

Stat514F05 Midterm I (Total 40 Points)

0. Exam time: one hour and 30 minutes.

1. Use $\alpha = 5\%$ throughout the exam.

2. Must show work to get credits.

3. Hand in both your exam and answer sheets.

1. An analyst wants to evaluate the effect of a safety program on reducing the loss of worker-hours due to accidents in manufacturing plants. He/she randomly chooses 10 plants and records their weekly losses of worker-hours due to accidents over an period of 10 weeks. Then the safety program is put into operation in these plants, and the analyst records the weekly losses of worker-hours due to accidents in these plants again over 10 weeks. Given below are the average weekly losses of worker-hours before and after the safety program.

Plants	1	2	3	4	5	6	7	8	9	10
Before	45	73	46	124	33	57	83	34	26	17
After	36	60	44	119	35	51	77	29	24	11
Differences	9	13	2	5	-2	6	6	5	2	6

a)(2) Describe the factor and its levels studied in this experiment.

b)(3) Which fundamental principles are used in this experiment? Describe their advantages.

c)(3) Suppose a normal probability plot (or QQplot) is needed to check if the differences are a sample from a certain normal distribution. What is the point in the QQ plot that corresponds to the difference for Plant 1. Hint: You are required to calculate the coordinates of that point.

d)(4) Test whether the safety program is effective in reducing the loss of worker-hours due to accident.

e)(2) If it is known that the variance of differences is 16, repeat d).

f)(4) Is the experiment or sample large enough so that the type II error of the decision rule in e) is not bigger than 5% for detecting a reduction of at least 4 hours.

2. A pharmaceutical manufacturer wants to investigate the bioactivity of a new drug. Four different dosage levels of the drug are considered and the response is a certain measurement of bioactivity. A completely randomized single-factor experiment is conducted and gives the following results.

Dosage	Bioactivity	Mean	St.D.
10g	24.17, 30.19, 26.31, 26.73, 24.67	26.41	2.37
20g	25.16, 24.31, 21.73, 22.77, 19.48	22.69	2.23
30g	23.10, 18.07, 17.16, 19.22, 20.47	19.60	2.32
40g	26.20, 27.34, 26.44, 22.43, 28.41	26.16	2.26

a)(4) It is given that SST=240.46. Construct the ANOVA table and test whether different dosage levels affect the bioactivity of the new drug.

b)(2) What is the estimate of τ_2 (the treatment effect of the dosage level 20g)?

c)(2) Without resorting to the residual plot and other formal tests, how do you think about the constant variance assumption? Justify your conclusion.

d)(2) What is the estimate of σ^2 (the error variance)?

e)(4) Let μ_1, μ_2, μ_3 and μ_4 be the treatment means at dosage levels 10g, 20g, 30g and 40g, respectively. Suppose the manufacturer considers the following three contrasts

$$\Gamma_1 = \mu_1 - \mu_4, \quad \Gamma_2 = \mu_2 - \mu_3, \quad \Gamma_3 = \mu_1 - \mu_2 - \mu_3 + \mu_4.$$

Verify that Γ_1, Γ_2 and Γ_3 form a complete set of orthogonal contrasts.

f)(2) What is the estimate of Γ_2 ?

g)(4) Given below are part of the SAS code and its output.

```
contrast 'C1' dosage 1 0 0 -1;
contrast 'C2' dosage 0 1 -1 0;
contrast 'C3' dosage 1 -1 -1 1;
```

```
-----
Contrast  DF      Contrast SS      Mean Square      F Value      Pr > F
C1         1         0.1562500         0.1562500         0.03         0.8654
C2         1        23.8084900        23.8084900         4.52         0.0494
C3         *          *****          *****          ****          *****
```

Find the DF, Contrast SS, Mean Square, and F Value for testing whether Γ_3 is significant.

h)(2) Interpret the reported results regarding Γ_1 and Γ_2 and your finding about Γ_3 in g).