**HW4**

1. Give one reason why we would use the square root of Count (instead of Count) as the response variable. **One reason we would use the square root of Count instead of just Count is to transform the non-linear change into linear change. This linear change helps to satisfy model assumptions.**
2. Do all combinations of the factors Time, Temp and Conc produce the same mean amount of bacteria? The answer involves exactly one hypothesis test. In addition to your answer (yes or no), provide the test statistic and the p-value of the test you use to make this decision. **No. The overall F test produced 40.70 between Time, Temp, and Conc was rejected with p < 0.001, meaning that the amount of bacteria produced between means is not the same.**
3. Which, if any, of the interactions are significant? Provide the p-value of every interaction test you use to make this decision (whether it is significant or not). Clearly label each test. **The only significant interaction is Time\*Temp with p<0.0001. The other interactions tested for were: Time\*Conc, Temp\*Conc, and Time\*Temp\*Conc with p=0.7, p=0.9673, and p=0.1713 respectively.**
4. In the Type III sums of squares (SS) table, the degrees of freedom for Conc is 4. Briefly explain why the degrees of freedom is 4. **The number of levels in the treatment factor of Conc is 5. So the degrees of freedom is 4 = 5 – 1. This accounts for the mean of the treatments in this factor, making the model an unbiased estimator.**
5. Is there a significant difference in mean bacteria comparing Concentration 0.8% and Concentration 1%? If this depends on Time and/or Temperature, your answer will involve multiple hypothesis tests. Clearly describe each test and provide the p-value of each test. **Since Concentration has no significant interactions, there are no dependencies with Time and/or Temperature. The t-test performing difference in mean effects between Concentration levels of 0.8% and 1.0% has a p=0.0025 < 0.05. This indicates that the means are not equal. Therefore, there is a statistical different between Concentration levels 0.8% and 1% on bacteria growth.**
6. Is there a significant difference in mean bacteria comparing Temperature 27 and Temperature 43? If this depends on Time and/or Concentration, your answer will involve multiple hypothesis tests. Clearly describe each test and provide the p-value of each test. **The t-test performing difference in mean effects between Temperature levels 27 and 43 has a p<0.0001 which is statistically significant. This indicates that there is a difference in means, however there is a dependency because Temp and Time have significant interaction. So looking at the two-way table between Time and Temp there are four t-tests that must be checked to verify the Temperature difference in mean bacteria growth. That is, Time could play a role in determining this. In the pairwise t-test difference of mean effect table, the following is checked: Time:24 Temp:27 compared to Time:24 Temp:43 showed p<0.0001, Time:24 Temp:27 compared to Time:48 Temp:43 showed p<0.0001, Time:48 Temp:27 compared to Time:24 Temp:43 showed p<0.0001, and Time:48 Temp:27 compared to Time:48 Temp:43 showed p=0.5610. In fact, Time does play a role due to the interaction. If time is 24 then there is a statistical significance difference in mean bacteria comparing Temperature levels 27 and 43, otherwise if time is 48 there is no difference. That is, if the Time was 48 for both treatments, there is no difference in temperature 27 to 43 means, otherwise if one or the other time was 48 there is a statistical difference.**
7. Provide a 95% confidence interval for the mean bacteria count (in millions of colony forming units) for Concentration 1.2%, Time 48 hours and Temperature 27°C. **The 95% CI for mean bacteria count of Time 48 Temperature 27 and Concentration 1.2% is (13.654935,** **15.588307)**.