Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	INDUSTRIAL RELIABILITY
COURSE CODE	:	BWB 22003
PROGRAMME CODE	:	BWQ
EXAMINATION DATE	:	JULY 2024
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 Given the cumulative distribution function as follows:

$$F(t) = 1 - \frac{700}{t+5t^2}.$$

(a) Calculate the probability that an item will fail between the interval of (100, 200) hours given that it has survived up to 100 hours.

(5 marks)

(b) Calculate the failure rate between the interval of (100, 200) hours.

(3 marks)

(c) Define the failure rate behaviour throughout an interval of (0, 200) hours.

(5 marks)

(d) A system has five identical components. Compute the probability that this system will fail at 15 hours when its first components fail.

(4 marks)

Q2 Given the following formula for mean residual lifetime function, $L(t)$ for Y parametric distribution:

$$L(t) = \frac{1}{\text{failure rate}}$$

(a) In general application of reliability, compare mean residual lifetime function and mean time to failure.

(4 marks)

(b) Determine what Y is and state **THREE (3)** conditions for the failure rate.

(4 marks)

(c) Given an item which follows the Y parametric distribution, the mean time to failure is 421,000 hours. Calculate the mean residual lifetime and the failure rate on the failures in time (FIT) scale.

(4 marks)

(d) An item following Y distribution has a failure rate of 2.61%/K. Calculate its reliability at 500 hours.

(4 marks)

Q3 In a reliability experiment involving 20 similar electronic components, temperature is the predetermined failure mode. **Table Q3** shows the recorded failure time in hours when the experiment was terminated after ten failures occurred.

Table Q3

24	47	55	55	66
70	70	71	80	102

(a) Determine the instantaneous speed of failure at 70 hours by using a maximum likelihood estimate for non-parametric.

(6 marks)

(b) Calculate the estimated survivor function at 60 hours using the Kaplan-Meier estimate.

(7 marks)

(c) State **THREE (3)** reasons why the empirical survivor function is unsuitable for the data.

(3 marks)

(d) Assume that the failure time of the electronic components is exponentially distributed, compute the estimated scale parameter.

(5 marks)

(e) From your answer in **Q3(d)**, construct a 95% confidence level for mean time to failure.

(10 marks)

Q4 **Table Q4** shows a repairable system's failure and repair process. All the recorded times are in hours.

Table Q4

Failure Number	Failure time (hours)	Duration of repairing (hours)
1	9	3
2	13	6
3	21	5
4	35	4
5	50	8
6	79	2

(a) Determine the mean time to failure and the failure rate.

(6 marks)

(b) Determine the mean time to repair and the repair rate.

(4 marks)

(c) Calculate the mean time between downing events for the system.

(3 marks)

(d) Calculate the limiting availability of the system.

(3 marks)

- END OF QUESTIONS -