UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	INDUSTRIAL RELIABILITY
COURSE CODE	:	BWB 22003
PROGRAMME CODE	:	BWB
EXAMINATION DATE	:	JULY / AUGUST 2023
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

TERBUKA

PART A

STATE WHETHER THE GIVEN STATEMENTS ARE TRUE OR FALSE

Q1   Availability can be used for repairable system in which the repair time can be ignored.

Q2   In order to apply availability, the time between failures need to be independent and identically distributed following Poisson distribution.

Q3   Time to failure distribution of a single event in the Homogeneous Poisson Process has exponential distribution.

Q4   In Lognormal distribution, an increase in the scale parameter has the effect of increasing the mode, mean and median of the distribution.

Q5   Mean Cumulative Function (MCF) is one of the nonparametric method in reliability analysis.

Q6   Mean Cumulative Function (MCF) can be used to compare the reliability of several systems.

Q7   The sample size must be sufficiently large and the point estimate of reliability is around 0.1 to construct the confidence interval of the empirical reliability function.

Q8   Type II censoring is more appropriate compared with Type I censoring if we have constraints on the cost of experiment.

Q9   Random right censoring is a failure mode censored.

Q10   "Joint Risk" is the maximum likelihood estimator when censored data happen at random and the exact failure time is recorded.

(10 marks)

PART B: SUBJECTIVE QUESTIONS

Q11   From an experiment, the recorded time of failure (in hours) are as follows:

$$10, 15, 28, 35, 47, 50$$

(a) Compute the instantaneous hazard function between 20 to 40 hours by using conditional probability.

(4 marks)

(b) Calculate the probability distribution function between 20 to 40 hours.

(4 marks)

(c) Calculate the reliability at 25 hours by using the empirical survivor function.

(4 marks)

(d) Suppose the item is known to be exponentially distributed and the experiment involving 20 identical items on test was stopped at 60 hours.

    (i)   State the type of data censoring for the experiment. Justify your answer.

                     (3 marks)

    (ii)   Calculate the point estimate of the failure rate.

                     (5 marks)

Q12   In a reliability experiment involving 20 similar electronic components, the temperature is the predetermine failure mode. **Table Q12** shows the recorded failure time in hours when the experiment was terminated after 10 failures occurred.

Table Q12

40	51	51	59	70
70	70	79	80	98

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

                     (5 marks)

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

                     (7 marks)

(c)   Give **THREE (3)** reasons why the empirical survivor function is not suitable to be used for the data.

                     (3 marks)

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

                     (5 marks)

(e)   From your answer in **Q12(d)**, construct a 95% confidence level for mean time to failure.

                     (10 marks)

Q13   Table Q13 below shows the failure and repair process for a repairable system. All the recorded times are in hours.

Table Q13

Failure Number	Failure time	Duration of repairing
1	8	3
2	15	6
3	22	5
4	30	4
5	44	8
6	57	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 -