Assignment 8

Due Thursday Nov. 10

1. An engineer is investigating the effects of four assembly methods (A, B, C, D) on the assembly time of a color television component. Four operators are selected for the study. Furthermore, the engineer knows that each assembly method produces such fatigue that the time required for the last assembly may be greater than the time required for the first, regardless of the method. That is, a trend develops in the required assembly time. To account for this source of variability, the engineer uses the Latin square design shown below.

order of	Operator			
Assembly	1	2	3	4
1	C=10	D=14	A=7	B=8
2	B=7	C=18	D=11	A=8
3	A=5	B=10	C=11	D=9
4	D=10	A=10	B=12	C=14

a) Test if there is a difference between the four assembly methods. State the hypotheses and use $\alpha = 5\%$.

b) Obtain the estimates of the treatment effects.

c) Use Tukey's method to perform pairwise comparison by hand

d) Check assumptions.

2. Suppose in Problem 1 the engineer suspects that the workplaces used by the four operators may represent an additional source of variation. A fourth factor, workplace (α, β, γ, δ), needs to be considered and another experiment is conducted. The layout of the experiment, and the data are given in the following.

order of	Operator			
Assembly	1	2	3	4
1	Cβ=11	Bγ=10	Dδ=14	Aα=8
2	Bα=8	Cδ=12	Aγ=10	Dβ=12
3	Aδ=9	Dα=11	Bβ=7	Cγ=15
4	Dγ=9	Aβ=8	Cα=18	Bδ=6

a) What design is employed in this experiment? Describe its major properties.

b) Test if the four assembly methods are different. Use $\alpha = 5\%$.

c) Is your conclusion consistent with that from Problem 1? If your answer is no, what are the possible causes for the inconsistency?

3. An engineer is studying the mileage performance characteristics of 5 different types of gasoline additives. In the road test he wishes to use cars as blocks; however, because of a time constraint, he must use an incomplete block design. He runs the balanced design with the five blocks that follow.

	car				
additive	1	2	3	4	5
1		17	14	13	12
2	14	14		13	10
3	12		13	12	9
4	13	11	11	12	
5	11	12	10		8

a) Verify that this is a balanced incomplete block design.

b) Test if there is a difference between the five additives? draw your conclusions using $\alpha = 5\%$.

c) Obtain the estimates of treatment means (i.e., the adjusted means or the least square means).

d) Calculate the standard error of the difference between two treatment mean estimates (i.e. the standard error of $\hat{\tau}_i - \hat{\tau}_j$).

e) Calculate the critical difference for Tukey's pairwise comparisons and draw the conclusions. Are they consistent with the results from SAS with the options

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lsmeans trt / pdiff adjust=tukey;
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f) Suppose the engineer wants to know whether the combination of additives 1 and 2 has the same characteristics as the combination of additives 4 and 5. Use a proper contrast to address this issue and offer your answer.