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MST–013

M. SC. (APPLIED STATISTICS)

(MSCAST)

Term-End Examination

June, 2025

MST-013 : SURVEY SAMPLING AND DESIGN OF EXPERIMENTS—I

Time : 3 Hours *Maximum Marks : 50*

Note : *Question No.* ***1*** *is compulsory. Attempt any* ***four*** *questions from the remaining Question Nos.* ***2*** *to* ***6****. Use of scientific calculator (non-programmable) is allowed. Symbols have their usual meanings.*

1. State whether the following statements are True *or* False. Give reasons in support of your answer : 5×2=10

   (a) Population of the number of heads or tails based on the tossings of a coin is an example of real population.

(b) Suppose the null hypothesis $H_0 : \mu_1 = \mu_2 = \mu_3$ is rejected. It only means that $\mu_1 \neq \mu_2, \mu_2 \neq \mu_3, \mu_1 = \mu_3$.

(c) Precision of an experiment is directly proportional to the variance of mean.

(d) If the elements within strata are heterogeneous, then stratified sampling scheme provides estimates with greater precision.

(e) One-way analysis of variance is a generalisation of the two-sample *t*-test.

2. Consider a population of 6 units with values 1, 2, 3, 4, 5 and 6. Write down all possible samples of size 2 (without replacement) which can be drawn from the given population and verify that sample mean is an unbiased estimate of the population mean. Also calculate the sampling variance and prove that : 10

$$\text{Var}_{(\text{SRSWOR})}^{(\bar{y})} < \text{Var}_{(\text{SRSWR})}^{(\bar{y})}$$

3. The following table presents the summary of data of complete census of all 450 farms of wheat in a region. The farms were stratified according to farm size (in acres) into two strata. The population values of strata means ($\bar{X}_i$) and standard deviation (σ_i) for the area under wheat are given as :

Stratum No.	Farm Size (in acres)	No. of Farms	Strata Mean	Standard Deviation
1	0—100	300	45	15
2	100—200	150	90	60

How would you draw the sample of size 45 using (i) Proportional allocation; (ii) Neyman allocation ?

Also obtain the variance of the sample mean for the proportional allocation and compare its efficiency with simple random sampling without replacement. 10

4. In an experiment to study the performance of 4 different detergents for cleaning fuel injectors of 3 different models of engines, the

effecting working hours after cleaning are obtained as follows : 10

Detergent	Engine		
	1	2	3
A	45	43	51
B	47	46	52
C	48	50	55
D	42	37	49

Construct the ANOVA table and test whether there are differences :

(i) between the detergents

(ii) between the engines, at 5% level of significance.

[You may use $F_{(2,\ 6)} = 7.26$ and $F_{(3,\ 6)} = 6.60$.]

5. In the following 3×3 design, the letters A, B and C represent the three methods for soldering copper electrical leads. The rows represent 3 different operators doing the soldering and the columns represent the 3 different solder fluxes used. The data are the number of pounds of tensile force

required to separate the solder leads. Assuming that the various sources of variation do not interact, test at 5% level of significance whether there are differences in (i) the methods, (ii) the operators, and (iii) the fluxes :

Flux / Operator	Flux 1	Flux 2	Flux 3
Operator 1	A (14.0)	B (16.5)	C (11.0)
Operator 2	C (9.5)	A (17.0)	B (15.0)
Operator 3	B (11.0)	C (12.0)	A (13.5)

[You may use $F_{(2,2)}^{(0.025)} = 39$ at 5% level of significance]. 10

6. (a) Define allocation of sample size in stratified random sampling. Describe various types of allocations with examples. 5

   (b) Explain design of experiments. Describe the basic principles of design of experiments. 5

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