MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING, APPLIED SCIENCES & TECHNOLOGY

DEPARTMENT OF APPLIED STATISTICS

MODULE: SURVEY TECHNIQUES

CODE: ASTA 221

SESSIONAL EXAMINATIONS
DECEMBER 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) Sampling units
ii) Study population
iii) Target population
iv) Element
v) Sampling frame

[2, 2, 2, 2, 2]

A2

If you are planning to carry out a sample survey to determine the acceptance levels for a new contraceptive method among currently married women, in a high density area of your provincial capital, discuss the different precautions you would take to reduce the non- response rate. There are numerous ways of Data Collection. State and explain any two methods giving 3 merits and 3 demerits for each method

[8]

A3 Show that

i) $E(Y_i) = \mu$

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

[5,5]

A4

a) Outline any four factors to consider when choosing a sampling design
b) Explain the difference between the following terms
i) Overcoverage and Undercoverage in the sampling frame
ii) Non Sampling errors and Sampling errors

[4,4,4]

SECTION B [60 MARKS]

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

B5

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

b) A simple random sample of n=10 students at MSUAS is drawn to estimate the average weight of N=500 students. The sample values for these 10 students weight is shown below

65 60 80 75 80 100 90 58 70 72

Estimate i)Sample mean

ii)Sample variance

iii)95% confidence interval

[12,2,3,3]

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	$\tilde{\mathrm{v}}_\mathrm{i}$	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 95% confidence interval of the population mean

[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) Kudemera 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) Discuss 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 90% confidence interval for the average score.

[8,4,5,3]

END OF 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	$n_i = n\frac{N_i}{N}$	$n_i = n\frac{N_i\sqrt{p_iq_i}/\sqrt{c_i}}{\sum_{j=1}^{L} N_j\sqrt{p_jq_j}/\sqrt{c_i}}$	$n_i = n\frac{N_i\sqrt{p_iq_i}}{\sum_{j=1}^{L} N_j\sqrt{p_jq_j}}$