter data, create some visual displays, change units for data, and calculate numeric summaries for any set of data;

answer questions about a density curve and know how are they different from relative frequency histograms or other visual displays;

know the fundamental properties of a density curve;

calculate the probability of a particular event happening given a density curve;

use symmetry, a bit of math, and problem-solving to find areas under a curve, quartiles, percentiles, medians, etc. given a density curve; understand how the shape of a density curve indicates the relative positions of the mean, the median and the mode;

answer questions about the normal distributions;

know the fundamental properties of a normal density curve;

give examples of variable which would have a normal distributions;

give an example of some variables which have non-normal distributions;

explain z-scores and why they are used;

explain the meaning of the 68-95-99.7 rule, and use it to estimate the probability of events coming from a normal distribution;

give the standard normal distribution;

give a clear, well detailed, and accurate probability calculation for problems that require the use of normal distributions;

give a clear, error-free path to a final answer;

calculate percentiles for normally distributed data and give a clear path to a final answer;

answer questions about assessing normality;

use at least two different ways of judge whether a given set of data are normally distributed;

use the graphic calculator to quickly and easily calculate probabilities and percentiles from normal distributions;

use normal distribution tables to perform the same skills;

answer questions about scatterplots;

describe the association (direction, strength, and form) from a given sample of data from visual displays (both scatterplots and residual plots);

observe and describe individual cases on a scatterplot;

recognize influential observations and outliers in a scatterplot;

decide which of two variables in a scenario, should be the "explanatory variable" and which the "response variable";

answer questions about correlation and regression;

understand the interpretation and properties of r;

use the graphic calculator or a computer printout to determine the least squares regression equation for predictions;

interpret the meaning of the numerical values of the slope and intercept of the regression equation, in proper context;

understand the technical meaning of r2

use means and standard deviations of x and y to find the slope and the intercept of the regression line;

use the regression line to predict y values for a given x value;

recognize extrapolation, and be aware of its dangers;

calculate the residual for a given observation and interpret residual plots;

recognize the fallacy: "correlation does not imply causation";

understand how to resolve the fallacy by explaining the role of lurking variables, common response, or confounding;

use a graphic calculator to make a scatterplot, find LSRL, find r and r2, and make a residual plot;

transform Data in a scatterplot curved pattern, by using a convenient model such as an exponential growth or decay function of the form y = abx or a power function of the form y = axb

linearize the data by making use of logarithms;

check to see which model is appropriate by transforming x, y, or both variables and checking the linearity of the resulting scatterplot;

find the LSRL for the transformed data and then perform the reverse transformation to find the regression model;

transform back to a power/exponential model;

interpret correlation and regression with caution;

know what lurking variables and common response are; and

use LSRL to predict values outside the domain of the explanatory variable used to create the model; and calculate probabilities, including conditional probabilities using two-way tables.

Second Quarter

Students will be able to:

identify the population in a sampling situation;

recognize bias due to voluntary response samples and other inferior sampling methods;

use a table of random digits to select a simple random sample (SRS) from a population;

recognize the presence of undercoverage and nonresponse as sources of error in a sample survey; recognize the effect of the wording of questions on the response;

use random digits to select a stratified random sample from a population when the strata are identified;

recognize whether a study is an observational study or an experiment;

recognize bias due to confounding of explanatory variables with lurking variables in either an observational study or an experiment;

describe how confounding occurs, in context of the situation;

identify the factors (explanatory variables), treatments, response variables, and experimental units or subjects in an experiment;

outline the design of a completely randomized experiment using a diagram showing the sizes of the groups, the specific treatments, and the response variable;

use a table of random digits or the graphic calculator to carry out the random assignment of subjects to groups in a completely randomized experiment;

recognize the placebo effect;

recognize when double-blinding should be used;

recognize a block design and when it would be appropriate;

explain when a matched pairs design would be appropriate and how to design a matched pairs experiment;

explain why a randomized comparative experiment can give good evidence for cause and effect relationships;

recognize when random phenomena can be investigated by means of a carefully designed simulation;

use the following steps to construct and run a simulation: a. state the problem or describe the experiment, b. state the assumptions, c. assign digits to represent a single trial, d. simulate many trials, and e. calculate relative frequencies and state your conclusions;

use a random number table or the graphic calculator to conduct simulations;

understand the basic laws that govern uses of probability;

describe a random variable “X”;

define and use a “discrete” random variable;

define and use a “continuous” random variable;

display the probability distribution of a continuous random variable with a density curve;

understand that all continuous probability distributions assign a probability of zero to each individual outcome;

define probabilities over a range of values; and

calculate the means and variances of random variables using the following formulas:

μa +bX = a + bμX

σa +bX2= b2σX2

μX ±Y = μX ± μY

σX ±Y2 =σX2 +σY2.

Third Quarter

Students will be able to:

use the binomial distribution in situations where there are two outcomes of interest, such as success or failure;

know how to obtain geometric probabilities through simulation;

know the difference between the geometric setting and the binomial setting;

know that for binomial settings (1) each observation is in one of two categories: success or failure, (2) success is the same for each observation, (3) observations are independent, (4) the number of trials required to obtain the first success;

calculate the mean and standard deviation for a geometric setting;

calculate the probability it will take more than n trials for an event to occur is (1-p)n

explain within Sampling Distributions the definition of: Parameter, Statistic, Sampling distribution of a statistic, an unbiased estimator;

explainwithin Sample Proportions the definition of p(hat), the sampling distribution of p(hat) and that it is reasonable to use the above statements when: pop>10n, np>10, n(1-p)>10;

use and apply THE CENTRAL LIMIT THEOREM;

estimate a confidence Interval for a Parameter;

calculate the margin of error for a parameter;

determine a sample size necessary for a given margin of error;

know the reasoning of a test of significance;

understand the concept of a z-value, t-value and P-value;

know that a statistical test could be 2-tail or 1-tail;

understand and discuss the concept of a Type I or Type II error, and the power of a test;

describe using t-Distributions the sampling distribution of x-bar when the population's standard deviation is unknown;

describe t-distributions for different degrees of freedom; and find t-statistics and p-values for sample means;

construct and interpret a level C confidence interval for a single mean when the population standard deviation is not known;

conduct a significance test for a claim about a single mean;

conduct a matched pairs t-test for the mean difference in a matched pairs setting;

describe the sampling distribution for the difference between sample means from two independent populations;

calculate and interpret a Level C confidence interval for the difference between two means;

conduct a two-sample t-test for the difference between two means;

calculate and interpret Confidence Intervals for means using your graphing calculator;

perform a one- or two-sample t-test using your graphing calculator and interpret the results;

describe the sampling distribution of p-hat for a single proportion or (p-hat1 - p-hat2) for a difference of proportions of a z-Distributions; find z-statistics and p-values for sample proportions;

construct and interpret a level C confidence interval for a single proportion;

conduct a significance test for a claim about a single proportion;

describe the sampling distribution for the difference between sample proportions from two independent populations;

calculate and interpret a Level C confidence interval for the difference between two proportions;

conduct a two-sample z-test for the difference between two proportions;

calculate and interpret Confidence Intervals for proportions using your graphing calculator; and

perform a one- or two-sample z-test using your graphing calculator and interpret the results.

Fourth Quarter

Students will be able to:

describe Chi-Square Distributions;

recognize when to use a Goodness of Fit Test;

test for Homogeneity, or Test for Independence;

use percents and bar graphs to compare hypothesized and actual distributions;

calculate expected counts;

calculate the chi-square statistic;

conduct a Goodness of Fit Test to determine if a population distribution is different from a specified distribution;

enter two-way table data into a matrix on the graphic calculator;

determine expected counts, chi-square statistic, and p-value from calculator output;

use calculator output to write a complete Chi- Square significance test;

organize data into a two-way table to Test for Homogeneity;

use percents and bar graphs to compare distributions;

calculate expected counts;

calculate the chi-square statistic;

determine degrees of freedom;

perform a Test for Homogeneity to determine if the distribution of a categorical variable is the same in multiple populations;

organize data into a two-way table to test for Independence;

use percents and bar graphs to compare distributions;

calculate expected counts;

calculate the chi-square statistic;

determine degrees of freedom;

perform a Test for Independence to determine if there is an association between two categorical variables;

describe conditions necessary to perform inference about the model;

show how inferential conditions are met for regression situations;

calculate and interpret a Level C confidence interval for the slope of the true regression line;

interpret the slope of the true regression line in the context of the situation;

perform a significance test on the Ho: slope = 0;

interpret computer output regarding a significance test on the slope of the true regression line;

enter bivariate data into the List Editor;

construct and interpret a Scatterplot;

calculate the LSRL;

interpret r and r2;

construct and interpret a Residual Plot;

perform a LinRegTTest;

use LinRegTTest output to determine SEslope; and

prepare and present a final project.

**Assessments**

First Quarter:

Homework Assignments

Quizzes in class and online

Chapter Tests

Second Quarter:

Homework Assignments

Quizzes in class and online

Chapter Tests

2hr Semester Exam

Third Quarter:

Homework Assignments

Quizzes in class and online

Chapter Tests

Fourth Quarter:

Homework Assignments

Quizzes in class and online

Chapter Tests

AP Exam

Project (test grade)

**Core Topics**

First Quarter

Displaying Distributions with Graphs

Describing Distributions with Numbers

Density Curves and the Normal Distribution

Standard Normal Calculations

Scatter plots

Correlation

Least Squares Regression

Transforming Relationships

Cautions about Correlation and Regression

Second Quarter

Relations in Categorical Data

Designing Samples

Designing Experiments & Simulations

Probability

More on Probability

Discrete & Continuous Random Variables

Means and Variances of Random Variables

Third Quarter

Binomial Distribution

Geometric Distribution

Sampling Distribution

Sample Proportions

Sample Means

Estimating with Confidence

Test of Significance

Making Sense of Statistical Significance & Inference as Decision

Inference for the Mean of a Population

Comparing Two Means

Inference for a Population Proportion

Comparing Two Proportions

Fourth Quarter

Test for Goodness of Fit

Inference for Two-Way Tables

Inference about the model

AP Exam review

Group Project

**Specific Content**

First Quarter

Constructing and interpreting graphical displays of distributions of univariate data (dotplot, stemplot, histogram, cumulative frequency plot):

Center and Spread

Clusters and gaps

Outliers and other unusual features

Shape

Summarizing distributions of univariate data:

Measuring center: median, mean

Measuring spread: range, interquartile range, standard deviation

Measuring position: quartiles, percentiles, standardized(z) scores

Using boxplots

The effect of changing units on summary measures

Comparing distributions of univariate data (dotplots, back-to-back stemplots, parallel boxplots):

Comparing center and spread: within group, between group variation

Comparing clusters and gaps

Comparing outliers and other unusual features

Comparing shapes

The normal distribution:

Properties of the normal distribution

Using tables of the normal distribution

The normal distribution as a model for measurements

Exploring bivariate data:

Analyzing patterns in scatterplots

Correlation and linearity

Least-squares regression line

Residual plots, outliers, and influential points

Transformations to achieve linearity: logarithmic and power transformations

Exploring categorical data:

Frequency tables and bar charts

Marginal and joint frequencies for two-way tables

Conditional relative frequencies and association

Comparing distributions using bar charts

Second Quarter

Overview of methods of data collection:

Census

Sample survey

Experiment

Observational study

Planning and conducting surveys:

Characteristics of a well-designed, well-conducted survey

Populations, samples, and random selection

Sources of bias in sampling and surveys

Sampling methods, including simple random sampling, stratified random sampling, and cluster sampling

Planning and conducting experiments:

Characteristics of a well-designed and conducted experiment

Treatments, control groups, experimental units, random assignments, and replication

Sources of bias & confounding, inc. placebo effect/blinding

Completely randomized design

Randomized block design, including matched pairs design

Generalize results and types of conclusions that can be drawn from observational studies, experiments, and surveys:

Probability

Interpreting probability, including long-run relative frequency interpretation

Law of Large Numbers concept

Addition rule, multiplication rule, conditional probability, and independence Discrete random variables and their probability distributions, including binomial and geometric

Simulation of random behavior and probability distributions

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

Third Quarter

Sampling distributions :

Sampling distributions of a sample proportion

Sampling distribution of a sample mean

Central Limit Theorem

Sampling distribution of a difference between two independent sample proportions

Sampling distribution of a difference between two independent sample means: Simulation of sampling distributions

t-distribution

Chi-square distribution

Estimation (point estimators and confidence intervals):

Estimating population parameters and margin of error

Properties of point estimators, inc. unbiasedness and variability

Logic of confidence intervals, meaning of confidence level and confidence intervals, and properties of confidence intervals

Large sample confidence interval for a proportion

Large sample confidence interval for a difference between two proportions Confidence interval for a mean

Confidence interval for a difference between two means (unpaired and paired) Confidence interval for the slope of a least-squares regression line

Tests of significance:

Logic of significance testing, null and alternative hypotheses; p-values; one- and two-sided tests, concepts of Type I and Type II errors; concept of power

Large sample test for a proportion

Large sample test for a difference between two proportions

Test for a mean

Test for a difference between two means (unpaired and paired)

Chi-square test for goodness of fit, homogeneity of proportions, and independence (one- and two-way tables)

Test for the slope of a least-squares regression line

Fourth Quarter

REVIEW FOR THE ADVANCED PLACEMENT STATISTICS EXAM

Earning college credit is a major goal for most of our students. Thus, we take the AP exam very seriously and take time to remind and review the ideas we’ve learned over the course of the year.

Chapter Review, Practice Problems

Mock AP Exam - Multiple Choice and Free Response Final Exam

Practice Multiple Choice Questions

Practice Free Response Questions

Grading and Strategies for Success

Students complete a final project on a topic of their choice. The purpose of the project is for students to demonstrate an integrated understanding of all aspects of the statistical process (design, analysis, and conclusions) and the major conceptual themes of AP statistics: Exploring Data, Sampling and Experimentation, Anticipating Patterns, and Statistical Inference. Students are expected to communicate their methods, results, and interpretations using proper statistical vocabulary.

**Resources**

Textbook: *The Practice of Statistics* 2nd Edition, W. F. Freeman and Company

TI-84 plus graphing calculator

Minitab output

Fathom software