**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Homework 1**

1. Courtney Leisner (MS Botany, 2009) designed an experiment to explore the growth of the plant *Bienertia Sinuspersici*, a species with C4 photosynthesis that is salt tolerant. Four levels of salt concentration were of interest to the researcher: 0, 50, 100 and 200 mM NaCl. The experiment consisted of 16 tubes identically planted with *Bienertia Sinuspersici* and then randomly assigned to the four salt treatments (4 replicate tubes per treatment). The tubes were placed in individual hydroponic growth systems at the specified concentration of NaCl in the water and the plants were allowed to grow for 8 weeks. At the end of the growth period, the plants were harvested and the dry weight of the roots was measured. The following table presents the data from this experiment:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NaCl Concentration (mM) | | | |
| Replicate | 0 | 50 | 100 | 200 |
| 1  2  3  4 | 2.4  10.6  12.0  4.6 | 40.9  47.7  31.9  36.3 | 70.5  96.7  26.4  76.0 | 127.2  134.0  28.1  78.3 |
| Mean | 7.4 | 39.2 | 67.4 | 91.9 |

**Show your work for each of following. All parts must be included**.

1. Construct, by hand, the entire ANOVA table for this analysis. Please refer to the example on page 409 of your textbook or the example on page 35 in the handout titled ‘Analysis of Variance for Completely Randomized One-Factor Design - Dr. Evans' Notes’. Also, conduct analysis of variance in R and SAS. Conduct hypothesis test using the traditional and p-value approach to hypothesis testing using α = 0.05. Perform multiple comparisons using Tukey’s procedure if necessary.





*Ho:*

*Ha:*  for at least one

= 0.05

*F = 6.308*

*Reject if*

*Pvalue = P(F(df1,df2))=P(F(3,12))<0.01*

Conclusion: Reject Ho, there is sufficient evidence to conclude that the mean number of dry weights of roots

between the four salt treatments.

b) Assess the assumption of normality using normal probability plot of residuals and Shapiro Wilk’s normality test. Produce necessary output in R and SAS.

c) Assess the assumption of equal variances using plot of residuals vs. predicted values. Construct plot in R and SAS. Also, conduct hypothesis test for comparing variances using either the Brown and Forsythe test (SAS) or Levine’s test (R).

2. Suppose the United States Golf Association wants to compare the distances associated with four different brands of golf clubs when struck with a driver. Iron Byron, the USGA’s robotic golfer, is used to hit a random sample of ten balls of each brand in a random sequence. The distance is recorded for each hit, and the results are shown below.

|  |  |  |  |
| --- | --- | --- | --- |
| Brand A | Brand B | Brand C | Brand D |
| 251.2 | 263.2 | 269.7 | 251.6 |
| 245.1 | 262.9 | 263.2 | 248.6 |
| 248.0 | 265.0 | 277.5 | 249.4 |
| 251.1 | 254.5 | 267.4 | 242.0 |
| 265.5 | 264.3 | 270.5 | 246.5 |
| 250.0 | 257.0 | 265.5 | 251.3 |
| 253.9 | 262.8 | 270.7 | 262.8 |
| 244.6 | 264.4 | 272.9 | 249.0 |
| 254.6 | 260.9 | 275.6 | 247.1 |
| 248.8 | 255.9 | 266.5 | 245.9 |

a) Conduct analysis of variance in R and SAS. Conduct hypothesis test using the traditional and p-value approach to hypothesis testing using α = 0.05. Perform multiple comparisons using Tukey’s procedure if necessary.

b) Assess the assumption of normality using normal probability plot of residuals and Shapiro Wilk’s normality test. Produce necessary output in R and SAS.

c) Assess the assumption of equal variances using plot of residuals vs. predicted values. Construct plot in R and SAS. Also, conduct hypothesis test for comparing variances using either the Brown and Forsythe test or Levine’s test.