

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 (APP STAT)

TIME: 3 HOURS

DAY/DATE: MONDAY 05/08/2019

2.30 PM – 5.30 PM

## INSTRUCTIONS:

- Answer Question One and any other Two
- Do all the working on the booklet provided

## QUESTION ONE (20 MARKS)

- (a) Define the following terms as used in survival analysis
- (i) Right censoring [2 marks]  
(ii) Interval censoring [2 marks]  
(iii) Non-parametric estimation [2 marks]
- (b) The following are failure times for cancer patients after receiving the drug 6-mp, 9, 13, 13\*, 23,25,28,31\*, 45, 48\*. Asterisks indicate censored times. Calculate the Kaplan Meier estimator of the survivor. [5 marks]
- (c) Consider the random variable X (future life time of an individual). Suppose X has the probability mass function given by  $f(t) = Pr[X = j] = \frac{1}{4}; j = 1, 2, 3, 4$   
Determine  
(i) Survival functions of X [2 marks]  
(ii) Hazard function of X [2 marks]
- (d) Fit the Kaplan-Meier curve on the following data [5 marks]

Time	5	7	8	10	12	15	18	21	27	30	34	38
No. at risk	26	25	24	23	22	21	20	17	15	14	12	11
No. at event	1	1	1	1	1	1	1	1	1	1	1	1

**QUESTION TWO (20 MARKS)**

- (a) Consider a discrete random variable taking values 0, 1, 2, 3,....  
Find E(T) as a function of the survivor function. Hence find the mean of the random variable whose survivor function is given as follows. [5 marks]

t	0	1	2	3	4	5
F(t)	1	0.8	0.6	0.4	0.2	0.1

- (b) Suppose the failure time T has a Weibull distribution with pdf

$$f(t) = \beta a(\alpha t)^{\beta-1} \text{ext}(-(\alpha t)^\beta) \quad t \geq 0$$

- (i) Derive the survivor and hazard functions [10 marks]  
 (ii) Derive the mean of T [5 marks]

**QUESTION THREE (20 MARKS)**

- (a) Define the following terms as used in survival analysis  
 (i) Survivor function [2 marks]  
 (ii) Hazard function [2 marks]  
 (iii) Cumulative hazard function [2 marks]
- (b) Show the mathematical relationship between functions in (a) above. [14 marks]

**QUESTION FOUR (20 MARKS)**

The following data shows two treatment methods of Renal patients in one hospital.  
 Group A: Surgically placed Catheter

Infection Times:	1.5 3.5 4.5 4.5 5.5 26.5 18.5 23.5 15.5 16.5 11.5 8.5 8.5 9.5 10.5
Censored Observations	2.5 2.5 3.5 3.5 3.5 4.5 5.5 6.5 6.5 7.5 7.5 7.5 7.5 8.5 9.5 10.5 11.5 12.5 12.5 13.5 14.5 14.5 14.5 21.5 21.5 22.5 22.5 28.5 27.5

Group B: Percutaneous Place Catheter

Infection Times	0.5 0.5 0.5 0.5 0.5 0.5 0.5 2.5 2.5 3.5 6.5 15.5
Censored Observations	0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 1.5 1.5 1.5 1.5 2.5 2.5 2.5 2.5 2.5 3.5 3.5 3.5 3.5 3.5 4.5 4.5 4.5 5.5 5.5 5.5 5.5 5.5 6.5 7.5 7.5 7.5 8.5 8.5 19.5 20.5 22.5 24.5 25.5 26.5 26.5 28.5

Using the Log Rank Test at the Survival times  
 0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5, 8.5, 9.5, 10.5, 11.5, 15.5, 16.5, 18.5, 23.5, 26.5  
 Test whether the two treatment methods are any different. [20 marks]

**QUESTION 5 (20 MARKS)**

The following is a report of a clinical trial to evaluate the efficiency of maintenance Chemotherapy for acute Leukemia. Patients were randomly allocated to group 1 and II. Group I was the treatment group while Group II was the placebo. The following data on time to remission (weeks-time to remission) were observed.

Group 1: 9, 13, 13\*, 18, 23, 28\*, 34, 34, 45\*, 48, 50\*

Group II: 5, 5, 8, 8, 12, 23, 23, 30, 33, 43, 45

- (a) Draw the Kaplan Meier curve representing the two sets of data. [6 marks]
- (b) Find the 95% confidence interval for group I and II, assume the exponential distribution for failure times. [14 marks]
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