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 $T_1, T_2, \ldots, T_n$ be n observations from a continuous nonnegative random variable T with the pdf f (t; ϕ) and hazard function h(t; ϕ). Some of the observations are censored values. Obtain the log likehood 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.

$$\frac{S(t)}{1-S_1(t)} = \frac{\psi S_o(t)}{1-S_o(t)}$$

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 $u_1 < u_2 < \ldots$ 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 $S(t) = \prod_{u_j < t} (1-h_j)$. 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 $S(t)=\exp\left\{-\left[\exp(\propto t)^{\beta}-1\right]\right\}$. 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)