MACHAKOS UNIVERSITY

University Examinations 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (STATISTICS AND PROGRAMMING)

SMA 366: QUALITY CONTROL METHODS

DATE: 25/8/2022 **TIME: 8.30-10.30 AM**

INSTRUCTION:
Answer question ONE and any other TWO questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Define the following terms:

i. Demography

ii. crude birth rate (CBR)

iii. age specific death rate (ASDR)

iv. mortality (4 marks)

b) State:

i. two limitation of a census (2 marks)

ii. three sources of error in demographic data (3 marks)

c) Differentiate between:-

i. Fertility and fecundity (2 marks)

ii. Crude death rate and age specific death rate. (2 marks)

d) In a certain population the following information was obtained:

AGE	NUMBER OF PEOPLE
0-15	200,000
16-40	460,000
41-64	300,600
65 and over	120,000

Calculate the dependency ratio. (2 marks)

e) Given that

$m_x = \frac{D_x}{P_x}$ is the age specific mortality

where D_x is the number of deaths and P_x is the mid-year population show that the probability of dying is given by $q_x = \frac{2m_x}{2 + m_x}$ (3 marks)

f) A zoologist researching on fish established a fish pond for a species of small fish. After one year, the fish population had grown from 680 to 1230.

i. Determine the population growth rate. (2 marks)

ii. Assuming an exponential growth, how many years will it take for the fish population in (i) above to triple? (3 marks)

g) The table below gives information, for a particular year, as obtained from a certain hospital.

Quarter	Number of live births	Number of deaths below 1 yr of age
January – March	46	1
April –June	80	2
July - September	120	6
October - December	98	3

Calculate the infant mortality rate. (3 marks)

h) In a stationary female population what percentage of the total population are aged;

i. 0-15 years

ii. (ii) between 15-65 year? (4 marks)

QUESTION TWO (20 MARKS)

a) Give two limitations of the crude birth rate (CBR). (2 marks)

b) From three different communities, the number of deaths attributed to a particular cause were recorded alongside the population at risk. The information is as presented below.

COMMUNITY	POPULATION AT RISK	DEATHS BY CAUSES		
		TB	MALARIA	DIABETES
A	304,848	278	252	188
B	211,075	170	170	154
C	416,418	193	180	228

Determine the cause specific death rates. (3 marks)

c) The following data were obtained from a population.

AGE	POPULATION OF FEMALES	LIVE BIRTHS
15-19	1,611,090	463,631
20-24	1,558,276	427,298
25-29	1,425,242	412,878
30-34	1,381,174	380,778
35-39	1,632,695	308,671
40-44	1,581, 373	281,161
45-49	140,055	239,701

Determine the;

i. General Fertility Rate (GFR) (3 marks)

ii. Total Fertility Rate (TFR) (3 marks)

iii. Age Specific Fertility Rates (ASFR) (3 marks)

d) The table below gives the numbers of births, deaths of infants aged under 1 year, and deaths of infants aged under 28 days, in the United Kingdom in selected recent calendar years.

AGE	**NO. OF BIRTHS**	**NO. OF DEATHS**	
		At ages under 1 year	**At ages under 28 days**
1971	901,600	16,200	10,800
1976	675,500	9,790	6,680
1981	730,800	8,160	4,930
1986	755,000	7,180	4,000
1991	792,500	5,820	3,460
1995	732,000	4,520	3,070

i. Calculate the percentage of infant deaths in each year which were neonatal deaths. (3 marks)

ii. Calculate the infant mortality rates for each year. (3 marks)

QUESTION THREE (20 MARKS)

a) Distinguish between a complete life table and an abridged life table. (2 marks)

b) State two uses of life tables (2 marks)

c) Life table for a male population in a certain community in Kenya.

Age (x)	**Number of survivors (l_x)**	**Number of person years after age x (T_x)**
0	100,000	7,122,658
20	97,051	5,152,148
40	93,045	3,251,188
60	78,213	1,538,608
80	46,833	294,648

i. Complete the life table. (3 marks)

ii. Calculate the;

I. Life table crude death rate (3 marks)

II. Proportion of people surviving from age 20 to age 40. (2 marks)

III. Probability of a person now aged 20 years dying before their 80^{th} birthday. (2 marks)

d) The wastage rates in a factory have been found to be as follows.

YEAR	WASTAGE RATES IN FACTORY
0	0.5
1	0.5
2	0.5
3	0.5
4	0.5
5	0.5
6	0.5
7	0.5
8	0.5
9	0.5
10	0.5

Calculate the average length of service of an employee and the annual intake required to maintain the staff at 1,500. (assume a radix of 1,000) (6 marks)

QUESTION FOUR (20 MARKS)

a) Define population growth rate. (1 mark)

b) State three factors that affect population growth rate. (3 marks)

c) In a certain country the population census were taken in 1950 and 1960. The ratio of $\frac{P_{1960}}{P_{1950}} = 1.62$. Assuming a geometric model, calculate the annual growth rate. (4 marks)

d) Show that in estimating population growth using the geometric model

$P_n = P(1+r)^n$ n = 1,2, … (6 marks)

e) The mid-year population of Kenya was 18 million in 1982. Between 1970 and 1982 the average annual rate of growth was 4%. The World Bank estimated that, in mid-1990, Kenya's population was 26 million, and that by the middle of the year 2000 it will be 40 million (World Bank, 1984).

i. Assuming that the growth in the population of Kenya between 1982 and 1990, and between 1990 and 2000, is exponential, calculate the annual growth rates using the World Bank's estimates of the population. (3 marks)

ii. Assume that the World Bank's estimate of 40 million in 2000 is correct. If Kenya's population continues to increase after 2000 at the same rate as the World Bank assumed it would increase between 1990 and 2000, when will it reach 80 million? (3 marks)

QUESTION FIVE (20 MARKS)

a) Differentiate between population growth and population projection. (2 marks)

b) State four uses of population projection. (4 marks)

c) i. Show that in population projection using the exponential model,

$P_t = P_0 e^{rt}$ (8 marks)

ii. If in a certain experiment on rats, the initial population, $P_0 = 2{,}000$ whereas the growth rate was established to be 0.13. Project the population of the rats 12 years from now. (3 marks)

iii. What would the population projection be if you used the geometric model? (3 marks)