Ref. No. : Ex/EE/5/T/513C/2024

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)
FIFITH YEAR FIRST SEMESTER EXAM 2024
RELIABILITY ENGINEERING

Full Marks 100

Time: Three hours **(50 marks for each part)**

Use a separate Answer-Script for each part

Question No.	PART- I	Marks
	Answer any **TWO** questions	
1. (a)	**Clearly explain the meaning of a posteriori failure distribution function in the context of reliability assessment of engineering items. How would you obtain the a posteriori failure distribution function from a knowledge of the failure density function?**	**10**
(b)	**Derive the expression for the a posteriori failure distribution, if the time to failure has a Weibull distribution.**	**10**
(c)	**How is the shape of the hazard function related to the ageing of the engineering item under consideration?**	**5**
2. (a)	**Preventive maintenance is to be performed every 5 days on a system having time-to-failure uniformly distributed over 0 to 100 days. Determine the expression for the reliability function of the system under preventive maintenance. Compare the reliability and the MTTF at 17 days, with and without preventive maintenance.** ***The probability of maintenance-induced failure during every preventive maintenance, may be ignored.*** **Derive the expression for the reliability under preventive maintenance, used for this purpose.**	**15**
(b)	**An analog-to-digital converter (ADC) has a life of 800 hours when tested at 70 °C. What is the life of the IC when operated at 20 °C ? Consider an activation energy E_a = 0.5 eV for the IC, and Boltzmann constant k = 8.6 $\times 10^{-5}$ eV/K.**	**10**
3. (a)	**The life of an industrial exhaust pump is exponentially distributed with a mean of 1000 hours. There is a standby pump, whose lifetime is also exponentially distributed with a mean of 900 hours, and is independent of that of the**	

Question No.	PART- I	Marks
	original. The changeover sensor & switch combination has a failure probability of 0.2.	
	(i) What is the probability of survival of the combination of these pumps for a period of 550 hours?	12
	(ii) What is the MTTF of the combination?	
	Derive the expressions used,	
(b)	A control system consists of three main components: a transducer, an amplifier and an actuator, having failure rates of 0.35, 0.05 and 0.02 f/ year, respectively. For the system to operate successfully, all the three types of components must be healthy. All components operate in their useful life period.	13
	(i) Evaluate the probability of this system surviving for 1 year without failure, and its mean-time-to-failure (MTTF).	
	(ii) What is the minimum number of transducers that must be connected in parallel redundancy, to increase the probability of the system surviving for 1 year without failure to greater than 0.9 ?	
	(iii) Evaluate the new probability of surviving for 1 year and the new MTTF after the improvement in (ii) has been implemented. Derive the expressions used.	
4.	Write short notes on any two of the following.	
(a)	Mission-oriented and continuously operated systems.	
(b)	Accelerated life testing by temperature cycling, elevated voltage and elevated current.	12 ½ +12 ½
(c)	MTTF and survival probability of non-repairable items with Weibull-distributed time-to-failure.	

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BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) EXAMINATION, 2024

(5thYear, 1st Semester)

RELIABILITY ENGINEERING

Time: Three Hours | Full Marks: 100

(50 marks for each part)

Use a separate Answer-script for each Part

PART-II

Answer any three questions

(Two marks are reserved for neatness and well organized answers)

1. a) Define the following terms:
i) Active failure ii) Passive failure and iii) Stuck condition of breaker 6

b) For the system shown in Fig. 1, compute the average repair time, annual outage duration and failure rate of load point L1 and L2 with the following condition.
i) isolation of failed component not possible
ii) isolation of failed component is possible
Considering the failure rate of 0.2 failures /yr, repair time of 30 hours and switching time of 2 hours for each transformer. 10

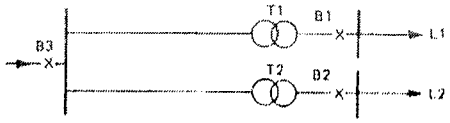

Fig. 1.

2. Calculate SAIFI, SAIDI, CAIDI, ASUI, ASAI, ENS AND AENS, ENS and AENS for the distribution system shown in Fig. 2, below. The number of customers and average load connected to each load point are shown in Table-1. The reliability parameters are given in Table-2. 16

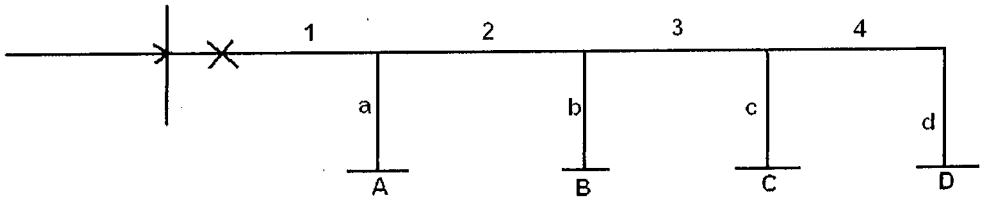

Fig.2.

Table 1

Load Point	Number of Customer	Average Load Connected (MW)
A	450	4
B	550	6
C	650	5
D	750	3

Table 2

Component	λ (f/yr)	r (hrs.)
1	0.1	1.3
2	0.2	2.5
3	0.3	1.5
4	0.2	2.5
a	0.2	2.5
b	0.3	3.0
c	0.2	1.3
d	0.4	3.0

3. a) Explain the method of recursion. 5

b) A generating station has four 120 MW units, each with FOR = 0.04. Construct the capacity outage probability table rounded off to 200 MW steps. Develop the cumulative probability table when another 100 MW unit is added to the system. FOR of the new unit is 0.03. Use method of recursion. 11

4. a) Show that the frequency of encountering a state can be expressed as: $f = A.\lambda$ or as: $f = U.\mu$ with usual nomenclature. 5

b) A system contains 5 × 40 MW unit with the following parameters: failure rate = 0.02 failures/day and repair rate = 0.48 repairs/day. Draw the state space diagram and compute the capacity outage probability table including rate of departure & frequency. 11

5. a) Deduce the expression for basic exponential reliability function. Comment on the shape of bath-tub characteristic. 6

b) Show that for a two component repairable parallel system, the total annual outage time is given by - $\lambda_1\lambda_2 r_1r_2/8760$ hours. 5

c) Each generator in a generating station has three 100 MW sets & one 200 MW set has a failure rate of 0.01 per day and 0.49 repairs/day. Determine capacity outage Probability table. 5

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