



MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS, STATISTICS AND ACTUARIAL SCIENCES

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN
BACHELOR OF SCIENCE IN ACTUARIAL SCIENCE
BACHELOR OF SCIENCE IN STATISTICS AND PROGRAMMING

SST 400/SAC 400: DEMOGRAPHY AND VITAL STATISTICS

DATE: 14TH JANUARY, 2025

TIME: 8.30 AM – 10.30 AM

INSTRUCTIONS:

Answer question ONE (Compulsory) and any other TWO questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Define demography (2marks)
- b) Differentiate between the national and international sources of demographic data giving examples in each (4marks)
- c) Explain any three sources of national demographic data (6marks)
- d) Discuss the importance of census statistics (4marks)
- e) Explain five features of a census (5marks)
- f) Distinguish between coverage errors and content errors in demographic data (2marks)

g) The following data relates to the population of a country for the age range 23-62.

Age	Population
23	38687
24	51289
25	77141
26-29	201450
30	110379
31-34	132136
35	64091
36-39	134140
40	81515
41-44	84422
45	44654
46-49	77102
50	52024
51-54	44751
55	14024
56-59	45283
60	38377
61	7866
62	4779

Determine the extent of age heaping on:

- i. Digit 0 and 5 **(3 marks)**
- ii. Digit 0 only **(2 marks)**
- iii. Digit 5 only **(2 marks)**

QUESTION TWO (20 MARKS)

a) Use the UNAI to assess the age- sex reporting of the data shown in the table below.

Age group	Male population	Female population
0-4	2376	2350
5-9	1983	1972
10-14	1628	1614
15-19	1277	1265
20-24	997	986
25-29	807	779
30-34	661	644
35-39	551	533
40-44	394	378
45-49	267	278
50-54	194	228
55-59	161	200
60-64	136	163
65-69	103	123
70-74	75	79
75-79	62	59

- i. Find the average sex ratio score (**S**) **(2 marks)**
- ii. Find the average male age ratio score (**M**) **(4 marks)**
- iii. Find the female age ratio score (**F**) **(4 marks)**
- iv. Obtain the United Nations age sex accuracy index **UNAI** **(3 marks)**

b) Given the following data, calculate the following measures:

Total number of births	2,000
Total number of deaths	1,500
Total population	50,000

Calculate the;

- i. Crude Birth Rate (CBR) **(2marks)**
- ii. Crude Death Rate (CDR) **(2marks)**
- iii. Net Reproduction Rate (NRR), **(3marks)**

QUESTION THREE (20 MARKS)

a) You are given the following data for a hypothetical population:

Age group	Number of individuals	Number of deaths
0-4	1000	20
5-9	950	10
10-14	940	5

Calculate the following:

- i) Probability of dying between age 0 and 4 (q_x) **(5 Marks)**
 - ii) Life expectancy at birth (e_0), assuming a simple life table where the number of survivors is calculated by subtracting the number of deaths from the total population in each age group. **(5 Marks)**
- b) You are provided with the following age-specific mortality rates for a population:

Age group	Mortality rates
0-4	0.02
5-9	0.01
10-14	0.015
15-19	0.03

Apply a 3-year moving weighted average to smooth these rates, using weights of 0.5, 0.3, and 0.2 for the current, previous, and next year, respectively. **(5 Marks)**

- c) Explain the Bayesian approach to graduation and apply it to the following mortality rates:

Age group	Mortality rates
0-4	0.022
5-9	0.012
10-14	0.016

Assume prior estimates for these rates are 0.020, 0.010, and 0.015 respectively. Calculate the Bayesian-adjusted rates using a prior weight of 0.5 for the prior estimates and 0.5 for the observed data. **(5 Marks)**

QUESTION FOUR (20 MARKS)

- a) Discuss how the crude birth rate and crude death rate can be used to evaluate the effectiveness of a public health intervention in a given region. Provide a hypothetical scenario and interpret the results. (10 Marks)
- b) Discuss how life tables can be used to assess mortality rates over time and predict future population trends. Use a hypothetical example to illustrate your point. (10 marks)

QUESTION FIVE (20 MARKS)

- a) The following is a cross-tabulation table relating to 4 counties from 2009 Census.

	Nandi	Siaya	Meru	Kiambu
Nandi	603460	2872	8243	6526
Siaya	4250	1003420	8369	6560
Meru	2460	20350	1460526	18278
Kiambu	2008	10278	35263	1829290

Determine the

- i. Crude in migration rate (2 Marks)
- ii. Crude outmigration rate (2 Marks)
- iii. Crude gross migration rate (2 Marks)
- iv. Crude net migration rate (2 Marks)

- b) Consider the following data and answer the questions that follow.

Age group	Female population	Female births	Total births
15-19	79865	4293	8813
20-24	63315	8582	17620
25-29	51860	7104	14585
30-34	44440	4986	10235
35-39	38795	3686	7569
40-44	32250	1344	2760
45-49	26720	186	381

- i. Determine the general fertility rate (3 Marks)
- ii. Find the age specific fertility rate (3 Marks)
- iii. Evaluate the total fertility rate (3 Marks)
- iv. Compute the gross reproductive rate (3 Marks)