

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE
IN APPLIED STATISTICS

MATH 856: SURVIVAL DATA ANALYSIS AND CLINICAL TRIALS

STREAMS: MSc. APPLIED STAT

TIME: 3 HOURS

DAY/DATE: TUESDAY 09/04/2024

11.30 A.M. – 2.30 P.M.

INSTRUCTIONS

- Answer any four questions

QUESTION ONE [15 MARKS]

(a) Define the following terms as used in Survival Analysis by Actuaries:

- (i) Survivorship function
- (ii) Hazard function
- (iii) Right censoring
- (iv) Left Censoring
- (v) Censored Data

[5 marks]

(b) The following data give survival time (in weeks) for $n=15$

1 1 1⁺ 1⁺ 1⁺ 2 2 2 2⁺ 2⁺ 3 3 3⁺ 4⁺ 5⁺

Where “+” denotes censored data.

Complete the following Kaplan-meir table

[10 marks]

$t(j)$	n_j	m_j	q_j	$s(t)$
0				
1				
2				
3				

QUESTION TWO [15 MARKS]

Forty-two patients with acute leukemia were randomized into a treatment group and a placebo group to assess the treatment effect to maintain remission. T : remission time

- 6-MP (6-mercaptopurine) group, $n_1 = 21$
6, 6, 6, 7, 10, 13, 16, 22, 23, 6⁺, 9⁺, 10⁺, 11⁺, 17⁺,
19⁺, 20⁺, 25⁺, 32⁺, 32⁺, 34⁺, 35⁺ (months)
- Placebo group, $n_2 = 21$
1, 1, 2, 2, 3, 4, 4, 5, 5, 8, 8, 8, 8, 11, 11, 12, 12, 15,
17, 22, 23 (months)

Required

- i. Determine the empirical survival function from the placebo group [3 marks]
- ii. Compute a 95% confidence interval at $t=4$ [3 marks]
- iii. For the 6MP group, Calculate the Kaplan-Meier estimate for the survival function ($t=10$) [3 marks]
- iv. Use Greenwood's formula to compute variance of survival estimate at $t=10$ [3 marks]
- v. Compute a 95% confidence interval at $t=10$ [3 marks]

QUESTION THREE [15 MARKS]

- a) The lifetime of light bulb follows on exponential distribution with a hazard rate at 0.001 failures per hour of use.

Required

- i. Find the mean lifetime of a randomly selected light bulb [2marks]
 - ii. Find the median lifetime of a randomly selected light bulb [2marks]
 - iii. What is the probability a light bulb will still function after 2000 hours of use? [2marks]
- b) The following is a report of a chemical trial to evaluate the efficiency of maintain Chemotherapy for acute Leukemia-patient are randomly allocated to group A and B. Group A received maintenance Chemotherapy and Group B did not. The following data on time to relapse (in weeks) time to remission were observed.

Group A	9	13	13 ⁺	18	23	28 ⁺
	34	45 ⁺	48	116 ⁺		
Group B	5	5	8	8	12	23
	23	30	33	43	45	

Find the 95% confidence interval for Group A and B. Assuming an exponential Distribution [9 marks]

QUESTION FOUR [15 MARKS]

(a) Biotech company conducted a 2-year clinical trial testing the efficacy of a new heart valve. The survival times (in months) of 10 patients with the heart valve implants were recorded. The sign "+" next to the observation signifies the observation is censored. The data are;

24+ 16+ 8 19 10 8+ 5 17 20 10

There are eight distinct survival times, given here in increasing order;

5 10 16 17 19 20 24

Required

- i. Estimate the survival function by the Kaplan-Meier method [9 marks]
- ii. Plot Kaplan-Meier survival curve and estimate probability of 15-month survival

b) A cox proportional hazard model fitted to the data with the R results in table below

Call

coxph(formular=surv(time,status) and age + gender, data=DATA

	<i>coef</i>	<i>exp(coef)</i>	<i>se(coef)</i>	<i>z</i>	<i>p</i>
<i>age</i>	<i>0.0124</i>	<i>1.012</i>	<i>0.0094</i>	<i>1.32</i>	<i>0.190</i>
<i>gender</i>	<i>-0.4972</i>	<i>0.608</i>	<i>0.1677</i>	<i>-2.96</i>	<i>0.003</i>

likelihood ratio=18.8 on 3 df *p=0.0002999* *n=26*

Required

- i. Write the fitted model and Comment on the significance of each regression coefficient and the overall model [3 marks]
- ii. Write a program in R that checks for violation of the assumption of proportional hazards of each of the covariates [3 marks]

QUESTION FIVE (15 MARKS)

- a) In a certain country, the probability for a new-born baby to survive over the first year is estimated as 0.993.

Required

- (i) Find the same probability for a country where the hazard rate for infants is three times higher. [1mark]
 - (ii) Find the same probability for a country where the hazard rate for infants is less by 0.001 year^{-1} [2 marks]
- b) A clinical trial is conducted to evaluate a new nicotine patch. Subjects are randomly assigned to either the treatment group or the control group. The treatment group receives the nicotine patch under study, while the control group receives the best nicotine patch currently available on the market. The measurement is the length of time in months that a subject goes without a cigarette. The data for the two groups are as follows

Treatment	3.4	3.6+	4.1	4.9+	5.8+
Control	2.0	3.7+	4.3	4.9+	

Use log-rank test at 5% significance level to test whether the two nicotine patches differ significantly [12 marks]

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