MACHAKOS UNIVERSITY

University Examinations 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (STATISTICS AND PROGRAMMING)

SAC 401: SURVIVAL MODELS

DATE: 29/8/2022 **TIME: 2.00-4.00 PM**

INSTRUCTION:

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Differentiate the following terms as they apply in survival models

i. Right censoring and left censoring (2 marks)

ii. Interpolation and Extrapolation point estimate (2 marks)

iii. Transactional Risk Exposure and Economic Risk Exposure (2 marks)

b) Given that a survival density function takes the form $f(t) = \lambda e^{-\lambda t}; t > 0, \ \lambda > 0$ determine;

i. $s(t)$ (3 marks)

ii. $h(t)$ (3 marks)

c) The population extract of a town where census is taken once in every 10 years is given below.

Year	1981	1991	2001	2011
Population	35000	42000	58000	84000

Estimate the population in the year 1985 (8 marks)

d) Determine the amount of an annuity of Ksh 30,000 every year for 10 years if the interest rate is 8% per annum compounded quarterly. (5 marks)

e) Given below is a life table extract from a certain county hospital in Kenya.

Age (Years)	<1	1-5	6-10	11-15	….
${}_nl_x$	10,000	9,885	9,339	8,887	….
${}_nd_x$	115	546	452	237	….

Using the table data determine the following;

i. ${}_5p_{10}$ (2 marks)

ii. ${}_5L_{10}$ (3 marks)

QUESTION TWO (20 MARKS)

a) An investor is indifferent on which investment option to invest his Ksh 450,000 among the following options;

Options	A	B	C
Risk of Loss (%)	5	8	12
Returns (%)	10	13	15

i. Advice the option with the least risk exposure (3 marks)

ii. Explain any two methods of managing business risk exposures (2 marks)

b) The following is an extract of the life table from an African country whose *radix* is 10,000.

Age (yrs)	<1	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70>
l_x	10000	9077	8288	7669	7146	6322	5173	3620	1289
${}_nd_x$	923	789	619	523	824	1149	1553	2331	1289

For each age group determine;

i. The probability of surviving (${}_nP_x$) (5 marks)

ii. Life expectancy $\left(e_x\right)$ (10 marks)

QUESTION THREE (20 MARKS)

a) The following data relates to the child's age in years and his weight in kilograms.

Age (Years)	5	6	9	11
Weight (kg)	12	13	14	16

Estimate his weight at 10 years. (5 marks)

b) The data below relates to the time to death after a kidney transplant in one of the referral hospitals. The patients were categorised into male and females.

Gender	**Time to discharge in years**				
Males (M)	7	13	18	19+	20
Females(F)	15	17	25	27+	35+

Test the hypothesis at $\alpha = 0.05$ that;

$$H_0: S_M(t) = S_F(t)$$
$$V\text{ersus } H_1: S_M(t) \neq S_F(t)$$

(15 marks)

QUESTION FOUR (20 MARKS)

a) Distinguish between retrospective policy value and prospective policy value (6 marks)

b) Suppose that 5000 lives were selected for life insurance at age 30. If $q_{[30]+k} = \frac{1.1}{50}$ for k=0,1,2,3,4,5,…..determine the numbers of deaths between the age of 30 to 32. (6 marks)

c) A medical insurance company had her clients' age distribution as summarised below in a certain centre.

Age (years)	0-19	20-39	40-59	60-79	80-99
No. Insured	41	62	65	50	17

Estimate the number of insured whose age is greater than 70 years. (8 marks)

QUESTION FIVE (20 MARKS)

a) Determine ${}_{20}V_{45}$ given that $P_{45} = 0.014$, $P_{\frac{1}{45:\overline{20}|}} = 0.22$ and $P_{45:\overline{20}|} = 0.030$ (5 marks)

b) A group of 15 laboratory rats were injected with a new pests control drug and observed over the following 30 days. The turn of events is as summarised below.

Death day	3	4	11	21	26
Rat number	4	13	6 & 9	10	5

The research also noted the following; On the 6th day rat number 7 escaped from the cage and rat number one was killed by the others on the 17th day. Rat number 8 and 12 escaped on the 24th and 25th day respectively. On the 30th day the experiment was closed and remaining rats were set free from the cage.

i. Represent the information in notation- wise form and then determine; (3 marks)

ii. The rats' survival function $s(t)$ (6 marks)

iii. The variance of $s(t)$ (3 marks)

iv. The 95% CI for $s(t)$ (3 marks)