**Name**:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**STAT 5309**

**Final Exam**

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**\*4 problems: 25 points each;4 or 5 points for each question parts**

**\* DUE: MON, May 7**

**\*Direction:** (1) Show work where it’s applicable. No credit if no work shown. **Show all calculations.**

(2) R IS USED ONLY TO ASSIST OR TO CHECK ANSWERS

1. **Problem 1**: The effect of 4 types of graphite coater types on light box reading are to be studied. The readings might differ from day to day. Here assume we have a fixed effect model. Observations are taken for 3 days on the four types. The results are

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| --- | --- | --- | --- | --- |
|  | Graphite coating types | | | |
| `Day | Type 1 | Type 2 | Type 3 | Type 4 |
| 1 | 4 | 4.8 | 5 | 4.6 |
| 2 | 4.8 | 5 | 5.2 | 4.6 |
| 3 | 4 | 4.8 | 5.6 | 5 |

1. Write the model equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

State all the assumptions about residuals: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Note: Day is used as blocking factor.**

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1. Use definitions to estimate the model parameters ( 14 parameters)

, where : treatment effects and block effects

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| (show calculations) |

1. Test the hypothesis that the effects ( ie, mean effect) of the 4 graphite coater types are the same.

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| Hypothesis: Ho\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Ha\_\_\_\_\_\_\_\_\_\_  Test statistic\_\_\_\_\_\_\_\_\_\_\_\_\_\_  P-values \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Conclusion\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. How would your analysis of variance be different if the experiment had not been blocked?

Write the ANOVA table with the value of the test statistic and p-value.

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1. **Problem 2**: The response time in milliseconds was determined for 3 different types of circuits that could be used in an automatic valve shutoff mechanism. The results from a completely randomized experiment are shown in the following table:

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| --- | --- | --- | --- | --- | --- |
| Circuit type | Response Time | | | | |
| 1 | 9 | 12 | 10 | 8 | 15 |
| 2 | 20 | 21 | 23 | 17 | 30 |
| 3 | 6 | 5 | 8 | 16 | 7 |

1. Write the model equation:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

State all the assumptions about residuals: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(b) Use definitions and R to find the estimates for the following parameters:

, : treatment effects

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1. Perform a Hypothesis Testing that the hypothesis to be tested for response time being equal for different circuit types.

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| Hypothesis.: Ho\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Ha\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Test statistics \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  P-value\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Decision: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Use |

1. Identify the **pairs of treatment means** which are different using Tukey’s tests with

Significant level.

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1. Suppose we want to test for the significant difference of Perform the appropriate test for **the contrast.**

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| Write Contrast C: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Find the estimate : c =\_\_\_\_\_\_\_\_\_\_\_\_\_se(c ) =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Hypothesis : Ho\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; Ha\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Test statistics\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; P-value\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Conclustion:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. **Problem 3:** A study is conducted to compare 4 menus in terms of numbers of calories. The 4 menus are:
2. No calories B- Calories C-Rank-ordered Calories D-Color-ordered Calories

Suppose n=20 per each menu. The sample means and estimated variance are

1. Complete the following table to test the

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source | SS | df | MS | F | P-values |
| Trt |  |  |  |  |  |
| Error |  |  |  |  |  |
| Total |  |  |  |  |  |

Reject \_\_\_\_\_\_\_\_\_\_\_\_Not reject \_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Difference between 2 means: .

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| Compute the standard error :\_\_\_\_\_\_\_\_\_\_\_\_\_  Compute the Fisher LSD\_\_\_\_\_\_\_\_\_\_\_\_\_  Write a 95%-CI for the difference, using Fisher LSD\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. Contrast C:

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| Write the contrast C which compares Menu 1 vs Menus {1,2,3} combined.  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    Calulate an estimate of C : c=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    Calculate the standard error of the contrast: se(c ) =\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Write a 95%-CI for C, using t-distribution :\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. Problem 4



1. Caculate, from scratch, effects of A, B, AB[ Hint: Chapter 6]

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1. Calculate the Sum Squares: SS(A), SS(B), SS(AB).

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1. Complete the ANOVA table: df, MS, F-stat, P-values of A, B, AB

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| --- | --- | --- | --- | --- | --- |
| Source | SS | df | MS | F-stat | P-value |
| A |  |  |  |  |  |
| B |  |  |  |  |  |
| AB |  |  |  |  |  |
| Total |  |  |  |  |  |

1. Use R, find the model matrix X.

Use X to calculate the vector of coefficients , for the regression model.