Design and Analysis of Experiments, HW 6

Due Thursday, Feb. 12, 4 PM

Instructions: The instructions for this hw are the same as those for HW 1 which is posted on the course website. Your are free to work on this hw with others but the final work must be your own.

1: Do problem 6.40, page 302 in your book, as instructed below. Surfactin is a surfactant with strong antimicrobial and antiviral properties; see wikipedia for details.

i. Do **part a** by using the "fat pencil" test and the hierarchical principle to determine effects for your reduced model and then fitting this model. What terms are significant at $\alpha = 0.05$? Keep all effects/terms which are significant and/or needed according to the hierarchical principle.

ii. Determine conditions which maximum yield, **part c**, using Minitab's response optimizer, `Stat > DOE > Factorial > Response Optimizer`. What are the values of your variables and the corresponding predicted yield (CMC)?

2: According to the author's discusssion in section 6.9, what is a key benefit of analyzing the data and building regression models using coded variables instead of the uncoded (natural) variables?

3: Do problem 8.35, page 382. Note that this is a 2^{5-1} half-fraction factorial experiment with a single center point. Do the following:

i. Download the resolution data from

`www.rose-hulman.edu/~inlow/resolution.MTW`

and analyze it using the "fat pencil" test and the hierarchical modeling principle. Be sure to include the center point term.

ii. What is the resolution of this half-fraction factorial? Are any main effects aliased with any two-way interaction effects/terms? Are any two-way interactions aliased with any other two-way interactions? In order for single replicate and fractional factorial experiments to accurately identify significant effects, the **sparsity of effects principle** must be satisfied. What is the author's definition/description of this principle?

iii. Fit the reduced model consisting of the terms you identified in part i plus the center point term. Assuming the ANOVA/regression assumptions are met what terms are significant at $\alpha = 0.10$? Is the center point term signficant? What does this imply about the presence of curvature and the need for quadratic terms in the model?

iv. Check the regression assumptions. In particular, check for obvious violations of the constant variance assumption, outliers, and substantial nonnormality. What do you conclude?

v. Suppose we want to maximize resolution. Based on your results from part iii what should you do next according to the response surface approach?

4: In this problem you will analze an initial 2^2 factorial experiment with center points, the first experiment of a response surface investigation to maximize the response variable, yield. Do the following:

i. Analyze the data below using Minitab's DOE routines. At $\alpha = 0.05$, check for interaction and curvature.

time	temp	yield
78	168	75.44
82	168	77.53
78	172	77.48
82	172	80.07
80	170	77.81
80	170	78.17
80	170	77.74
80	170	78.22
80	170	77.89

ii. In part i, you should have concluded that there is neither interaction nor curvature. Therefore, to maximize the yield you need to move along the gradient. Compute the gradient in terms of $x1$ and $x2$ using your fitted reduced model.

iii. Express the gradient in terms of the natural variables, time and temp.

iv. Suppose you want to proceed along the gradient with steps having 4 minute time increments. What are the corresponding temperature increments?