# STAT 514 Homework#6
# (Due Thursday 10/8/15 BEFORE CLASS)

**1.** For the automobile emission experiment, the experimenter decides to employ three cars and three drivers to study the four gasoline additives. Plan a randomized complete block design for this study. Compare your design to the Latin square design mentioned in Lecture 7 for advantages and disadvantages. How would you increase the power (or sample size) in either design?

**2.** An industrial engineer is investigating the effects of four assembly methods (A, B, C, D) on the assembly time for 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.

**3.** 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 ( $\alpha$, $\beta$, $\gamma$,

$\delta$) needs to be considered and another experiment is conducted. The layout of the experiment and the data are given in the following.

| Order of Assembly | Operator 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | C$\beta$=11 | B$\gamma$=10 | D$\delta$=14 | A$\alpha$=8 |
| 2 | B$\alpha$=8 | C$\delta$=12 | A$\gamma$=10 | D$\beta$=12 |
| 3 | A$\delta$=9 | D$\alpha$=11 | B$\beta$=7 | C$\gamma$=15 |
| 4 | D$\gamma$=9 | A$\beta$=8 | C$\alpha$=18 | B$\delta$=6 |

**(a)** What design is employed in this experiment? why?

**(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?

**4.** Discuss how you would use the OC curves in the appendix to determine power of a Latin square (assume fixed treatment effect case). In other words, suppose you have a $p \times p$ Latin square and you want to know the power for detecting a difference of size $D$ between any two treatments when the variance is $\sigma^2$. Describe how you would use Chart V (i.e., what is $v_1$, $v_2$, and $\Phi$?). (Hint: $E[MS_{\text{Treatment}}] = \sigma^2 + p\sum_{j=1}^{p} \tau_j^2/(p-1)$.)

**5.** A virologist has asked you to help design an experiment to compare the effects of two different media (A and B) and two different incubation times (12 and 18 hours) on the growth of a specific bacteria. She has access and money to do 24 different runs (single combination of the two factors like media A for 12 hours) but can only do as many as 6 runs a day.

**(a)** Based on this information, propose two potential **balanced** designs that use all 24 runs and present an ANOVA table with sources and degrees of freedom.

**(b)** Suppose the experimenter wants to minimize the length of a 95% confidence interval for a treatment difference $(\mu_i - \mu_j)$. Which of the two designs proposed in (a) is better? Explain.