**CHUKA UNIVERSITY**

# UNIVERSITY EXAMINATIONS

**EXAMINATION FOR THE AWARD OF DEGREE IN BACHELOR OF SCIENCE IN ACTURIAL SCIENCE**

**ACMT 412: SURVIVAL MODELS**

**STREAMS:** **TIME: 2 HOURS**

**DAY/DATE: TUESDAY 18/4/2023** **8.30 A.M. – 11.30 A.M.**

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## QUESTION ONE (30 MARKS)

**A.** Differentiate between initial and central rates of mortality **(4 Marks)**

**B.** Show algebraically that $e_x = P_x\,(1 + e_{x+t})$ **(5 marks)**

**C.** What is censoring in data? Give two types of data censoring and explain them **(6 marks)**

**D.** State the formula for the relationship between the Kaplan - Meier and Nelson Aalen estimates **(5 marks)**

**E.** Give and explain an example of a situation in which the hazard function may be expected to follow each of the below distributions **(10 marks)**

*i. Exponential*

*ii. Decreasing Weibull*

*iii. Gompertz Makham*

*iv. Log logistic*

## QUESTION TWO (20 MARKS)

A. Differentiate between covariate and proportional hazard model. **( 4marks)**

B. The covariates' for the $i^{th}$ observed life are (56, 183 ,40) representing (age last birthday, height in cm, daily dose of drug A in mg) Using the regression parameters β=(0.0172, 0.0028, - 0.0036) . Calculate $\lambda$ $(t:Z_i)$ in terms of $\lambda_0$ (t) **(6 marks)**

C. (i) If $\mu_x$ takes the constant value 0.001 between ages 25 and 35. Calculate the probability that a life aged exactly 25 will survive to age 35 **( 5 marks)**

(ii) If $\mu_x$ takes the constant value 0.0025 at all ages, Calculate the age x for which ${}_xp_o$= 22330.5. What does this age represent? **(5 marks)**

## QUESTION 3 (20 MARKS)

A. Differentiate between Type 1 censoring and type II censoring **(4 marks)**

B. What are the two conventions adapted by the Kaplan – Maier estimate of the survivor function **(6 marks)**

C. Butterflies of a certain species have short lives after hatching each butterfly experience a lifetime defined by the following probability distribution

| **Life time (days)** | **Probability** |
|---|---|
| 1 | 0.10 |
| 2 | 0.30 |
| 3 | 0.25 |
| 4 | 0.20 |
| 5 | 0.15 |

D. Calculate $\lambda_t$ = for J = 1, 2, … 5 and sketch a graph for a discrete hazard function. **(10 marks)**

**QUESTION 4 (20 MARKS)**

A. Losses arising from a certain group of policies are assumed to follow an Exp ($\lambda$) distribution. You are given the below data

(i) The exaxct amount of $x_1$, $x_2$, …. $X_n$ paid by the insurer in respect of n losses

(ii) Data from a further m losses in respect of whch the insuer paid an amount M. The actual loss amount exceeded M But we don't know how much.

Calculate the maximum likelihood estimator of $\lambda$ **(10 marks)**

B. List and explain the main problem of using a parametric approach to analyze observed survivor times. **(10 marks)**

**QUESTION FIVE (20 MARKS)**

A. List and explain scenarios where type 1 censoring occurs **(8 marks)**

B. If $\mu_{60} = 0.01$, $\mu_{61} = 0.02$ and $\mu_{3} = 0.03$. Calculate the values of

(i) $p_{60}$

(ii) ${}_2P_{60}$

(iii) ${}_3P_{60}$

**(9 marks)**

C. List and explain 3 examples scenarios of Random censoring **(3 marks)**

**END**

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