No. of Printed Pages : 7 **MST–003**

POST GRADUATE DIPLOMA IN APPLIED STATISTICS (PGDAST)

Term-End Examination

June, 2025

MST-003 : PROBABILITY THEORY

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) If Ω is the sample space of a random experiment, then there exists an event E such that P(E) > P(Ω).

(b) Classical approach to probability theory works well even in the case when the outcomes of the experiment are not equally likely.

(c) Let Ω be the sample space of a random experiment, then random variable is a function from N to Ω, where N denotes the set of all natural numbers.

(d) If an experiment is conducted on 20 subjects whose outcomes are either success or failure only. Suppose probability of success is not constant, then it is a perfect situation for applying binomial probability distribution to obtain probability of 5 success.

(e) If X is a continuous random variable and b is a real number, then $P(X \leq b) > P(X < b)$.

2. (a) The menstrual cycle in woman following normal distribution has a mean of 28 days and S.D. of 2 days. How frequently would you expect a menstrual cycle of (i) more than 30 days and (ii) less than 22 days ? 4

(b) The pulse rate of healthy males follows a normal distribution with a mean of 72 per minute and S.D. of 3.5 per minute. 6

(i) In what percentage of individuals pulse rate will differ by 2 beats from the mean ?

(ii) Mark out symmetrical region around the mean the range in which 50% of the individuals will lie.

3. (a) Metro trains are scheduled every 5 minutes at a certain station. A person

comes to the station at a random time. Let the random variable X represents the waiting time for the next train and follows U (0, 5). Find the probability that he has to wait at least 3 minutes for the train. 4

(b) State and prove memoryless property of exponential distribution. 4

(c) Write any *two* properties of Gamma distribution. 2

4. (a) In a study of drug-induced anaphylaxis among patients taking rocuronium bromide as part of their anesthesia, a doctor found that the occurrence of anaphylaxis followed a Poisson model with $\lambda = 12$ incidents per year in a certain hospital. 6

(i) Find the probability that in the next year, among patients receiving rocuronium, exactly three will experience anaphylaxis.

(ii) What is the probability that at least three patients in the next year will experience anaphylaxis if rocuronium is administered with anesthesia ?

Take $e^{-12} = 6.144 \times 10^{-6}$.

(b) Suppose a discrete random variable X has the following p.m.f. : 4

$$p_{(X)}(1) = \frac{1}{2}, \quad p_{(X)}(2) = \frac{1}{4}, \quad p_{(X)}(3) = \frac{1}{8},$$

$$p_{(X)}(4) = \frac{1}{8}$$

Find and sketch the c.d.f. $F_X(x)$ of the random variable X. Also find P (X ≤ 1) and P (1 < X ≤ 3).

5. Let Ω be the sample space of the random experiment of throwing one red and one black dice simultaneously. Consider the following three random variables :

X : Sum of the numbers on red and black dice.

Y : Minimum of the numbers on red and black dice.

Z : Maximum of the numbers on red and black dice.

Answer the following questions :

(i) What are domains of X, Y and Z ? 1

(ii) What are ranges of X, Y and Z ? 3

(iii) What are probability distributions of these random variables ? 6

6. (a) If E and F are independent events, then prove that E and F are also independent. 2

(b) Box I contains 6 red and 4 white balls. Box II contains 5 red and 3 white balls. A ball is drawn from Box I and without noticing its colour transferred to Box II. Then a ball is drawn from Box II, what is the probability that it is a red ball ? 4

(c) Probability of solving a randomly selected problem from a book by three students X, Y and Z are 40%, 70% and 80% respectively. If a randomly selected problem is given to these three students, then what is the probability that problem will be solved ? 4

7. (a) If n randomly selected persons are in a room, then what is the probability of sharing a birthday ? Assume that each of them has his/her birthday in non-leap year. 2

(b) Define conditional probability with example. 2

(c) Define random variable, discrete random variable and continuous random variabl, with suitable examples. 6

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