Roll No. | | | | | | | | | | |

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

INDUSTRIAL ENGINEERING
SemesterVI
IE5653 RELIABILITY ENGINEERING
(Regulation2019)

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-Applying, 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 plottingprobability 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): λ_1=0.001, λ_2=0.005, λ_3=0.0007, λ_4=0.0025, and λ_5=0.001. Find the System MTTF.	4	1	2
(ii)	The reliability of a turbine blade can be represented by the following: $R(t) = [1 - t/t_0]^2 0 \le t \le t_0$ 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**	1	2
(ii)	Compare the measures of central tendency of the failure time distribution.	**9**	1	2
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**	2	3
	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**	2	3

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**	3	3
(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**	3	3
	OR			
13 (b)	Consider a system with 4 components in parallel (it is a ¾ 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**	3	3
14. (a)	List out the various measures of availability. Define each measure and bring out the distinctiveness in each measure.	**13**	4	2
	OR			
14 (b) (i)	Demonstrate the application of Lognormal distribution in Maintainability evaluation.	**4**	4	2
(ii)	Discuss about the methods available for spare parts planning given the failure rates of the parts.	**9**	4	2
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	5
	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	5

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