HW3

1. (10 points) There are many different ways to bake brownies. The purpose of this experiment was to determine how the pan material, the brand of brownie mix, and the stirring method affect the scrumptiousness of brownies. The factor levels were

Factor	Low (−)	High (+)
A = pan material	Glass	Aluminum
B = stirring method	Spoon	Mixer
C = brand of mix	Expensive	Cheap

The response variable was scrumptiousness, a subjective measure derived from a questionnaire given to the subjects who sampled each batch of brownies. (The questionnaire dealt with such issues as taste, appearance, consistency, aroma, and so forth.) An eight-person test panel sampled each batch and filled out the questionnaire. The design matrix and the response data are shown below: [see `brownie.dat`]:

				Test Panel Results							
Batch	A	B	C	T1	T2	T3	T4	T5	T6	T7	T8
1	−	−	−	11	9	10	10	11	10	8	9
2	+	−	−	15	10	16	14	12	9	6	15
3	−	+	−	9	12	11	11	11	11	11	12
4	+	+	−	16	17	15	12	13	13	11	11
5	−	−	+	10	11	15	8	6	8	9	14
6	+	−	+	12	13	14	13	9	13	14	9
7	−	+	+	10	12	13	10	7	7	17	13
8	+	+	+	15	12	15	13	12	12	9	14

(a) Analyze the data from this experiment as if there were eight replicates of a 2^3 design. Comment on the results.

(b) Analyze the average and standard deviation of the scrumptiousness ratings. Comment on the results.

(c) Which analysis is more appropriate? Briefly explain why.

2. (10 points) An experiment was conducted on a chemical process that produces a polymer. The four factors studied were temperature (A), catalyst concentration (B), time (C), and pressure (D). Two responses, molecular weight and viscosity, were observed. The design matrix and response data are shown below: [see `polymer.dat`]

Run Number	Actual Run Order	A	B	C	D	Molecular Weight	Viscosity
1	18	−	−	−	−	2400	1400
2	9	+	−	−	−	2410	1500
3	13	−	+	−	−	2315	1520
4	8	+	+	−	−	2510	1630
5	3	−	−	+	−	2615	1380
6	11	+	−	+	−	2625	1525
7	14	−	+	+	−	2400	1500
8	17	+	+	+	−	2750	1620
9	6	−	−	−	+	2400	1400
10	7	+	−	−	+	2390	1525
11	2	−	+	−	+	2300	1500
12	10	+	+	−	+	2520	1500
13	4	−	−	+	+	2625	1420
14	19	+	−	+	+	2630	1490
15	15	−	+	+	+	2500	1500
16	20	+	+	+	+	2710	1600
17	1	0	0	0	0	2515	1500
18	5	0	0	0	0	2500	1460
19	16	0	0	0	0	2400	1525
20	12	0	0	0	0	2475	1500

Factor Levels	Low (−)	High (+)
A (°C)	100	120
B (%)	4	8
C (min)	20	30
D (psi)	60	75

(a) Consider only the molecular weight response. Compute the factorial effects by using the observations from runs 1–16. Use half-normal plot to identify important effects.

(b) Use regression to confirm the results from part (a) by using all runs. [Hint: code − as −1, + as +1, and 0 as 0.]

(c) Write down a regression model to predict molecular weight as a function of the important variables.

(d) Perform residual analysis for the model in (c). Comment on the model assumptions.

3. (10 points) To arrange a 2^6 design in 16 blocks, two blocking schemes are being considered. The first has the generators $\mathbf{B_1} = \mathbf{126}, \mathbf{B_2} = \mathbf{136}$, $\mathbf{B_3} = \mathbf{346}, \mathbf{B_4} = \mathbf{456}$ and the second has generators $\mathbf{B_1} = \mathbf{136}, \mathbf{B_2} = \mathbf{1234}$, $\mathbf{B_3} = \mathbf{3456}, \mathbf{B_4} = \mathbf{123456}$.

(a) What factorial effects are confounded with block effects for the first scheme? What are the $g_i(b)$? What is the order of estimability?

(b) Repeat the questions in (a) for the second scheme?

(c) Which scheme do you recommend? Briefly explain why.

Instruction: Answer the questions with necessary graphs and computer outputs.