



B. Sc. Examination 2008 By Course Unit

MAS 234 Sampling, Surveys and Simulation

Duration: 1.5 hours

Date and time: Nov 5th 2007, 1310–1440

You should attempt all questions. Marks awarded are shown next to the questions.

Statistical functions provided by the calculator may be used provided that you state clearly where you have used them.

Question 1 Define the *sampling distribution* of an estimator. [5]

Question 2 State Theorem 2.1 and the key step in its proof. [10]

Question 3 Use Waterman's algorithm to draw a SRS of size $n = 6$ from a population size $N = 9$ using the random string 48332507912... as economically as possible. [10]

Question 4 A simple random sample of students is poststratified into those who live at home and those who live on campus, and the data recorded are the weekly expenditures on travel:

	Number	Mean	S.D.
Home	10	15.67	3.65
Campus	12	8.89	2.08

Estimate the population mean given the extra information that there are 325 at home and 400 on campus, and give a 95% C.I. [13]

Question 5 A further sample of $n = 50$ students is to be drawn from the remaining population using stratified random sampling with optimal (Neyman) allocation based on the above S.D.s and stratum sizes. How many home-based students would you sample? What is the (estimate of the) achieved variance of your unbiased estimator \bar{y}_{st} based on this sample? [13]

Question 6 Give formulae with the usual notation for

- (a) the ratio estimator of the population mean \bar{Y} . Is it unbiased under SRS? [4]
- (b) the variance of this estimator under SRS. Is this formula exact? [4]
- (c) an approximately unbiased estimator of this variance [4]

Question 7 A simple random sample of 4 households gave the following data:

Number of voters (X)	2	1	3	4
No. supporting Tories (Y)	1	1	3	0

Given that there are 10000 households with 22000 voters in the constituency, and the sample moments are $s_X^2 = 1.6$, $s_Y^2 = 1.583$, $s_{XY} = -0.16$, find an estimate for the proportion of voters R supporting the Tories, giving the corresponding variance estimate in each case,

- (a) based on the ratio estimator [11]
- (b) based on the unbiased estimator \bar{y}/\bar{X} [7]
- (c) based on an unbiased estimator if the sample had been selected by PPS (with replacement) rather than by SRS [11]
- (d) based on the proportion if the 10 voters in the sample had been selected at random, rather than by households [7]