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Paper ID [EC512]

MAY 2008

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M.Tech (Sem. - 2nd)

RELIABILITY OF ELECTRONICS & COMMUNICATION SYSTEMS

(EC - 512)

Time : 03 Hours **Maximum Marks : 100**

Instruction to Candidates:

1) Attempt any **Five** questions.
2) **All** questions carry equal marks.

Q1) (a) Define MTBF and MTTR. A component has MTBF = 200 hr and MTTR = 10 hr with both the failure and repair distribution exponential, what is the availability at 10 hr, for first 10 hour and at steady state?

(b) A system has 5 independent and identical components of which each component has random chances of 1 in 100 failing If failure follow binomial distribution. What is the probability of two failures?

Q2) (a) Consider the probability density function.

$$f(t)=\begin{cases} 0.002e^{-0.002t} & t\geq 0 \\ 0 & \text{otherwise} \end{cases} \quad \text{for } t \text{ is in hours}$$

Calculate reliability function, failure times, and design life is reliability of 0.95 is desired.

(b) Discuss constant failure rate model with suitable example.

Q3) (a) A microwave transmitter has exhibited a constant failure rate of 0.00034 failures per operating hour, which gives non-acceptable design life (0.95 reliability) of 150 hours. A second redundant transmitter is added (parallel). What is design life of the new system? What will failure rate and hazard rate function of this redundant system?

(b) What are time dependent failure rate models? Discuss with suitable example.

Q4) (a) Prove that with three-state devices, it is not necessary true that low-level redundancy provides a greater reliability than high-level redundancy.

(b) A space vehicle requires three out of its four main engines to operate in order to achieve orbit. If each has a reliability of 0.97, determine the reliability of achieving orbit.

(c) A radio set consists of three major components: a power supply, a receiver, and an amplifier, having reliabilities of 0.8, 0.9 and 0.85, respectively. Compute system reliabilities for both high-level and low-level redundancy for systems with parallel components.

Q5) (a) A copying machine consists of the following components :

	control unit	input tray systems	camera unit	feeder system	power unit
Quantity	1	2	1	2	1
Failure rate, λ_i	0.0016	0.008	0.001	0.021	0.005

Specification require the average repair time to be 4 hr. Determine a suitable allocation of the MTTR if each component. Assume equal operating hours for each component.

(b) Describe the method of cut set and tie set for reliability evaluation.

Q6) (a) A transceiver has four components: a receiver, a power supply, a transmitter, and an antenna system. Reliability specifications require the transceiver to operate 1000 hr with a probability of 0.99. Determine the components reliability. The component data is as follows:

Components	Importance index, w_i	Operating time, h_r	Number of modules, n_i
Receiver	0.8	1000	25
Antenna	1.0	1000	15
Transmitter	0.7	500	23
Power supply	1.0	1000	70

(b) What is meant by availability? Discuss inherent availability, achieved availability, operational availability. Explain one availability model.

Q7) (a) What is meant by non destructive testing? Describe mathematical modeling of any one of the destruction test with suitable example.

(b) In the design of a space station, four major subsystems have been identified, each having a Weibull failure distribution with parameter values as given here :

Subsystem	Scale parameter, θ, yr	Shape parameter, β
Computer	3.5	0.91
Avionics	4.0	0.80
Structures	5.0	1.80
Life support	6.0	1.00

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The reliability of the station must be 0.995 at the end of the first year. Determine the percentage increase in reliability for each of the major subsystems needed in order to reach the system goal. Assign equal reliability goals to all subsystems.

Q8) (a) Two nickel-cadmium batteries provide electrical power to operate a satellite transceiver. If both batteries are operating in parallel, they have an individual failure rate of 0.1 per year. If one fails, the other can operate the transceiver (at a reduced power output). However, the increased electrical demand will triple the failure rate of the remaining battery. Determine the system reliability at 1, 2, 3, 4, and 5 yr. What is the system MTTF?

(b) Write a short note on Reliability management.