This question paper contains 6 printed pages.]

5131 *Your Roll No.* .....

B.Sc. (Prog.) / III **B**

OR-301 – OPERATIONAL RESEARCH

Reliability and Statistical Quality Control

(Admissions of 2005 and onwards)

Time : 3 Hours *Maximum Marks : 112*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt five questions in all. Selecting at least two questions from each section. Question No. 4 in section - A and Question No. 8 in Section B are compulsory.

SECTION - A

1. (a) Define

(i) failure time density

(ii) reliability function

(iii) hazard function

show that knowing any one of these is enough to find all the others. 10

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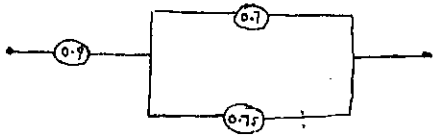
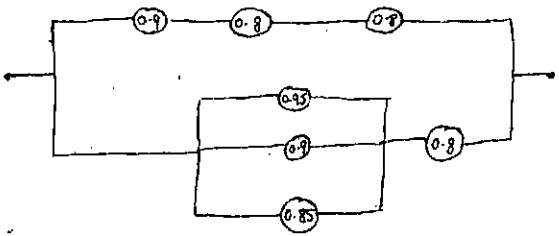
(b) Find the reliability of the following systems : 6

(i)



(ii)



(c) Find MTBF when the failure time density function is exponential and Gamma. 6

2. (a) Show that reliability of the series system of order n with hazard rate of its component 10
λ_i $(i = 1, 2, \ldots n)$ is

$$R(+) = e^{-\sum_{i=1}^{n} \lambda_i t}$$

(b) Describe a series-parallel system of order (m, n). Obtain its reliability function and MTBF when all its components are independent each with constant failure rate λ. 12

3. (a) Consider 1 out of 2 system in which both components are operable. At any instant of time the system must be in either one of the following mutually exclusive states :

State 0 : both components are operating.

State 1 : one component has failed and the other is operating.

State 2 : both components have failed, with $p_i(t)$ being the probability that at time t the system is in state i, $i = 0, 1, 2$. When a component fails it is put back into operation. The system fails when both its components fail. Assume that each component has constant failure rate λ and constant repair rate μ.

Obtain system reliability and system MTBF. Compare the latter with system MTBF without repair and interpret the result obtained. 15

(b) Explain the difference between reliability maintainability and availability. 7

4. Write short notes on any three of the following :

(i) Stand-by system

(ii) Parallel - series system

(iii) Preventive Maintenance

(iv) System Availability Measures 23

SECTION - B

5. (a) What is control chart ? Explain the justification for using 3 sigma limits in the control charts. 5

(b) A machine is manufacturing mica discs with specified thickness between 0.008" and 0.015". Samples of size 4 are drawn every hour and their thickness in units (1 unit = 0.001") are recorded as follows :

Sample No.	Thickness of mica discs (1 unit = 0.001")			
1	14	8	12	12
2	11	10	13	8
3	11	12	16	13
4	15	12	14	11
5	10	10	8	8

For the above data, set up on R-chart and on $\overline{X}$-chart. Plot the observed points and comment on the same. 17

6. (a) The following data gives the number of defectives in 10 independent samples of varying size from a production process.

Sample No.	Sample Size	No. of Defectives
1	2,000	425
2	1,500	430
3	1400	216
4	1350	341
5	1250	225
6	1760	322
7	1875	280
8	1955	306
9	3125	337
10	1575	305

Draw the control chart for fraction defective and comment on it. 11

(b) Draw a suitable control chart for the following data pertaining to the number of coloured threads (considered as defects) in 15 pieces of cloth in a certain make of synthetic fiber and state your conclusions :

7, 12, 3, 20, 21, 5, 4, 3, 10, 8, 0, 9, 6, 7, 20. 11

7. (a) Describe a single sampling plan for attributes with lot size N, sample size n and allowable defectives C. For this sampling plan, obtain the probability of

acceptance of the lot if the lot function defective is p. Modify the expression obtained using : 12

(i) Binomial approximation

(ii) Poisson approximation

(b) Assuming that the number of defective items follows Poisson law, determine the most economical single sampling plan given lot size (N), AOQL and process average quality ($\bar{p}$).

10

8. Write short notes on any three of the following :

(i) Natural Tolerance Limits and Specification Limits

(ii) u - chart

(iii) Process Capability Measures

(iv) ASN and ATI of single sampling plan for attributes. 23