Ref. No. : Ex/EE/5/T/513B/2018 (Old)

B.E. ELECTRICAL ENGINEERING (PART TIME) - FIFTH YEAR - FIRST SEMESTER, 2018 (Old)

RELIABILITY ENGINEERING

Time: Three hours

Full Marks 100
(50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART- I	Marks
	Answer any *TWO* questions	
1. (a)	Derive the expression for the hazard function, if the time to failure of an engineering item has a Weibull distribution.	10
(b)	A system without redundancy (i.e. series model) comprises two non-repairable subsystems having statistically independent times-to-failure with Weibull distributions. The shaping and the scaling parameters for the time-to-failure of one of the subsystems are 2 and 3000 hours respectively, while those for the other are 3 and 4000 hours respectively. If the system starts operating under new condition, (i) determine the probability of the complete system surviving for a period of 1000 hours. (ii) given the complete system has survived up to 3000 hours, the probability of the complete system surviving over a further period of 1000 hours. *No derivation of the expression for the reliability function of a Weibull distributed time-to-failure is required.*	8
(c)	An electronic system consists of three items with failure rates of 0.5×10^{-5} failure/ hour, 2.5×10^{-6} failure/ hour, and 1.5×10^{-6} failure/ hour, operating in complete redundancy (i.e. in parallel). Obtain the mean time-to-failure of the electronic system. Derive the expression used.	7
2. (a)	Point out clearly the necessity of accelerated testing of electronic components.	5

No. of Questions	PART I	Marks
(b)	An analog multiplier module is found o have a life of 800 hours when tested at 70 °C and 90% relative humidity. What is the life of the module, when operated at 20 °C and 60% relative humidity. Consider an activation energy $E_a = 0.5$ eV for the module, and Boltzmann constant $k = 8.6 \times 10^{-5}$ eV/K.	8
(c)	Consider a pumping system comprising 4 identical pumps each having a failure rate of 0.1×10^{-5} f/hr. Evaluate the probability of the system surviving 5000 hours if for the successful operation of the system, (i) at least 3 pumps must operate successfully and (ii) at least 2 pumps must operate successfully.	12
3. (a)	Preventive maintenance is to be performed every 5 days on a system with a time-to-failure that is uniformly distributed from 0 to 100 days (without maintenance). Derive the expression for the reliability function of the system under preventive maintenance. Compare the mean-time-to-failure (MTTF) and the reliability at 17 days with and without preventive maintenance.	12
(b)	A generator is operating with a single standby. Both have time-to-failure that are exponentially distributed, but with different failure rates. Derive expressions for the reliability function and the MTTF of the complete system. State clearly any simplifying assumption made.	13
4.	Write <u>short</u> notes on *any two* of the following.	
	(i) Causes of failure of engineering items, from reliability point of view.	12 ½ + 12 ½
	(ii) Accelerated testing of electronic components, by increased voltage and also by increased temperature cycling.	
	(iii) Hazard function– its definition, its relations with failure density function, and a posteriori reliability function, and the relation between the shape of the hazard function and ageing of the system.	
	(iv) Binomial distribution.	

Ex/EE/5/T/513B/2018 (Old)

BACHELOR OF ELECTRICAL ENGINEERING (EVENING)EXAMINATION, 2018

(5^{th}Year, 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 neatnessand well organized answers)

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

b) A system contains four 70 MW units, each having a failure rate of 0.02 per day and 0.48 repairs per day. Construct the capacity outage probability table. Neglect probability values less than 10^{-6}. 10

2. 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 0.3 failures /yr, repair time of 45 hours and switching time of 2 hours for each transformer. 10

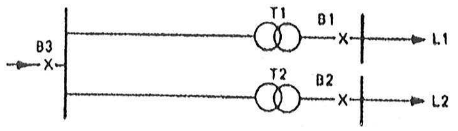

Fig. 1

3. Calculate SAIFI, SAIDI, CAIDI, ASUI, ASAI, ENS AND AENS, ENS and AENS for the distribution system shown in the 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

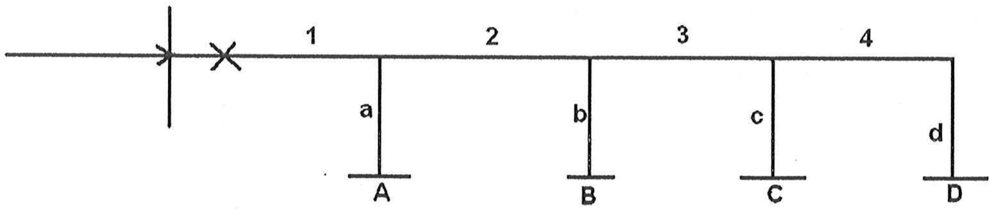

Fig.2

Table 1

Load Point	Number of Customer	Average Load Connected (MW)
A	700	3
B	600	6
C	500	5
D	400	4

Table2

Component	λ (f/yr)	r (hrs.)
1	0.2	1.5
2	0.1	2.2
3	0.1	1.2
4	0.3	2.0
a	0.2	2.5
b	0.3	3.0
c	0.4	1.3
d	0.3	3.0

4.a) 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

b) 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) 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 find out the F.O.R. 6

5. a) Explain the method of recursion. 5

c) A generating station has four 70 MW units, each with FOR = 0.03. Construct the capacity outage probability table rounded off to 150 MW steps. Develop the cumulative probability table when another 150 MW unit is added to the system. FOR of the new unit is 0.02. Use method of recursion. 11

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