STAT 514 Midterm 2 (Total 50 Points)

Name:
Section: 9:30am; 2:30pm

- **Exam time: 7:00-8:30pm.**
- **Must show all work to get credits.**
- **Hand in both exam and answer sheets.**

1. Consider a Latin square design with 3 treatments. Assume MSE = 18 and we would like to test the contrast: $\mu_1-2\mu_2+\mu_3=0$.

(1) What are the degrees of freedom for the overall F-test?

(2) What is the standard error of the overall mean?

(3) What is the degree of freedom for a t-test on the contrast?

(4) What is the standard error of the estimate of the contrast?

2. Disk drive substrates may affect the amplitude of the signal obtained during readback. A manufacturer compares four substrates: aluminum(A), nickel-plated amuminum (B), and two types of glass (C and D). Sixteen disk drives will be made, four using each of the substrates. The design responses (in microvolts) are given in the following table (data from Nelson 1993, Greek letters indicate day):

Machine	Operator			
	1	2	3	4
1	$A\alpha = 8$	$C\gamma = 11$	$D\delta = 2$	$B\beta = 8$
2	$C\delta = 7$	$A\beta = 5$	$B\alpha = 2$	$D\gamma = 4$
3	$D\beta = 3$	$B\delta = 9$	$A\gamma = 7$	$C\alpha = 9$
4	$B\gamma = 4$	$D\alpha = 5$	$C\beta = 9$	$A\delta = 3$

The grand mean is 6, and the level means for the four substrates are

A: 5.75 B: 5.75 C: 9.00 D: 3.50

(1) What kind of design is used for the experiment? Describe the major advantages.

(2) Calculate the estimates of the treatment effects.

(3) Complete the following output from SAS.

Source	DF	Squares	Mean Square	F Value	Pr > F
Model	12	100.5000000	8.3750000	1.17	0.5098
Error	3	21.5000000	7.1666667		
Corrected Total	15	122.0000000			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
row	3	21.50000000	7.16666667	1.00	0.5000
col	3	14.00000000	4.66666667	0.65	0.6335
trt	3	61.50000000	20.50000000	2.86	0.2055
greek	3	3.50000000	1.16666667	0.16	0.9149

Test if the substrates are different in terms of their effects on the responses at α=0.1. State the hypotheses, obtain the test statistic and draw your conclusion.

(4) If the machine were not considered as blocks and not included in ANOVA model, will the test results change? Justify your answer.

3. A chemical production process consists of a first reaction with an alcohol and a second reaction with a base. A 3x2 factorial experiment with three alcohols and two based was conducted with three replicate reactions conducted in a completely randomized design. The collected data were percent yield.

Base	Alcohol		
	1	2	3
1	91, 90, 91	89, 88, 90	87, 89, 90
2	87, 88, 91	91, 92, 95	90, 92, 93

(1) Write a linear model for this experiment, explain the terms and specify assumptions.

(2) What are the constraints need to be satisfied?

(3) What are the estimates of effects for base=1, and for the combinations of base and alcohol, i.e., (base, alcohol)=(2,3)?

(4) Given the following is the ANOVA table from SAS, test if the main effects and interactions are significant at α=0.05.

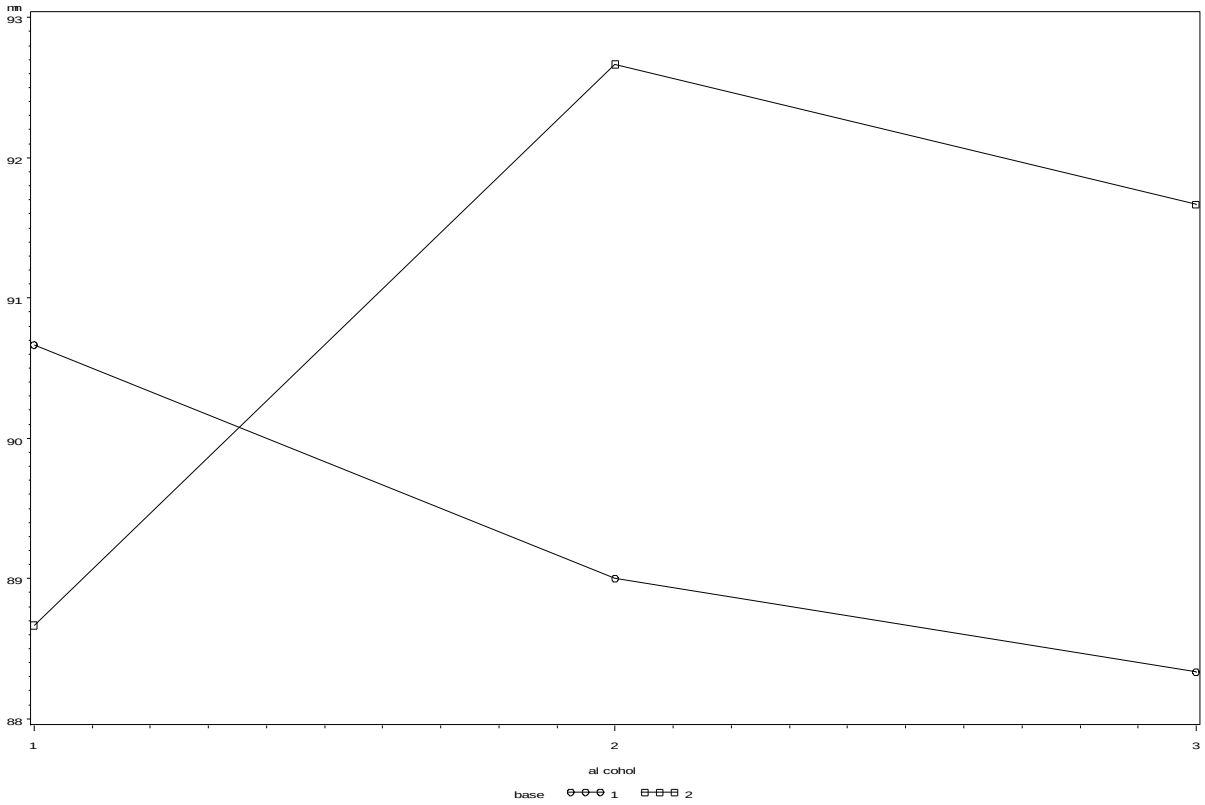
Source	DF	Squares	Mean Square	F Value	Pr > F
Model	5	47.16666667	9.43333333	3.86	0.0257
Error	12	29.33333333	2.44444444		
Corrected Total	17	76.50000000			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
base	1	12.50000000	12.50000000	5.11	0.0431
alcohol	2	4.33333333	2.16666667	0.89	0.4375
base*alcohol	2	30.33333333	15.16666667	6.20	0.0141

(5) Use Bonferroni method to compare the following treatments: (1,2), (1,3), (2,1) and (2,2), use α=0.05. Calculate the critical difference and report the results.

(6) Ignore the interaction between base and alcohol, and suppose Tukey's method is used to compare the level means of alcohol pairwise. Calculate the critical difference.

(7) Interpret the following interaction plot between base and alcohol.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93
92
91
90
89
88
1
2
3
al cohol
base
1
2