

 W1-2-60-1-6

**JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY**

**UNIVERSITY EXAMINATIONS 2013/2014**

**YEAR IV EXAMINATION FOR THE DEGREE OF BACHELOR OF SCINECE IN MATHEMATICS AND COMPUTER SCIENCE**

**SMA 2432: DESIGN AND ANALYSIS OF SAMPLE SURVEYS**

**DATE: DECEMBER 2013 TIME: 2 HOURS**

**INSTRUCTIONS: ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS**

**QUESTION ONE**

1. In a simple random sample without replacement show that the sample mean is an unbiased estimate of the population mean [5 marks]
2. Show that S2 = 

Starting from S2 =  [4 marks]

1. If N= 6, n= 3 and the values of the 6 members of the population are 1,2,4,6,7 and 16. Find the standard error of the mean. [5 marks]
2. If a sample of size 4 taken from 16 townships of a country has a standard deviation of 45, find the standard error of the mean. [3 marks]
3. A survey is to be conducted of repair work to farms after cyclone bola. The ministry of Agriculture and Fisheries supplies a sampling frame where farms are categorized as small, medium and large. One of the variables of interest is the amount of money spent on repair work. The sampling frame and a small pilot study give the following information.

|  |  |  |  |
| --- | --- | --- | --- |
| Size of farm | No. of farms | Variance of Money spent | Cost per Interview |
| Small | 269 | 1000 | $16 |
| Medium | 108 | 1960 | $16 |
| Large | 79 | 4000 | $25 |

1. Design a proportionally allocated sample if the total budget is $3000 with overheads costing $1000. [i.e. Determine the sample sizes under proportional allocation]
2. A proportionally allocated sample is conducted and the mean amount spent on repair for small, medium and large farms is respectively, $2100, $6,700 and $10,600. Estimate the total amount spent on repair work and give the standard error of this estimate. [13 marks]

**QUESTION TWO**

1. A population of size N = 5 has the values of a certain characteristic as 3,2,5,1,6. Show that the mean of simple random samples of size 2 drawn from the population is an unbiased estimator of the population mean and the sample variance is an unbiased estimator of the population variance. [12 marks]
2. An economist wants to estimate the average weekly amount spent on food by families with children in a certain country known to be a poverty area. A complete list of all the 25o families in the Country is available, but it is impossible to identify those families with children. The economist selects a simple random sample of n = 50 families and finds that n1 = 42 families have at least one child. The 42 families with children were interviewed and gave the following information.

  

 Where y*i* is the average weekly food expenditure for the *i*th family.

 Estimate the average weekly amount spent on food by all families with children, and

 give a 95% confidence interval for your estimate.

 Confidence probability (%) 5.0 80 90 99 95

 0.67 1.28 1.64 2.58 1.96 [8 marks]

**QUESTION THREE**

1. Show that Vsrs > V prop > Vopt

Where Vsrs is the variance of the estimated mean under s.r.s., Vprop is the variance of the estimated mean under proportional allocation and Vopt is the variance of the estimated mean under optimum allocation. [9 marks]

1. A stratified population has 3 strata whose sizes and other characteristics are given below:

Stratum *Ni  Si*

1 10,000 90 30

2 500 500 100

3 70 3000 1250

Calculate the overall mean ** and the population variance S2

For a stratified random sample of size 500, determine the appropriate sample sizes under proportional and Neyman allocation. How do the variances under each type of allocation compare with each other and to the variance under simple random sampling? (Ignore sampling fractions) [11 marks]

**QUESTION FOUR**

1. Compare the systematic with simple and stratified random samples for a population with linear trend of the form.

   where N = nk [10 marks]

1. According to the N. ~~Z~~ Herald (30th September 1992) there have been 118 cases of menengitis reported in 1992 in New Zealand. The number of cases in each reporting district is listed below:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| District No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| No. of cases | 9 | 37 | 15 | 3 | 8 | 6 | 4 | 9 | 12 | 9 | 6 | 0 |

Suppose a public health researcher had decided to estimate the total number of Menengitis cases in 1992, not by contacting each of the N=12 reporting districts, but by selecting a one-in-three systematic sample from the 12 districts.

 Selecting a starting district number on the list at random from the 1,2,3 the sample includes that district and every third district thereafter on the list.

1. List every possible systematic sample that could be obtained with the design.
2. To estimate the total number of cases T (the true value is 118), the researcher multiplied the total number of cases in the sample by 3. Is this estimate unbiased for the true population total T? Justify your answer.

(ii) What is the true variance of the researcher’s estimate?

(iii) For an estimate of the variance in part (iii), the researcher used 12(12-4), where

 S2 is the sample variance of the values in the sample. Is this estimate unbiased for

 the variance in part (iii)? Justify your answer. [10 marks]