

GUJARAT TECHNOLOGICAL UNIVERSITY
ME Semester –I Examination Feb. - 2012

Subject code: 710906N**Date: 21/02/2012****Subject Name: Robust Design****Time: 10.30 am – 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a)** (i) The diameters of steel shafts produced by a certain manufacturing process should have a mean diameter of 12mm. The diameter is known to have a standard deviation of 0.01mm. Setup an appropriate hypothesis on the mean. **07**

(ii) Differentiate between effects and means models.

- (b)** A manufacturer of television sets is interested in the effect on tube conductivity of four different types of coatings for colour picture tubes. The following conductivity data are obtained: **07**

Coating type	conductivity			
1	143	141	150	146
2	152	149	137	143
3	134	136	132	127
4	129	127	132	129

Test all pairs using Fisher LSD method with $\alpha = 0.05$. $t_{0.025,12} = 2.179$

- Q.2 (a)** An experiment describing the amount of radon released in showers was conducted with the following data **07**

Orifice diameter	conductivity			
.37	80	83	83	85
.51	75	75	79	79
.71	74	73	76	77
1.02	67	72	74	74

Does the size of the orifice affect the mean percentage of radon released?

Use $\alpha = 0.05$, $F_{0.05,3,12} = 3.12$; $F_{0.05,4,15} = 3.06$; $F_{0.05,3,15} = 3.29$; $F_{0.05,4,12} = 3.06$

- (b)** Consider the following data from a two-factor factorial experiment. Analyze the data and draw conclusions. Use $\alpha = 0.05$, $F_{0.05,2,9} = 4.20$; $F_{0.05,4,9} = 3.63$; $F_{0.05,2,10} = 4.10$; $F_{0.05,4,10} = 3.48$ **07**

Row Factor	Colum factor		
	1	2	3
1	36&38	39&41	36&37
2	18&17	20&21	22&20
3	30&31	37&36	33&32

OR

- (b)** With the help of a suitable example, explain how the main and interactive effects of a 2^2 design can be estimated, in terms of contrast. **07**

- Q.3 (a)** In the manufacturing of integrated circuits, a basic step is to grow an epitaxil layer thickness (in μm) on polished silicon wafers. An experiment was run on two factors: arsenic flow rate (A) and deposition time (B) and the data is given below. Estimate the factor effects and hence develop a predictive equation **07**

A	B	Replicate		Factor levels		
		I	II	Low (–)		High (+)
–	–	14.037	16.165	A	55%	59%
+	–	13.880	13.860			
–	+	14.821	14.757	B	short (10 min)	long (15 min)
+	+	14.888	14.921			

- (b)** In a 2^3 design involving factors A, B and C, write down the contrast for A, AB, ABC. Explain how contrast can be used to calculate the sum squares of factors and interactions required for ANOVA **07**

OR

- Q.3 (a)** Explain, with the help of suitable example, how blocking and confounding are effective across many situations that are likely to be encountered in practice. **07**

- (b)** In the manufacturing of integrated circuits, a basic step is to grow an epitaxil layer thickness (in μm) on polished silicon wafers. An experiment was run on two factors: arsenic flow rate (A) and deposition time (B) and the data is given below. **07**

- (i) Conduct an analysis of variance. Which factors are important?
(ii) Analyze residuals. Are there any residuals that should cause concern?

Use $\alpha = 0.05$, $F_{0.05,1,4} = 7.71$; $F_{0.05,1,5} = 6.61$; $F_{0.05,2,4} = 6.94$; $F_{0.05,2,5} = 5.79$

A	B	Replicate		Factor levels		
		I	II	Low (–)		High (+)
–	–	14.037	16.165	A	55%	59%
+	–	13.880	13.860			
–	+	14.821	14.757	B	short (10 min)	long (15 min)
+	+	14.888	14.921			

- Q.4 (a)** With the help of a suitable example explain the concept of Robust design **07**

- (b)** What do you mean by response surface? With the help of a suitable example, explain how response surface can be used for process optimization. **07**

OR

- Q.4 (a)** Explain, giving suitable examples, how non-linearity is useful in ensuring robust performance of products **07**

- (b)** Explain the term quality loss function. With the help of a suitable example explain how it can be used to estimate factory tolerances **07**

- Q.5 (a)** Explain, giving suitable example, how will you construct the one-half fraction of the 2^3 design **07**

- (b)** With help of suitable sketches explain (i) CCD, (ii) Rotatability (iii) the Spherical CCD **07**

OR

- Q.5 (a)** Explain, giving suitable example, how will you construct the one-quarter fraction of the 2^k design **07**

- (b) A study was performed on wear of a bearing y and its relationship to $x_1 =$ oil viscosity and $x_2 =$ load. The following data were obtained. Fit a multiple linear regression model to the data

y	x_1	x_2
193	1.6	851
230	15.5	816
172	22	1058
91	43	1201
113	33	1357
125	40	1115
