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MST-005

POST GRADUATE DIPLOMA IN APPLIED STATISTICS (PGDAST)/CERTIFICATE IN CONDITION MONITORING (CCOMO)

Term-End Examination

June, 2023

MST-005 : STATISTICAL TECHNIQUES

Time : 3 Hours *Maximum Marks : 50*

Note : (*i*) *Question No.* ***1*** *is compulsory.*

(*ii*) *Attempt any* ***four*** *questions from the remaining (Question Nos.* ***2*** *to* ***7****).*

(*iii*) *Use of scientific (non-programmable) calculator is allowed.*

(*iv*) *Use of Formulae and Statistical Tables Booklet for PGDAST is allowed.*

(*v*) *Symbols have their usual meanings.*

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

   (a) The probability of selection of any one sample out of ${}^{7}C_{2}$ samples is 1/21.

(b) When population size is 25 and sample size is 7, then linear systematic random sampling is appropriate.

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

(d) If a random number 15 is generated using middle square method, then the next random number will be 25.

(e) If there is one missing value in Randomized Block Design with 3 blocks and 4 treatments, the total degrees of freedom will be 10.

2. A sample of 30 students is to be drawn from a population consisting of 300 students belonging to two colleges A and B. The means and standard deviations of their marks are given as follows : 10

	Number of Students	Means $(\bar{y}_i)$	Standard Deviation (σ_i)
College A	200	30	10
College B	100	60	40

Using this information, answer the following questions :

(i) What would be the sample size if you draw the samples using proportional and Neyman allocation techniques ?

(ii) Obtain the variance of estimate of population mean for proportional allocation and compare its efficiency with simple random sampling without replacement.

3. In an experiment to study the performance of 4 different detergents for cleaning fuel injectors of 3 different models of engines, the following data were obtained : 10

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

Test whether there are differences :

(i) in the detergents

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

4. Consider the following data with some missing values : 10

Treatment	Block		
	I	II	III
A	12	14	12
B	10	y	8
C	x	15	10

Obtain the estimates of the missing values using Yates method. Also analyse the given data using suitable technique.

5. (a) Explain lottery method of generation of random numbers with an example. 3

(b) The following U (0, 1) data were generated by a generator. Use Chi-square test to test the fitting of the uniform distribution to the following data : 7

Class Interval	Frequency
0.0—0.2	5
0.2—0.4	14
0.4—0.6	7
0.6—0.8	4
0.8—1.0	10

6. (a) 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 sample variance and verify that : 5

$$\text{Var}_{\text{SRSWR}}(\bar{x}) > \text{Var}_{\text{SRSWOR}}(\bar{x})$$

(b) Three drying formulas for a glue were studied and the following drying times (in minutes) were observed : 5

Formula A	Formula B	Formula C
13	13	4
10	10	1
8	14	3
11	14	4
8		2
		4

At $\alpha = 0.1$, test the hypothesis that the average drying times for the three formulas are the same.

7. (a) 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 is the number of pounds of tensile force required to separate the solder leads. Assuming that 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. 7

	Flux		
Operators	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)

(b) Give an algorithm using IPT method to generate variate from the following Beta probability density function : 3

$$f(x) = 6x(1-x), \ 0 \leq x \leq 1$$

Also, find x when $u = 0.5$.