MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

THIRD YEAR FIRST SEMESTER 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

SMA 365: DESIGN AND ANALYSIS OF SAMPLE SURVEYS

DATE: 6/12/2017 **TIME: 8:30 – 10:30 AM**

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 may need a Scientific Calculator and Statistical Tables for this paper.*

1. (a) Justify why most research studies prefer a sample survey to a census. (6 *marks*)

(b) Explain **three** sampling errors which may occur in a sample survey, illustrating each with an example from a real life situation. (6 *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) Most extensive surveys carry out a *pre-test* before the main survey is rolled out. Justify this undertaking giving two reasons. (4 *marks*)

(e) Using a population of size $N = 5$ comprising the units 12, 15, 24, 18, 21, from 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 an unbiased estimator of the population mean $\bar{X}$. (10 *marks*)

2. (a) Explain the circumstance under which each of the following sampling techniques is suitable in the collection of statistical data.

   (i) Simple random sampling;

   (ii) Simple random sampling;

   (iii) Multi-stage sampling. (10 *marks*)

   (b) 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. (10 *marks*)

3. (a) It is generally assumed that multi-stage sampling eliminates bias in a sample. However, there is no guarantee that this will be achieved. Account for this statement, illustrating with a real life example. (4 *marks*)

   (b) By taking the example of a survey to be conducted in your campus, and taking the Bachelor of Science students from the Department of Mathematics as your target population, and assuming a sample of size n = **25** to be selected from a population of size N = **750**, select procedurally an actual sample stating clearly the range of your sampling frame and the selected sampling units using:

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

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

   (iii) Stratified random sampling (assume proportional allocation).
   Hint: use the data below for the various strata. (8 *marks*)
   K63 250 students, S09 300 students, S10 200 students, Total 750 students

4. (a) Illustrating with a real life example in any are of application, show how you would select a sample using multi-stage sampling technique. (8 *marks*)

   (b) A random sample of size 210 is to be selected from a target population of size 3500. This target population is divided into four strata as shown below:

Strata	A	B	C	D	E
Strata size	400	600	800	1000	700
Standard deviation	5	9	6	6	4

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

   (i) proportional allocation; (4 *marks*)

   (ii) optimum allocation with fixed cost. (8 *marks*)

5. (a) 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 $\bar{\bar{X}}$. (10 *marks*)

(b) A simple random sample of 25 households was drawn from an urban centre comprising 12,000 households. The number of persons per household in the sample were as follows:

5, 6, 3, 3, 2, 3, 3, 3, 4, 4, 3, 2, 7, 4, 3, 5, 4, 4, 3, 3, 5, 2, 4, 3, 4.

(i) Estimate the total number of people in the urban centre; (2 marks)

(ii) Determine the 95% confidence limits for the population mean of the number of people in the centre; (4 *marks*)

(iii) Determine the 99% confidence limits for the population total of the number of people in the centre. (4 *marks*)