

STATISTICS 642 - ASSIGNMENT 3 -Summer 2015

DUE DATE: NOON, Friday June 26, 2015

Name (**Typed**) _____

Email Address (**Typed**) _____

Make this cover sheet the first page of your Solutions.

STATISTICS 642 - ASSIGNMENT #3

- DUE DATE: Noon, Friday June 26, 2015
- Read Handouts 3 & 4 and Chapters 2 & 3 in the Textbook
- Hand in the following problems:

1. **(16 points)** - Textbook - Chapter 2 - Problem 10
2. **(14 points)** - Refer to Problem 6 - Chapter 2 in the Textbook
 - a. What is the power of the test of a difference in the five treatment means if the treatments have the following means:
 $\mu_{Premolt} = 90, \mu_{Fasting} = 100, \mu_{60g} = 120, \mu_{80g} = 110, \mu_{Mash} = 80$
 Use $\alpha = .05$ and $\hat{\sigma}_e^2 = 150$ in your calculations.
 - b. Determine the number of chickens per treatment needed to have an $\alpha = .01$ test with a power of .90 to detect a difference of at least 20 units of T3 concentration between the means of any one of the pairs of treatments. Use $\hat{\sigma}_e^2 = 150$ in your calculations.

3. **(13 points)** - Refer to Exercise 1 - Chapter 2 in the Textbook.
 - a. Display the power curve for this experiment. Use $\hat{\sigma}_e^2 = 12$ in your calculations?
 - b. How many intersections would the engineer need for each type of traffic signal to obtain a test of hypotheses having level of significance 0.05 with a Type II error rate of at most 0.20 if the mean delays are 16 for Pretimed, 17 for Semi-actuated, and 19 for Fully-actuated. Use $\hat{\sigma}_e^2 = 12$ in your calculations?
4. **(10 points)** - Salary disputes and their eventual resolutions often leave both employers and employees embittered by the entire ordeal. To assess employee reactions to a recently devised salary and fringe benefits plan, the H.R. department obtained random samples of 15 employees from each of three divisions in the company: Manufacturing, Marketing, and Research. Staff from the H.R. department asked each selected employee to respond (in confidence) to a series of questions. Several employees refused to respond, as reflected by the unequal sample sizes. The data are summarized in the following table:

| | Manufacturing | Marketing | Research |
|-----------------|---------------|-----------|----------|
| Sample Size | 12 | 14 | 11 |
| Sample Mean | 25.2 | 32.6 | 28.1 |
| Sample Variance | 3.6 | 4.8 | 5.3 |

- a. Write a model for the this experimental situation.
 - b. Use the summary of the responses to test for a difference in the means for the three divisions (the higher a score, the greater the employee's acceptance of the new plan). Use $\alpha = 0.01$ in your test.
5. **(20 points)** - Answer each of the following questions with a brief statement or mathematical derivation:
 - (A) A completely randomized design with $t = 4$ fixed effects treatments and $n_1 = 6, n_2 = 3, n_3 = 5, n_4 = 3$, reps/treatment was run. The following model was fit to the data: $Y_{ij} = \mu + \tau_i + e_{ij}$. The company's computer programmer wrote code that yielded the following least squares estimates of four of the five parameters (only need 4 parameters to represent the 4 treatment means):

$$\hat{\mu} = 5.3; \quad \hat{\tau}_1 = -2.3; \quad \hat{\tau}_2 = -1.7; \quad \hat{\tau}_3 = 1.8$$

What is the value of the least squares estimate of τ_4 ?

- (B) A medical researcher is designing a study to compare the effect of exposing lab mice to five different levels of tritium. Forty mice are obtained for the study and 8 mice are randomly assigned to each level of tritium exposure. The firm supplying the mice claims the mice are nearly identical. Why is it necessary to randomly assign the mice to the exposure levels?
- (C) An experiment is planned to compare the effectiveness of four different types of paint used to cover graffiti on overpasses in a large city. A large container of the paint is obtained from each of the manufactures. The paint is then applied at twenty randomly selected locations where graffiti is present and the effectiveness of the coverage is measured. Thus, each of the four types of paint are observed at twenty locations. What is a major weakness in this experiment?
- (D) A psychologist is comparing the impact of five intervention programs on people who have an addiction to gambling. The psychologist randomly assigns 20 people to each of the 5 programs and after the treatment period, the psychologist assigns a score to each patient based on a series of questions which reflect the patients potential to return to an addiction to gambling. The model $y_{ij} = \mu + \tau_i + e_{ij}$ is fit to the data using SAS and the least squares estimate $\hat{\tau}_1 = -2.3$ is obtained. The five programs are entered into SAS as P1, P2, P3, P4, P5. The psychologist would like you to provide an interpretation of $\hat{\tau}_1 = -2.3$. Which of the following statements is correct? Justify your answer.
- Program P1 has a mean response which is 2.3 units less than the average of the mean responses of the 5 programs.
 - Program P1 has a mean response which is 2.3 units greater than the average of the mean responses of the 5 programs.
 - Program P1 has a mean response which is 2.3 units less than the mean response of program P5.
 - Program P1 has a mean response which is 2.3 units greater than the mean response of program P5.
- (E) A testing laboratory is evaluating the differences in accuracy of field test devices for detecting *e. coli* in meat products. There are five major types of devices for detecting *e. coli* and the testing laboratory wants to evaluate the differences in the mean accuracy of these 5 devices. The laboratory concludes that if a difference of 5.1 ppm or greater exists in the mean detection rate of any pair of the devices then it is very crucial that this difference be identified using an $\alpha = .01$ AOV F-test. How many samples of meat product must be conducted using each of the five field test devices in order to detect a difference of 5.1 ppm with probability of at least 0.95 using an $\alpha = .01$ test? From historical data, the value of σ_e , the overall measurement error, of the devices is taken to be 2 ppm.

The following study will be used in answering questions 6 and 7:

A study was designed to evaluate the temperature at *e. coli* develops most rapidly. There were five temperatures used in a incubator: 10, 15, 20, 25, and 30 °C. Ten containers with a specified level of *e. coli* were randomly assigned to each of the temperatures. The containers were left in the incubator for 24 hours at the specified temperatures. The *e. coli* concentration data is given in the following table:

| Temperature | <i>e. coli</i> level | | | | | | | | | |
|-------------|----------------------|------|------|------|------|------|------|------|-----|-----|
| 10 | 7.2 | 7.8 | 7.1 | 7.9 | 8.1 | 8.8 | 8.3 | 8.9 | 9.3 | 9.8 |
| 15 | 8.1 | 8.1 | 8.0 | 8.9 | 8.2 | 8.9 | 8.1 | 8.8 | 9.2 | 9.9 |
| 20 | 9.0 | 9.9 | 9.2 | 9.8 | 10.0 | 10.8 | 10.2 | 10.7 | 9.9 | 9.0 |
| 25 | 9.2 | 9.8 | 9.1 | 9.9 | 10.1 | 10.8 | 10.3 | 10.9 | 9.3 | 9.8 |
| 30 | 10.2 | 10.8 | 10.1 | 10.9 | 11.1 | 11.8 | 11.3 | 11.9 | 9.3 | 9.9 |

6. (3 points each) - Use the data from the *e. coli* study to answer the following questions. Contrasts of interest to the researchers were

C1: 30 °C vs Average of the means of the other four Temperature levels

C2: Linear trend across the 5 Temperature Levels

C3: Quadratic trend across the 5 Temperature Levels

C4: Cubic trend across the 5 Temperature Levels

- a. Are the four contrasts mutually orthogonal? Justify your answer. If not, select three contrasts from the four contrasts which are mutually orthogonal.
 - b. Provide an estimate of each contrast along with the standard error of the estimator.
 - c. Use the Scheffè test at the $\alpha = .05$ level of significance to test the significance of the four contrasts.
 - d. Use a Bonferroni test with $\alpha_E = .05$ level of significance to test the significance of the four contrasts.
 - e. Test the three trend contrasts simultaneously using the matrix approach from HO 4.
 - f. Is there a trend in the mean *e. coli* concentration as a function of Temperature in the incubator? Justify your answer
7. (**3 points each**) - Use the data from the *e. coli* study to answer the following questions:
- a. With a probability of correct selection of 0.95, which temperature(s) have the smallest mean *e. coli* concentration.
 - b. Do any of the temperatures have a mean *e. coli* concentration less than the mean *e. coli* concentration for a temperature of 30 °C? Use $\alpha = .05$ in your answer.
 - c. Which pairs of the 5 treatment means are different using the Tukey procedure at the .05 significance level.