Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER III–EXAMINATION – WINTER 2015

Subject code: 2732806 **Date: 04/12/2015**

Subject Name: Design of Experiment

Time: 2:30 PM to 5:00 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)** State the expressions for null and alternative hypothesis and interpret them. **07**

(b) What do you mean by ANOVA? Explain various elements of the ANOVA table. How it could be used to establish significance of factors and interactions? **07**

Q.2 **(a)** The impurity in a chemical product is affected by two factors pressure and temperature. The data from a single replicate of a factorial experiment is given **07**

Temperature	Pressure				
	25	30	35	40	45
100	5	4	6	3	5
125	3	1	4	2	3
150	1	1	3	1	2

Calculate, using basic equations, the sum squares of factors and total.

(b) Explain the following terms citing suitable examples: **07**
(a) Full factorial design (b) One-half factorial design

OR

(b) With the help of suitable example explain following terms: **07**
(a) Main Effects (b) Interaction

Q.3 **(a)** Taking a 2^3 design as an example, explain confounding in two blocks. **07**

(b) A chemist wishes to test the effect of four chemical agents on the strength of a particular type of cloth. Because there might be variability between bolts (= a roll of cloth of specific length), the chemist decides to use a randomized block design, with the bolts of cloth considered as blocks. She selects four bolts. the resulting tensile strength is: **07**

Chemical	Bolts			
	1	2	3	4
1	73	68	74	71
2	73	67	75	72
3	75	68	78	73
4	73	71	75	75

Analysis the data from this experiment for α=0.05 and check whether the chemical affects the strength of the cloth. $F_{0.05,3,9}$ = 3.86; $F_{0.05,3,12}$ = 3.49

OR

Q.3 **(a)** Explain, citing suitable example, why fractional factorial designs are used instead of full factorial design. **07**

(b) An industrial engineers investing the effect of four assembly methods (A, B, C, D) on the assembly time for a colour television component. Four operators are selected for the study. Furthermore, the engineer knows that each assembly produces such fatigue that the time required for the last assembly may be greater than the time required for the first, regardless of the method. To account these sources of variability, the engineer uses the Latin square design shown below. Analysis the data for α=0.05 and draw conclusions. $F_{0.05,3,6}$ = 4.76; $F_{0.05,3,7}$ = 4.35 **07**

Order of Assembly	Operator			
	1	2	3	4
1	C=10	D=14	A=7	B=8
2	B=7	C=18	D=11	A=8
3	A=5	B=10	C=11	D=9
4	D=10	A=10	B=12	C=14

Q.4 **(a)** For a 2^3 design, show graphically, the main effects and two factor interactions. **07**

(b) The experimental data for a chemical reaction involves two factors A and B with two levels (factor A : low value = 15, high value = 25; factor B:low value =1, high value =2) is given below: **07**

A	B	Replicate		
		I	II	III
-	-	28	25	27
+	-	36	32	32
-	+	18	19	23
+	+	31	30	29

The fitted model is $\hat{y}=27.5(8.33/2)\ x_1 + (-5.00/2)\ x_2$. Convert the model in to a model of natural variables.

OR

Q.4 **(a)** Differentiate between first order and second order models. When will you go for a central composite design? **07**

(b) An engineer is interested in the effects of cutting speed (A), tool geometry (B) and cutting angle (C) on the life in hours of a cutting tool. Two levels of each factor are chosen, and a 23 factorial design is run. **07**

The results are:

A	B	C	Treatment Combinations	Tool Life in hours
-	-	-	(1)	22
+	-	-	a	32
-	+	-	b	35
+	+	-	ab	55
-	-	+	c	44
+	-	+	ac	40
-	+	+	bc	60
+	+	+	abc	39

Use ANOVA and identify the most significant factor. Write down the regression model for predicting tool life in hours based on the results of this experiment.

Q.5 **(a)** Explain the procedure to be adopted, in detail, to identify the optimal region for a response surface model. **07**

(b) Explain how randomization and replica are useful in design of experiments. **07**

OR

Q.5 **(a)** With help of neat sketches explain (a) Blocking (b) Response surface **07**

(b) Giving suitable expressions, state how you fit a regression model. **07**

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