

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

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

Final Examination: Semester 1  
Date: 2 October 2006  
Subject: 225-502 Experimental Designs

Academic Year: 2006  
Time: 9.00 – 12.00  
Room: R 300

ทฤษฎีในการสอบ โทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทฤษฎี และพักการเรียนหนึ่งภาคการศึกษา

**Instructions: Read carefully**

1. All materials are allowed.
2. There are 6 problems, do all of them. Also show your work clearly and legibly.
3. Answer the questions in this test paper, only.
4. You must write your name and your student ID in every page of the test.
5. Total score is 100 points.

**Distribution of Score**

Problem	Points	(a)	(b)	(c)
1	20	8	7	5
2	15	-	-	-
3	20	-	-	-
4	15	-	-	-
5	20	-	-	-
6	10	-	-	-

Tests are prepared by  
Nikorn Sirivongpaisal

**Problem 1: (20 points)** An experiment was performed to improve the yield of a chemical process. Four factors were selected, and two replicates of a completely randomized experiment were run. The results are shown in the following table:

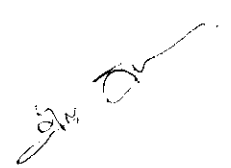
Treatment Combination	Replicate		Treatment Combination	Replicate	
	I	II		I	II
(1)	90	93	<i>d</i>	98	95
<i>a</i>	74	78	<i>ad</i>	72	76
<i>b</i>	81	85	<i>bd</i>	87	83
<i>ab</i>	83	80	<i>abd</i>	85	86
<i>c</i>	77	78	<i>cd</i>	99	90
<i>ac</i>	81	80	<i>acd</i>	79	75
<i>bc</i>	88	82	<i>bcd</i>	87	84
<i>abc</i>	73	70	<i>abcd</i>	80	80

(a) Estimate the factor effects

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(b) Prepare an analysis of variance table, and determine which factors are important in explaining yield.

(c) Write down a regression model for predicting yield, assuming that all four factors were varied over the range from -1 to +1 (in coded units).



**Problem 2: (15 points)** A router is used to cut location notches on a printed circuit board. The vibration level at the surface of the board as it is cut is considered to be a major source of dimensional variation in the notches. Two factors are thought to influence vibration: bit size ( $A$ ) and cutting speed ( $B$ ). Two bit sizes (1/16 and 1/8 inch) and two speeds (40 and 90 rpm) are selected. And four boards are considered as blocking factors. The response variable is vibration measured on each test circuit board. Analyze the data from this experiment. Use  $\alpha = 0.05$ .

$A$	$B$	Treatment Combination	Block			
			1	2	3	4
-	-	(1)	18.2	18.9	12.9	14.4
+	-	$A$	27.2	24.0	22.4	22.5
-	+	$B$	15.9	14.5	15.1	14.2
+	+	$Ab$	41.0	43.9	36.3	39.9

**Problem 3: (20 points)** An experiment was conducted on a chemical process that produces a polymer. The four factors studied were temperature (*A*), catalyst concentration (*B*), time (*C*), and pressure (*D*). The response, which is viscosity, was observed. The design matrix and response data are shown below. Analyze the data from this experiment. Use  $\alpha = 0.05$ .

<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	Viscosity
-	-	-	-	1400
+	-	-	-	1500
-	+	-	-	1520
+	+	-	-	1630
-	-	+	-	1380
+	-	+	-	1525
-	+	+	-	1500
+	+	+	-	1620
-	-	-	+	1400
+	-	-	+	1525
-	+	-	+	1500
+	+	-	+	1500
-	-	+	+	1420
+	-	+	+	1490
-	+	+	+	1500
+	+	+	+	1600

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**Problem 4: (15 points)** Construct a  $2^5$  design in eight blocks with *ABE*, *BCE*, and *CDE* confounded.

2/20/20

**Problem 5: (20 points)** An experiment was run in a plant in an effort to increase yield. Five factors, *A*, *B*, *C*, *D*, and *E*, each at two levels, were studied. The unreplicated  $2^5$  design shown below was run. Suppose that only a one-half fraction could be run. Construct the highest resolution design and analyze the data. Use  $\alpha = 0.05$ .

$(I) = 7$	$d = 8$	$e = 8$	$de = 6$
$a = 9$	$ad = 10$	$ae = 12$	$ade = 10$
$b = 34$	$bd = 32$	$be = 35$	$bde = 30$
$ab = 55$	$abd = 50$	$abe = 52$	$abde = 53$
$c = 16$	$cd = 18$	$ce = 15$	$cde = 15$
$ac = 20$	$acd = 21$	$ace = 22$	$acde = 20$
$bc = 40$	$bcd = 44$	$bce = 45$	$bcde = 41$
$abc = 60$	$abcd = 61$	$abce = 65$	$abcde = 63$

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**Problem 6: (10 points)** Summarize all the term projects in your class as listed in the below table.

Member	Response Variable	Factors	Design
น.ส. วิชุดา สองเมือง			
น.ส. วิภา วิเศษสินธุ์			
ว่าที่ร.ต. อนุพนธ์ ยอดค่อ			
น.ส. กุสุมา เรืองดิษฐ์			
น.ส. ธนวรรณ วานิช			
น.ส. ไศภิน สุดสะอาด			
นาย นนทพงศ์ สุนทรนนท์			
นาย ขงยุทธ ดุลยกุล			
นาย สาริต คงเขียว			
นาย อรรถวาท หิรัญสาย			
นาย ธนา ศรีจันทร์งาม			
นาย อับดุล บินระหีม			
นาย ศิวนาท ลอยกุลนันท์			
นาย สัญชัย ร่ำหมาน			
น.ส. ณีฎ์ชญาภา			
น.ส. อรกานต์ รอดรักษ์			