# POST GRADUATE DIPLOMA IN
# APPLIED STATISTICS (PGDAST)

## Term-End Examination

## December, 2018

00542

## MST-005 : STATISTICAL TECHNIQUES

*Time : 3 hours*        *Maximum Marks : 50*

**Note :**

(i)    Attempt **all** questions. Questions no. 2 to 5 have internal choices.

(ii)    Use of scientific calculator is allowed.

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

(iv)   Symbols have their usual meanings.

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

(a)   If an investigator interested in drawing a random sample from sequentially numbered invoices uses a random starting point, then draws every $50^{th}$ invoice, a sequential sampling is to be applied.

(b) In a stratified random sampling, the elements within a stratum should be as heterogeneous as possible.

(c) Equality of means of k(>2) independent normal populations is tested by $\chi^2$-test.

(d) A two-factor study with two levels of factor A and three levels of factor B uses separate random samples of 4 participants in each treatment combination. Then the number of participants needed for the entire study will be 24.

(e) If a random number 23 is generated by middle square method, then the next random number generated is 52.

2. (a) The average yield of wheat crop (in quintals/ha) pertaining to fields of 40 villages in a district is given below :

20, 21, 32, 41, 55, 22, 64, 42, 28, 35, 25, 25, 24, 32, 75, 28, 29, 38, 19, 19, 16, 28, 30, 29, 29, 19, 37, 34, 31, 35, 29, 19, 27, 42, 39, 11, 26, 21, 45, 61

Select a random sample of size 10 by simple random sampling without replacement and estimate the average yield along with its standard error on the basis of selected units. 7

(b) Show that the sample mean is an unbiased estimator of the population mean. *3*

## OR

A stratified random sample of size 60 is to be drawn from 300 fields in a region growing rice crop. These fields were stratified according to field size (in hectares) into 3 Strata (A, B and C). The mean yield in quintals/ha $(\overline{X}_i)$, size $(N_i)$ and standard deviation $(S_i)$ of each stratum are given as follows :

| Stratum No. | A | B | C |
|---|---|---|---|
| $N_i$ | 150 | 100 | 50 |
| $\overline{X}_i$ | 55 | 80 | 95 |
| $S_i$ | 8 | 10 | 4 |

Determine the sample sizes from these strata by (i) Proportional Allocation, and (ii) Neyman Allocation. Also obtain variance of the estimate of population mean for proportional allocation and compare its efficiency with that of simple random sampling without replacement. *10*

**3.** Twenty individuals were randomly assigned to four different production processes. Production of units per hour for the four processes are given below :

| Process I : | 33 | 30 | 28 | 29 | 30 |
|---|---|---|---|---|---|
| Process II : | 33 | 35 | 30 | 38 | 34 |
| Process III : | 28 | 38 | 30 | 34 | 30 |
| Process IV : | 34 | 28 | 29 | 26 | 28 |

Use Analysis of variance procedure with $\alpha = 0.05$ to determine if there is significant difference in the mean production of units per hour for the four types of production processes. *10*

## OR

The marketing department of a company has designed three different types of boxes for its products. The boxes were sold in five stores for a period of one month. The information on sales (in '000) are given below :

| Types of Boxes | Store 1 | Store 2 | Store 3 | Store 4 | Store 5 |
|---|---|---|---|---|---|
| I | 21 | 24 | 23 | 19 | 18 |
| II | 19 | 18 | 19 | 20 | 19 |
| III | 20 | 18 | 21 | 21 | 20 |

Test whether there are significant differences at 5% level of significance

(i)  in the three types of boxes.

(ii)  in the five stores.                                                                              *10*

4.  A plant researcher conducted an experiment to compare the yields (in quintals/ha) of 4 varieties of peanuts (A, B, C and D). A plot of land was divided into 16 subplots (4 rows and 4 columns) to obtain the Latin square design. The responses are given in the following table :

Yields of Peanuts

| | | Columns | | | |
|---|---|---|---|---|---|
| | | E | EC | WC | W |
| Rows | N | 26 (C) | 19 (A) | 29 (B) | 17 (D) |
| | NC | 23 (A) | 21 (B) | 24 (D) | 29 (C) |
| | SC | 29 (B) | 24 (D) | 29 (C) | 19 (A) |
| | S | 25 (D) | 17 (C) | 28 (A) | 29 (B) |

Under the assumption that various sources of variation do not interact, test at 1% level that there is no significant difference between (i) average yields of the 4 varieties of peanuts, (ii) rows, and (iii) columns.                                                                              *10*

**OR**

A $2^2$ experiment was conducted to study the effect of two factors of temperature ($t_0$ and $t_1$) and two factors of pressures ($p_0$ and $p_1$) on a chemical product. The data are as follows :

| Block 1 | (1) | (t) | (p) | (tp) |
|---------|-----|-----|-----|------|
|         | 59  | 68  | 60  | 67   |
| Block 2 | (p) | (1) | (t) | (tp) |
|         | 69  | 64  | 60  | 69   |
| Block 3 | (1) | (t) | (tp)| (p)  |
|         | 57  | 59  | 68  | 62   |
| Block 4 | (tp)| (t) | (p) | (1)  |
|         | 72  | 45  | 69  | 60   |

Analyse the data at 1% level of significance and draw the conclusion.                                    10

5.  Obtain two random numbers from Poisson distribution with $\lambda = 4$ using first fourteen uniform random numbers U(0, 1) generated from linear congruential generator $x_i = (17\ x_{i-1} + 3)$ mod 16 with $x_0 = 3$.                          10

**OR**

(a) A production unit has been set up with an initial capital of ₹ 10 lakhs. Suppose $(YCF)_j$ is distributed normally with mean ₹ 5 lakhs and standard deviation of ₹ 1 lakh. For one simulation (N = 1), obtain the present worth of the entire proposed investment for n = 10 by considering the annual interest of 10 percent (i = 0·10) using the following random numbers from standard normal distribution : 7

−0·2, 0·4, 0·2, −1·6, 1·7, 0·3, −0·4, −0·8, 0·6, −0·3

(b) What are the advantages and disadvantages of simulation ? 3

———