**ST 573 Portion of Methods Comprehensive Exam 2008** **ID: _____**

1. Use JMP to construct a fractional factorial design for ___ factors in ____ runs. Note that JMP uses X1, X2, X3, … to denote the factors. No printing of the output is required. Simply view what JMP does and write the answers below.

a. What are the generators JMP chooses for this design if you select a design without blocking?

- List **one** of the **shortest** words in the defining relation for JMP's design, and write out what aliasing this causes for main effects.

b. What are the generators JMP chooses for this design if it is run in two blocks?

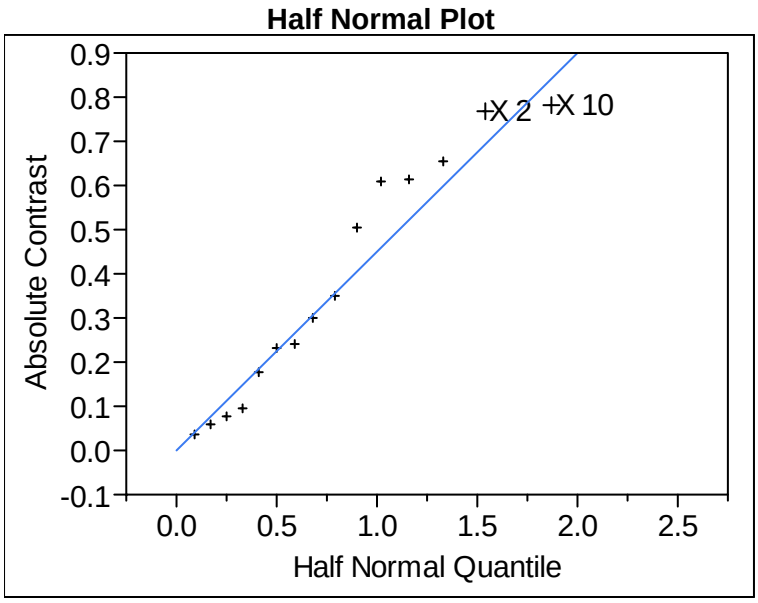
Generators for factors:

Interaction confounded with blocks:

2. A fractional factorial design with 15 factors and 16 was performed. JMP's screening analysis is shown below.

**Contrasts**

| Term | Contrast | Plot of t-Ratio | Lenth t-Ratio | Individual p-Value |
|---|---|---|---|---|
| X 12 | 0.654563 | | 1.46 | 0.1483 |
| X 10 | -0.783973 | | -1.74 | 0.0945 |
| X 11 | 0.505187 | | 1.12 | 0.2467 |
| X 3 | -0.610870 | | -1.36 | 0.1735 |
| X 2 | -0.769511 | | -1.71 | 0.0989 |
| X 9 | 0.613366 | | 1.36 | 0.1714 |
| X 7 | 0.349716 | | 0.78 | 0.4086 |
| X 4 | 0.299664 | | 0.67 | 0.5002 |
| X 13 | 0.240691 | | 0.54 | 0.6241 |
| X 6 | -0.231708 | | -0.52 | 0.6360 |
| X 1 | 0.177562 | | 0.40 | 0.7153 |
| X 15 | 0.097029 | | 0.22 | 0.8421 |
| X 5 | -0.061308 | | -0.14 | 0.9027 |
| X 8 | -0.078655 | | -0.17 | 0.8719 |
| X 14 | -0.034584 | | -0.08 | 0.9452 |




a) What do you conclude about the effects of the factors? (Use $\alpha = .05$.)

b) What assumption is this analysis based on? Do we know whether this assumption holds or not? Explain.

3. Suppose the design for question 2 was augmented with a foldover fraction of 16 runs.
    a. Explain how this foldover fraction would be obtained.

    b. What would be the resolution of the combined, 32-run design?

    c. Given the results from question 2, what would you guess would be the standard error for the main effects coefficients based on the combined 32 runs? (Answer with a number, and then if you wish justify your answer.)

4. Look at Example 9-1, a 54-run experiment in Montgomery (pp. 351-352). Suppose nozzle type (factor A) is difficult to change.

    a. Describe carefully how to conduct a split unit design with six whole units of size 9.

    b. As an indication that you would understand how to do the analysis,
        - What would be the whole unit degrees of freedom?

        - What would be the split unit degrees of freedom?

        (Hint: these should sum to N-1.)

    c. Explain why a split unit design would be more convenient than a completely randomized design here.

5. A 3x3x3 factorial experiment has been proposed which involves 3 quantitative factors: temperature (T), pressure (P) and concentration (C). The levels are: Temperature (80, 100, 120); Pressure (10, 15, 20); Concentration (1, 2, 3).

    a. If we begin our analyses by fitting a full factorial model in T, P, and C, with the factors declared nominal, what will be:
        - Degrees of freedom for the model:
        - Degrees of freedom for error:
        - List the terms in this full factorial model, and the degrees of freedom for each

    b. Suppose instead that we ask JMP to fit a "response surface model" to these data.
        - What would its model degrees of freedom be?
        - What terms would the model contain?
        - What would be its degrees of freedom for error? (Is this pure error?)

6. Propose an alternative design for T, P, and C, with fewer runs than a 3x3x3. **List the actual treatment combinations for the design you propose, using natural units.** (In choosing natural unit levels, recall levels listed for the $3^3$above.)

7. Comment briefly on what is wrong with the following two analyses of Exercise 14-1?

**Analysis 1:**
**Analysis of Variance**

| Source | DF | Sum of Squares | Mean Square | F Ratio |
|---|---|---|---|---|
| Model | 2 | 713.6056 | 356.803 | 4.7211 |
| Error | 33 | 2494.0333 | 75.577 | **Prob > F** |
| C. Total | 35 | 3207.6389 | | 0.0157 |

**Parameter Estimates**

| Term | Estimate | Std Error | t Ratio | Prob>\|t\| |
|---|---|---|---|---|
| Intercept | 9.8333333 | 5.019189 | 1.96 | 0.0586 |
| Process | 5 | 1.774551 | 2.82 | 0.0081 |
| Batch | 1.5888889 | 1.295949 | 1.23 | 0.2289 |

a) Briefly, what is wrong with analysis 1?

**Analysis II:**
**Analysis of Variance**

| Source | DF | Sum of Squares | Mean Square | F Ratio |
|---|---|---|---|---|
| Model | 11 | 2753.6389 | 250.331 | 13.2333 |
| Error | 24 | 454.0000 | 18.917 | **Prob > F** |
| C. Total | 35 | 3207.6389 | | <.0001 |

**Effect Tests**

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---|---|---|---|---|---|
| Process | 2 | 2 | 676.0556 | 17.8693 | <.0001 |
| Batch | 3 | 3 | 230.3056 | 4.0582 | 0.0182 |
| Process*Batch | 6 | 6 | 1847.2778 | 16.2756 | <.0001 |

b) Briefly, what is wrong with analysis 2?

c) What analysis should be done instead? (Just discuss. No analysis required.)