

2007 MEC 623 SIX SIGMA – TEST II

Time: 60 minutes

Max marks:20

Use of approved Six Sigma Tables is permitted

- 1) Explain the benefits of randomisation in experimental design. (2 marks)

- 2) It is required to conduct a test programme to compare the performance of three detergents, Surf, Jwala and Tide. The clothes can be just dirty or very dirty. Hot water or cold water can be used. Design a full factorial experiment with two replications randomised in two blocks. Provide a table so that a person unfamiliar with DoE will be able to carry out the experiments. (4 marks)

- 3) An experiment was conducted to study heat transfer in article molds used in the manufacture of drinking glasses. The factors involved are A. Glass Type, B. Glass Temperature and C. Cooling Time. The mould temperature is the response variable. Calculate all effects and interactions.

A	B	C	Rep 1	Rep 2
Alpha	1200	15	436	438
Beta	1200	15	461	459
Alpha	1300	15	436	440
Beta	1300	15	462	470
Alpha	1200	20	436	440
Beta	1200	20	464	466
Alpha	1300	20	439	437
Beta	1300	20	470	464

- 4) Identify the significant effects in the unreplicated, four factor, factorial experiment given below using higher order interaction method. The effects have already been calculated using Yates algorithm. (4 marks)

A	B	C	D	R	Effects	
-1	-1	-1	-1	104	100.4375	1
1	-1	-1	-1	96	-1.375	A
-1	1	-1	-1	110	18.625	B
1	1	-1	-1	110	1.875	AB
-1	-1	1	-1	93	1.875	C
1	-1	1	-1	100	1.625	AC
-1	1	1	-1	101	1.125	BC
1	1	1	-1	100	-1.625	ABC
-1	-1	-1	1	92	1.875	D
1	-1	-1	1	90	-1.875	AD
-1	1	-1	1	114	9.625	BD
1	1	-1	1	111	0.375	ABD
-1	-1	1	1	79	2.375	CD
1	-1	1	1	81	-0.375	ACD
-1	1	1	1	106	-0.375	BCD
1	1	1	1	114	-0.625	ABCD

(4 marks)

- 5) Determine the residuals in the three factor factorial experiment with two replications as given below and check whether they are normally distributed, if the model equation is $Y=100+20B+10C$

A	B	C	Rep 1	Rep 2
-1	-1	-1	73	69
1	-1	-1	73	75
-1	1	-1	106	111
1	1	-1	107	112
-1	-1	1	92	88
1	-1	1	85	91
-1	1	1	131	135
1	1	1	125	129

(4 marks)

- 6) An experiment was carried out to determine the factors affecting tensile strength in casting. In order to establish the validity of results over cast irons with differing carbon content, it was treated as a blocking factor. Determine the significant factors from the results given below:

Pouring speed (l/min)	Pouring temp ($^{\circ}$ C)	Carbon %	Tensile strength (kg/cm^2)
5	1300	3	14
10	1300	3	16
5	1400	3	20
10	1400	3	19
5	1300	4	18
10	1300	4	19
5	1400	4	26
10	1400	4	23

(4 marks)

SOLUTIONS TO NUMERICAL PROBLEMS

3.

Average	1	2	3	Div	Effects	
437	897	1801	3609	8	451	1
460	904	1808	107	4	26.8	A
438	903	51	9	4	2.25	B
466	905	56	7	4	1.75	AB
438	23	7	7	4	1.75	C
465	28	2	5	4	1.25	AC
438	27	5	-5	4	-1.3	BC
467	29	2	-3	4	-0.8	ABC

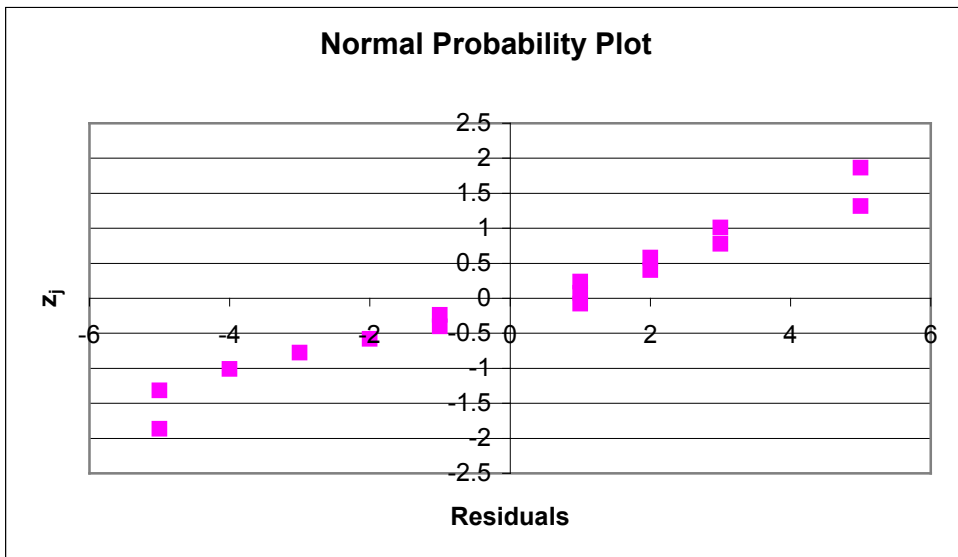
4.

		t
1		
A		-1.65456
B		22.41172
AB		2.256213
C		2.256213
AC		1.955385
BC		1.353728
ABC	-1.625	
D		2.256213
AD		-2.25621
BD		11.58189
ABD	0.375	
CD		2.85787
ACD	-0.375	
BCD	-0.375	
ABCD	-0.625	
Sumsq(HI)	3.453125	
SE	0.831039	
tcrit	2.570578	

5.

A	B	C	Y	Res 1	Res2
-1	-1	-1	70	3	-1
1	-1	-1	70	3	5
-1	1	-1	110	-4	1
1	1	-1	110	-3	2
-1	-1	1	90	2	-2
1	-1	1	90	-5	1
-1	1	1	130	1	5
1	1	1	130	-5	-1

1	-5	0.03125	-1.86273
2	-5	0.09375	-1.31801
3	-4	0.15625	-1.00999
4	-3	0.21875	-0.77642
5	-2	0.28125	-0.57913
6	-1	0.34375	-0.40225
7	-1	0.40625	-0.2372
8	1	0.46875	-0.07841
9	1	0.53125	0.078412
10	1	0.59375	0.237202
11	2	0.65625	0.40225
12	2	0.71875	0.579132
13	3	0.78125	0.776422
14	3	0.84375	1.009989
15	5	0.90625	1.318012
16	5	0.96875	1.862727



Residuals appear to be normally distributed.

6.

R	1	2	3	Div			t
14	30	69	155	8	19.4	1	
16	39	86	-1	4	-0.3	A	-0.4
20	37	1	21	4	5.25	B	8.345
19	49	-2	-7	4	-1.8	AB	-2.78
18	2	9	17	4	4.25	C	6.755
19	-1	12	-3	4	-0.8	AC	
26	1	-3	3	4	0.75	BC	
23	-3	-4	-1	4	-0.3	ABC	
					1.19	SumSq(BI)	
					0.63	SE	
					3.18	tcrit	