

(4 Hours)

[Total Marks : 100

- N.B.** (1) Attempt any five questions.
 (2) Navnits Logarithmic and Statistical Table is permitted.
 (3) All questions carry equal marks.
 (4) Assume data wherever necessary.

M.E.C.M) Sem II PTDC mic Design Engg Experimentation & Reliability Engg. 5

1. (a) What do you understand by 'Robust Design' ? 5
 (b) How orthogonal arrays help in reducing the number of trials and economics of conducting experiments ? 5
 (c) Using the eight corners of a cube, obtain an orthogonal array for effects of three factors x_1 , x_2 and x_3 , including effects of interactions. 10

2. (a) State and explain the definition of 'quality' as suggested by Taguchi. 6
 (b) A manufacturer of watches, uses inspection process to screen out defective watches before they are shipped. The rejected watches are rest by the factory. The tarjet performance of the watch is to have a tolerance of ± 5 seconds per month. If a sold watch performs away from the tarjet tolerance, the customer is entitled to have replacement. The replacement costs customer Rs. 100 per watch for postage and incovinience. 14
 (i) Derive the loss function
 (ii) If cost of setting a watch costs Rs. 8 at the factory what should be the manufacturers tolerance.

3. (a) A company is manufacturing tubes for tube lights. It was found that mean life of the tubes is 1200 hours with a standard deviation of 20 hours. Determine the percentage of tubes that would survive. 6
 (i) for more than 1240 hours and
 (ii) between 1180 hours and 1240 hours.
 (b) A farmer wishes to test the effect of four different fertilisers A, B, C and D on the yield of wheat. To eliminate the sources of error due to variable soil fertility, he uses the Latin square arrangement as shown in table, where numbers indicate yield in kg/unit area. Perform analysis of variance and show if there is any significant difference between the fertilisers at 0.05 and 0.01 level of significance. State your conclusion. 14

| | | | |
|----------|----------|----------|----------|
| A_{20} | B_{12} | C_{21} | D_{25} |
| B_{15} | C_{22} | D_{24} | A_{15} |
| C_{23} | D_{22} | A_{16} | B_{11} |
| D_{21} | A_{25} | B_{10} | C_{19} |

Or

3. (a) Define coefficient of correlation considering two related variables x and y which have tendency to covary. 6
 (b) X and Y covary as shown below : 8
 $X = 1, 2, 3, 4, 5, 6$
 $Y = 6, 2, 4, 10, 12, 8$
 Determine the coefficient of co-rrelation and coefficient of determination.
 (c) X and Y are two variable which co-vary. Give possible relationships that can exist between X and Y. 6

4. (a) Prove that for parallel system configuration, system reliability is given by 10
 $R_s = 1 - (1 - R_1)(1 - R_2) \dots (1 - R_n)$
 where $R_1, R_2 \dots R_n$ are the reliabilities of components 1, 2, n connected in parallel.
 (b) Explain with examples MTTF and MTBF. 10

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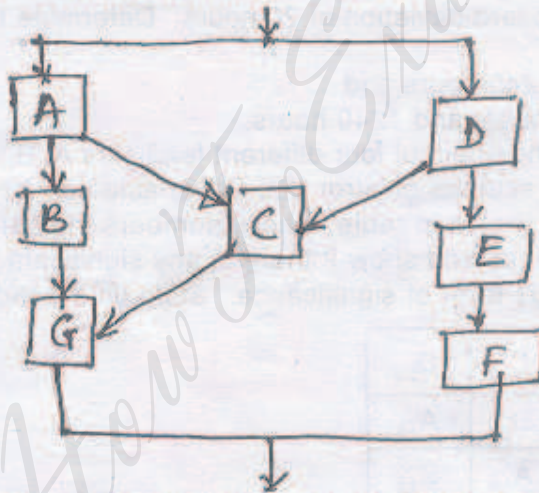
M. E (M) M. C. D. S. J. S. P. P. M. Engg. Experimentation 19/6/08
 Reliability Engg.

5. (a) A given component has an MTBF of 10^6 hours. 10
- (i) What is the reliability for an operating period of 10 hours for 5 units in series for 15 in series ?
 - (ii) What is the reliability for a single component for an operating period of 100 hours ? Starting from an age of 1000 hours from an age of 2000 hours ? What inherent assumption did you make ?
 - (iii) What is the reliability for an component which starts operating at an age of 2100 hours in useful life ? What assumption did you make ?
 - (iv) What is the reliability for an operating period of 80 hours ?
- (b) A company is manufacturing electric bulbs. The bulbs were put to real life test, for targeted performance under simulated condition. The test results are as follows : 10

| | | | | | | | | |
|--------------------------|------|------|------|------|------|------|------|------|
| No. of Bulbs | 3 | 10 | 20 | 30 | 15 | 10 | 10 | 2 |
| Time to failure in hours | 1200 | 1300 | 1600 | 1900 | 2100 | 2400 | 2600 | 3000 |

Determine :

- (i) Mean time to failure.
 - (ii) Reliability of the bulbs for 1500 hours and 2400 hours of operation, assuming constant rate of failure.
6. (a) Given the system shown, find its reliability of system success requires that at least one of the following path be good. ABG, ACG, DCG, DEF (if Bayes theorem is used it may be necessary to use it more than once or twice) 15



- (b) Explain the methods available for improving the reliability of system. 5
- Or

6. In a factory, the experiment data obtained with set of 10,000 identical components as shown in table. Plot and comment on the corresponding failure - rate (h) - time (t) curve. In the table t is time of observation in hours and NS-Numbers of components operating at time t. 20

| | | | | | | | | |
|----------------|--------|------|------|------|------|------|------|------|
| t | 0 | 50 | 100 | 150 | 200 | 250 | 300 | 350 |
| N _s | 10,000 | 8800 | 8300 | 7918 | 7585 | 7274 | 6968 | 6668 |
| t | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 |
| N _s | 6375 | 6088 | 5808 | 5535 | 5269 | 5011 | 4760 | 4517 |
| t | 800 | 850 | 900 | 950 | 1000 | | | |
| N _s | 4237 | 3864 | 3396 | 2819 | 2219 | | | |