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MST–005

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

Term-End Examination

December, 2025

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 of PGDAST is allowed.

(v) 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) If there are 100 sampling units, then $^{100}C_5$ samples of size 5 are possible under linear systematic sampling.

   (b) If there are cows of 4 breeds and each breed has 10 cows, then to compare the 4 different cows' breeds we will use CRD.

   (c) Simulation is the technique in which the experiments are conducted on the actual units.

   (d) If there are 100 colleges/universities in a country, which have Master programme in Statistics and we choose 4 colleges/universities randomly to test whether Statistics knowledge in 4 selected colleges/universities is same or not, then we will use the fixed effect model.

(e) If there are 21 players and we want to select 11 players in such a way that one particular player should be selected, then the probability of his/her selection is $\frac{11}{21}$.

2. (a) A company has five data analysts whose monthly salary is given as follows : 7

Data Analyst	**Monthly Salary (in ₹ '000)**
Lavnik	75
Aman	72
Shalu	65
Rajni	70
Rani	60

If we select two data analysts with SRSWOR, then :

(i) How many samples are possible ?

(ii) Write all possible samples.

(iii) Calculate mean of salaries of the data analyst selected in each sample.

(iv) Show that sample mean is an unbiased estimate of the population mean.

(v) Compare the variances of sample mean under SRSWR and SRSWOR.

(b) What is systematic sampling ? Describe its types. 3

3. Suppose an investigator wants to estimate the average income (in ₹) of a family in a city. For that, he divides the city into four groups which are homogeneous within and heterogeneous between with respect to income and observes the following information : 10

Group	I	II	III	IV
Group size	2000	3000	8000	7000
Group mean (in ₹ '000)	10	12	12	15
Group mean square	4	16	9	4

(i) If he selects 160 families from the city, then how many families he has to select from each group under proportional and optimum allocation, where cost of survey of each family is same ?

(ii) Obtain variances of sample mean under proportional and optimum allocations.

4. A chemist wishes to test the effect of four chemicals (A, B, C and D) on the strength of a particular type of cloth. She selects five bolts of clothes (1, 2, 3, 4 and 5) and applies all four chemicals in random order to each bolt. Due to some reason, she does not obtain the observation for chemical type B and bolt 3, the rest observations are as follows :

Chemical	Bolt				
	1	2	3	4	5
A	73	68	74	71	67
B	73	67	–	72	70
C	75	68	78	73	68
D	73	71	75	75	69

(i) Estimate the missing observation.

(ii) Test whether the effect of chemical and bolt is significant at 5% level of significance. 10

5. An engineer is interested in the effects cutting speed (A), tool geometry (B) and cutting angle (C) on the life (in hours) of a machine tool. Two levels of each factor are chosen and three replicates of a 2^3-factorial design are run. The obtained results are as follows : 10

Replication I

(1)	ab	c	abc	bc	ac	a	b
22	55	44	39	60	40	32	35

Replication II

abc	(1)	b	bc	ac	a	c	ab
41	31	34	50	37	43	45	50

Replication III

bc	ab	ac	abc	a	c	b	(1)
54	46	36	47	29	38	50	25

(a) Estimate the factor effects. Which effects appear to be large ?

(b) Conduct the analysis of the design at 5% level of significance.

6. (a) In a warehouse three trucks arrive per hour to be unloaded. The interarrival time of trucks follows exponential distribution with $\alpha = 3$. The management team of the warehouse wants to estimate the interarrival times of ten trucks. For that : 8

(i) Generate 10 $U(0,1)$ random numbers using the following LCG :

$$x_i = (1573\, x_{i-1} + 19) \bmod 1000$$

taking x_0 as 159.

(ii) Generate interarrival times for 10 trucks using random numbers generated in part (i).

(b) What is pseudo random numbers ? 2

7. (a) A research scholar generates 40 random numbers from $U(0,1)$ distribution, which are classified as follows : 6

Class	Frequency
0—0.2	5

0.2—0.4	14
0.4—0.6	7
0.6—0.8	6
0.8—1.0	8

Test whether these random numbers follow $U(0,1)$ distribution or not using Chi-square test. (Given $\alpha = 0.05$).

(b) Describe the principles of design of experiment. 4

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