

B.E. ELECTRICAL ENGINEERING EXAMINATION, 2025(4thYear, 1st Semester, Supplementary)**RELIABILITY ENGINEERING**

Time: Three Hours

Full Marks: 100

(50 marks for each part)

Use a separate Answer-script for each Part

PART-I**Answer any three questions**(Two marks are reserve for neatness
and well organized answers)

1. Calculate SAIFI, SAIDI, CAIDI, ASUI, ASAI, ENS AND AENS, ENS and AENS for the distribution system shown in Fig. 1, 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.

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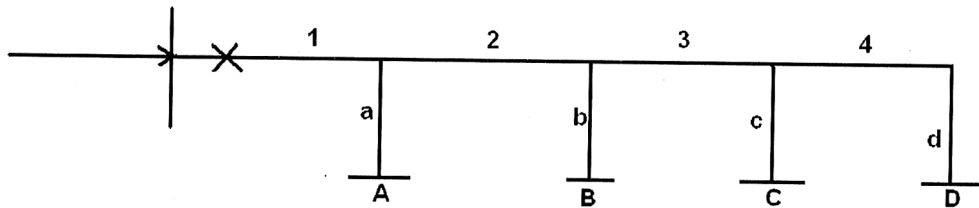


Fig.1.

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

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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. 2, 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 failure/yr, repair time of 35 hours and switching time of 2 hours for each transformer. 10

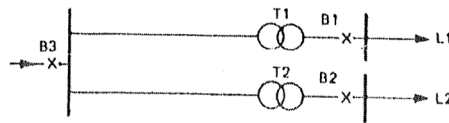


Fig. 2

3. a) Explain the method of recursion. 5
- b) A generating station has four 75 MW units, each with FOR = 0.04. Construct the capacity outage probability table rounded off to 150 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) 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 a 100 day period is 75 MW, what is the LOLE for this period? 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) Deduce the expression for basic exponential reliability function. Comment on the shape of bath-tub characteristic. 6
5. 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) A system contains 5×50 MW units with the following parameters: failure rate = 0.02 failure/day and repair rate = 0.48 repair/day. Draw the state space diagram. Compute the capacity outage probability table including rate of departure & frequency. 11

B.E. ELECTRICAL ENGINEERING FOURTH YEAR FIRST SEMESTER
EXAMINATION, 2025

RELIABILITY ENGINEERING (HONS)

Full Marks 100

Time: Three hours

(50 marks for each part)

Use a separate Answer-Script for each part

**Question
No.**

PART- II

Marks

Answer any *TWO* questions

1. (a) Consider a system comprising four statistically identical non-repairable electronic units each having a mean-time to failure (MTTF) of 12 years. Evaluate the probability of the system surviving 7 years, and also the MTTF of the system, if, for the successful operation of the system, at least any two units should operate successfully. 13

Assume that each unit is operating in its useful life period.
Derive the expressions used.

- (b) The life of an industrial exhaust pump is exponentially distributed with a mean of 2000 hours. There is a standby pump, whose lifetime is also exponentially distributed with a mean of 1800 hours, and is independent of that of the original. The changeover sensor & switch combination has a failure probability of 0.3. 12

What is the probability of survival of the combination of these pumps for a period of 1000 hours?

What is the MTTF of the combination?

Derive the expressions used. State clearly the assumption made (if any).

2. (a) The time-to-failure of an alternator has a Weibull distribution with a shape parameter of 0.5 and a characteristic life of 10000 operating hours. Determine the probability of survival of the alternator over a period of 5000 operating hours and the mean-time to-failure (MTTF). Also determine the above probability, if there is a 500 hourly routine preventive maintenance schedule. Derive the expressions used. 18

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- (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. 7

3. (a) 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.

(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 ? 15

- (b) Define “Maintainability” and “Availability” of continuously operated systems.

The repair-time of a continuously operated system lognormal distribution with a mean of 4.30 and a standard deviation of 1 determine the 2+8

(i) probability that the repair will be completed by 25 hours.

(ii) availability, if the mean-time-to-failure is 300 hours .

Use the attached table for standard normal distribution. Use linear interpolation if necessary.

4. Write brief notes on any two of the following.

(a) Accelerated life testing of electronic components at enhanced humidity, at elevated current and at escalated voltage.

(b) Causes of failure of engineering items.

(c) Hazard function and a posteriori failure probability

12 ½
+12 ½

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	.9920	.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