Full Marks: 30   **Time: 2 Hours**

Instructions:
(i) Attempt all questions, (ii) Maximum marks are shown against each question, (iii) Answers should be short and to the point, (iv) Subject specific terminology must be used, (v) Use statistical tables whenever required.

Question 1: Answer the following questions.   [10 Marks]

1. What is the difference between repetition and replication? What errors we may commit if we do not include replication and repetition in an experiment? Illustrate your answer with suitable example.
2. What is OFAT? What are the limitations of this approach? How do we overcome the shortcomings of this approach with different design of experiment strategy?
3. What is the quality of design, conformance and performance? How can you achieve the high quality at low cost?
4. What is the difference between off-line quality control and on-line quality control? Give two examples of each.

Question 2   [10 Marks]

The following are the burning times (in minutes) of chemical flares of two different formulations. The design engineers are interested in both the means and variance of the burning times.

Type 1		Type 2	
65	82	64	56
81	67	71	69
57	59	83	74
66	75	59	82
82	70	65	79

(a) Test the hypotheses that the two variances are equal. Use $\alpha = 0.05$.
(b) Using the results of (a), test the hypotheses that the mean burning times are equal. Use $\alpha = 0.05$.
(c) Compute a 95 percent interval estimate of the mean of formulation Type 2. Compute a 99 percent interval estimate of the mean difference between formulations Types 1 and 2.
(d) Test pairs of means using the Fisher LSD method with $\alpha=0.05$ and $\alpha=0.01$.
(e) Assuming that formulation Type 1 is currently in use, what are your recommendations to the manufacturer?

Question 3   [10 Marks]

Mr. Rishabh Rathore is a scientist at Ranbaxy Pharmaceuticals Ltd at New York. Mr. Rathore is analyzing four types of compositions for inventing a new drug for HIV. In the experimentation, he wishes to use four suppliers as blocks; however, because of a time constraint, he must use an incomplete block design. He runs the balanced design with the four blocks. Analyze the data from this experiment (use $\alpha=0.05$ and $\alpha=0.025$) and draw conclusions about effectiveness of the four drugs for treating HIV.

	-	18	16	13
	15	14	-	10
	14	-	13	12
	13	12	11	18

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