Instruction:

- The data for all questions will be delivered in Excel format through your OneDrive or cmich email.
- Answer all questions. Print your answer, your name, number the pages, and number the problems of the exam. Write on one side only. Please use only black pens or pencils.
- Submit your exam in printed paper including the compute outputs using Minitab, Excel, or SAS with either typed answers or handwritten answers.
- Statistical tables will be provided for questions that need critical values not available in Minitab, Excel, or SAS.

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1. Microcomputer components data given below compiles the monthly data for the past 16 months on the value of the components used by industry production of processing units (X, in million dollars) and the value of the components used by the company (Y, in thousand dollars).

   a) Fit a simple linear least square regression model and obtain the residuals. Make a time series plot for the residuals and explain if there is any positive or negative autocorrelation.
   b) Conduct the Durbin-Watson Test using $\alpha = .05$. State the alternatives, decision rules, and conclusions.
   c) Use one of the three procedures: Cochrane-Orcutt, Hildreth-Lu, or the First Differences to fit the transformed simple linear least square regression model and obtain the residuals. Make a time series plot for the residuals and explain if there is any positive or negative autocorrelation.
   d) Repeat part b) on the model obtained from part c).
   e) Has the method you have chosen been effective in removing the autocorrelation? Is the method you have chosen better than the other two methods? Explain.
   f) The value of industry production in month 17 will be \$2.210 million. Predict the value of the firm's components used in month 17; compute a 95 percent prediction interval. Interpret your interval.

2. Chemical process yield (Y) depends on the temperature (X_1) and pressure (X_2) with the data given in the following table.

$$Y_i = \gamma_0 \left(X_{i1}\right)^{\gamma_1} \left(X_{i2}\right)^{\gamma_2} + \varepsilon_i$$

   a) Obtain the stating values for γ_0, γ_1 and γ_2 using the logarithmic transformation.
   b) Compute the least square estimates for γ_0, γ_1 and γ_2 using the starting values obtained from par a).
   c) Compute a 95% confidence interval (CI) for μ_y and a 95% prediction interval (PI) for Y at X_1=50 and X_2=20.
   d) Is there any extrapolation in part c?
   e) Are data observational or experimental.

3. Annual dues data for a professional association, as the results of a random sample, are shown in the following with variables X, the dollars of increase in annual dues; Y, with 1 if the membership will not be renewed, with 0 if the membership will be renewed in the posted survey interview.

   a) Fit a logistic regression model. State the regression function and give the maximum likelihood estimates of β_0 and β_1.
   b) Give the $\exp(b_1)$ and its interpretation.
   c) Obtain the scatter plot of the data with the fitted logistic response function from part a). Does it seem to fit the data well? Explain.
   d) Compute the estimated probability that the members will not renew their membership if the dues are increased by $40.
   e) Estimate the amount of dues for which 75% of the members are expected not to renew the membership.

4. Premium distribution data are collected to study the timeliness for distributing the premiums of the soft drink manufacturer. There is a total of five agents (1, 2, 3, 4, 5) are included in the study. factor
   a) Obtain the ANOVA table for the study
   b) Test whether all the level means are equal.
   c) Obtain the 90% family CIs for all pairwise comparisons using the Bonferroni procedure.
   d) Would the Tukey procedure be more efficient to be used in part c)? Explain.
   e) Estimate the following comparisons with 90% family CIs using Scheffe's procedure.

$$D_1 = \mu_1 - \mu_2 \qquad D_2 = \mu_3 - \mu_4$$

$$L_1 = \frac{\mu_1 + \mu_2}{2} - \mu_5 \qquad L_2 = \frac{\mu_3 + \mu_4}{2} - \mu_5 \qquad L_3 = \frac{\mu_1 + \mu_2}{2} - \frac{\mu_3 + \mu_4}{2}$$