Instruction:
* The data for all questions will be delivered in Excel format to your cmich email box.
* 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 print paper including the computer outputs of Minitab, SAS or Excel with either typed answers or hand-write answers. Statistical tables will be provided for questions that need critical values not available in Minitab, SAS or Excel.

1. McGill Company sales. The data below show seasonally adjusted quarterly sales for the McGill Company (Y, in million dollars) and for the entire industry (X, in million dollars) for the most recent 20 quarters.

   a) Fit a simple linear least squares 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 Cochrane-Orcutt method 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 form part c).
   e) Has the method you have chosen been effective to remove the autocorrelation?
   f) Industry sales for quarter 21 are expected to be $181.0 million. Use the model in part c) to predict the McGill Company sales for quarter 21, using a 95 percent prediction interval. Interpret your interval.

2. Chemical process yield (Y) depends on the temperature (X_1) and pressure (X_2). The following model is proposed to model the relationships.

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

   a) Obtain the starting 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% CI for $\mu_{y,}$ and 95% PI for Y at X_1=50 and X_2=20.
   d) Is there any extrapolation in part c?
   e) Are data collected from an observational study or experimental design?

3. Premium distribution data are collected to study the timeliness for distributing the premiums of the soft-drink manufacturer. There are total of five agents (1, 2, 3, 4, 5) are included in the study.
   a) Obtain the ANOVA table for the study.
   b) Test whether all the level means are equal.
   c) Obtain the 95% 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 95% family CIs using the Scheffe' procedure.

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

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