ST 512 - Lab 4 - Two-Way ANOVA!

The point of this lab is to give you some practice:

1. analyzing a two-factor data set
2. finding simple effects and main effects

Example
The drought resistance of four varieties of a field crop was compared using three different pretreatments. For each variety, the pretreatment was applied to stimulate root growth, a drought condition was simulated, and the root lengths were measured after four months. In total, each treatment was replicated 3 times and the experiment was conducted in a greenhouse.

1. Identify the response variable, factors, factor levels, and treatments.
2. What model should be used to investigate this data?
3. What hypotheses do you want to test?
4. Use the provided SAS code to create the ROOT data set in SAS.
5. We already know the model and the hypotheses to be tested, now use SAS to graphically check the model assumptions.
6. Regardless of how you feel about the model assumptions, let's get a feel for the data by investigating plots. Use the interaction plot provided by PROC GLM to answer the following:
   (a) Do you think there is an interaction? Why? If it is present, what type is it?
   (b) Do you think there is a main effect for variety? How can you tell?
   (c) Do you think there is a main effect for pretreatment? How can you tell?
7. Of course, the graphs don't provide statistically significant evidence, so let's look at our output. Looking at the overall F test, what decision and contextual conclusion can you make?
8. Next, we investigate the interaction effect (recall: if interaction is significant, both factors are important and it likely will not not make sense to look at main effects - ***we should look at simple effects only***). What is your conclusion about the interaction effect?
9. The interaction was significant at the 5% level, so we should now look at simple effects. (Recall: **simple effects** are the effects of a factor while holding a level of other factors constant. E.g., Difference in mean root length between variety 1 and variety 2 for pretreatment 1.) Examine the pairwise contrasts for the treatment means using a Tukey adjustment in LSMEANS.

10. Wow, that's a lot of comparisons! What is your conclusions about the difference in root length means between

    - Variety 1 and Variety 2 for Pretreatment 1?
    - Variety 1 and Variety 2 for Pretreatment 2?
    - Variety 1 and Variety 2 for Pretreatment 3?

11. By just using Tukey as our MC correction, we may be correcting for comparisons we don't care about here. Instead, we could write estimate (or contrast) statements to test only the effects of interest and apply our Bonferroni MC adjustment. Suppose our interest is in the following:

    - difference in root length means between variety 1 and variety 2 for pretreatment 1
    - difference in root length means between variety 1 and variety 2 for pretreatment 2
    - difference in root length means between pretreatment 1 and pretreatment 2 for variety 1
    - difference in root length means between pretreatment 1 and pretreatment 2 for variety 2
    - difference in root length means between pretreatment 1 and pretreatment 2 for variety 3
    - difference in root length means between pretreatment 1 and pretreatment 2 for variety 4

    The table below has the necessary contrasts already provided for the means model, and the first contrast has already been converted to the effects model. Fill in the rest of the table to obtain the coefficients for the contrasts of interest.

Means Model	Effects Model
$\mu_{1,1} - \mu_{1,2}$	$(\mu + \alpha_1 + \beta_1 + (\alpha\beta)_{11}) - (\mu + \alpha_1 + \beta_2 + (\alpha\beta)_{12}) = \beta_1 - \beta_2 + (\alpha\beta)_{11} - (\alpha\beta)_{12}$
$\mu_{2,1} - \mu_{2,2}$	
$\mu_{1,1} - \mu_{2,1}$	
$\mu_{1,2} - \mu_{2,2}$	
$\mu_{1,3} - \mu_{2,3}$	
$\mu_{1,4} - \mu_{2,4}$	

12. Use the coefficients you determined in the previous table along with the appropriate Bonferroni correction to investigate these contrasts. What do you notice about the width of these confidence intervals compared to the width of the Tukey corrected intervals?

13. Another common effect that we may want to inspect when an interaction is present is that of whether or not there is an effect of pretreatment at variety 1, at variety 2, at variety 3 or at variety 4. Use the SLICE= option in LSMEANS to investigate this. At what levels of Variety is there an effect due to Pretreatment?

14. Conduct the similar test for an effect of Variety at each level of Pretreatment. Where is the pretreatment effect present?

    Notice: The results of these differ for certain levels as there is an interaction present. If no interaction, then the effect of variety would be the same at every level of pretreatment!

For those of you who requested an additional problem for extra practice, you can use the data set named hayfever.txt. This data comes from a study on developing a new medicine for the relief of Hay Fever that uses two active ingredients. y represents the number of hours of relief after taking the medication, Factor A is the amount of the first active ingredient (1 = Low, 2 = Medium, 3 = High), and Factor B is the amount of the second active ingredient (1 = Low, 2 = Medium, 3 = High).

1. Identify variables (response and explanatory) and the treatments
2. State the model and define all terms
3. Determine if the data satisfies the ANOVA assumptions
4. Carry out the ANOVA and determine which factors have an effect on the mean number of hours of relief
5. Explore the necessary contrasts to completely analyze the data. Use appropriate MCP methods.