Long Problem Set 6

For each problem below, complete the requested calculations and answer the accompanying questions. Your responses are evaluated on the appropriateness of your approach and the insightfulness of your analysis. Your answers are due on Friday, November 4th.

1. The file Acetone.RData contains results from a study to determine the amount of acetone in aqueous solutions of cellulose acetate. The analytical method requires a chemical disintegration of the cellulose acetate followed by an analysis for acetone. The effect of the disintegration step on the amount of acetone was investigated using the following 2^3 full-factorial design

factor/level	–1	+1
A: pH of solvent	acidic	basic
B: solvent (%water)	100	0
C: disintegration time (min)	3.00	6.00

   where the solvent is a mixture of water and methanol. Analyze the data by first finding the full-factorial model, including all possible main effects and interactions. Use a qqnorm plot to evaluate the model's parameters and identify those that are significant. Reanalyze the data using this simpler model and comment on your results.

2. An alternative approach to determining significant factors is to estimate the standard deviation for factor effects (s_{FE}) by making duplicate runs at each set of factor levels. The variance for the difference between the duplicate runs is

$$s^2 = \frac{\sum d_i^2}{2n}$$

   where d_i is the difference between results for a given set of factor levels and n is the number of different factor levels (that is, $n = 2^k$). The standard deviation for factor effects is

$$s_{FE} = \sqrt{\frac{2s^2}{n}}$$

   A coefficient that falls outside a confidence interval of $0 \pm t(\alpha, \nu)s_{FE}$ is considered significant. The degrees of freedom is the number of unique factor level; that is, $\nu = n$. Use this approach and the objects "trial.one" and "trial.two" in the file Acetone.RData to reanalyze the data from the previous problem and compare your conclusions to those determined earlier.

3. The file tRNA.RData contains results from the study of the esterification of tRNA by arginine. The parameters are the pH, the amount of enzyme used to catalyze the reaction, and the amount of arginine used. The reaction was monitored by using ^{14}C-labeled arginine and measuring the amount of radioactivity as counts. The following central-composite design was used

factor/level	–1.7	–1.0	0	+1.0	+1.7
A: enzyme (mg)	3.2	6.0	10.0	14.0	16.8
B: arginine (pmol)	860	1000	1200	1400	1540
C: pH	6.6	7.0	7.5	8.0	8.4

   Develop a suitable model that predicts the counts as a function of the available factors, retaining terms where p is less than 0.10. Does your model predict successfully the intercept? Create a perspective plot that displays counts on the z-axis as a function of the two most important factors; if your model includes a third factor, then set its value to a level of zero. What is the expected count for an experiment that uses 7.0 mg of enzyme, 1300 pmol of arginine, and a pH of 7.5?