



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2010/2011

INSTITUTIONAL BASED PROGRAMME (IBP) – DECEMBER SESSION

EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE SMA

675/SMA/SS/573: SURVIVAL ANALYSIS

DATE: Friday, 29th April, 2011

TIME: 9.00 a.m. – 12.00 p.m.

INSTRUCTIONS:

Answer any **THREE** questions.

Question 1

- a) Distinguish between the following terms as used in Survival Analysis
- i) Right censoring and left censoring (2 marks)
 - ii) Type I and Type II censoring (4 marks)
- b) Let $T_1, T_2, \dots, T_n$ be n observations from a continuous nonnegative random variable T with the pdf $f(t; \phi)$ and hazard function $h(t; \phi)$. Some of the observations are censored values. Obtain the log likelihood function of the observations. Describe three methods based on the likelihood for making inference about ϕ . (11 marks)
- c) The following are remission times (in weeks) of leukemia patients:
6, 9, 13, 13*, 18, 23, 28, 31, 34, 45*, 48, 56.
Assuming that these observations follow the exponential distribution with parameter λ given by $f(t; \lambda) = \lambda \exp \{-\lambda t\}$, $t > 0$ obtain the 95% confidence interval for λ . (6 marks)

Question 2

- a) Distinguish between a proportional hazard (PH) model and accelerated failure time (AFT) model. (4 marks)
- b) Derive the condition under which both PH model and AFT model coincide (13 marks)
- c) Suppose that in the two sample problem, satisfy the proportion odds model.
- $$\frac{S(t)}{1-S_1(t)} = \psi \frac{S_o(t)}{1-S_o(t)}$$

Derive the condition for the proportional odds model to coincide with the Accelerated Failure Time (AFT) model. (6 marks)

Question 3

- a) Let T be a discrete nonnegative random variable with the probability mass function $S(t)$ and survivor function $S(t)$. Further if $u_1 < u_2 < \dots$ be the ordered atoms of T .
- i) Stating the assumptions you make, obtain the log likelihood function. (9 marks)
- ii) In the usual notations, show that $S(t) = \prod_{\substack{u_j < \\ t}} (1 - h_j)$. Hence obtain the Kaplan – Meier estimator of $S(t)$. (3 marks)
- b) The following are survival times of 10 cancer patients after receiving some treatment: 9, 13⁺, 23, 18, 31, 28, 34, 48, 45⁺, 50, (⁺) indicate censored observation. Calculate the product – limit estimator (11 marks)

Question 4

- a) Derive a general nonparametric test for comparing two survivor functions. Hence obtain the proportional hazard test statistic. (4 marks)
- b) Consider the following survivor times (in days) for the comparison of mortality in two groups; ⁺ indicates censored times.

Group 0	2,	2,	3 ⁺ ,	4,	6 ⁺ ,	6 ⁺ ,	7,	10		
Group 1:	1 ⁺ ,	3,	4 ⁺ ,	5,	5,	6 ⁺ ,	7,	7,	7 ⁺	8

Group 1 is the treatment group while Group 0 is the control group. Calculate the value of the log rank statistic and comment on the result. (19 marks)

Question 5

- a) Suppose T is a nonnegative continuous random variable representing survival time with a probability density function (pdf) $f(t)$. Using usual notations define the following.

- i) survival function
- ii) hazard function

Explain why hazard function rather than the probability density function is more useful in choosing a life time model.

(6 marks)

- b) i) A survivor function is given by $S(t) = \exp \left\{ - \left[\exp(\alpha t)^\beta - 1 \right] \right\}$. Find the hazard function. (3 marks)

- ii) A Weibull distribution has the pdf.

$f(t) = k \lambda (\lambda t)^{k-1} \exp \left\{ -(\lambda t)^k \right\}, t \geq 0$. Find the hazard function of T^k hence deduce the distribution of T^k and comment on the application of this result in the analysis of data that has been modeled using the Weibull distribution. (5 marks)

- c) i) Consider a nonnegative continuous random variable T with the survivor function $S(t)$. Show that $E[T] = \int_0^\infty S(t) dt$. (4 marks)

- ii) Let T be a discrete random variable which takes the values 0, 1, 2, 3, ... Find $E[T]$ as a function of the survivor function. Hence find the mean of a random variable whose survivor function is given below:

T	0	1	2	3	4	5
$S(t)$	1	0.8	0.6	0.4	0.2	0.1

(5 marks)

