Assignment 5

(Due next Friday (10/28/05))

1. A chemist wishes to test the effects of four chemical agents on the strength of a particular type of cloth. Because there might be variability from one bolt to another, the chemist decides to use a randomized complete block design, with the bolts of cloth considered as blocks. he/She selects five bolts and applies all four chemicals in random order to each bolt. The resulting tensile strengths follow.

	Bolt				
Chemical	1	2	3	4	5
1	73	68	74	71	67
2	73	67	75	72	70
3	75	68	78	73	68
4	73	71	75	75	69

a) Apply ANOVA to the data from the experiment (use $\alpha = 5\%$) and draw conclusions.

b) Use appropriate plots to check assumptions.

c) Construct a 95% confidence interval for each treatment mean (one-at-a-time CI).

d) Perform Tukey and Bonferroni pairwise comparisons for treatments (use $\alpha = 5\%$).

2. A clay tile company is interested in studying the effect of cooling temperature on strength. The company has five ovens which produce the tiles. Four tiles are baked in each oven and then randomly assigned to one of the four cooling temperatures. The data are shown below.

Cooling	Oven					
Temp	1	2	3	4	5	Mean
5	3	10	7	4	3	5.40
10	3	8	12	2	4	5.80
15	9	13	15	3	10	10
20	7	12	9	8	13	9.80
Mean	5.50	10.75	10.75	4.25	7.50	7.75

a) If $MS_E = 6.275$, calculate the F-statistic to determine if there is a difference among the four cooling temperatures (use $\alpha = 5\%$).

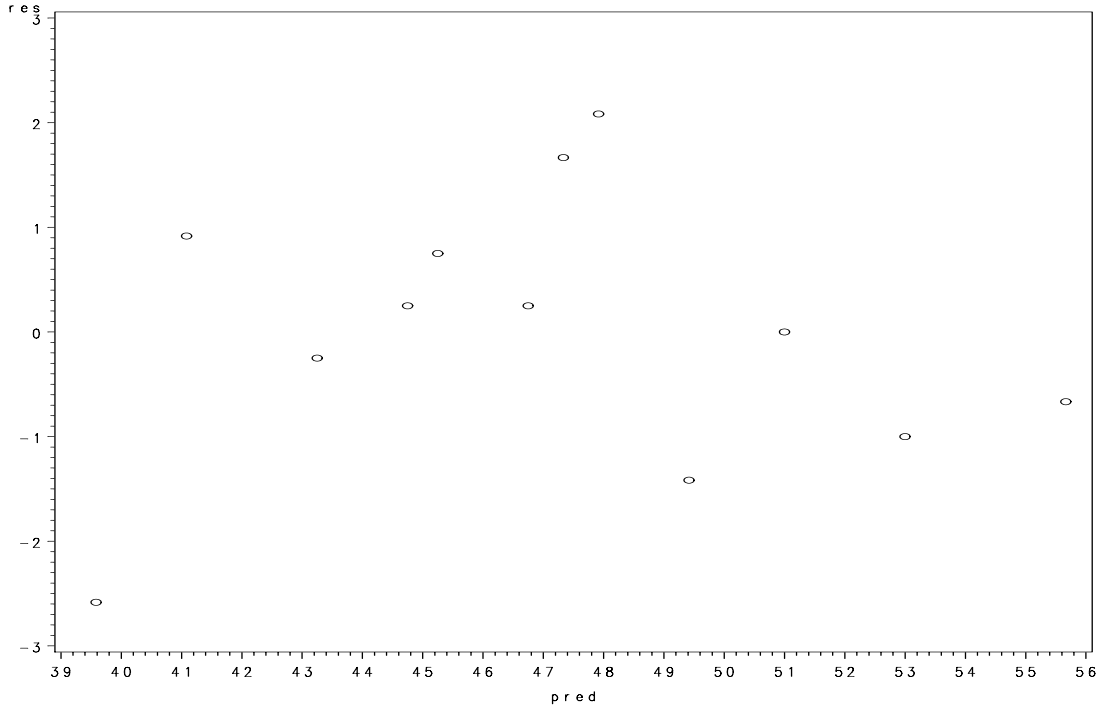
b) If there is a difference among the four temperatures, perform pairwise comparisons using Tukey's procedure, please calculate by hands first, then use SAS to verify your results.

c) Suppose the company believes there is a jump in the strength at 12.5° but otherwise cooling temperature has no effect, that is, 5° and 10° are not different, neither are 15° and 20°, but these two groups of temperatures have different effects. Find a set of orthogonal contrasts that would allow you to test this.

d) Test these contrasts using SAS (or by hand). State your conclusions.

3. An experiment was designed to study the performance of four different detergents for cleaning clothes. The following "cleanness" readings (higher=cleaner) were obtained with specially designed equipment for three different types of common stains.

	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 has been generated for checking assumptions. The plot appears to have some suspicious curvilinearity that could imply the additive model assumption might be violated. Use Tukey's test for non-additivity to settle this issue.