1. (6 pts total) Problem 19.6 in KNNL gives three sets of treatment means \( \hat{\mu}_{ij} \) for students’ grades in a course, where factor A is the student’s major (A1: computer science, A2: mathematics) and factor B is student’s class level (B1: junior, B2: senior, B3: graduate student). For each set of data, prepare a treatment means plot (interaction plot). Interpret each plot with respect to the interaction and main effects. Note: Since you are already given the treatment means, you can create these plots in SAS as follows (example for Set 1):

```sas
****SET 1 ***********;
data mean_grades;
input mean_grade major $ class $;
datalines;
80 CompSci Junior
80 CompSci Senior
80 CompSci Grad
90 Math Junior
90 Math Senior
90 Math Grad;
symbol1 v=dot i=join c=blue;
symbol2 v=dot i=join c=red;
proc gplot data=mean_grades;
plot mean_grade*class=major;
run;
```

2. (19 pts total) Consider the Disk Drive Service data set described in KNNL 19.16 (pg 869) and available on my website (CH19PR16.TXT).
   
a. (2 pts) Use SAS to obtain a table of sample sizes, means and standard deviations for the nine different treatment combinations.

b. (6 pts) Write the factor effects model for this analysis (with any assumptions and constraints). Estimate the parameters of this model under the zero-sum constraint.

c. (5 pts) Perform the two-way ANOVA for this data set. State the null and alternative hypotheses for the main and interaction effects in terms of the factor effects model parameters. For each test, give the test statistic with degrees of freedom and P-value, and your conclusion for each test. State the order in which you are conducting these tests and comment on how you should proceed given these results.

d. (3 pts) Examine the appropriate diagnostic plots to check the assumptions of normality and constant variance. Comment on your findings.

e. (3 pts) Make an interaction plot of the treatment (cell) means with the technician on the x-axis and different lines for each make of drive. Interpret the plot and discuss why looking at the main effect of technician and drive make alone could be misleading in this example. If you were a manager, how might you use these results in assigning jobs to the three technicians?
3. (10 pts total) Consider the Soybean Sausage data set described in KNNL 20.8 (pg 890) and available on my website (CH20PR8 . TXT).

a. (3 pts) Perform a two-way ANOVA, including both main effects and the interaction term.  What are the error degrees of freedom for this model? Explain how this happened for this data set and note how this affected your results in the SAS output.

b. (2 pts) Now, perform the two-way additive ANOVA model, with only the main effects. Use the results of the hypothesis tests to determine whether main effects are significant.

c. (2 pts) Plot the data vs. temperature, using three different lines for the three humidity levels. Based on your graph, do you think that interaction is important for this problem?

d. (3 pts) Use the Tukey comparison procedure to determine all significant differences in means for the main effect of temperature.