Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER III (NEW) – EXAMINATION – WINTER-2016

Subject Code: 2735005 Date:25/10/2016

Subject Name: Design and Analysis of Experiments

Time:02:30 pm to 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)** What is "Factorial Experiment"? Differentiate between full factorial design and fractional factorial design of experiments. **07**

(b) What is an Experiment? Enlist Various objectives of the experiment. **07**

Q.2 **(a)** Explain central limit theorem. What is its importance? **07**

(b) The shelf life of a carbonated beverage is of interest. Ten bottles are randomly selected and tested, and the following results are obtained: **07**

Days	
108	138
124	163
124	159
106	134
115	139

(a) We would like to demonstrate that the mean shelf life exceeds 120 days. Set up m appropriate hypotheses for investigating this claim.

(b) Test these hypotheses using $\alpha = 0.01$. What are your conclusions?

(c) Find the P-value for the test in part (b).

(d) Construct a 99 percent confidence interval on the mean shelf life.

OR

(b) Three different washing solutions are being compared to study their effectiveness in retarding bacteria growth in 5-gallon milk containers. The analysis is done in a laboratory, and only three trials can be run on any day. Because days could represent a potential source of variability, the experimenter decides to use a randomized block design. Observations are taken for four days, and the data are shown here. Analyze the data from this experiment (use $\alpha = 0.05$) and draw conclusions. **07**

	Days			
Solution	1	2	3	4
1	13	22	18	39
2	16	24	17	44
3	5	4	1	22

Q.3 **(a)** An industrial engineer employed by a beverage bottler is interested in the effects of two different types of 32-ounce bottles on the time to deliver 12-bottle cases of the product. The two bottle types are glass and plastic. Two workers are used to perform a task consisting of moving 40 cases of the product 50 feet on a standard type of hand truck and stacking the cases in a display. Four replicates of **07**

a 22 factorial design are performed, and the times observed are listed in the following table. Analyze the data and draw appropriate conclusions. Analyze the residuals and comment on the model's adequacy.

	Worker			
Bottle Type	1		2	
Glass	5.12	4.89	6.65	6.24
	4.98	5.00	5.49	5.55
Plastic	4.95	4.43	5.28	4.91
	4.27	4.25	4.75	4.71

(b) The effect of five different ingredients (A, B, C, D, E) on the reaction time of a chemical process is being studied. Each batch of new material is only large enough to permit five runs to be made. Furthermore, each run requires approximately 1.5 hours, so only five runs can be made in one day. The experimenter decides to run the experiment as a Latin square so that day and batch effects may be systematically controlled. She obtains the data that follow. Analyze the data from this experiment (use $\alpha = 0.05$) and draw conclusions. **07**

	Day				
Batch	1	2	3	4	5
1	$A = 8$	$B = 7$	$D = 1$	$C = 7$	$E = 3$
2	$C = 11$	$E = 2$	$A = 7$	$D = 3$	$B = 8$
3	$B = 4$	$A = 9$	$C = 10$	$E = 1$	$D = 5$
4	$D = 6$	$C = 8$	$E = 6$	$B = 6$	$A = 10$
5	$E = 4$	$D = 2$	$B = 3$	$A = 8$	$C = 8$

OR

Q.3 **(a)** What is a paired comparison? What are the advantages of the same? **07**

(b) Develop and explain ANOVA table Two-factor factorial design with fixed effects model. **07**

Q.4 **(a)** Explain the "Concept of General Factorial Design". **07**

(b) Write a short note on "Method of Steepest Ascent'. **07**

OR

Q.4 **(a)** What is Linear Regression Model? **07**

(b) Derive the following relation for least squares estimator of β, **07**

$$\hat{\beta} = (X'X)^{-1} X'y$$

Q.5 **(a)** Explain general 2^k Design with respect to its analysis procedure and provide general form of analysis of variance for a 2^k factorial design with n replicates. **07**

(b) Define the term "Response Surface". Explain the sequential nature of RSM to obtain optimum operating conditions. **07**

OR

Q.5 **(a)** Write in detain Randomized Complete Block Design. **07**

(b) Which are the desirable features of desirable designs, when selecting Response Surface Design? **07**

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