MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS, STATISTICS AND ACTUARIAL SCIENCE

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE
BACHELOR OF SCIENCE IN STATISTICS AND PROGRAMMING
BACHELOR OF SCIENCE IN MATHEMATICS
BACHELOR OF EDUCATION
BACHELOR OF ARTS

SMA 365 : DESIGN AND ANALYSIS OF SAMPLE SURVEYS

DATE: 27/9/2019 **TIME: 11:00 – 1:00 PM**

Instructions to the Candidate:

1. *Answer **Question 1** and any other **two** questions.*
2. *Out of the **three** questions answered, each question must start on a new page.*
3. *You need a Scientific Calculator and Statistical Tables for this paper*

1. (a) (i) Explain the importance of a *pre-test* in a survey. (4 *marks*)

(ii) Explain *three* ways in which a questionnaire can be administered during data collection in a survey. (6 *marks*)

(b) Differentiate between the terms *under-coverage* and *over-coverage* as used in a survey, illustrating each with an example from a real life situation. (4 *marks*)

(c) Given an SRS-WOR with a sample mean $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$ and a population mean $\bar{X} = \frac{1}{N}\sum_{i=1}^{N} x_i$.

Show that the sample mean $\bar{x}$ is an unbiased estimator of the population mean $\bar{X}$. (4 *marks*)

(d) Given a stratified random sampling with a stratified mean given by $\bar{X}_{st} = \frac{1}{N}\sum_{i=1}^{m} N_i \bar{x}_i$ and a population mean given by $\bar{X} = \frac{1}{N}\sum_{i=1}^{m} X_i$, show that the stratified mean $\bar{X}_{st}$ is an unbiased estimator of the population mean $\bar{X}$. (4 *marks*)

(e) Using a population of size $N = 5$ comprising the values 12, 24, 18, 15, 21, from which a random sample of size $n = 3$ is to be selected, determine all the possible samples of size 3 which can be drawn from the population.

Hence using the selected samples, prove that the sample mean $\bar{x}$ is an unbiased estimator of the population mean $\bar{X}$. (8 *marks*)

2. (a) Explain each of the following sampling techniques as applied in the collection of statistical data.

(i) Simple random sampling;

(ii) Stratified random sampling. (5 *marks*)

(b) A survey was conducted to determine the number of children of male residents among a pastoralist community in Kenyan. A simple random sample of 20 male residents was drawn without replacement from a community comprising 500 male residents. The number of children for each of the male residents in the sample was as follows:

15, 10, 18, 12, 20, 15, 10, 14, 20, 17, 19, 14, 18, 16, 19, 15, 12, 20, 16, 10.

(i) Estimate the total number of children among the pastoralist community; (3 marks)

(ii) Determine the 95% confidence limits for the population mean of the number of children per mal resident in the pastoralist community; (6 *marks*)

(iii) Determine the 95% confidence limits for the population total of the number of children in the pastoralist community. (6 *marks*)

3. (a) Explain the term *questionnaire* as used in the collection of statistical data. (2 *marks*)

(b) Explain the *three* errors which may occur in a sampling in a sample survey, illustrating each with an example from a real life situation. (9 *marks*)

(c) Given an SRS-WOR with 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. (9 *marks*)

4. (a) Explain the term *sampling frame* as used in a sample survey, giving *two* examples from real life situations. (4 *marks*)

(b) A survey is to be conducted among patients in a county hospital, with the patients categorised as children, teenagers, middle age and old age. A sample of size $n = 25$ is to be selected from a population of size $N = 500$. Select an *actual sample* procedurally stating clearly the range of your sampling frame and the selected sampling units using each of the following sampling techniques:

(i) Simple random sampling; (4 *marks*)

(ii) Systematic random sampling; (4 *marks*)

(iii) Stratified random sampling (assume proportional allocation).

The strata sizes are as follows:
children 200, teenagers 150, middle age 100, old age 50 patients (8 *marks*)

5. (a) (i) Explain the term *multi-stage sampling* as used in the collection of statistical data. (2 *marks*)

(ii) Outline *three* factors which determine the sample size of a stratum in stratified random sampling with optimum allocation. (3 *marks*)

(b) Given a two-stage sample in which the sample mean is given by $\bar{\bar{x}} = \frac{1}{n\,m}\sum_{i=1}^{n}\sum_{j=1}^{m} x_{ij}$ and its corresponding population mean is given by $\bar{\bar{X}} = \frac{1}{N\,M}\sum_{i=1}^{N}\sum_{j=1}^{M} x_{ij}$. Show that the sample mean $\bar{\bar{x}}$ is an unbiased estimator of the population mean $\bar{\bar{X}}$. (6 *marks*)

(c) A random sample of size 140 is to be selected from a target population of size 2800. This target population is divided into four strata as shown below:

Strata	A	B	C	D
Strata size	800	900	600	500
Standard deviation	4	5	8	3

Determine the sample size for each stratum if the sample is to be drawn using stratified random sampling with:

(i) proportional allocation; (3 *marks*)

(ii) optimum allocation with fixed cost. (6 *marks*)