Australian National University

RESEARCH SCHOOL OF FINANCE, ACTUARIAL STUDIES AND APPLIED STATISTICS

Second Semester Mid-Semester Exam 2013

Survival Models / Biostatistics

(STAT3032/7042/8003)

Writing period: 1 Hour duration

Permitted materials: Calculators, lecture notes, dictionary

You must attempt to answer all questions.
All questions are to be completed in the script book provided.

Question 1 (5 marks)

Given that $l_x = (1 - x/100)^{1/2}$, compute the force of mortality at age 50 years.

$$\mu_x = -\frac{1}{l_x}\frac{dl_x}{dx}$$
$$= \frac{1}{\sqrt{1-x/100}}\frac{1}{2}\frac{1}{\sqrt{1-x/100}}\frac{1}{100}$$
$$= \frac{1}{200}\frac{1}{1-\frac{x}{100}}$$
$$\mu_{50} = \frac{1}{200}\frac{1}{1-\frac{50}{100}} = 1/100$$

Question 2 (2+2+2+2+2=10 marks)

(For each part, you will gain 2 marks for a correct answer, be penalized 2 marks for an incorrect answer, and score 0 if no answer is given.)

Answer each question "TRUE" or "FALSE". In each case, write the whole word. It is **not** acceptable to write only "T" or "F" and answers presented in this form **will be graded incorrect**.

a) ${}_5p_{34}$ must be less than or equal to ${}_7p_{33}$.

FALSE

b) Parameter estimates obtained using method of moments estimation will be the same as those obtained from maximum likelihood estimation.

FALSE

c) For human populations a force of mortality function (μ_x) for which $\lim_{x\to\infty}\int_0^x \mu_s ds \neq \infty$ is plausible.

FALSE

d) $e_x = p_x(1 + e_{x+1})$.

TRUE

e) The coefficient estimate for a particular covariate in a fitted Cox proportional hazards regression model is -0.5. This means that, everything else constant, it is estimated that a one unit increase in the particular covariate results in the hazard decreasing by more than 50%.

FALSE

Question 3 (5+5=10 marks)

The results of a clinical trial to study the time to relapse for a group of cancer patients given a new treatment are shown below. The times denoted with a * represent censored observations.

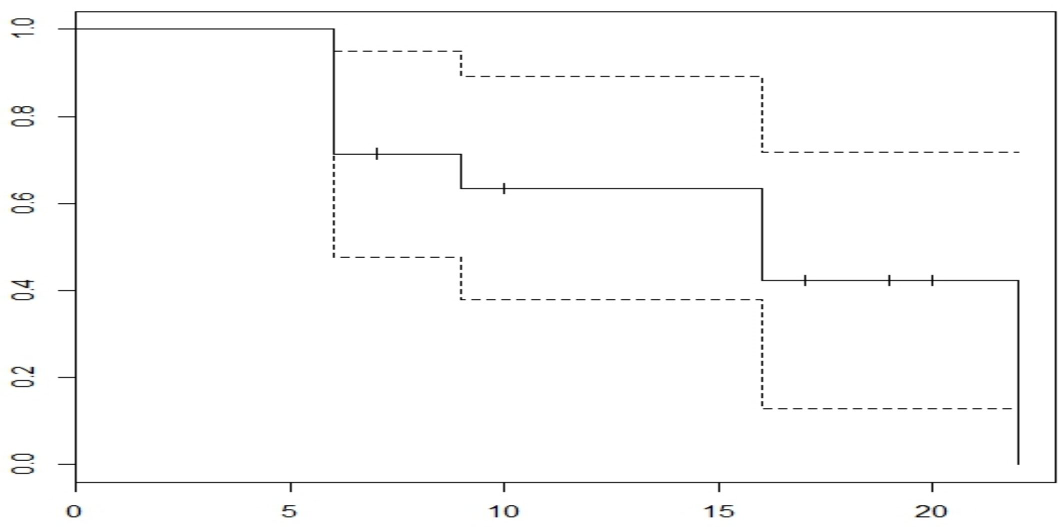
6, 6, 6, 6, 7*, 9, 10*, 10*, 16, 16, 17*, 19*, 20*, 22

a) Compute the Kaplan-Meier estimate of the survival function for relapse times less than 12. You should also provide standard errors for your estimated function.

```
> summary(km.est)
Call: survfit(formula = Surv(times, ind) ~ 1, conf.type = "plain")
```

time	n.risk	n.event	survival	std.err	lower 95% CI	upper 95% CI
6	14	4	0.714	0.121	0.478	0.951
9	9	1	0.635	0.131	0.378	0.891
16	6	2	0.423	0.150	0.129	0.718
22	1	1	0.000	NaN	NaN	NaN

b) Provide an estimate of the mean time to relapse for cancer patients.



Expected value can be estimates as area under the survival curve. The areas is approximately: 15.

Question 4 (5 marks)

The following force of mortality is assumed to hold for an individual aged x:

$$\mu_x = \frac{1}{100-x}, \ 0 \le x < 100$$

Assuming this force of mortality holds, calculate $S(50)$ the probability that an individual aged 0 survives to age 50.

$$S(x) = \exp\{-\int_0^x (\varpi - t)^{-1} dt\}$$
$$= \exp\{-[-\log(100-t)]_0^x\}$$
$$= \exp\{-[-\log(100-x) + \log(100)]\}$$
$$= \exp\{\log(100-x) - \log(100)\}$$
$$= \frac{100-x}{100} = 1 - \frac{x}{100}$$
$$S(50) = 1/2.$$

End of Examination