Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Regular Examination January / February 2011

Subject code: 710906N

Subject Name: Robust Design

Date: 03 /02 /2011 **Time: 02.30 pm – 05.00 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)** Compare the following quality loss functions, giving suitable examples: step and quadratic functions. **07**

Suppose, the functional limit for a colour television is m ± 7 and the repair cost of a television set in the field is Rs. 980. Calculate the quality loss associated with each m ± 4 set.

(b) Suppose, a response is functionally represented as y = f (A, B), where both A & B are variables with two levels. Design a suitable experiment. If, the responses are represented by y_i, where, i =1ton and n = total number of experiments. Estimate the factor effects and their interactions in terms of y_i. The experiments are not replicated. **07**

Explain the reasons for replicating experiments.

Q.2 **(a)** With the help of suitable examples explain the meaning and significance of Randomization, and blocking **07**

(b) A router is used to cut locating 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 vibrations: bit size (A) and cutting speed (B). Two bit sizes (1/16 and 1/8 inch) and two speeds (40 and 60 rpm) are selected, and two boards are cut at each set of conditions shown below. The response variables is vibration measured **07**

A	B	Treatment Combination	Replicate	
			Response 1	Response 2
–	–	(1)	18.2	18.9
+	–	a	27.2	24.0
–	+	b	15.9	14.5
+	+	ab	41.0	43.9

(i) Draw the plots of main effects and interactions and interpret them

(ii) What levels of bit size and speed would you recommend for routine operation?

OR

(b) For the problem given in Q 2 (b), fit a linear regression model and conduct the ANOVA and draw conclusions. **07**

$F_{.05, 1, 4} = 7.71$; $F_{.05, 2, 4} = 6.94$

Q.3 **(a)** What do you mean by confounding? Explain the procedure to be adopted to a 2^3 design into two block with ABC confounded **07**

(b) For the design and the experimental results given below (i) Estimate the factor effects, (ii) write down the equation that could be used to predict the response for specific values of A & B, within the experimental region **07**

A	B	Treatment Combination	Replicate	
			Response 1	Response 2
–	–	(1)	14.04	16.16
+	–	a	13.88	13.86
–	+	b	14.82	14.78
+	+	ab	14.88	14.92

OR

Q.3 **(a)** Explain with a suitable example, how to create an on-half fraction of a 2^4 design. Also specify the principal and complimentary fraction **07**

(b) For the 2^{4-1}_{IV} Design with the defining relation I = ABCD given below, develop a prediction equation. **07**

Basic Design A	B	C	Treatment Combination	Response	Run
–	–	–	(1)	45	1
+	–	–	ad	100	2
–	+	–	bd	45	3
+	+	–	ab	65	4
–	–	+	cd	75	5
+	–	+	ac	60	6
–	+	+	bc	80	7
+	+	+	abcd	96	8

Q.4 **(a)** Explain the following terms: Response surface, First-order model, Second-order model **07**

(b) A study was performed on wear of a bearing y and its relationship to x1= oil viscosity and x2= load. The following data were obtained: **07**

y	x1	x2
193	1.6	851
230	15.5	816
172	22	1058
91	43	1201
113	33	1357
125	40	1115

Fit a linear regression model to fit the data

OR

Q.4 **(a)** Explain the terms: Central Composite Design, rotatability and a Spherical Central Composite Design **07**

(b) The region of experimentation for two factors are temperature ($100 \leq T \leq 300°F$) and catalyst feed rate ($10 \leq C \leq 30$ lb/in). A first order model in the usual ±1 coded variables bas been fit to a molecular weight response, yielding the following model: **07**

$\hat{y} = 2000 + 125x1 + 40\ x2$

Find the path of steepest ascent. It is desired to move to a region where the molecular weights are above 2500. How many steps are required to move to the region of interest?

Q.5 **(a)** Explain the meaning and significance of the "The Method of steepest Ascent" **07**

(b) Differentiate between: (i) means and effects models (ii) fixed and random effect models. **07**

Also write down an appropriate hypothesis for a fixed effect model

OR

Q.5 **(a)** With a suitable example explain the term 'Robust Design' **07**

(b) With the help of a suitable example show how will you use contrast to estimate factor and interaction effects? Also explain how contrast can be used for estimating the sum squares of factors and interactions **07**

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