

STA 3227-1



MAASAI MARA UNIVERSITY

**REGULAR UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR
THIRD YEAR SECOND SEMESTER**

**SCHOOL OF PURE, APPLIED AND HEALTH
SCIENCES
BACHELOR OF SCIENCE APPLIED STATISTICS
WITH COMPUTING**

**COURSE CODE: STA 3227-1
COURSE TITLE: SAMPLING THEORY & METHODS I**

DATE: 21/4/2023

TIME: 0830-1030 HRS

INSTRUCTIONS TO CANDIDATES

1. Answer **Question ONE** and any other **Two** questions.
 2. Show all the workings clearly
 3. Do not write on the question paper
 4. All Examination Rules Apply.
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Question One (20 Marks)

a) Briefly discuss how to draw a simple random sample from a population.

(3 Marks)

b) Describe how lottery method is used to select a simple random sampling.

(4 Marks)

c) A corporation desires to estimate the total number of man-hours lost, for a given month, because of accidents among all employees. Since laborers, technicians, and administrators have different accident rates, the researcher decides to use stratified random sampling, with each group forming a separate stratum. Data from previous years suggest the variances shown in the accompanying table for the number of man-hours lost per employee in the three groups, and current data give the stratum sizes. Determine the Neyman allocation for a sample of $n = 30$ employees.

(5 Marks)

I (Laborers)	II (Technicians)	III (Administrator)
$\sigma_1^2 = 36$	$\sigma_1^2 = 36$	$\sigma_1^2 = 36$
$N_1 = 132$	$N_1 = 132$	$N_1 = 132$

d) A large construction firm has 120 houses in various stages of completion. For estimation of the total amount of construction in the process, a simple random sample of 12 houses is selected and the accumulated costs determined on each. The following costs were obtained.

35.5	30.2	28.9	36.4	29.8	34.1
32.6	26.4	38.0	38.2	32.2	27.5

i) Calculate the sample mean and variance

(5 Marks)

- ii) Estimate the total number of houses in the area and its approximate 99% Confidence Interval **(3 Marks)**

Question Two (15 Marks)

- a) A standard quality control check on automobile batteries involves simply measuring their weight. One particular shipment from the manufacturer consisted of batteries produced in two different months, with the same number of batteries from each month. The investigator decides to stratify on months in the sampling inspection in order to observe month-to-month variation. Simple random samples of battery weights for the two months yielded the following measurements (in pounds):

Month A	Month B
61.5	64.5
63.5	63.8
63.5	63.5
64.0	66.5
63.8	63.5
64.5	64.0

Estimate the average weight of the batteries in the population (shipment), and place a bound on the error of estimation. Ignore the fpc. The manufacturing standard for this type of battery is 69 pounds. Do you think this shipment meets the standard on the average? **(8 Marks)**

- b) In the use of \bar{y}_{st} as an estimator of μ , finding an allocation and a sample size that minimizes the $V(\bar{y}_{st})$ for fixed cost c is sometimes advantageous. That is, the cost c allowed for the survey is fixed, and we want to find the best the best allocation of resources in terms of maximizing the information on μ . Show that the appropriate choice for n is

$$n = \frac{(c - c_0) \sum_{i=1}^k N_i \sigma_i \sqrt{c_i}}{\sum_{i=1}^k N_i \sigma_i \sqrt{c_i}} \text{ where } c_0 \text{ is fixed overhead cost for the survey.}$$

(7 Marks)

Question Three (15 Marks)

(a) The quality control section of an industrial firm uses systematic sampling to estimate the average amount of fill in 12-ounce cans coming off an assembly line. The data in the accompanying table represent a 1-in-50 systematic sample of the production in one day.

Amount of Fill (ounces)					
12.00	11.97	12.01	12.03	12.01	11.80
11.91	11.98	12.03	11.98	12.00	11.83
11.87	12.01	11.98	11.87	11.90	11.88
12.05	11.87	11.91	11.93	11.94	11.89
11.72	11.93	11.95	11.97	11.93	12.05
11.85	11.98	11.87	12.05	12.02	12.04

i) Estimate μ and place a bound on the error of estimation. Assume $N = 1800$. **(6 Marks)**

ii) Find the 95% confidence interval for the total number of a day's production. **(4 Marks)**

a) A dentist is interested in the effectiveness of a new toothpaste. A group of 1000 school children participated in the study. The pre-study records showed that there was an average of 2.2 cavities every six months. After three months of the study, the dentist sampled 10 children to determine how they were progressing on the new toothpaste. The following results were obtained.

Child	1	2	3	4	5	6	7	8	9	10
No. of cavities	0	4	2	3	2	0	3	4	1	1

Calculate \bar{y} and $V(\bar{y})$

(5 Marks)

Question Four (15 Marks)

a) Using the Neyman allocation, show that the sample size is given by

$$n = \frac{\left(\sum_{i=1}^k W_i s_i \right)^2}{V(\bar{y}_{st}) + \frac{\sum_{i=1}^k W_i s_i^2}{N}} \quad \text{(6 Marks)}$$

b) A market research firm conducted a survey in a city for the purpose of estimating the total monthly household expenditure on Compact Discs (CDs) and the total number of households owning a Compact Disc Player (CDP). The city was divided into four areas and a random sample of households was selected from each area. The results of the survey are shown below.

Area	N_i	n_i	Sample Average Monthly expenditure	Sample proportion owning CDP
1	20,000	100	10.40	0.150
2	10,000	100	6.10	0.083
3	35,000	100	4.05	0.042
4	15,000	100	8.24	0.075

- i) Estimate the average monthly household expenditure on CDs in the city and the proportion of households in the city that owns CDP. **(5 Marks)**
- ii) Calculate the total monthly expenditure on CDs and the total number of households owning a CDP in the city. **(4 Marks)**

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