Statistics 402 A **Assignment 10** **Due Friday, April 23**

1. A horticulturist conducted a nitrogen fertility experiment for lettuce. A field was divided into 3 blocks. Each block contained 10 plots of land. Five treatments (0, 50, 100, 150, and 200 pounds of ammonium nitrate per acre) were randomly assigned to the 10 plots within each block in a completely randomized fashion. The number of lettuce heads harvested from each plot was recorded at the conclusion of the experiment. The data are contained in *hw10pr1.sas*.

This experiment is an example of a randomized complete block design with replication of each treatment within each block. This topic is discussed in the last subsection on page 271 of your text book. Fit a model that includes terms for block effects, treatment effects, and block-by-treatment interaction. Consider all terms to be fixed effects until directed otherwise.

a) Is there evidence of treatment-by-block interaction? Conduct one test to answer this question. Provide a test statistic, its degrees of freedom, a *p*-value, and a brief conclusion.

b) You should have found evidence for treatment-by-block interaction in part (a). This interaction suggests that the treatment effects are not the same in every block or, in other words, that the differences among the treatments are not the same in every block. Find the treatment means separately for each block. (Add *lsmeans block*trt;* to your code.) Can you explain the main reason why there is significant treatment-by-block interaction in this case?

c) Separately for each block, test for evidence of differences among treatment means. Provide a test statistic, its degrees of freedom, a *p*-value, and a brief conclusion for each block. (Hint: Use the *slice* option with your *lsmeans* statement.)

d) Each treatment has three means, one for each block. If we average the three means to get one mean for each treatment, can we say there are significant differences among these means? Conduct one test to answer this question. Provide a test statistic, its degrees of freedom, a *p*-value, and a brief conclusion. (Hint: This is a test automatically produced by SAS. It should already appear in your output.)

e) Suppose now that we wish to consider block effects and block-by-treatment interaction effects as random effects. Conduct one test for differences among treatments. Provide a test statistic, its degrees of freedom, a *p*-value, and a brief conclusion. (Hint: Add a random statement to your code so that you can see expected mean squares and determine an appropriate error term for testing for treatment effects.)

f) In part (b) you found treatment means separately for each block. Treating these means as data points, you have a dataset with 3 blocks, 5 treatments, and one data point for each combination of block and treatment. This data can be analyzed just like a standard randomized complete block design. Test for significant treatment effects using this dataset. Provide a test statistic, its degrees of freedom, a *p*-value, and a brief conclusion. How does this answer compare with the answer to part (e)?

2. Researchers were interested in learning how treating dams (mother pigs in this case) with diets (A, B, or C) and drugs (1 or 2) might effect physical characteristics of male and female piglets. A total of 24 dams were used in the experiment. The 24 dams were randomly assigned to the 6 combinations of diet and drug using a completely randomized design. After approximately 8 weeks on the assigned treatment, each dam gave birth to a litter of piglets. One male and one female piglet were selected from each litter. A response variable of interest was measured for each piglet.

a) Provide an ANOVA table with only SOURCE and DF columns for the analysis of this data. You should assume that the response variable might be affected by diet, drug, gender, and interactions among these factors.

b) Suppose that the 24 dams had been mated with 4 sires (father pigs) in order to obtain the 24 litters. Suppose that the 24 sows were randomly assigned to the 4 sires in a completely random fashion with 6 dams per sire. If this were the situation, explain how you would randomly assign diets and drugs to the sows.

c) Given your answer to part (b), provide an ANOVA table with only SOURCE and DF columns for the analysis of this data.

3. An experiment was conducted to study how temperature, moisture, and seed variety affect the seed quality of grain stored for a long fixed period of time. Six large containers were available for seed storage. Three of the six containers were randomly selected to be kept at a temperature of 50 degrees throughout the experiment. The other three were kept at a temperature of 70 degrees throughout the experiment. Two humidity chambers were placed inside each container. Within each container, one humidity chamber was randomly selected for high humidity, and the other was set at low humidity. Five seed sacks - one from each of five varieties (A, B, C, D, and E) - were randomly selected and randomly positioned within each humidity chamber. At the end of storage period, a measure of seed quality was obtained for each sack. The higher the measurement, the higher the seed quality. Data from the experiment and code for analysis can be found in the program *seed.sas* on the Stat402 web site. Run the program, examine the output, and write a paragraph describing the results. Make sure there is enough detail in your paragraph to answer all the basic questions the researchers might try to answer with the data from this experiment.

4. You do not need to turn in anything for this problem. Only problems 1 through 3 will be graded. Originally I was going to ask you to write your own code for problem 3. Could you have done it? Without looking at the code or output, try to write down the model terms with d.f. as in problem 2. See if you can come up with the code on your own. Try to understand what each line of code is doing and why I decided to write the code as I did.