MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE, APPLIED AND HEALTH SCIENCES

DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

FOURTH YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN MATHEMATICS AND ECONOMICS

AMS 417: DESIGN AND ANALYSIS OF SAMPLE SURVEYS

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) (i) Differentiate sampling unit from sampling frame (2 marks)
(ii) Differentiate descriptive from analytical surveys (2 marks)
(iii) Discuss three types of sampling (6 marks)

b) Explain three properties of estimators (3marks)

c) A sample of 30 students is to be drawn from a population of 300 student belonging to two colleges A and B. The means and standard deviations of their marks are given below;

	Total number of students	yi	Si
College A	200	30	10
College B	100	60	40

Use the information to confirm that Neyman's allocation scheme is a more efficient scheme when compared to proportional allocation. (6 marks)

d) Show that $\bar{y}_{sy}$ is unbiased estimator of $\bar{Y}$ (3 marks)

e) A daily newspaper conducts a survey food costs by taking a simple random sample of 48 basic food stuffs purchased in large supermarket prices (in kshs) for those items are recorded in two separate occasions, three months apart, the earlier ones being denoted x_i and the later y_i. The following results were obtained: $\bar{x} = 11.41,\ \bar{y} = 12.07, \sum {x_i}^2 = 8431.7,\ \sum {y_i}^2 = 9270.6, \sum x_i y_i = 8564.1$ and $n = 48$. Calculate;

i) Ratio estimator (r) (1 mark)
ii) Sampling variance of the ratio estimator (4 marks)
iii) The 95% confidence interval for the ration estimator (3 marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a) Given an SRSWOR within a sample variance given by $s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$ and its corresponding population variance given by $S^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2$, show that the sample variance s^2 is an unbiased estimator of the population variance S^2 (10marks)

b) Signatures to a petition were collected on 676 sheets, each sheet had enough space for 42 signatures, but on many sheets, a smaller number of signatures had been collected. The number of signatures per sheet were counted on a random sample of 50 sheets (about 7% sample). The results are given in the table below.

Yi	42	41	36	32	29	27	23	19	16	15	14	11	10	7	6	5	4	3
fi	23	4	1	1	1	2	1	1	2	2	1	1	1	1	3	2	1	2

Estimate the total number of signatures to the petition and 80% confidence limits. (7marks)

c) Let N=100 and $n = 10$. Assume the random start r is selected, say $r = 5$. Find a systematic sample composition. (3marks)

QUESTION THREE (20 MARKS)

a) A stratified population has 5 strata, the stratum sizes Ni and means $\overline{Y_i}$ and Si^2 of some variable Y are as follows

Stratum	Ni	Yi	Si
1	117	7.3	1.31
2	98	6.9	2.03
3	74	11.2	1.13
4	41	9.1	1.96
5	45	9.6	1.74

i) Calculate the overall population mean and variance (5marks)

ii) For a stratified simple random sample of size 80, determine the appropriate stratum sample sizes under proportional allocation and Neyman allocation (7marks)

b) A videotape hire company has shops in each of 5 regions, three regions have 12 shops and others have 8. To estimate the total number Y of video films hired from the company in a particular week, the sales manager phones 12 shops chosen by picking 3 regions at random then making a choice of 3,5 and 4 shops from the chosen regions. The results were as follows;

First region	260	296	182			12 shops
Second region	156	261	130	302	241	8 shops
Third region	196	356	264	284		12 shops

Estimate the total Number of Y (8marks)

QUESTION FOUR (20 MARKS)

a) In a private Library, the books are kept on 130 shelves of similar size. The member of books on 15 shelves picked at random were found to be 28,23,25,33,31,18,22,29,30,22,26,20,21,28 and 25. Estimate the total number Y_T, of books in the library and calculate an approximate 95% confidence interval for Y_T (8marks)

b) For a systematic random sampling clearly show that $\bar{y}_{sy}$ is more precise than $\bar{y}_{wsy}$ if $s^2 < s^2{}_{wsy}$ in the case when units within the system same are more homogeneous than the whole population (8marks

c) Explain four types of imputation (4marks)