Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER DEGREE EXAMINATIONS, JANUARY - 2021

RELIABILITY AND SAFETY ENGINEERING [ICE 4029]

TIME: 3 HOURS 29-01-2021 MAX. MARKS: 50

Instructions to candidates :*Answer ALL questions and missing data may be suitably assumed.*

1A. Find the reliability and MTTF of a system consisting of seven subsystems represented by the RDB shown in Figure 1A. Assume that each subsystem is characterized by a different failure rate constant λ.

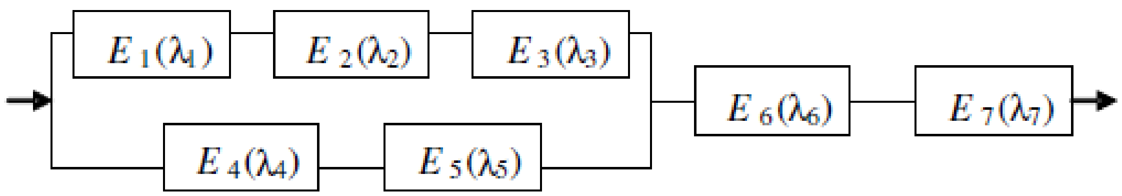

Figure 1A: RBD

1B. With neat diagrams, explain reliability centred maintenance.

1C. A product has a maximum life of 100 hours, and its probability density function is given by a triangular distribution as shown in the figure 1C. Develop the probability density function, cumulative distribution function, reliability function and MTTF for this product.

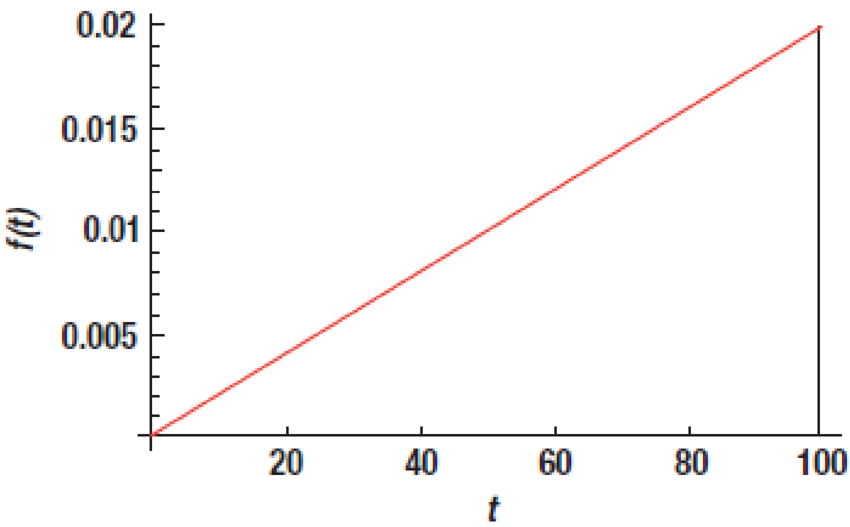

Figure 1C

(3+3+4)

2A Seven prototypes are monitored for some failure during development testing or as fielded products. The failures on the products are fixed (it is assumed that we can renew the product) and testing continues. The testing is stopped at the times given in Table 2A for each product. Find the Mean Time Between Failures (MTBF).

Table 2A: Testing data for each product

Product no.	Hours when failures are recorded	Hours when testing is stopped
01	2467; 3128; 3283; 7988	8012
02	None	6147
03	1870; 6121; 6175	9002
04	3721; 4393; 5848; 6425; 6353	11,000
05	498	4651
06	184; 216; 561; 2804	5012
07	2342; 4213	12,718

2B Derive the expression for reliability of 2 out of 3 redundancy RBD model.

2C A warranty reporting system reports field failures. For the rear brake drums on a particular pickup truck, the coded data shown in Table 2C were obtained. For the data provided, plot the failure probability density function, and the reliability function. Assume that the population size is 2680 and that the data represent all of the failures.

Table 2C: Coded data for rear brake drums

Kilometer interval	Number of failures
$M < 2000$	707
$2000 \leq M < 4000$	532
$4000 \leq M < 6000$	368
$6000 \leq M < 8000$	233
$8000 \leq M < 10{,}000$	231
$10{,}000 \leq M < 12{,}000$	136
$12{,}000 \leq M < 14{,}000$	141
$14{,}000 \leq M < 16{,}000$	78
$16{,}000 \leq M < 18{,}000$	101
$18{,}000 \leq M < 20{,}000$	46
$20{,}000 \leq M < 22{,}000$	51
$22{,}000 \leq M < 24{,}000$	56

(4+2+4)

3A Describe fault tree analysis (FTA) with a suitable example.

3B Illustrate the basic elements required for improvement of product safety program.

3C With neat diagram, explain life characteristic curve.

(4+4+2)

4A Illustrate different types of testing methods used in the reliability engineering.

4B Explain Preliminary Hazard Analysis.

4C Using cut set and tie set methods, find the reliability of the bridge circuit shown in figure 4C.

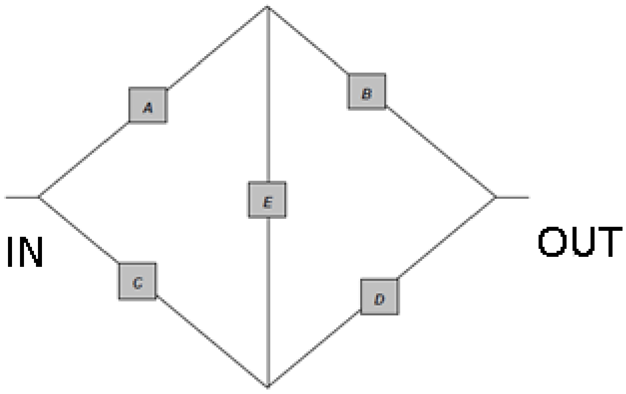

Figure 4C: Bridge circuit

(3+3+4)

5A With a neat flow chart, describe Event Tree Analysis

5B The life distribution for miles to failure for the engine of a Honda car follows the Weibull distribution with $\beta = 3.8$ and $\theta = 185{,}000$ miles.

(a) Find the mean miles between failures, or the expected life for the engine.

(b) Find the standard deviation for miles to failure.

(c) What percent of these engines will fail by 100,000 miles?

(d) What is the failure rate of an engine that has a life of 100,000 miles?

5C Explain different types of redundancy techniques used in reliability and safety engineering.

(3+4+3)

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