Total No. of Questions : 12]

SEAT No. :

P746

[Total No. of Pages : 4

[4659] - 50

B.E. (Mechanical) (Semester - II)

RELIABILITY ENGINEERING

(2008 Pattern) (Elective - IV(c))

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answer 03 questions from Section I and 03 questions from Section II.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Explain the following terms: **[8]**

i) MTTF

ii) Maintainability

iii) Availability

iv) MTBF

b) 100 components are put under test. After every hour number of failures are recorded. Find the failure density, hazard rate & reliability from the given data & plat these functions against time. **[8]**

Time interval (hrs)	1	2	3	4	5	6	7	8	9	10
No. of failures	21	13	9	7	6	6	5	7	11	15

OR

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Q2) a) Draw "Bath tub curve" & explain in detail the three regions involved in it. **[8]**

b) A total number of 50 components. Whose MTTF is known to be 200hrs, are placed on a test continuously. Estimate the number of components which would fail in the time intervals

i) 0 to 50 hrs.
ii) 50 to 100 hrs.
iii) 100 to 150 hrs.
iv) 150 to 200hrs.

[8]

Q3) a) A delicate recorder mounted on the platform, exposed to a random vibration is likely to fail when the horizontal acceleration exceeds 0.05g. The platform experiences an exponentially distributed horizontal vibrations with mean acceleration of 0.035g. What is the probability that the recorder will not fail? If the reliability of recorder is to be 0.9 or above, determine the limit for mean acceleration. **[6]**

b) Prove that component redundant structure is more reliable than unit redundant structure. **[4]**

c) Explain theorem of total probability. **[6]**

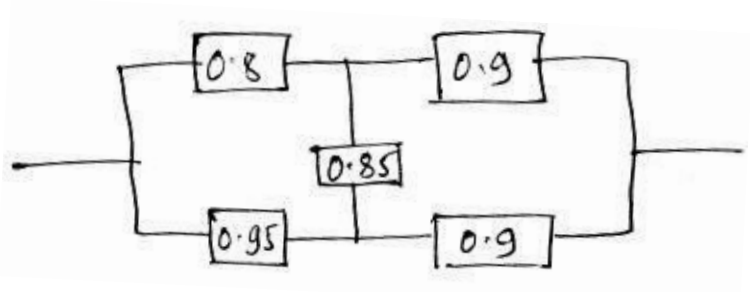
OR

Q4) a) Explain conditional probability method. **[6]**

b) Explain system reliability model in parallel configuration. **[4]**

c) A system is operating from the time t = 0. Prove that the probability of system functioning properly between times t_2 & t_1 $(t_2 > t_1)$ is $R_{t_2-t_1} = 1 - R_{t_1} + R_{t_2}$ **[6]**

Q5) a) Find the reliability of the system shown below using Delta star method. **[6]**



b) A system consists of three components converted in series with reliabilities R_1 = 0.8, R_2 = 0.7 & R_3 = 0.9. It is desired that the reliability of the system be 0.65. How should this be apportioned in three units using minimum effort method? **[6]**

c) Explain AGREE apportionment technique. **[6]**

OR

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Q6) a) A system consist of four subsystems A, B, C & D having failure rates 0.005, 0.002, 0.004, 0.008 failures per hour respectively. If the mission time is 50 hours & the system reliability required is 0.95. Find the reliability & failure rate of each subsystem for the entire mission using ARINC method. **[6]**

b) Write a note on node removal matrix method. **[6]**

c) Five components are connected in series having reliabilities 0.99, 0.995, 0.989, 0.994, 0.996 respectively. For the given system reliability goal has been set to 0.96. Allocate the reliabilities to each component using reliability allocation based on unreliability. **[6]**

SECTION - II

Q7) a) Explain reliability, maintainability and availability. What are the types of availabilities? **[8]**

b) If the inherent availability of a system is 0.92, when the MTBF is 220hrs, what is the maximum value of MTTR? Assuming logistic time for administrative support as 30% of the total down time, find out the operational availability. **[8]**

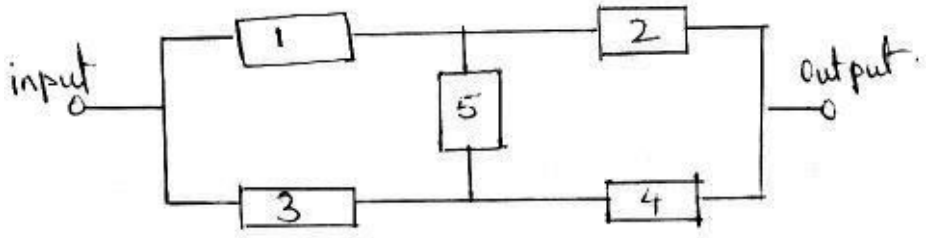
OR

Q8) a) What is meant by "Reliability Centered Maintenance"? Explain the part played by "CBM" [Condition Based Monitoring] in achieving specific level of reliability. **[8]**

b) If the repair rate μ (t) is a constant and is equal to 'μ'. Show that MTTR is a constant repair time z. **[8]**

Q9) a) Explain the methodology of constructing Fault tree diagram. What are the various symbols used while constructing the fault tree diagram? **[8]**

b) What is meant by Tie sets and Cut sets? State their application in determining the reliability of a system shown in the figure below. **[8]**



OR

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Q10) a) How Boolean Algebraic principles can help in simplifying the FMEA diagram, so that the estimation of overall failure probability becomes easier? **[8]**

OR

b) If in a system we need atleast one out of '3' units to operate for the successful working of the system, then prove that the system reliability can be written as

$R_s(t) = 3e^{-\lambda t} - 3e^{-2\lambda t} + e^{-3\lambda t}$ where λ = constant failure of 't' mission time. **[8]**

Q11) a) Derive reliability equation when strength and load follow normal distribution. **[8]**

b) The following data refers to a certain test of equipment.

Failure No.	1	2	3	4	5	6	7	8
Operating time to failures (hours)	10	22	12	16	15	24	28	32

Find out the reliability by

i) Mean method and

ii) Median method and compare the two by plotting.

[10]

OR

Q12) a) Explain

i) Accelerated Life Testing

ii) DTMC & CTMS models.

[8]

b) Find the reliability and the corresponding control factor of safety of a system for which $\mu_s = 15{,}000 \text{ kg/cm}^2$ and $\mu_l = 10{,}000 \text{ kg/cm}^2$, $\sigma_s = 3{,}000 \text{ kg/cm}^2$ and $\sigma_l = 1{,}000 \text{ kg/cm}^2$ and s & l follow normal distribution.

Table shows normal variant (z) and $\phi(z)$.

z	1.56	1.58	1.60
ϕ (z)	0.9406	0.9429	0.9452

[10]