COURSE NUMBER/TITLE: STAT-440/640 Advanced Linear Modeling – Regression & Time Series Analysis

CREDITS: 3

COURSE DESCRIPTION: Multiple regression, inference about regression parameters, remedial regression measures, quantitative and qualitative regression, model selection/validation, nonlinear regression, neural networks, logistic and Poisson regression, generalized linear models, time series, smoothing, stochastic time series, moving average and autoregressive models, auto regressive integrated moving average (ARIMA), estimating and forecasting with time series. Prerequisite: STAT-332 Probability & Mathematical Statistics II or permission of instructor.


COURSE OBJECTIVES:
Upon completing the course students will be able to:

I. Regression
   - Calculate ordinary least square estimates of the parameters of single and multiple linear regression models.
   - Test hypotheses and construct confidence intervals for the parameters of single and multiple linear regression models, including tests involving more than one parameter.
   - Determine aptness of a regression model using:
     - Analysis of the residuals, and
     - F test for lack of fit.
   - Perform appropriate data transformations and remedial measures when the data set is observed to possess one or more of the following characteristics:
     - Non-constancy of error variances (heteroscedasticity),
     - Non-independence of error terms (serial correlation),
     - Multicollinearity,
     - Nonlinearity of the regression function.
   - Perform analysis of variance in regression models, prepare Analysis of Variance (ANOVA) tables and test hypotheses using relevant t and F statistics.
   - Determine estimates of, and confidence intervals for new observations using regression (including stepwise and piecewise linear) models.
   - Formulate and analyze regression models using dummy variables.
   - Distinguish between Regression and Correlation models, and calculate elasticity and partial correlations.
   - Demonstrate familiarity with intrinsically nonlinear regression models, and in particular set up least square normal equations to estimate the parameters of such models using appropriate software.
   - Distinguish between ordinary least square and Generalized Linear Models (GLM) and utilize
GLM procedures.

II. Time Series
- Distinguish the basic difference between Regression and Time Series models, and thereby be able to recognize when a Time Series model should be used.
- Distinguish between deterministic and Stochastic Time Series models.
- Recognize characteristics of Stationary Time Series and compute autocorrelation functions.
- Analyze data using a Random Walk model.
- Estimate the parameters of an Auto Regressive Integrated Moving Average (ARIMA) model, and the simpler models Moving Average (MA), Auto Regressive (AR), and Auto Regressive Moving Average (ARMA) as special cases.
- Generate forecasts using ARIMA and simpler models, and develop confidence intervals for the forecasts.
- Demonstrate a familiarity with properties of ARIMA forecasts.
- Run diagnostic checks validating a specified Time Series Model.

GRADUATE OBJECTIVES
Graduate students will be assigned extra self-study in the following topics and encouraged to write their project using topics in these areas.
- Distinguish between Regression and Correlation models, and calculate elasticity and partial correlations.
- Demonstrate familiarity with intrinsically nonlinear regression models, and in particular set up least square normal equations to estimate the parameters of such models using appropriate software.
- Distinguish between ordinary least square and Generalized Linear Models (GLM) and utilize GLM procedures.
- Distinguish between deterministic and Stochastic Time Series models.
- Demonstrate a familiarity with properties of ARIMA forecasts.

COURSE OUTLINE:
I. Introduction to Forecasting: Methods, Software
II. Review of Single Variable Regression Models and Matrix Algebra
III. Multiple Regression Models
IV. Serial Correlation and Heteroscedasticity
V. Regression and ANOVA Tables
VI. Inference in Regression
VII. Nonlinear Models
VIII. Generalized Linear Models
IX. Time Series Models
X. Smoothing
XI. Stochastic Time Series Models
XII. MA, AR, ARMA and ARIMA Models
XIII. Estimating and Forecasting with Time Series Models
XIV. Properties of ARIMA Forecasts
XV. Combined Regression and Time Series Models