Assignment 3 – STAT 453/558 Spring 2024
Due date March 8th, 2024

Question 1. (Example 6.6. of your textbook). An article in the *International Journal of Research in Marketing* ("Experimental Design on the Front Lines of Marketing: Testing New Ideas to Increase Direct Mail Sales," 2006, Vol. 23, pp. 309–319) describes an experiment to test new ideas to increase credit card division of a financial services company. They want to improve the response rate to its credit card offers. They know from experience that the interest rates are an important factor in attracting potential customers, so they have decided to focus on factors involving both interest rates and fees. They want to test changes in both introductory and long-term rates, as well as the effects of adding an account-opening fee and lowering the annual fee. The factors tested in the experiment are as follows:

Table 1: The 2^4 Factorial Design Used in the Credit Card Marketing Experiment

Run	A	B	C	D	y	label
1	-	-	-	-	2.45	(1)
2	+	-	-	-	3.36	a
3	-	+	-	-	2.16	b
4	+	+	-	-	2.29	ab
5	-	-	+	-	2.49	c
6	+	-	+	-	3.39	ac
7	-	+	+	-	2.32	bc
8	+	+	+	-	2.44	abc
9	-	-	-	+	1.84	d
10	+	-	-	+	2.24	ad
11	-	+	-	+	1.69	bd
12	+	+	-	+	1.87	abd
13	-	-	+	+	2.29	cd
14	+	-	+	+	2.92	acd
15	-	+	+	+	2.04	bcd
16	+	+	+	+	2.03	abcd

Factor	(-1) Control	(+1) New Idea
A: Annual Fee	Current	Lower
B: Account-opening fee	No	Yes
C: Initial interest rate	Current	Lower
D: Long-term interest rate	Low	High

a) Analyze the data and determine which factor is not significant.
b) Project the 2^4 design into two replicates of a 2^3 on the significant factors. The new design table should include the runs, factors, responses, and labels
c) In the projected design, what is the estimated effect of the account-opening fee in the response rate?
d) Using the projected design, is the account-opening fee significant?
e) Confound the projected design with blocks using the highest order interaction as a confounding. Write down the runs for both blocks and estimate the block effect. What is the block effect really estimating in this case?

Question 2. An experiment was performed to improve the yield of a chemical process. Four factors were selected, and two replicates of a completely randomized experiment were run. The results are shown in the following table:

Treatment Combination	Replicat I	Replicat II	Treatment Combination	Replicat I	Replicat II
(1)	90	93	*d*	98	95
a	74	78	*ad*	72	76
b	81	85	*bd*	87	83
ab	83	80	*abd*	85	86
c	77	78	*cd*	99	90
ac	81	80	*acd*	79	75
bc	88	82	*bcd*	87	84
abc	73	70	*abcd*	80	80

a) Estimate the factor effects.
b) Prepare an analysis of variance table, and determine which factors are important in explaining yield.
c) Write down a regression model for predicting yield, assuming that all four factors were varied over the range from –1 to +1 (in coded units).
d) Does the residual analysis appear satisfactory?

Question 3. The effect estimates from a 2^4 factorial experiment are listed here.

a) Are any of the effects significant?
b) What happens if you the effect of the interaction AB was -50.5229 instead of -10.5229?

ABCD =	-2.5251	*AD* =	-1.6564
BCD =	4.4054	*AC* =	1.1109
ACD =	-0.4932	*AB* =	-10.5229
ABD =	-5.0842	*D* =	-6.0275
ABC =	-5.7696	*C* =	-8.2045
CD =	4.6707	*B* =	-6.5304
BD =	-4.6620	*A* =	-0.7914
BC =	-0.7982		

Question 4. An article in *Quality and Reliability Engineering International* (2010, Vol. 26, pp. 223-233) presents a 2^5 factorial design. The experiment is shown in the following table:

A	B	C	D	E	y
-1	-1	-1	-1	-1	8.11
1	-1	-1	-1	-1	5.56
-1	1	-1	-1	-1	5.77
1	1	-1	-1	-1	5.82
-1	-1	1	-1	-1	9.17
1	-1	1	-1	-1	7.8
-1	1	1	-1	-1	3.23
1	1	1	-1	-1	5.69
-1	-1	-1	1	-1	8.82
1	-1	-1	1	-1	14.23
-1	1	-1	1	-1	9.2
1	1	-1	1	-1	8.94
-1	-1	1	1	-1	8.68
1	-1	1	1	-1	11.49
-1	1	1	1	-1	6.25
1	1	1	1	-1	9.12
-1	-1	-1	-1	1	7.93

1	-1	-1	-1	1	5
-1	1	-1	-1	1	7.47
1	1	-1	-1	1	12
-1	-1	1	-1	1	9.86
1	-1	1	-1	1	3.65
-1	1	1	-1	1	6.4
1	1	1	-1	1	11.61
-1	-1	-1	1	1	12.43
1	-1	-1	1	1	17.55
-1	1	-1	1	1	8.87
1	1	-1	1	1	25.38
-1	-1	1	1	1	13.06
1	-1	1	1	1	18.85
-1	1	1	1	1	11.78
1	1	1	1	1	26.05

(a) Analyze the data from this experiment. Identify the significant factors and interactions and removing the non-significant terms, when appropriate.

(b) One of the factors from this experiment does not seem to be important. If you drop this factor, what type of design remains? Analyze the data using the full factorial model for only the four active factors, including model adequacy checking.

(c) Find the settings of the active factors that maximize the predicted response.

Question 5. Consider the full 2^5 factorial design Question 4 above. Suppose that this experiment had been run in two blocks with *ABCDE* confounded with the blocks. Set up the blocked design and perform the analysis. Compare your results with the results obtained for the completely randomized design in Question 4.