MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF APPLIED SCIENCES & TECHNOLOGY

DEPARTMENT OF APPLIED STATISTICS

MODULE: SURVEY TECHNIQUES

CODE: ASTA 221

SESSIONAL EXAMINATIONS
JUNE 2023

DURATION: 3 HOURS

EXAMINER: MR ZVAWANDA I

INSTRUCTIONS

1. *Answer **ALL** questions from Section A*
2. *Answer any **three** questions from Section B*

REQUIREMENTS

Statistical tables;
Non-programmable scientific calculator
Graph paper

SECTION A [40 MARKS]

Answer **All** Questions in this Section

A1. Define the following terms as used in survey techniques

i) Questionnaire
ii) Element
iii) Target population
iv) Sample
v) Sampling frame

[2, 2, 2, 2, 2]

A2

There are various ways of collecting data. State and explain any two methods giving 3 merits and 3 demerits for each method

[8]

A3

a) State any four factors to consider when choosing a sampling design
b) Distinguish between the following terms
i) Overcoverage and undercoverage in the sampling frame
ii) Sampling errors and non sampling errors

[4,4,2]

A4

Surveys can be classified into four criteria. State and explain the four classification of surveys

[12]

SECTION B [60 MARKS]

*Answer any **THREE** questions in this section*

B5

a) Prove that

i) $E(Y_i) = \mu$

ii) $Var(Y_i) = \delta^2$

b) Suppose we have a population of N=4, measurements given by 30, 40, 50, 60

i) List all possible simple random samples of size n =2 that can be selected from the population and state the probability of selecting any one of the samples

ii) Compute E(ỹ) and V(ỹ)

[4,5,4,7]

B6

a) Training of enumerators is very important in survey fieldwork. Discuss the significance of training of enumerators.

b) The results of a stratified random sampling are summarized below

Stratum	N_i	n_i	$\tilde{v}_i$	s_i^2
1	1000	25	30.125	26.333
2	1200	35	35.725	14.667
3	900	20	25.125	19.111
4	1400	40	30.725	15.625

i) Estimate the population mean and its associated variance

ii) Estimate the population total

[8, 8, 4]

B7

a) Enumerators are critical participants in a survey. Evaluate the critical roles that are carried out by enumerators in a survey

b) Manjengwa Trading provides food for students at a certain University. A 1 in 100 systematic sample of the N = 2000 students listed in the University register is taken to estimate the average amount of money spent on food per semester. The results of the sample are listed on the table below

Student	**Amount Spent**
1	5.0
2	4.2
3	6.0
4	10.6
5	12.0
6	4.2
7	4.8
8	5.6
9	7.2
10	8.4
11	8.2
12	7.8
13	8.7
14	6.8
15	9.6
16	4.6
17	11.2
18	10.6
19	5.5
20	4.9

i) Estimate the average amount of money spent on food per semester by a student

ii) Estimate the corresponding variance

iii) Hence place a bound on the error of estimation using $\alpha = 0.01$

[10,4,3,3]

B8

a) Outline the ethical considerations when carrying out survey fieldwork

b) A statistician developed a test designed to assess the attitudes of students towards mathematics at a certain school with 100 classes. He sampled 20 classes and tested every member of the sampled class .The results are shown on the diagram below

Class	Number of students	Total score
1	30	1400
2	25	1000
3	35	1500
4	20	1400
5	28	1400
6	30	1200
7	32	1800
8	34	1400
9	36	1600
10	32	1200
11	35	1700
12	40	1800

13	20	1000
14	25	1000
15	38	2100
16	32	1200
17	26	1000
18	28	1500
19	25	1000
20	40	2000

i) Estimate the average score at the school

ii) Estimate the variance of the average score

iii) Hence find a 95% confidence interval for the average score.

[8, 4, 5, 3]

END OF EXAMINATION PAPER

FORMULAE

Sampling Procedure	Estimator	Variance	Sample size [bound d]
Simple			
mean	$\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$	$Var(\bar{y}) = \frac{s^2}{n}\left(\frac{N-n}{N}\right)$	$n = \frac{N\sigma^2}{\frac{d^2}{z^2}(N-1)+\sigma^2}$
total	$\hat{\tau} = N\bar{y}$	$Var(\hat{\tau}) = N^2 Var(\bar{y})$	$n = \frac{N\sigma^2}{\frac{d^2}{z^2N^2}(N-1)+\sigma^2}$
proportion	$\hat{p} = \frac{1}{n}\sum_{i=1}^{n} y_i$	$Var(\hat{p}) = \frac{\hat{p}\hat{q}}{n-1}\left(\frac{N-n}{N}\right)$	$n = \frac{Npq}{\frac{d^2}{z^2}(N-1)+pq}$
Stratified			
mean	$\bar{y}_{st} = \frac{1}{N}\sum N_i\bar{y}_i$	$Var(\bar{y}_{st}) = \frac{1}{N^2}\sum N_i^2\left(\frac{N_i-n_i}{N_i}\right)\frac{s_i^2}{n_i}$	$n = \frac{\sum N_i^2\sigma_i^2/w_i}{\frac{N^2d^2}{z^2}+\sum N_i\sigma_i^2}$
total	$\hat{\tau}_{st} = \sum N_i\bar{y}_i$	$Var(\hat{\tau}_{st}) = \sum N_i^2\left(\frac{N_i-n_i}{N_i}\right)\frac{s_i^2}{n_i}$	$n = \frac{\sum N_i^2\sigma_i^2/w_i}{\frac{d^2}{z^2}+\sum_{i=1}^{L} N_i\sigma_i^2}$
proportion	$\hat{p}_{st} = \frac{1}{N}\sum N_i\hat{p}_i$	$Var(\hat{p}_{st}) = \frac{1}{N^2}\sum N_i(N_i-n_i)\frac{\hat{p}_i\hat{q}_i}{n_i-1}$	$n = \frac{\sum N_i^2 p_i q_i/w_i}{\frac{N^2d^2}{z^2}+\sum N_i p_i q_i}$
Systematic			
mean	$\bar{y}_{sy} = \frac{1}{n}\sum_{i=1}^{n} y_i$	$Var(\bar{y}_{sy}) = \frac{s^2}{n}\left(\frac{N-n}{N}\right)$	$n = \frac{N\sigma^2}{\frac{d^2}{z^2}(N-1)+\sigma^2}$
total	$\hat{\tau}_{sy} = N\bar{y}$	$Var(\hat{\tau}_{sy}) = N^2 Var(\bar{y})$	$n = \frac{N\sigma^2}{\frac{d^2}{z^2N^2}(N-1)+\sigma^2}$
proportion	$\hat{p}_{sy} = \frac{1}{n}\sum_{i=1}^{n} y_i$	$Var(\hat{p}_{sy}) = \frac{\hat{p}_{sy}\hat{q}_{sy}}{n-1}\left(\frac{N-n}{N}\right)$	$n = \frac{Npq}{\frac{d^2}{z^2}(N-1)+pq}$
Cluster			
mean	$\bar{y} = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} m_i}$	$Var(\bar{y}) = \left(\frac{N-n}{Nn\bar{M}^2}\right)\frac{\sum_{i=1}^{n}(y_i-\bar{y}m_i)^2}{n-1}$	$n = \frac{N\sigma_c^2}{\frac{d^2}{z^2}N\bar{M}^2+\sigma_c^2}$
total	$\hat{\tau} = M\bar{y}$	$Var(\hat{\tau}) = M^2 Var(\bar{y})$	$n = \frac{N\sigma_c^2}{\frac{d^2}{z^2N}+\sigma_c^2}$
proportion	$\hat{p} = \frac{\sum_{i=1}^{n} a_i}{\sum_{i=1}^{n} m_i}$	$Var(\hat{p}) = \left(\frac{N-n}{Nn\bar{M}^2}\right)\frac{\sum_{i=1}^{n}(a_i-\hat{p}m_i)^2}{n-1}$	$n = \frac{N\sigma_c^2}{\frac{d^2}{z^2}N\bar{M}^2+\sigma_c^2}$

Stratified	**Allocation** proportional	fixed cost c_i or variance	Neyman
mean	$n_i = n\frac{N_i}{N}$	$n_i = n\frac{N_i\sigma_i/\sqrt{c_i}}{\sum_{j=1}^{L} N_j\sigma_j/\sqrt{c_i}}$	$n_i = n\frac{N_i\sigma_i}{\sum_{j=1}^{L} N_j\sigma_j}$
proportion	$n_i = n\frac{N_i}{N}$	$n_i = n\frac{N_i\sqrt{p_iq_i}/\sqrt{c_i}}{\sum_{j=1}^{L} N_j\sqrt{p_jq_j}/\sqrt{c_i}}$	$n_i = n\frac{N_i\sqrt{p_iq_i}}{\sum_{j=1}^{L} N_j\sqrt{p_jq_j}}$