

JOOUST UNIVERSITY

UNIVERSITY EXAMINATIONS 2013/2014

SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF SCIENCE IN ACTUARIAL SCIENCES WITH IT/ APPLIED STATISTICS WITH IT

(MAIN-CAMPUS)

SAS 201: SAMPLE SURVEYS

DATE: April, 2014

TIME: 2 Hours

Instructions:

1. Answer Question **ONE** and **ANY** other **TWO** questions.
2. Show all your working.

QUESTION ONE

- (a) Define the following terms as used in sample surveys;
- Sampling error.
 - Stratified random sampling.
 - Multi-stage sampling.
 - Purposive sampling. [4 marks]
- (b) Explain briefly the difference between a census and a sample survey and give two reasons why sample survey is preferred to a census. [3 marks]
- (c) In a population of six households, a household size, Y'_i s, values are given by 8, 6, 3, 5, 4, 4. Show that
- $E(\bar{y}) = \bar{Y}$
 - $var(\bar{y}) = \frac{N-n}{N} \frac{S^2}{n}$
 - $E(s^2) = S$ [10 marks]
- (d) In sampling from a population with some attributes, show that the sample variance can be computed by

$$s^2 = \frac{np(1-p)}{n-1}$$

[4 marks]

- (e) A sample of thirty students is to be drawn from a population of 300 students belonging to two colleges, A and B. The means and standard deviations of their marks are given below:

	No. of students	Y_h	S_h
College A	200	30	10
College B	100	60	40

How would you determine the sample size using;

- Proportional allocation technique.
- Neyman's allocation technique. [4 marks]
- Verify that Neyman's allocation technique is more efficient than Proportional allocation technique. [5 marks]

QUESTION TWO

- (a) Explain the meaning and purpose of sampling frame. [2 marks]
- (b) You are required to obtain the views of pupils in a school about the school's magazine. It is decided to be done by means of a small panel of pupils. Describe briefly how you would select such a panel using:
- Simple random sampling.
 - Stratified random sampling. [4 marks]
 - State with reasons which of the two sampling methods in part (c) above is considered to be more appropriate. [4 marks]
- (c) State specific advantages that cluster sampling has over other sampling procedures. [3 marks]

- (d) Show that in ratio estimation, the variance of the ratio estimator, \bar{r} is given by

$$var(\bar{r}) = \frac{1}{\bar{x}^2} \frac{N-n}{Nn} \frac{\sum_{i=1}^N (Y_i - Rx_i)^2}{N-1}$$

[7 marks]

QUESTION THREE

An advertising firm, interested in determining how much to emphasize television in a certain county, decides to conduct a sample survey to estimate the average number of hours per week that households within the county watch TV. The county contains two towns, town A and town B, and a rural area. Town A is built around a factory, and most households contain factory workers with school children. Town B is an exclusive suburb of a city in a neighboring county and contains older residents with few children at home. There are 155 households in town A, 62 in town B, and 93 in the rural area.

- (a) Discuss the merits of stratified random sampling in this situation. [3 marks]
- (b) Suppose a survey is carried out. The advertising firm has enough money to interview 40 households and decides to select 20 from town A, 8 from town B and 12 from the rural area. (This is in fact proportional allocation.) The results are shown below.

Television viewing time, in hours per week											
Stratum 1				Stratum 2				Stratum 3			
Town A				Rural Area				Town B			
35	28	26	41	27	4	49	10	8	15	21	7
43	29	32	37	15	41	25	30	14	30	20	11
36	25	29	31	12	32	34	24				
39	38	40	45								
28	27	35	34								

- (c) Estimate the average television viewing time and give a 95% confidence interval, in hours per week, for
- All households in the county,
 - All households in town B.
- [17 marks]

QUESTION FOUR

- (a) Give an estimator for the population total in stratified random sampling without replacement. [3 marks]
- (b) Define proportional allocation and optimum allocation and write expressions for the variance of the sample mean, $var(\bar{y}_{str})$, under these allocations as $V_{prop}(\bar{y}_{str})$ and $V_{opt}(\bar{y}_{str})$ and hence compare these variances with that of simple random sampling mean, $V_{SRS}(\bar{y})$. Show that

$$V_{opt}(\bar{y}_{str}) \leq V_{prop}(\bar{y}_{str}) \leq V_{SRS}(\bar{y})$$

[14 marks]

- (c) A population consists of $N = nk$ units. Explain how you would obtain a systematic sample of size n from this population. [3 marks]

QUESTION FIVE

- (a) Discuss with examples, sampling errors and non-random sampling errors. [6 marks]
- (b) Show that sample variance s^2 , is an unbiased estimate of the population variance, S^2 . [3 marks]
- (c) Using Lagrange's multipliers, show that for optimum allocation, the stratum sample size is given by

$$n_h = \frac{N_h S_h}{\frac{1}{n} \sum N_h S_h}$$

[5 marks]

- (d) Consider the following data obtained by cluster sampling method based on $n = 5$ clusters out of 80 clusters in the population. Use the data below to estimate population mean and its standard error.

Cluster	y_{ij}
1	23, 11, 12, 18, 22, 16
2	10, 22, 34, 32, 18, 20
3	44, 24, 33, 13, 16, 21
4	19, 29, 11, 19, 20, 31
5	34, 45, 28, 19, 11, 14

[6 marks]