Math 1241: Statistical Analysis II

Credit hours: **3 credits**
Prerequisites: **Math 1240 with a grade of C or better.**

Course Description:

This course builds upon the foundation developed in Math 1240 with an emphasis on problems encountered in business. Topics include a review of probability, a comprehensive look at hypothesis testing, regression analysis, and modeling. Students will be expected to utilize a statistical package, such as Excel, to complete some assignments. A culminating project using data from industry rounds out the course.

Course Objectives:

1. Further develop the understanding of data analysis, probability, and decision theory established in Math 1240.
2. Expand the use of regression analysis, hypothesis testing, and modeling to analyze more complex problems.
3. Utilize the skills learned to complete a culminating project using data from business and industry.

Learning Outcomes:

1. Construct both simple and complex linear regression models for forecasting and assess their effectiveness using criteria like the coefficient of determination and predictor variable significance.

2. Perform single and dual parameter hypothesis tests and assess their results for relevance and importance.

3. Execute Chi-square tests for fit quality and independence and evaluate the results' importance and relevance.

4. Develop forecasting models using time series data and gauge their accuracy through error metrics.

List of Topics:

I. Samples and Sampling Distributions.
   a. Random samples
   b. Sampling distributions
      i. Distributions of the sample mean and sample proportion.
      ii. The central limit theorem.
   c. Sampling methods.

II. Estimation with Confidence Intervals: Single Sample.
   a. Estimating the population mean.
      i. σ known.
      ii. σ unknown.
   b. Estimating the population proportion.
   c. Estimating the population standard deviation and variance.
   d. Computing a margin of error.

III. Hypothesis Testing: Single Sample.
   a. A general overview of hypothesis testing.
   b. Testing a hypothesis about a population mean.
      i. σ known.
      ii. σ unknown.
   c. The relationship between confidence interval estimation and hypothesis testing.
   d. Testing a hypothesis about a population proportion.
   e. Testing a hypothesis about a population variance.

IV. Inferences about Two Samples.
   a. Comparing two population means.
      i. σ_1 and σ_2 known.
      ii. σ_1 and σ_2 unknown.
   b. Paired difference test.
   c. Comparing two population proportions.
   d. Comparing two population variances.

V. Analysis of Variance (ANOVA).
   a. Introduction to ANOVA.
   b. Assumptions in an ANOVA test.
   c. The F-distribution and F-test.
   d. Multiple comparison procedures.
   e. Two-way ANOVA.
      i. The randomized block design.
      ii. The factorial design.

VI. Regression, Inference and Model Building.
   a. The simple linear regression model.

b. Residual analysis.
c. Evaluating the fit of the linear regression model and the correlation coefficient.
d. Fitting a linear time trend.
e. Inference concerning the slope.
f. Inference concerning the model's prediction.

VII. Multiple Regression
a. The multiple regression model.
b. The coefficient of determination and adjusted R^2 space.
c. Inference concerning the multiple regression model and its coefficients.
d. Inference concerning the model's prediction.
e. Models with qualitative independent variables.

VIII. Time Series Analysis and Forecasting.
a. Time series components.
b. Moving averages.
c. Exponential smoothing techniques.
d. Forecast accuracy.
e. Seasonality.

IX. Relationships in Qualitative Data
a. The Chi-Square distribution.
b. The Chi-Square test for:
    i. Goodness of fit.
    ii. Association.

X. Nonparametric Statistics
a. The sign test.
b. The Wilcoxon signed-rank test.
c. The Wilcoxon rank-sum test.
d. The rank correlation test.
e. The Runs test for randomness.
f. The Kruskal-Wallis test.