

Name \_\_\_\_\_ Student ID \_\_\_\_\_

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

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Final Examination: Semester 1

Academic Year: 2003

Date: 8<sup>th</sup> October 2003

Time: 9-12 pm

Subject: 225-547 Engineering Statistics II

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Room: R300

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

Distribution of Scores

Problem 1	25 points
Problem 2	25 points
Problem 3	25 points
Problem 4	25 points

Test are prepared by  
Nikorn Sirivongpaisal

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**Problem 1:** (25 points) Aircraft primer paints are applied to aluminum surfaces by two methods – dipping and spraying. The purpose of the primer is to improve paint adhesions. An engineer who is interested in learning performs an experiment to investigate the effect of paint primer type and application method on paint adhesion. Three specimens are painted with each primer using each application method, and the adhesion force is measured. The following data are obtained. If you are an engineer, what are your conclusions that you will get from this experiment? (**Note:** In your conclusions, choose 95% confidence level or  $\alpha = 0.05$  )

Primer Type	Application Method	
	Dipping	Spraying
1	4.0, 4.5, 4.3	5.4, 4.9, 5.6
2	5.6, 4.9, 5.4	5.8, 6.1, 6.3
3	3.8, 3.7, 4.0	5.5, 5.0, 5.0

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**Problem 2:** (25 points) An experiment  $2^3$  factorial design is performed to investigate the surface finish of a metal part. The experimental factors are feed rate (A), depth of cut (B), and tool angle (C), with  $n = 2$  replicates. Data shown in the following table presents the observed surface-finish for this experiment.

Run		Surface Finish
1	(1)	9, 7
2	a	10, 12
3	b	9, 11
4	ab	12, 15
5	c	11, 10
6	ac	10, 13
7	bc	10, 8
8	abc	16, 14

Analyze and draw conclusion from this above design.

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**Problem 3:** (25 points) Data from study of gage repeatability and reproducibility (GR&R) are shown in the following table.

	Operator 1		Operator 2		Operator 3	
	Measurements (mm)		Measurements (mm)		Measurements (mm)	
Part Number	1	2	1	2	1	2
1	21	20	20	20	19	21
2	24	23	24	24	23	24
3	20	21	19	21	20	22
4	27	27	28	26	27	28
5	19	18	19	18	18	21
6	23	21	24	21	23	22
7	22	21	22	24	22	20
8	19	17	18	20	19	18
9	24	23	25	23	24	24
10	25	23	26	25	24	25
11	21	20	20	20	21	20
12	18	19	17	19	18	19
13	23	25	25	25	25	25
14	24	24	23	25	24	25
15	29	30	30	28	21	20
16	26	26	25	26	25	27
17	20	20	19	20	20	20
18	19	21	19	19	21	23
19	25	26	25	24	25	25
20	19	19	18	17	19	17

Assume data above are qualified and can be used to analyze GR&R. Do the following problems.

3.1 Evaluate gage repeatability.

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3.2 Evaluate gage reproducibility.

3.3 Evaluate gage repeatability and reproducibility (GR&R).

3.4 Evaluate gage capability if this measurement system has to be used to measure the products which upper specification limit is 60 mm. and lower specification limit is 5 mm.

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**Problem 4:** (25 points) Select to answer any 4 questions from the following 5 questions. Explain them roughly.

4.1 There are two main approaches in quality improvement. Explain each approach and how are they different? (5 points)

4.2 Explain  $6\sigma$  process by using concept of process capability ( $C_p$ ). (5 points)

4.3 What is the roadmap of  $6\sigma$ ? Explain each phase and tools, including statistical tools, applied in each phase. (10 points)

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4.4 Explain FMEA concept. What is it useful for? (5 points)

4.5 Explain COQ (Cost of Quality) concept. What is it useful for? (5 points)