



Roll No.

--	--	--	--	--	--	--	--	--	--

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)
B.E.(Full Time) - END SEMESTER EXAMINATIONS, MAY 2024

INDUSTRIAL ENGINEERING
Semester VI
IE5653 RELIABILITY ENGINEERING
(Regulation 2019)

Time: 3hrs

Max. Marks: 100

CO1	Describe Reliability Engineering concepts
CO2	Understand to fit failure data into a theoretical distribution
CO3	Evaluate reliability of different system configurations
CO4	Describe knowledge in reliability monitoring methods
CO5	Analyze various techniques to improve reliability of system

BL – Bloom's Taxonomy Levels

(L1-Remembering, L2-Understanding, L3-Appling, L4-Analyzing, L5-Evaluating, L6-Creating)

Use of Statistical Tables is permitted.

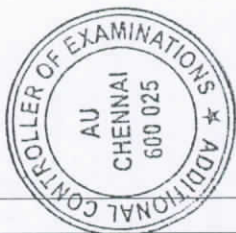
PART- A (10x2=20 Marks)
(Answer all Questions)

Q.No.	Questions	Marks	CO	BL
1	Define probability density function of failure time distribution.	2	1	1
2	How one would compute MTBF of components which can be repaired when they fail?	2	1	3
3	What do you mean by a Singly censored failure time data in reliability studies?	2	2	1
4	While employing the Exponential hazard plotting probability paper, MTBF is that value of time to failure at which cumulative percentage of failures is 63.2% Why?	2	2	3
5	Give the application of Binomial distribution to solve parallel redundant reliability block diagram.	2	3	4
6	Calculate the reliability of a standby system consisting of one operating unit and one identical standby unit operating for a period of 120 hours. The failure rate for each unit is 0.004 failures/hr. Assume that the failure sensing and connecting switch has 100% reliability.	2	3	2
7	List out the Human Factors that would have an influence on Maintainability.	2	4	3
8	Define Preventive Maintenance.	2	4	2
9	What is meant by 'Economic Life'?	2	5	1
10	State the purpose of conducting a Life Test?	2	5	2

PART- B (5x 13=65 Marks)

(Restrict to a maximum of 2 subdivisions)

Q.No.	Questions	Marks	CO	BL
11 (a) (i)	A hydraulic system is comprised of five components having the following constant failure rates (times are in days): $\lambda_1=0.001$, $\lambda_2=0.005$, $\lambda_3=0.0007$, $\lambda_4=0.0025$, and $\lambda_5=0.001$. Find the System MTTF.	4	1	2
(ii)	The reliability of a turbine blade can be represented by the following: $R(t) = [1 - t/t_0]^2$ $0 \leq t \leq t_0$ where t_0 is the maximum life of the blade. Compute MTTF as a function of the maximum life. (5 marks). Also determine the failure rate (4 marks).	9	1	2



OR									
11 (b) (i)	Prove that Mean Time To Failure is the reciprocal of the Failure Rate during Useful life period.						4	<u>1</u>	<u>2</u>
(ii)	Compare the measures of central tendency of the failure time distribution.						9	<u>1</u>	<u>2</u>
12 (a)	The following multiply censored data reflect failure times in months, of a new laser printer. Censored times resulted from removals of the printer due to upgrades. Determine the reliability of this printer over it's 2 year warranty period. Apply the adjusted rank method. 12, 41, 19 ⁺ , 26, 32, 23 ⁺ , 12, 34, 25 ⁺ , 38, 44, 20						13	<u>2</u>	<u>3</u>
OR									
12 (b)	Failure data on a digital medical device are given below. Establish whether this device follows exponential failure times using chi-square test.						13	<u>2</u>	<u>3</u>
	Time interval	0-25	25-50	50-75	75-100	100-125	125-150		
	# of failures	5	11	21	8	4	2		
13 (a) (i)	Failure rate of a pneumatic subsystem is 0.0003 failures per hour. If an operational period of 500 hours with a probability of success of 0.90 is desired, what level of parallel redundancy is needed?						5	<u>3</u>	<u>3</u>
(ii)	Derive the reliability function of a system connected with components in series (4 marks), and if the components are connected in parallel (4 marks).						8	<u>3</u>	<u>3</u>
OR									
13 (b)	Consider a system with 4 components in parallel (it is a $\frac{3}{4}$ system) each with a reliability of R_1 , R_2 , R_3 and R_4 . Derive the reliability of this system using Baye's decomposition method, Let component 1 be the keystone element.						13	<u>3</u>	<u>3</u>
14. (a)	List out the various measures of availability. Define each measure and bring out the distinctiveness in each measure.						13	<u>4</u>	<u>2</u>
OR									
14 (b) (i)	Demonstrate the application of Lognormal distribution in Maintainability evaluation.						4	4	<u>2</u>
(ii)	Discuss about the methods available for spare parts planning given the failure rates of the parts.						9	4	<u>2</u>
15 (a)	Conduct a Sequential Reliability testing with the following parameters: Producer's risk=Consumer's risk=10% Upper MTBF=300, Lower MTBF=180						13	5	<u>5</u>
OR									
15 (b)	Explain in detail how Reliability Allocation is made amongst all components in a System in series configuration. Demonstrate the application with the data of your choice.						13	5	<u>5</u>

PART- C (1x 15=15 Marks)

(Q.No.16 is compulsory)

Q.No.	Questions	Marks	CO	BL
16.	The following failure times were obtained from testing 15 units until each had failed. Construct a Weibull plot of failure data and	15	2	4