UNIVERSITY EXAMINATIONS

2022/2023 ACADEMIC YEAR

FORTH YEAR FIRST SEMESTER

MAIN EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

COURSE CODE: STA 414/STA 447

COURSE TITLE: SURVIVAL ANALYSIS

DATE: 27/4/2023 **TIME**: 9 AM - 11 AM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

QUESTION 1: (30 MARKS)

(a) Comment on the Non-parametric and the parametric methods of analyzing survival data in terms of their efficiency. What is the recommended procedure when handling such data? (4 marks)

(b) State the uses of the survivorship or survival functions (3 marks)

(c) Illustrate how you would determine that a given data of survival time T come from an exponential distribution (4 marks)

(d) i) What do you understand by the term Censoring? (2 marks)

ii) By use of suitable examples, distinguish right from left Censoring. (4 marks)

(e) i) What do you understand by the term Truncation? (2 marks)

ii) Using suitable examples distinguish right from left Truncation (4 marks)

(f) Let the survival time ,T follow the Weibull distribution with survivorship function, S(t) given as :

$$S(t) = e^{-(\lambda t)^{\gamma}}$$

Where γ and λ are parameters.

How would you ascertain the appropriate weibull fit for such survival data? (7 marks)

QUESTION 2: (20 MARKS)

(a) Given the Survival function,

$$S(t) = \exp(-t^{\gamma})$$

Derive the corresponding probability density function and the hazard function. (3 + 3 marks)

(b) The time to death (in days) following a kidney transplant follows a Log- logistic distribution with $\alpha = 1.5$ and $\lambda = 0.01$. The probability density function of the Log- logistic distribution is

$$f(t) = \frac{\alpha t^{\alpha - 1}\lambda}{(1 + \lambda t^{\alpha})^2} \qquad \text{for } t \geq 0;,, \alpha, \lambda > 0$$

(i) Find the 50, 100 and 150 day survival probabilities for kidney transplantation in patients (2+2+2 marks)

(ii) Show that the hazard rate is initially increasing and then decreasing over time (4 marks)

(iii) Find the time at which the hazard rate changes from increasing to decreasing (4 marks)

QUESTION 3: (20 MARKS)

Consider a clinical trial in which 10 lung cancer patients are followed to death. The table is given below.

Time,t (in months)	i
4	1
5	2
6	3
8	4
8	5
8	6
10	7
10	8
11	9
12	10

(a) Obtain the:

(i) Product limit (PL) estimate of the survivorship function, $\hat{S}(t)$.(5 marks)

(ii) Binomial estimate of the survivorship function, $\hat{S}(t)$ (5 marks)

Comment on the results so obtained in a (i) and a (ii) above. (2 marks)

(b) Find $Var\left[\hat{S}(5)\right]$ and hence the estimated standard error (5 + 3 marks)

QUESTION 4: (20 MARKS)

(a) Let t_1, t2, t3,......., tn be the exact survival times of n individuals under study. State how you would find an estimate of the survivorship function S(t) from such a sample.(2 marks)

(b) Suppose the following remission durations are observed from 10 patients (n=10) with solid tumors. Six patients relapse at 3.0, 6.5, 6.5, 10, 12 and 15 months; 1 patient is lost to follow up at 8.4 months; and 3 patients are still in remission at the end of study after 4.0, 5.7, and 10 months.

(i) Calculate the estimate of the survival time, S(t) for this study (8 marks)

(ii) Plot S(t) verses t and estimate the median remission time (5+3 marks)

(iii) In this situation is it possible to calculate the Binomial estimate of the survival Function? Explain (2 marks)

QUESTION 5: (20 MARKS)

(a) For the i^{th} individual, let values of P variables be $x_{1i}, x_{2i}, \ldots\ldots\ldots x_{pi}$. If $h_i(t)$ is the hazard function of the i^{th} individual, write an expression relating $h_i(t)$ and the baseline hazard, $h_0(t)$, making cox proportional hazards assumption.

(b) Illustrate how you would estimate the coefficients of x_{ji}'s in (a) above

(c) What are accelerated failure time models?

(d) Assume survival time T_i follows exponential distribution with a parameter λ . Under the assumption of right Censored data, obtain the likelihood for the exponential model.