Homework 7 Due Mar.22

1. An experiment was conducted to study the performances of four different types of detergents in cleaning stains. The following "cleanness" readings (higher=cleaner) were obtained with specially designed equipment for three different types of common stains. (This is the data used in Lecture 6).

	Stain 1	Stain 2	Stain 3
Detergent 1	45	43	51
Detergent 2	47	46	52
Detergent 3	48	50	55
Detergent 4	42	37	49

The conclusion from ANOVA is the detergents are different. A residual plot generated for checking assumptions appears to have some suspicious curvilinearity. Use Tukey's test for non-additivity to obtain a rigorous conclusion.

2. 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 a 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 comparisons.
d) Check model assumptions.

3. Continue with Problem.2. Suppose 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 used 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.2? If your answer is no, what are the possible causes for the inconsistency?

4. 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 five blocks given below.

	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 exists difference between the five additives? draw your conclusions using $\alpha = 5\%$.
c) 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 help the engineer out.