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JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

University Examinations 2016/2017

YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF

BACHELOR OF SCIENCE IN STATISTICS

STA 2490 : DEMOGRAPHIC TECHNIQUES

DATE: JUNE 2017

TIME: 2 HOURS

INSTRUCTIONS: Answer question ONE and any other TWO questions

Question One (30 Marks)

- (a) For a life table, modeled on ages below 5, the formula proposed for evaluating ${}_4L_1$ is given by ${}_4L_1 = k_1l_1 + k_2l_2$. Given that when $l_1 = 9800$ and $l_2 = 9,400$, it is found that ${}_4L_1 = 38,080$. Determine the values of k_1 and k_2 . [4 marks]
- (b) The population of a country in 1960 was 6.73 million while in 1970 it was 8.54 million. Find the size of the population in 1965 using arithmetic interpolation. [3 marks]
- (c) The accuracy of demographic statistics is dependent on the accuracy of data used. Describe two types of errors in demographic data explaining their possible sources [2 marks]
- (d) A particular population can be modeled for a person aged x years, where $0 \leq x \leq 5$, by the survival function $S(x)$ where ;

Question Two (20 Marks)

(a) The following incomplete data are given on women of child bearing age, in the province of Welfaria, in the county of Burania, for the year 2015. 54 6/10

Age group	15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49
Number of Women	150,000	120,000		96,000		88,000	84,000
Total number of births in 2015	450		8,250	4,800	3,600		2,100
ASFR		0.080	0.075		0.040		
Probability of survival to mid age of the age group	0.965	0.951	0.932	0.926	0.914	0.905	0.895

(i) Copy and complete the table below. [3 marks]

(ii) Calculate correct to one decimal place [1 marks]

i. The mean of child bearing [2 marks]

ii. The median age for child bearing [2 marks]

iii. The modal age for child bearing [2 marks]

(iii) Calculate correct to three decimal places

i. The total fertility rate. [1 marks]

ii. The gross rate of reproduction [2 marks]

iii. The net rate of reproduction [2 marks]

(b) A follow up study of migrants to a work area finds that all of them leave before their fourth anniversary in the area. 40% leave in the first year, 30% in the second year, 20% in the third year, 10% in the fourth year. The number of migrants entering the area each year is 80% of the total migrant population. This pattern has been observed for many years.

(i) What is the average length of time that a migrant remains in the working area? (assume that migration is distributed evenly through the year) [3 marks]

(ii) For migrants who have remained in the area for exactly one year, what is the probability of remaining exactly two more years? [1 marks]

9600

$$S(x) = \begin{cases} \cos(\frac{\pi x}{3}) & \text{for } 0 \leq x \leq 1 \\ \beta e^{-\alpha x} & \text{for } 1 < x \leq 5 \end{cases}$$

Given that $S(5) = \frac{2}{5}$, determine the values of the constants α and β each correct to three significant figures [3 marks]

- (c) A farmer had 200 goats, which he wanted to sell to the local market, held from Monday to Friday. On Monday he sold 24 goats, so that by the end of that day the remaining goats had achieved their first birthday. On Tuesday, Wednesday and Thursday, he sold 37, 76 and 42 goats respectively, and then sold all the remaining goats on Friday. Copy and complete the table below:

X	l_x	d_x	q_x	p_x	L_x	T_x	e_x
0	200	24					
1							
2							
3							
4							
5	0	0					

[5 marks]

- (f) Compute the CDR, CBR and the rate of growth and the rate of natural increase for the population of a certain town, for the year 2011, based on the vital statistics given below; [6 marks]

Population January 2011	25,675
Number of births	954
Number of Deaths	412
Number of immigrants	375
Number of emigrants	55

- (g) The population P , t years after the initial observation is given by;

$$P = 1000(2^{1.01t})$$

Determine the initial population and the population 100 years later, and also the rate of growth of the population after 0 and 100 years. [5 marks]

- (h) How long will it take a country's population of 6.73 million to double if growing at a constant rate of 2.4% per annum starting from the base year 1980? [2 marks]

7.01 (1000)

- (iii) If the migrants who have been in the area between 2 and 3 years represent 15.22% of the total migrant population, what is the rate of growth? [1 marks]
- (iv) What is the proportion of the migrants who leave the area each year? [2 marks]

Question Three (20 Marks)

- (a) It is estimated that t years from now, the population of a certain country in millions will be

$$P = \frac{20}{2 + 3e^{-0.008t}}$$

- (i) What is the current population
- (ii) What will be the population 50 years from now?
- (iii) What will happen to the population in the long run?

[6 marks]

- (b) The census figures for the population of Nairobi are as follows.

Year	1969	1979	1989	1999
Population in millions	0.51	0.83	1.32	2.14

2009

It is proposed to fit the data to a model $P = Ae^{rt}$ where t is the time in decades after the observation in 1969.

- (i) Transform the model into appropriate logarithmic form, and fit a regression model to the data to determine the values of the constants A and r , correct to three decimal places. [8 marks]
- (ii) Use your model to predict the size of the population in 2019 (in millions) correct to three significant figures. [3 marks]
- (iii) The 2009 census figures gave the actual population as 3.14 million. Predict the size of the population in 2009 using your model and show that the percentage error in your prediction is just less than 10% [3 marks]

Question Four (20 Marks)

- (a) In a certain island, data on age groups in a reproductive-span of women, their number and recorded number of births, for a given calendar year, were recorded as follows; It is also

Age-group	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Number of women	210,000	175,000	157,500	140,000	122,500	105,000	87,500
Number of births	1,080	8,400	9,450	1,140	23,100	5,400	3,600

known that 55% of births are female births. Calculate the following rates

- (i) Age Specific fertility rate [3 marks]
 - (ii) Total Fertility rate [2 marks]
 - (iii) General Fertility rate [2 marks]
 - (iv) In what way(s) is the General Fertility Rate a better measure of fertility levels than the Crude Birth Rate? [1 mark]
- (b) A population model for a small town is given by $P = a + bc^t$ where P is the population t years after the initial observation. Given that $P(0) = 3,000$, $P(1) = 4000$ and $P(2) = 6000$. Determine the values of the constants a, b and c and hence the formula for the size of the population at time t . [12 marks]

THE END