Assignment 4

Due next Thursday (02/16/06) (Due Thursday (02/23/06) for tape-delayed students)

1. An experiment is conducted to study the impact of hormone on the liver of rat. Two types of hormones (I, II) each with two levels are involved. We consider the following four treatments: (A) Hormone I at high level; (a) Hormone I at low level; (B) Hormone II at high level; (b) Hormone II at low level. Each treatment is applied to six randomly selected rats. The response is the amount of glycogen (in mg) in the liver of a rat after a certain period of time.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>106 101 120 86 132 97</td>
</tr>
<tr>
<td>a</td>
<td>51 98 85 50 111 72</td>
</tr>
<tr>
<td>B</td>
<td>103 84 100 83 110 91</td>
</tr>
<tr>
<td>b</td>
<td>50 66 61 72 85 60</td>
</tr>
</tbody>
</table>

Suppose we are interested in the following three contrasts:

<table>
<thead>
<tr>
<th>Comparison</th>
<th>A</th>
<th>a</th>
<th>B</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hormone I vs Hormone II</td>
<td>1</td>
<td>1</td>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>Low Level vs High level</td>
<td>-1</td>
<td>1</td>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>Equivalence of Level</td>
<td>-1</td>
<td>-1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

a). Use ANOVA to check if there exist differences between the treatments ($\alpha = 5\%$).
b). Show that the contrasts are orthogonal to each other.
c). Use contrast sum of squares to test if the contrasts are significant ($\alpha = 5\%$). Interpret the results. (You need to use datalines to input the data. To avoid some unexpected complexity in SAS, please code the treatments as 1, 2, 3 and 4 respectively).

2. An experiment is run to determine whether four specific firing temperatures have different effects on the density of certain brick. The experiment generates the following data (temperature.dat on the class website).
temperature density
1 22.8 1 22.5 1 21.5 1 21.6 1 22.1
2 21.2 2 19.5 2 20.3 2 20.6 2 19.8
3 20.8 3 21 3 22.2 3 21.6 3 20.4
4 23.7 4 23.3 4 22.4 4 22.6 4 22.9

where the temperature levels are 100, 125, 150 and 175 coded as 1, 2, 3 and 4 respectively.

a). Test if the firing temperatures have different effects? Use $\alpha = .05$.
b). Since temperature is a quantitative factor, the experimenter is also interested in modeling
the functional relationship between brick density and temperature. Use orthogonal contrasts
to fit an orthogonal polynomial model. Test if the linear, quadratic and cubic effects are
significant ($\alpha = 5\%$).
c)(Optional). Use the polynomial model obtained in b), which only includes the significant
terms, to find the temperature that produces the lowest density.

3. The tensile strength of portland cement is being studied. Four different mixing tech-
niques are commonly used in producing the cement. The following data (cement.dat) are
collected from an experiment that is conducted to investigate the four techniques.

mixing tensile
1 3129 1 3000 1 2865 1 2890
2 3200 2 3300 2 2975 2 3150
3 2800 3 2900 3 2985 3 3050
4 2600 4 2700 4 2600 4 2765

a). Test if the mixing techniques have different effects on the strength of the cement. Use
$\alpha = 5\%$
b). What is the least difference two treatment sample means should have so that they can
be declared to be significantly different from each other, if you use

b1. the LSD comparison procedure?

b2. Tukey’s method?

b3. Bonferroni’s method?

b4. Scheffé’s method?

c). Report the results using each method. Explain the relationship between power and critical difference. Which of the four is the most powerful and which is the most conservative?

4. Recall Problem 1 in Assignment 3. Compare the treatments (the four different pesticides) with the control at $\alpha = 5\%$ using

a). the Bonferroni method.

b). Dunnet’s method (Table IX or Table VIII in Montgomery)

c). Compare the results in a) and b).