**Homework 8:**

1, a,

```r
> aov1 <- aov(weight[Time==21] ~ Diet[Time==21])
> summary(aov1)

Df  Sum Sq  Mean Sq  F value    Pr(> F)
Diet[Time == 21]  3  57164   19055  4.6547 0.006858 **
Residuals         41 167839    4094
---
```

b,

```r
> data1 <- data.frame (weight[Time==21], Diet[Time==21], weight[Time==0 & Chick!=8 & Chick!=15 & Chick!=16 & Chick!=18 & Chick!=44])
> names(data1)<-c("weight","group","birthweight")
> aov2 <- aov(data1$weight ~ data1$group + data1$birthweight)
> summary(aov2)

Df  Sum Sq  Mean Sq  F value    Pr(> F)
data1$group        3  57164   19055  4.7429 0.006364 **
data1$birthweight  1   7137    7137  1.7764 0.190137
Residuals         40 160703    4018
---
```

```r
> summary(lm(data1$weight ~ data1$group + data1$birthweight - 1))

Call: lm(formula = data1$weight ~ data1$group + data1$birthweight - 1)

Residuals:
  Min   1Q Median   3Q   Max
-144.7 -41.24  -1.904  41.33 120.6

Coefficients:
            Value    Std. Error t value    Pr(>|t|)
data1$group1  671.7107     370.9546  1.8108    0.0777
data1$group2  698.4101     363.4780  1.9215    0.0618
data1$group3  755.1986     364.3684  2.0726    0.0447
data1$group4  724.5105     365.2210  1.9838    0.0542
data1$birthweight -11.8848      8.9171  -1.3328    0.1901

Residual standard error: 63.38 on 40 degrees of freedom
Multiple R-Squared: 0.9324
F-statistic: 110.3 on 5 and 40 degrees of freedom, the p-value is 0

Correlation of Coefficients:

<table>
<thead>
<tr>
<th>data1$group1</th>
<th>data1$group2</th>
<th>data1$group3</th>
<th>data1$group4</th>
<th>data1$group2</th>
</tr>
</thead>
<tbody>
<tr>
<td>data1$group2</td>
<td>0.9976</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
data1$group3  0.9976        0.9970
data1$group4  0.9974        0.9968        0.9968
data1$birthweight -0.9991       -0.9985       -0.9985       -0.9983

<table>
<thead>
<tr>
<th>Group</th>
<th>Birthweight mean</th>
<th>21st day weight mean</th>
<th>Adjusted mean(SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>41.5625</td>
<td>177.75</td>
<td>671.711(63.38)</td>
</tr>
<tr>
<td>Group 2</td>
<td>40.7</td>
<td>214.7</td>
<td>698.411(63.38)</td>
</tr>
<tr>
<td>Group 3</td>
<td>40.8</td>
<td>270.3</td>
<td>755.199(63.38)</td>
</tr>
<tr>
<td>Group 4</td>
<td>40.88889</td>
<td>238.556</td>
<td>724.511(63.38)</td>
</tr>
</tbody>
</table>

c,
> aov3<-aov(data1$weight~data1$group*data1$birthweight)
> summary(aov3)

<table>
<thead>
<tr>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt; F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>data1$group</td>
<td>3</td>
<td>57164</td>
<td>19055</td>
<td>5.3202 2 **</td>
</tr>
<tr>
<td>data1$birthweight</td>
<td>1</td>
<td>7137</td>
<td>7137</td>
<td>1.9926 0.006420</td>
</tr>
<tr>
<td>data1$group: data1$birthweight</td>
<td>3</td>
<td>28185</td>
<td>9395</td>
<td>2.6232 0.064948 .</td>
</tr>
<tr>
<td>Residuals</td>
<td>37</td>
<td>132517</td>
<td>3582</td>
<td></td>
</tr>
</tbody>
</table>

2, a,
first sort the data.

the sas code is:

```sas
proc mixed data=data3;
class chick time diet;
model weight=time diet time*diet /solution;
repeated /type=un subject=chick;
run;
```

and change type to cs(compound symmetry), and AR(1) we can get results for the other two covariance structures.

<table>
<thead>
<tr>
<th>Num</th>
<th>Den</th>
<th>Effect</th>
<th>DF</th>
<th>DF</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>2</td>
<td>41</td>
<td>54.54</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>diet</td>
<td>3</td>
<td>41</td>
<td>4.73</td>
<td>0.0063</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time*diet</td>
<td>6</td>
<td>41</td>
<td>2.59</td>
<td>0.0319</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

while the other two results should be: cs: <.0001; 0.0063; 0.0461
AR(1): <.0001; 0.0064; 0.0333.
which all indicate that the diet effects are significant.

in splus or R cs structure can be done by anova(weight~Time*Diet+Error(Chick)) which will return the same results as in SAS. but somehow, if we want to specify the covariance structure, the job can’t be done by aov for sure. so we probably will need gls or lme, like,

anova(gls(weight~Time*Diet, corr=corCompSymm(form=~1|Chick))) this should yield the same results as aov(weight~Time*Diet+Error(Chick)), but somehow I did not get the same results. so I don’t know how to set the covariance structure in R or splus.

here is a website in ucla which has a rather clear explanation of the repeated measures in R.
http://www.ats.ucla.edu/stat/R/seminars/Repeated_Measures/repeated_measures.htm

b,

```r
proc mixed data=data3;
class chick time diet;
model weight=time diet time*diet birth/solution;
repeated /type=un subject=chick;
run;
```

adding birth in the model statement, however, the results showed that birth is not significant for all three cases while diet still remains the significant.

we can add another interaction term of birth and diet to see whether the common slope is appropriate.

```r
proc mixed data=data3;
class chick time diet;
model weight=time diet time*diet birth birth*diet/solution;
repeated /type=un subject=chick;
run;
```

the results show that under all three cases, both birth and interaction of birth and diet are insignificant, which supports the accuracy of the mixed model of adding a single birth term with common slope. however, after adding in the interaction term. the diet becomes not significant any more. so I would suggest we stick with the original model without considering adjusting for the birthweight.