



# MURANG'A UNIVERSITY OF TECHNOLOGY

## SCHOOL OF PURE AND APPLIED SCIENCES

### DEPARTMENT OF APPLIED SCIENCES

#### UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

**SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF  
BACHELOR OF SCIENCE IN APPLIED STATISTICS & PROGRAMMING**

AMS 201 – SAMPLE SURVEYS I

DURATION: 2 HOURS

DATE: 7<sup>TH</sup> DECEMBER, 2017

TIME: 9.00 – 11.00 A.M.

#### **Instructions to Candidates:**

1. Answer **Question 1** 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 ONE - COMPULSORY

### QUESTION ONE

- (a) Briefly explain the meaning of the following terms
- i) Census
  - ii) Sample survey
  - iii) Sampling errors
  - iv) Systematic bias (4 marks)
- (b) Explain what is a good sample in measurement terms (3 marks)
- (c) State and explain four reasons of sampling (4 marks)
- (d) Define the following terms as used in non-probability sampling methods
- i) Purposive sampling
  - ii) Convenience sampling
  - iii) Quota sampling (3 marks)
- (e) State and explain four causes of systematic bias in sampling (4 marks)
- (f) Give four advantages of stratified sampling (4 marks)
- (g) Suppose that we have a population of size  $N=4$  whose population units are 1,2,3,4 and that we require a sample of size  $n=2$  from the population. Assuming we use simple random sampling without replacement (SRSWOR). Find
- i) The number of possible samples and the probability of selecting each sample (2 marks)
  - ii) Specify these samples (2 marks)
  - iii) Show that the sample mean is unbiased for the population mean using this data (4 marks)

## SECTION TWO – ANSWER ANY TWO

### QUESTION TWO

- (a) Let  $Y_i$  be the value of the characteristic under study for the  $i^{\text{th}}$  unit of the population and  $X_i$  be the value of the auxiliary characteristic of the  $i^{\text{th}}$  unit of the population.
- i) Show that the ratio estimator ( $\bar{y}_R$ ) is a biased estimator of population mean  $\bar{Y}$
  - ii) Show that the variance of the ratio estimator is given .....
- $$\text{Var}(\bar{y}_R) = \bar{Y}^2 \left( \frac{N-n}{Nn} \right) (C_y^2 - 2\rho C_x C_y + C_x^2) \quad (7 \text{ marks})$$

- (b) In a particular sector of the industry, a survey is conducted to investigate the extent of absenteeism from duty which is not connected to illness or official holidays. A random sample of 1000 employees out of the total workforce of 36,000 were asked to indicate the number of days they had failed to report to work for the previous six months. They were also asked to give reasons. The following were the results

Number of days	0	2	3	4	5	6	7	8	9
Number of employees	451	187	112	49	21	5	11	2	0

- i) Determine the average number of days that were lost by the industry (3 marks)  
 ii) Determine an estimate of population variance  $S^2$  (4 marks)

### QUESTION THREE

- (a) Show that in simple random sampling without replacement
- i) The sample mean is an unbiased estimator of the population mean  $E(\bar{y}) = \bar{Y}$  (4 marks)  
 ii) The sample variance is unbiased estimator of population variance  $E(\overline{S^2}) = S^2$  (9 marks)
- (b) Suppose the following summarized information is made available  
 $n = 25, N = 275, \bar{x} = 92, \bar{y} = 2.6, \sum_{i=1}^{25} x_i^2 = 2200, \sum_{i=1}^{25} x_2 y_i = 500, \sum_{i=1}^{25} y_i^2 = 170$   
 Estimate R and Var(R) (7 marks)

### QUESTION FOUR

- (a) Research it to be carried out in the informal sector. The sector is divided into three groups, that is, low income earners, medium income earners and high income earners. He total amount allocated to this research is \$1500. The following data was collected after the interviews

	Number of subsectors taken ( $N_i$ )	Variance of money spent $S_i^2$	Cost per interview $C_i$
Low	350	200	5
Medium	500	400	8
High	250	500	12

- i) Design a proportional allocation sample (6 marks)  
 ii) Design an optimal allocation sample (7 marks)

- iii) For the two designs in (i) and (ii) determine the estimated variances of the average amount spent hence or otherwise state the more efficient design and explain why (7 marks)

### QUESTION FIVE

- (a) Let a population consist of  $N$  units. Suppose the population is divided into  $K$  strata, and the  $i^{\text{th}}$  stratum consisting of  $N_i$  units
- i) Show that  $\bar{y}_w$  is unbiased of  $\bar{Y}$  (5 marks)
- ii) Show that in proportional allocation  $Var(\bar{y}_w)_{\text{prop}} = \frac{1-f}{n} \sum_{i=1}^k W_i S_i^2$  (5 marks)
- (b) A daily newspaper conducts a survey of food costs by taking a simple random sample of 48 basic food stuffs purchased in a large supermarket. Prices (in Kenya shillings) for these items are recorded in two separate occasions, three months apart, the earlier ones being denoted  $x_i$  and the latter  $y_i$ . The sample ratio  $r = \frac{\bar{y}}{\bar{x}}$  gives an indication of change of these basic food prices over three months period in the form of an estimate of the population ratio  $R$  of the mean prices of food. The following results were obtained:
- $\bar{x} = 11.41, \bar{y} = 12.07, \sum x_i^2 = 8431.7, \sum x_i y_i = 8564.1, \sum y_i^2 = 9270.6 \quad n = 48$
- i) Obtain the value of  $r$  (3 marks)
- ii) Estimate variance of  $r$  (4 marks)
- iii) Obtain the 95% confidence interval for the population ratio  $R$  (3 marks)