1. KNNL Problem 17.2
   It is true that the standard errors and estimates do not change when using the Bonferroni
   adjustment. What does change, however, is the \( t \) statistic and this depends on the overall
   significance level, \( \alpha \), and the number of tests considered. When one scans a number of
   comparisons and then does formal tests on only those that appear interesting, the total
   number of comparisons should not just be those formally tested but the entire number of
   tests considered.

2. KNNL Problem 17.3
   Contrasts are linear combinations when the sum of the coefficients is zero. In this case, com-
   bination (i) and (iii) are contrasts. The coefficients are \((1, 3, -4, 0)\) and \((1/3, 1/3, 1/3, -1)\)
   respectively.
   An unbiased estimate of each combination can be obtained by replacing the mean with an
   unbiased estimate (e.g., the sample mean). If one uses the sample means, the estimated
   variance will be (i) \( \text{MSE} \frac{26}{n} \); (ii) \( \text{MSE} \frac{36}{n} \); (iii) \( \text{MSE} \frac{4}{3n} \).

3. KNNL Problem 17.12 For d, please calculate the confidence intervals used for the plot
   but ignore the plot itself.
   The main effects plot shows that machines 3 and 4 have much higher means than the other
   4 machines. In other words, there appears to be a large amount of variability among the
   machines.

   ![Main effects plot](image)
   
   Figure 1: Main effects plot

   The confidence interval for machine 1 is \((-0.004, 0.151)\). This was obtained using the
   MSE and no multiple adjustment. The 95% CI for \( \mu_2 - \mu_1 \) is \( 0.117 \pm 0.1102 \). This again
   uses the MSE and \( t \) distribution.
To generate the paired comparison plot, we use Tukey’s multiple adjustment. The minimum significant difference in this case is 0.1613. Half of this amount is the value we add and subtract from each mean. In this case it would be ±0.08065. The intervals for machines 3 and 4 overlap as well as the intervals for machines 2, 6, 5, and 1.

To do the Bonferroni adjustment, we first need to determine the significance level for each comparison. With 3 machines, there are 3 pairwise comparisons so the significance level of each test would be 0.0333. We can get SAS to use this significance level by tweaking the alpha level. With 6 machines, there are 15 comparisons so in order for the comparison level alpha to be 0.0333, we need to specify $\alpha = 0.0333 = .5$. The results are shown below.

<table>
<thead>
<tr>
<th>Mean</th>
<th>N</th>
<th>machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 0.36550</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>B 0.12500</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>B 0.07350</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

Using Bonferroni for these three machines is more efficient than Tukey because Tukey’s procedure considers all pairwise comparisons. We can see that by looking at the minimum significant difference. For Bonferroni, it is 0.1199. For Tukey’s at the $\alpha = 0.10$ level, the minimum significant difference is 0.146.

4. KNNL Problem 17.17

The estimate is $-0.2808$ and the interval is $(-0.3587, -0.2028)$. Since 0 is not in the interval, this suggests that reconditioned machines have a significantly higher mean than the newly purchased ones.

For the 7 linear combinations, I used the Bonferroni adjustment in this case. For an overall $\alpha = .1$, we used $\alpha = .10/7$ for each interval.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>-0.25546909, 0.02146909</td>
</tr>
<tr>
<td>D2</td>
<td>-0.04396909, 0.23296909</td>
</tr>
<tr>
<td>D3</td>
<td>-0.16496909, 0.11196909</td>
</tr>
<tr>
<td>L1</td>
<td>-0.37866243, -0.18283757</td>
</tr>
<tr>
<td>L2</td>
<td>-0.10416243, 0.09166243</td>
</tr>
<tr>
<td>L3</td>
<td>-0.36241965, -0.19283035</td>
</tr>
<tr>
<td>L4</td>
<td>0.04933035, 0.21891965</td>
</tr>
</tbody>
</table>

5. KNNL Problem 17.25

With only 4 confidence intervals, the Bonferroni adjustment is the most appropriate one. This means we’ll use $\alpha = 0.0125$ for each confidence interval. One can also show that the
contrast with the largest SE is \( L_1 \) and \( L_2 \). The SE = \( \sigma \sqrt{2/n} \). If we consider \( \sigma^2 = MSE = 0.031 \), we would want a sample size \( n \) such that \( 0.08 = z_{0.99375} \sqrt{2(0.031)/n} \). This results in \( n = 61 \) samples per machine. This could be fine-tuned using the \( t \) distribution but the sample size would likely only increase to 62.

6. KNNL Problem 18.2
   Omitted.

7. KNNL Problem 18.17
   Omitted.

/****** SAS Codes for Q3 ******/
options nocenter ls=74; goptions colors=(none);
data prob3;
   infile 'u:\.www\datasets525\ch16pr11.txt';
   input y machine;
proc means;
   var y;
   by machine;
   output out=new1 mean=mn;
symbol1 v=circle i=join;
proc gplot;
   plot mn*machine;
run;
proc glm data=prob3;
   class machine;
   model y=machine;
   means machine / t clm;
   means machine / lsd cldiff;
   means machine / tukey;
   means machine / bon alpha=.5;
   means machine / tukey alpha=.10;
run;
proc glm data=prob3;
   class machine;
   model y=machine / clparm;
   estimate 'L' machine .5 .5 -.5 -.5 0 0;
run;
proc glm data=prob3;
   class machine;
   model y=machine / clparm alpha=.0142857;
   estimate 'D1' machine 1 -1 0 0 0 0;
   estimate 'D2' machine 0 0 1 -1 0 0;
   estimate 'D3' machine 0 0 0 0 1 -1;
   estimate 'L1' machine .5 .5 -.5 -.5 0 0;
   estimate 'L2' machine .5 .5 0 0 -.5 -.5;
   estimate 'L3' machine .25 .25 -.5 -.5 .25 .25;
   estimate 'L4' machine .25 .25 .25 -.5 -.5 .25;
run;