STATISTICS 642 - ASSIGNMENT 5 - Summer 2015

DUE DATE: NOON, Friday, July 11 2015

Name (**Typed**) _____

Email Address (**Typed**) _____

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STATISTICS 642 - ASSIGNMENT #5

- Due Noon July 11 2015
- Read Chapters 5 and 6 in the Textbook; Handouts 6-8
- **Submit for grading the following problems:**

1. (10 points) In the Cell means model, explain why
   a. df_{A*B} = ab - [b+(a-1)]
   b. df_A = ab - [a(b-1)+1]

2. (25 points) The porosity index is a measure used by soil scientists to assist in the prediction of water movement, storage availability, and aeration conditions of soils. A soil scientist designed a study to examine differences in porosity in three types of soil: Clay (C), Loam (L), and Sandy (S). Ten fields of each soil type were randomly selected to measure the porosity index of the soil. At 1 or 2 randomly selected locations in each field, the porosity index of the soil was measured yielding the data in the following table.

Soil Type	Field	Porosity	Field	Section	Porosity
C	1	3.846, 5.212	L	17	5.942
	2	5.129, 4.521		18	5.014, 4.728
	3	4.587, 5.137		19	5.143
	4	4.621		20	4.061
	5	4.411	S	21	7.635, 6.964
	6	3.357		22	6.784, 5.398
	7	4.491, 3.721		23	6.193
	8	3.766		24	6.725, 7.352
	9	3.177, 4.357		25	5.074
	10	3.333		26	5.483
L	11	5.355, 5.592		27	6.867, 6.289
	12	3.940, 4.410		28	6.212
	13	4.983		29	5.547, 6.428
	14	4.396		30	6.730
	15	5.603			
	16	3.683, 4.339			

   a. Write a linear model (effects model) for this study. Make sure to explain all the terms in your model.
   b. Display the AOV table for this data set and display the expected mean squares in your table.
   c. Display the proportion of total variance in the individual porosity readings due to fields and locations.
   d. Group the types of soils on the basis of their mean porosity index.
   e. Test the hypotheses $H_o : \sigma_e = 0$ vs $H_o : \sigma_e > 0$ for the fields' component of variance.

3. (24 points) A study was conducted to investigate the effect of nitrogen fertility on nitrogen fixation by *Rhizobium* bacteria. The study included four crops: alfalfa, soybeans, guar, and mungbean. Two plants of each crop were inoculated with the *Rhizobium* bacteria and grown in a growth chamber with one of three amounts of nitrogen in the growth media: 0, 50, or 100 ppm N. Four growth chambers were randomly assigned to each of the 12 combinations of crop and and amount of nitrogen. The acetylene reduction was measured when the plants were at the flowering stage. Acetylene reduction reflects the amount of nitrogen that is fixed by the bacteria in the symbiotic relationship with the plant.

	Type of Crop			
Nitrogen	Alfalfa	Soybean	Guar	Mungbean
0	2.6, 1.1	6.5, 2.6	0.5, 0.9	0.8, 0.9
	0.9, 1.2	3.9, 4.3	0.7, 0.7	2.2, 1.2
50	1.5, 1.8	0.6, 0.6	0.3, 0.5	0.7, 0.7
	0.7, 2.2	0.3, 0.8	0.4, 0.4	0.5, 0.6
100	0.6, 1.3	0.5, 0.1	0.2, 0.1	0.3, 0.4
	1.9, 2.6	0.1, 0.3	0.1, 0.2	0.2, 0.2

   a. Write a linear model (effects model) for this experiment. Make sure to identify terms in your model.
   b. Do the three model conditions appear to be satisfied as seen through the data?
   c. Construct a complete ANOVA table for the data.
   d. Test all appropriate hypotheses about main effects and interactions between type of crop and amount of nitrogen.
   e. Construct a profile plot of the treatment means to illustrate your conclusions from part (d.).
   f. Group the four crops relative to their mean acetylene reduction.

4. (20 points) Write the following models for the nitrogen study described in Problem 3. Make sure to explicitly identify all the coefficients and variables in your models.

   a. Cell Means Model
   b. Effects Model
   c. Provide the design matrix for the cell means model
   d. Provide the design matrix for the effects model after reparameterizing the model to have only nonzero coefficients in the model.

5. (21 points) This problem is to evaluate your understanding of the definitions of main effect and interaction effect. The values given in the following table are the **Population Means NOT the Sample Means**, μ_{ijk} for a three factor experiment with factors:

   F_1 with 2 levels; F_2 with 2 levels; F_3 with 2 levels

   The following table contains the values of μ_{ijk}, for example, $\mu_{111} = 8$ and $\mu_{212} = 6$

F_1	1	1	1	1	2	2	2	2
F_2	1	1	2	2	1	1	2	2
F_3	1	2	1	2	1	2	1	2
μ_{ijk}	8	4	2	4	4	6	6	2

   1. Is there a 3-way interaction between the three factors? Justify your answer.
   2. Do the factors F_2 and F_3 interact? Justify your answer. (Answer this question even if $F_1 * F_2 * F_3 \neq 0$)
   3. Is there a main effect due to F_3? Justify your answer. (Answer this question even if $F_1 * F_3 \neq 0$ and/or $F_2 * F_3 \neq 0$)