

Name _____ Student ID _____

Prince of Songkla University
Department of Industrial Engineering, Faculty of Engineering

Final Examination: Semester 1

Academic Year: 2003

Date: 30th September 2003

Time: 9-12 pm

Subject: 227-551 Res. Methods and Res. Statistics

Room: R300

- Instruction: 1. Open books and notes are allowed.
2. Calculators are also allowed, except personal computers, notebooks.
3. There are 6 problems (total 100 pts) and do all of them.
4. Show your work clearly and legibly.

Distribution of Scores

Problem 1	15 points
Problem 2	15 points
Problem 3	20 points
Problem 4	20 points
Problem 5	15 points
Problem 6	15 points

Test are prepared by
Nikorn Sirivongpaisal

Name _____ Student ID _____

Problem 1: (15 points) A manager of a factory would like to know whether a special training course will shorten the manufacturing time. Eight workers are randomly selected and tested before the training course and after the training course. The time in minutes are recorded as follows:

Worker	1	2	3	4	5	6	7	8
Before training	32	24	40	29	19	36	29	20
After training	27	24	31	21	20	30	25	22

Does the training course shorten the manufacturing time? State the hypothesis and find the P -value. What assumptions are needed so that your test is valid? Use $\alpha = 0.05$

Name _____ Student ID _____

Problem 2: (15 points) An environmental engineer would like to determine whether the average toxic material (measured in parts per million) in three different sites are the same. The following data are obtained.

Site 1	16	22	15	20	22
Site 2	10	11	18	21	
Site 3	28	29	26	22	25

(a) Test the hypothesis that the three sites have the same average toxic material with $\alpha = 0.05$.

(b) Use Tukey's method to make comparisons between pairs of means (use $\alpha = 0.05$). Are the comparisons consistent with the test in (a)?

Name _____ Student ID _____

Problem 3: (20 points) A company has five buses. The manager wants to compare three bands of tires. The tires are randomly assigned to the buses and run for 15,000 miles, the tread wear in millimeters is measured. The data are given as follows.

Tire	Bus				
	1	2	3	4	5
1	17	19	15	14	10
2	29	22	30	27	25
3	29	19	27	25	22

Obtain an appropriate statistical model for this experiment and determine whether there is any difference among the tires. Use $\alpha = 0.05$.

Problem 4: (20 points) Given the two-factor factorial design for the fixed model

$$Y_{ijk} = \mu + \tau_i + \beta_j + (\tau\beta)_{ij} + \varepsilon_{ijk}$$

$$i = 1, 2, \dots, 5 \quad \text{and} \quad j = 1, 2, \dots, 4 \quad \text{and} \quad k = 1, 2, 3$$

Analysis of Variance (ANOVA Table)

Source of Variance	SS	df	MS
Factor A	615	?	?
Factor B	?	?	34
Interaction	183	?	?
Error	?	?	?
Total	1796	?	

(a) Complete the ANOVA table and perform the appropriate statistical tests for factor A effect, factor B effect, and interaction. Use $\alpha = 0.05$.

Source of Variance	SS	df	MS
Factor A	615		
Factor B			34
Interaction	183		
Error			
Total	1796		

(b) In a future design, suppose we wish to reject the null hypothesis with probability at least 0.9 if the difference between any two means for factor A is as great as 10, how many replicates should be run?

Name _____ Student ID _____

Problem 5: (15 points) In a 2^3 design with 4 replicate, the following treatment combination totals are given

Treatment Combination	(1)	a	b	ab	c	ac	bc	abc
Totals	6	11	8	15	9	13	12	21

The total sum of squares is 74.

(a) Find the estimates of the main effects and interactions.

(b) Construct the ANOVA table and perform appropriate tests at $\alpha = 0.05$.

(c) Find a regression equation that could be used to predict a response based on the results of this experiment.

Name _____ Student ID _____

Problem 6: (15 points) In a 2^4 design with 4 blocks, each block has four runs. Construct a design with ABC and BCD confounded with the blocks.