2005 SIX SIGMA – TEST II

Time: 50 minutes, Max marks:25

Use of approved Six Sigma Tables is permitted

1) Explain the deficiencies of a one factor at a time experiment.

(2 marks)

2) It is planned to study the variables that affect abrasive jet machining. The factors and possible levels are Nozzle dia 2 and 3 mm, stand-off distance 5 and 25mm, jet pressure 1 and 4 kg/sqcm. Design a Data Collection form for a two level Full Factorial experiment with two replications randomised in two blocks using uncoded variables, so that the machine operator can easily carry out the experiment.

(3 marks)

3) Judge the significance of the following effects using a normal probability plot: A=17, B=2, AB=1, C=6, AC=1, BC=0.5, ABC=-4, D=42, AD=-58, BD=-3, ABD=4, CD=1, ACD=2, BCD=-3, ABCD=-2.

(5 marks)

4) An experiment was conducted to study the factors affecting tensile strength after aging of a Beryllium Bronze with results as follows

A	B	C	Rep	Rep		
Be content %	Aging temp ^{o}C	Aging time min	1	2	Effects	
1	300	20	80	76	50	1
2	300	20	16	24	-19.5	a
1	400	20	76	80	0.5	b
2	400	20	22	18	1	ab
1	300	80	44	39	2	c
2	300	80	64	57	38.5	ac
1	400	80	41	42	-2.5	bc
2	400	80	62	59	-1	abc

Only the factors A and AC statistically significant. Develop a linear model and predict the strength for a Beryllium content of 1.75%, Aging Temp of 325^{o}C and Aging Time of 60min.

(5 marks)

5) Calculate the residuals for the above problem (Q4).

(5 marks)

6) Determine the Curvature and test for its significance in the following experiment.

A	**B**	**R1**	**R2**
-1	-1	-6	0
1	-1	35	31
-1	1	22	24
1	1	25	29
0	0	22	24
0	0	23	26

(5 marks)

7) An experiment was carried out to determine the factors affecting tool life. In order to establish the validity of results over mild steels with different carbon content, it was treated as a blocking factor. Determine the significant factors from the results given below:

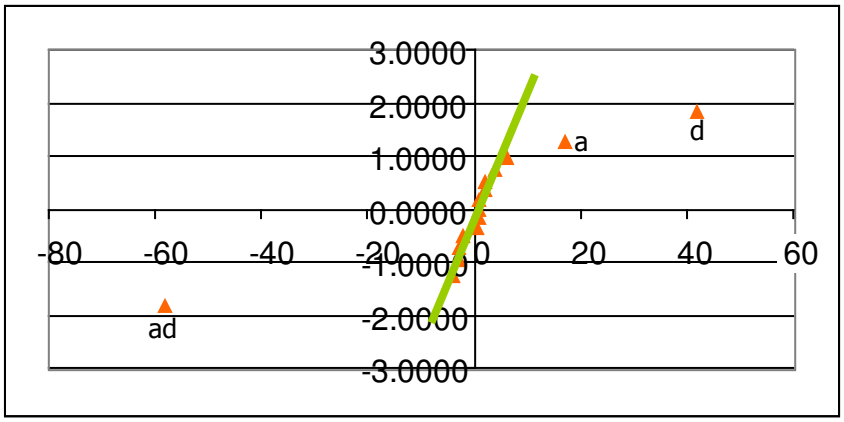
Speed (m/min)	**Depth of cut (mm)**	**Carbon %**	**Tool Life (min)**
5	2	0.05	44
20	2	0.05	48
5	6	0.05	50
20	6	0.05	59
5	2	0.1	28
20	2	0.1	23
5	6	0.1	31
20	6	0.1	40

(5 marks)

SOLUTIONS TO PROBLEMS

3.

ad	-58	1	0.0333	-1.8339
abc	-4	2	0.1000	-1.2816
bd	-3	3	0.1667	-0.9674
bcd	-3	4	0.2333	-0.7279
abcd	-2	5	0.3000	-0.5244
bc	0.5	6	0.3667	-0.3407
ab	1	7	0.4333	-0.1679
ac	1	8	0.5000	0.0000
cd	1	9	0.5667	0.1679
b	2	10	0.6333	0.3407
acd	2	11	0.7000	0.5244
abd	4	12	0.7667	0.7279
c	6	13	0.8333	0.9674
a	17	14	0.9000	1.2816
d	42	15	0.9667	1.8339



4.

To predict at	1.75	325	60
Centre	1.50	350	50
Coded to predict	0.500	-0.500	0.333

Ypred = 50 - 4.875 + 0.3333 + 3.2083 = 48.666

5.

Effects	last col	deleting insig	Reversing	1	2	3	div/8	Reversing	Res 1	Res 2
50	400	400	0	0	162	484	60.5	78	2	-2
-19.5	-78	-78	0	162	322	332	41.5	20	-4	4
0.5	2	0	154	0	-146	484	60.5	78	-2	2
1	4	0	8	322	478	332	41.5	20	2	-2
2	8	8	0	0	162	160	20	41.5	2.5	-2.5
38.5	154	154	0	-146	322	624	78	60.5	3.5	-3.5
-2.5	-10	0	-78	0	-146	160	20	41.5	-0.5	0.5
-1	-4	0	400	478	478	624	78	60.5	1.5	-1.5

6.

Average	Variance	dof	Curvature	3.7500
-3	18	1	Sp^2	6.3929
33	8	1	Sp	2.5284
23	2	1	Sc	1.5483
27	8	1	t	2.4220
23.75	2.9167	3	tcrit	2.3646

Curvature is significant.

7.

1	2	3	Effects		
92	201	323	40.375	1	t
109	122	17	4.25	S	2.252
51	13	37	9.25	D	4.901
71	4	19	4.75	SD	2.517
4	17	-79	-19.75	C	
9	20	-9	-2.25	SC	
-5	5	3	0.75	DC	
9	14	9	2.25	SDC	
				Sumsq Bl	10.6875
				Se^2	3.5625
				Se	1.8875
				tcrit	3.182449291

Only D is significant.