Stat 441/541 Homework #7 Due: Friday, March 31, 2017

1. Consider the data from Problem 13.2, pages 601-602. The data will be emailed to you. In this experiment, a "Test" represents a replicate.

   (a) (4.5pt) Answer part (a), page 602. Include checking the model assumptions.

   (b) (1.5pt) Provide estimates of the variance components.

   (c) (1.5pt) Provide a practical interpretation of the variance component estimates in the context of the study.

2. (1.5pt) Consider the situation described in Problem 13.7, page 602. Provide estimates of the variance components.

3. The quality control department of a fabric finishing plant is studying the effect of three factors on the dyeing of cotton-synthetic cloth used to manufacture men's shirts. A three-factor factorial experiment was run. Four replications of cloth specimens were dyed under each combination of Temperature (300°C, 350°C), Operator (1,2,3) and Cycle Time (40,50,60). The finished cloth was compared to a standard, and a numerical score was assigned. Assume all factors are fixed. The response Here is the data in the SAS file sent to you.

```
DATA IN;
  DO TEMP = 300 TO 350 BY 50;
  DO OPER = 1 TO 3;
  DO CYCLE= 40 TO 60 BY 10;
  DO REP = 1 TO 4;
     INPUT SCORE @@; OUPUT;
  END; END; END; END;
LINES;
29.5 27.3 24.5 28.8   30.8 33.1 31.4 31.9   22.7 29.1 31.3 28.9
25.7 23.4 19.3 26.3   28.4 29.3 31.6 28.4   30.3 22.7 21.9 24.7
28.2 25.6 28.7 23.2   32.2 27.0 30.2 28.7   26.1 26.6 21.4 24.5
32.1 37.4 34.4 32.1   36.2 40.5 39.9 36.0   28.3 28.4 26.8 25.2
29.1 29.9 28.7 32.8   32.4 35.3 34.3 43.5   24.9 26.4 25.4 29.3
26.4 28.4 32.6 29.9   35.4 35.9 34.3 32.0   24.7 20.9 24.0 26.4
;
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   (a) (2pt) Generate an ANOVA table for the model that includes all main effects, and all two and three factor interactions.

   (b) (2pt) Use interaction plots to interpret any significant interaction effects with respect to the score response.

   (c) (2pt) For each significant main factor, provide an interpretation of that main effect (if possible).

   (d) (.5pt) If larger scores are desirable, what set of factor conditions would you recommend?

   (e) (.5pt) If a target score of 30 is desirable, what set of factor conditions would you recommend?

   (f) (1pt) Is there any serious problem with the model assumptions? If yes, what is the problem?

4. Suppose that the data in Problem 3 was not collected as a completely randomized design. Suppose that two replicates of the three-factor factorial were collected on Monday and the remaining two replicates of the three-factor factorial were collected on Friday, and that within each day the 36 experimental runs were completely randomized.

   (a) (1.5pt) Describe the model that incorporates the model effects from Problem 2 and additional effects involving Days (Monday, Friday) and all two-factor interactions with Days.

   (b) (1.5pt) Set up a partial ANOVA table with a column for the Source of Variation. This will include rows that corresponding to the model effects in (a) as well as rows for Error and Total. Include a second column with the associated degrees of freedom. No data analysis is needed.

   (c) (1pt) Typically, the MSE represents an estimate of σ^2. For this to be true, we will need to assume all other potential model effects are negligible and can be ignored. What potential model effects did we assume to be negligible and exclude from the model?

5. Consider the information on pages 192-194 for Example 5.1 for the battery design experiment. Suppose the researcher is planning another 3×3 factorial experiment. The goal is to determine the sample size required so that the power of each F-test (for Material Type, Temperature, and their interaction) is $\geq .90$.

   (a) (.5pt) Based on this experiment, what is the estimate of σ?

   (b) (1.5pt) Determine the desired sample size assuming you use the sample mean $\overline{y}_{ij}$ as an estimate of μ_{ij} for $i = 1, 2, 3$ and $j = 1, 2, 3$. You can assume $\alpha = .05$.

6. **Stat 541 students**: Suppose that the data in Problem 3 was not collected as a completely randomized design. Suppose that one replicate of the three-factor factorial was collected on Monday, Tuesday, Thursday, and Friday, and that within each of these four days, the 18 experimental runs were completely randomized.

   (a) (3pt) For a model that incorporates model effects involving Days, Temperature, Operator, and Cycle Time, as well as all two-factor and three-factor interactions involving Temperature, Operator, Cycle Time, and Days, set up a partial ANOVA table that includes these model effects and the associated degrees of freedom.

   (b) (1pt) What does the MSE actually estimate in the context of this study?