Ref No: Ex/EE/T/424B/2017 (Old)

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING 4TH YEAR

EXAMINATION, 2017 (OLD)

(2nd Semester)

RELIABILITY ENGINEERING

Full Marks 100

Time: Three hours **(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)	A non-repairable electronic system consists of two subsystems in series. The s-independent failure-free operating times of the subsystems have Weibull distributions. The shaping and the scaling parameters of the distribution for subsystem-A are 3 and 2500 hours respectively. The corresponding parameters of the distribution for subsystem-B are 0.5 and 3000 hours respectively. State the expressions for the reliability functions of each of the subsystems. Compute their "Mean Time To Failure" (MTTFs) . Derive the expression used. Determine the probability of failure of the composite system for a mission time of 1000 hours. If the composite system has survived up to 200 hours, what is the probability of its survival for the next 50 hours ? Derive the expression used.	8+4+6
(b)	An electronic device has a life of 4500 hours when tested at 50 °C and 1500 hours when tested at 80 °C. What is the life of the device when operated at 25 °C ? Boltzmann's constant is 8.6×10^{-5} eV/K.	7
2. (a)	A certain electronic circuit uses an instrumentation amplifier with a failure rate of 0.05 f/ year. There are 3 spares (standbys) for the instrumentation amplifier, with failure rates of 0.03 f/year, 0.1f/year and 0.07 f/year.	

[Turn over

No. of Questions	PART I	Marks
	Assume immediate replacement in the event of failure of the main instrumentation amplifier and each of its spares. Obtain the expressions for probability density function of the time-to-failure of the combination of the main instrumentation amplifier and all its standbys , the corresponding reliability function and also the mean-time to failure (MTTF). Derive the expressions used	15
(b)	A main generator is augmented by a standby generator, each having a failure rate of 0.05 f/hour. Assuming that the decision switch has a failure probability of 0.2, compute the reliability of the system for a 10 hour operation, and the MTTF of the system. Derive the expressions used.	10
3. (a)	There are 400 identical fire sensors installed in a large building. The life of this variety of sensors is normally distributed with a mean of μ=16 months and a standard deviation σ = 5 months. Determine: (i) the number of sensors expected to survive up to 10 months. (ii) the number of sensors expected to fail in between 10 to 20 months. (iii) The time up to which 300 sensors are expected to survive. Use the table of cumulative distribution function of standard normal random variable (Z), attached.	15
(b)	Introduce the concept of 'Hazard function' in connection with reliability assessment of engineering items. Derive a relation between the reliability function and the hazard function. Check whether the following is a valid expression for hazard function $\lambda(t)=\left[\frac{1}{12-t}\right]\left[u(t-2)-u(t-12)\right]$	10

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	PART- I	
4.	Write short notes any two of the following. (a) Reliability assessment of K out of N systems. (b) Uniform distribution and its application in reliability assessment. (c) Causes of failure of engineering items from reliability point of view.	12 ½ ×2
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PART- I

Cumulative distribution function

Table Standard normal distribution **Q(z) for z= 0.00– 2.99**

Z	0	1	2	3	4	5	6	7	8	9
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7703	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9820	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986

Ex/EE/T/424B/2017 (Old)

BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING EXAMINATION, 2017

(4thYear, 2nd 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 **question No.1** and ***any two*** from the rest

1. a) Define the following terms:
i) Active failure ii) Passive failure and iii) Stuck condition related to circuit 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) if isolation of failed component is not allowed
   ii) if isolation of failed component is allowed
In the above cases, consider (a) the failure rate of 0.4 failures /yr, (b) repair time of 50 hours and (c) switching time of 2.5 hours, for each transformer. 10

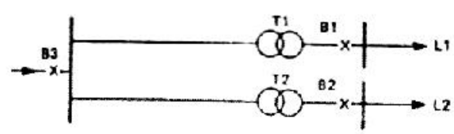

Fig.1

c) Deduce the expression for basic exponential reliability function. Comment on the shape of bath-tub characteristic. 4

2. a) A generating system contains three 25 MW generating units each with 4% F.O.R. and one 30 MW unit with 5% F.O.R. If the peak load for duration of 100 day is 75 MW, what is the LOLE for this duration? Assume that the appropriate load characteristic is a straight line from the 100% to the 60% load points. Variation of load from 100% to 60% takes place in 100 days. 10

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, where the symbols have usual meaning. 5

3. For the system shown in Fig. 2, the main feeders of section 1, 2 and 3 have failure rate of 0.1 failures/ yr and the lateral distributions have a failure rate of 0.4 failures/ yr. Other reliability parameters are given in Table-1.The number of customers and average load connected to load points A, B and C are 700, 1000 MW, 500, 2500 MW and 1000, 4000 MW respectively.

Calculate the failure rate, outage time, unavailability of each load point and also the load and energy oriented indices. 15

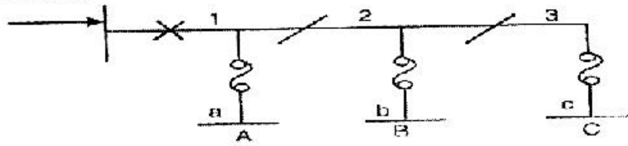

Fig. 2

Table - 1

Component	r (hrs)	s (hrs)
Section 1	 2.0	 0.25
2	3.0	0.10
3	2.0	0.25
Distributor a	 2.5	 0.40
b	2.0	0.30
c	2.5	0.40

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

   b) A system contains 6 × 50 MW unit with the following parameters: (a) failure rate = 0.01 failures/day and (b) repair rate = 0.49 repairs/day. Draw the state space diagram and compute the capacity outage probability table including rate of departure & frequency. 10

5. a) Explain the method of recursion. 5

   b) A generating station has five 60 MW units, each with FOR = 0.04. Construct the capacity outage probability table rounded off to 100 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. 10

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