# Statistics Question Bank

Second Paper

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# Contents

# Chapter 1

# Probability

## 1.1 Creative Questions

1. **Events that do not depend on each other are called independent events, and events that cannot occurr simulataneously are called disjoint events.**

   (a) Provide an example of disjoint events, using the set theory. 1

   (b) Prove that $P(A \cap \bar{B}) = P(A) - P(A \cap B)$ 2

   (c) If there are k mutually and exhaustive events, prove $\sum_{i=1}^{k} P(A_i) = 1$ 3

   (d) Prove that two events cannot be simulataneously independent and mutually exclusive. 4

2. **A quality control analyst in an industry tracks the no. of defective items produced per day. He observes 150 successive days and then prepares a table.**

| No. of items | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Frequency | 30 | 32 | 40 | 28 | 20 |

   (a) What is the formula of classical probability? 1

   (b) Explain the difference between Priori Approach and Empirical Approach of probability. 2

   (c) What is the probability that less than 2 defective items would be produced on a particular day? 3

   (d) Explain the relationship between independency and mutual excluvity in the light of the stem. 4

### 1.1.1 Applied Set Theory

3. **The manager of Future Shopping Center analyzed the usage of card-based payment. He observed that most buyers use either Visa cards (25 %) or Master cards (60 %), or both (15 %). On a certain day, 1000 buyers showed up.**

   (a) Are the events of using Visa cards and Master cards independent? 3

   (b) Analyze the statement: **The probability that no buyer used cards on that day is 0.3**. 4

4. **At CityHub High School, each student studies at least one language— Spanish, French, or Latin—and no student studies all three languages. 100 students study Spanish, 80 study French, 40 study Latin, and 22 study exactly two languages.**

   (a) How many students are there at the High School? 3

(b) If a student is selected at random, what is the probability that the student studies only one language? 4

5. **An office supply store carries an inventory of 1,345 different products, all of which it categorizes as "business use," "personal use," or both. There are 740 products categorized as "business use" only and 520 products categorized as both "business use" and "personal use."**

(a) Find the number of products characterized as "personal use" 3

(b) Question 4

6. **Sakib has recently graduated from the University of Dhaka. he applies to two firms - EduCube & Digic- for a Data Analyst job. The probability of hiring by EduCube is 0.8 and by Digic is 0.4. The probability that none hires is 0.5.**

(a) What is a sample space? 1

(b) Explain how to find $P(\bar{A} \cap B)$ using Venn Diagram. 2

(c) Find the probability of hiirng by by Digic but not by EduCube. 3

(d) Find the probability that no firm will reject him. 4

7. **Recently there is an increase in the number of electronic medias in Bangladesh. A professor stated in the class room that very few people now resort to print media for news. A research indicates 70% people collect news from electronic media, 60% from print media, and 50% from both.**

(a) What is an impossible event? 1

(b) Write the event ”None of the two occurs” in two different notations. 2

(c) What is the probability of getting news from at most one type of media? 3

(d) Is the professor correct in his/her statement? Analyze. 4

8. **It is observed that 50% of mails are spam. A software filters spam mail before reaching the inbox. Its accuracy for detecting a spam mail is 99% and chances of tagging a non-spam mail as spam mail is 5%.**

(a) What is a disjoint event? 1

(b) For two independent events, what does the Bayes' theorem reduce to? 2

(c) What is the probability that a mail is tagged as spam? 3

(d) If a certain mail is tagged as spam, find the probability that it is not a spam mail. 4

9. **A company receives 60% of its job applications from applicants with the required qualifications. A hiring software screens applications for minimum qualifications. It correctly identifies qualified applications 97% of the time, but it also incorrectly marks 4% of unqualified applications as qualified.**

(a) What is the probability that an application is marked as qualified? 3

(b) If an application is marked as qualified, find the probability that it actually does not meet the required qualifications. 4

10. **In a survey of a town's population of 500 people, it was found that 150 people read the local newspaper daily, 200 people listen to the radio daily, and 80 people do both.**

(a) What is the probability that a randomly selected person reads the newspaper given that they listen to the radio? 3

(b) Calculate the probability that a randomly selected person neither reads the newspaper nor listens to the radio. 4

11. **In a school with 200 students, 60 students participate in the science club, 80 participate in the math club, and 30 participate in both.**

(a) What is the probability that a randomly selected student participates in both clubs? 3

(b) If a student is chosen at random, what is the probability that they are in exactly one of the clubs? 4

12. **In a community of 300 residents, it was found that 90 people use public transportation regularly, 120 use bicycles, and 40 use both.**

    (a) What is the probability that a randomly selected resident uses either public transportation or bicycles? 3

    (b) What is the conditional probability that a resident uses public transportation given that they use a bicycle? 4

13. **A dope test correctly identifies a drug user as positive 90% of the time, but incorrectly identifes 20% non-users as users. The probability of drug use is 0.05.**

    (a) Write down the formula of conditional probability. 1

    (b) Express $P(A|B)$ in terms of $P(B|A)$. 2

    (c) Find the probability of testing positive in the test. 3

    (d) If the test shows a user positive, what is the probability that the person is actually a user? 4

14. **It is observed that in a college, there are 100 students, of whom 30 play football, 40 play cricket, and 20 play both.**

    (a) What is the range of probability? 1

    (b) What is the relationship between independence and mutual excluvity? 2

    (c) Are the probabilities of playing cricket and that of football independent? Prove. 3

    (d) If a student is selected randomly, and if he does not play cricket, what is the probability that he plays football? 4

15. **In a school, there are 120 students, of whom 50 are in the drama club, 60 are in the music club, and 30 are in both.**

    (a) Are the events of being in the drama club and the music club independent? Prove by calculating the conditional probability. 3

    (b) If a student is selected randomly, and if they do not belong to the music club, what is the probability that they are a member of the drama club? 4

16. **In a survey of 150 people, it is found that 70 own a car, 90 own a house, and 50 own both.**

    (a) Are the events of owning a car and owning a house independent? 3

    (b) If a person is selected randomly, and if they do not own a house, what is the probability that they own a car? 4

17. **In a survey of 150 people, it is found that 60 like basketball, 80 like soccer, and 50 like both.**

    (a) What is the probability that a randomly selected person likes only one sport (either basketball or soccer, but not both)? 3

    (b) If a person is selected randomly, and if they like soccer, what is the probability that they like basketball? 4

### 1.1.2 Selection of Items

18. **An urn contains 4 white, 5 black, and 6 red balls. Three (3) balls are drawn at random from the urn. Adnan anticipated all the balls would be the same color, while Saad thought the balls would be three different colors.**

    (a) What is the probability that at least two balls are black? 3

    (b) Whose expectation is more probable? Analyze. 4

19. **A box contains 5 green, 8 yellow, and 7 orange marbles. A child takes out three balls at random.**

    (a) What is the probability that two marbles are yellow and one green? 3

    (b) Determine the probability that the marbles are the same color. 4

20. **A box contains 7 green, 8 blue, and 7 red marbles. A child takes out three balls at random.**

    (a) What is the probability that the marbles are different colors? 3

    (b) Determine the probability that at least one marbel is red. 4

21. **A magician draws two cards from a pack (i) with replacement and then (ii) without replacement. The cards were well-shuffled before drawing.**

    (a) What is the probability of an impossible event? 1

    (b) How to determine the probability of a joint event? 2

    (c) As per (i), what is the probability that the cards have different color? 3

    (d) As per (ii), what is the probability that the cardsare aces of same color? 4

22. **A box contains four blue and 6 green balls. 3 balls are drawn randomly.**

    (a) What is the value of ${}^{n}C_{r}$? 1

    (b) Illustrate the difference between permutation and combination with an example. 2

    (c) What is the probability that all balls are green? 3

    (d) What is the probabilith that one ball has a different color? 4

23. **A jar contains 5 red marbles and 7 yellow marbles. Three marbles are drawn at random.**

    (a) What is the probability that all marbles are yellow? 3

    (b) What is the probability that a marble has a different color? 4

24. **Sadman has an urn with 5 red and 4 white balls. He has randomly drawn two balls from the urn.**

    (a) What is the probability of an uncertain event? 1

    (b) Write the third axiom of probability. 2

    (c) What is the probability that both the balls drawn by Sadman are white? 3

    (d) Are the probabilities of both balls being same color and different color equal? Analyze. 4

### 1.1.3 Coin - Die

25. **An analyst threw a coin and a die simultaneously and thought the events of getting a head from the coin and an even number from the die are independent.**

    (a) Find the probability [1] that the analyst does not get a head but gets a number less than 4. 3

    (b) Analyze the thought of the analyst [2]. 4

26. **Ratul and Tomal both have an unbiased die. Each has randomly thrown their die once.**

    (a) What are equally likely events? 1

    (b) If a die is thrown once, what is the probability of getting a prime number? 2

    (c) From the stem, what is the probability that the sum of numbers appearing on the dice is greater than 6? 3

    (d) Examine the statement: the probabilities of getting the sum less than 6 and greater than 6 are equal. 4

27. **A red and a blue dice are thrown once. The dice are absolutely neutral and independent.**

    (a) What is a simple event? 1

    (b) Give an example of a certain event using set theory. 2

    (c) Find the probability that the difference of two digits from two dices is less than 3. 3

    (d) Are the probabilities of getting greater digit from the blue die and that from the red die equal? Justify. 4

28. **An unbiased coin is tossed 10 times.**

    (a) If a coin is flung 3 times, how many outcomes are generated? 1

    (b) If a coin is flung n times, show how many outcomes are generated. 2

    (c) What is the probability of getting a) at least 3 heads, b) at most 3 heads? 3

    (d) Are these probabilities equal? a) Getting at least 2 heads & b) Getting at least 2 tails. Also justify logically. 4

29. **Two dice are thrown together. The dice are named A and B.**

    (a) What is the sample space for the sum of the two dice? 2

    (b) What is the probability that the difference between the outcomes of die A and die B is exactly 3? 3

    (c) What is the probability that the sum of the dice is divisible by 3 and greater than 7? 4

30. **Two dice are thrown together. The dice are named A and B.**

    (a) What is the sample space for the possible outcomes of the two dice? 2

    (b) What is the probability that the absolute difference between the two dice is exactly 1? 3

    (c) What is the probability that the sum of the dice is a prime number and the outcome of die A is greater than that of die B? 4

31. **Two dice are thrown together. The dice are named A and B.**

    (a) What is P(A=7)? 1

    (b) Create the sample space. 2

    (c) What is the probability that the outcomes of A & B are different? 3

    (d) Determine the probability that the summation of outcome of two dice is a prime number. 4

[1] $\frac{3}{12} = \frac{1}{4}$

[2] TRUE

### 1.1.4 Set Theory

32. $P(A) = \frac{3}{10}, P(B) = \frac{2}{5}, P(B \cup A) = \frac{1}{2}$
    (a) Find $P(A|B)$ and $P(B|A)$ 3
    (b) Verify the equality mathematically & empirically: $P(B) = P(A) \cdot P(B|A) + P(\bar{A}) \cdot P(B|\bar{A})$ 4

33. $P(A|B) = \frac{1}{8}, P(A) = \frac{1}{2}, P(B) = \frac{1}{5}$
    (a)
    (b) Find $P(A \cap B)$. 2
    (c) Find $P(A|\bar{B})$. 3
    (d) Are the probabilities $P(A|B)$ and $P(B|A)$ equal? Justify 4

34. $P(B|A) = \frac{1}{4}, P(B) = \frac{1}{2}, P(A) = \frac{1}{3}$
    (a) Find $P(B|\bar{A})$. 3
    (b) Find $P(\bar{A} \cap \bar{B})$ 4

35. $P(C|D) = \frac{2}{5}, P(C) = \frac{3}{4}, P(D) = \frac{1}{2}$
    (a) Find $P(C|\bar{D})$. 3
    (b) Examine the following statements:
    i) A and B are independent and
    ii) A and B are mutually exclusive. 4

36. $P(X|Y) = \frac{1}{6}, P(X \cap Y) = \frac{1}{10}, P(Y) = \frac{3}{4}$
    (a) Find $P(X|\bar{Y})$. 3
    (b) Are $P(\bar{X})$ and $P(Y)$ independent? 4

37. $P(M|N) = \frac{2}{9}, P(M \cup N) = \frac{5}{7}, P(N) = \frac{4}{7}$
    (a) Calculate $P(M \cap \bar{N})$. 3
    (b) Examine whether 4
    i. $P(M|N) = P(N|M)$
    ii. $P(M \cap \bar{N}) = P(\bar{M} \cap N)$

38. $P(G|H) = \frac{3}{8}, P(G \cap H) = \frac{1}{6}, P(H) = \frac{2}{5}$
    (a) Find $P(G \cup \bar{H})$. 3
    (b) Verify the equality mathematically & empirically:
    $P(G) = P(H) \cdot P(G|H) + P(\bar{H}) \cdot P(G|\bar{H})$ 4

39. $P(T|U) = \frac{5}{12}, P(T \cup U) = \frac{7}{10}, P(U) = \frac{1}{2}$
    (a) Determine $P(T \cap \bar{U})$. 3
    (b) What conditions must hold for $T$ and $U$ to be mutually exclusive? 4

## 1.2 Short Questions

1. What is a comprhensive event? 1
2. If $A$ and $B$ are independent events, what about $\bar{A}$ and $\bar{B}$? 2
3. What is a disjoint event? 1
4. How are disjoint and independent events related? [3] 2
5. What is a trial in the context of probability? 1
6. What is an experiment in probability. 1
7. What is a sample space? 1
8. What is a sample point in probability? 1
9. Explain what an event is in probability. 1
10. What is a simple event? 1
11. What is a compound event. 1
12. What is an impossible event? 1
13. What is a certain event? 1
14. Describe an uncertain event in probability. 1
15. What does it mean when events are mutually exclusive? 2
16. What is a complementary event? 1
17. What are equally likely events. 1
18. What is the difference between a permutation and a combination? 2
19. In how many different ways can 5 books be arranged on a shelf? 2
20. In how many different ways can 6 people be seated around a circular table? 2
21. In how many ways can 3 books be chosen from a set of 8 books? 2
22. How many different ways can a team of 4 players be selected from a group of 12 players? 2
23. How many different ways can a committee of 5 members be selected from a group of 15 people? 2
24. In how many ways can 3 students be chosen from a class of 20 students to represent the class at a competition? 2
25. How many different ways can 2 representatives be selected from each of 4 departments in a company, given that there are 6 employees in each department? 2
26. In how many different ways can 4 red balls and 3 blue balls be arranged in a row? 2
27. In how many ways can a committee of 3 people be selected from a group of 8 people? 2
28. If there are 4 different letters, how many unique 2-letter permutations can be formed? 1
29. Calculate the number of 3-letter combinations that can be formed from 7 different letters. 2
30. In how many ways can a president and a vice president be chosen from a group of 10 candidates? 2
31. How many different 4-digit passwords can be created using the digits 1 to 9 if repetition is not allowed? 2

[3] Read online: Relationship between Disjoint and Independent Events

32. What is the number of ways to arrange the letters in the word "APPLE"? 1
33. If 10 people are at a meeting, how many ways can 2 people be chosen to speak? 2
34. How many different teams of 4 players can be formed from a group of 12 players? 2
35. How many different teams of 4 players can be formed from a group of 12 players, always including a certain person? 2
36. What is the formula for calculating the number of permutations of n objects taken r at a time? 1
37. How many different 3-digit combinations can be formed using the digits 2, 4, 6, 8, and 9 if repetition is allowed? 2
38. In how many ways can 6 people be seated in a row? 2
39. If a deck of cards is shuffled, in how many ways can 5 cards be selected from the deck? 2
40. What is the value of 5!? 1
41. Expand $^nP_r$
42. Expand $^nC_r$
43. What is the classical definition of probability? 1
44. What is the range of probability? 1
45. Briefly explain empirical probability with an example. 2
46. How does the classical definition of probability differ from the empirical definition? 2
47. Which definition of probability does this formula belong to:
$$P(E) = \lim_{n \to \infty} \frac{\text{n(A)}}{n(S)}$$
48. What are the three axioms of probability in the axiomatic approach? 2
49. In the axiomatic approach, if $P(S) = 1$, where $S$ is the sample space, what does this imply? 1
50. How does the axiomatic approach define the probability of the union of two mutually exclusive events $A$ and $B$? 2
51. What is the third axiom of probability? 1
52. In the third axiom, what is the value of $\sum_{i=1}^{n} P(A_i i)$
53. What does it mean when $P(A) = 0$ in probability theory? 1
54. When $P(A) = 1$, what does this signify about the event $A$? 1

**Set Questions**

55. When is the equation $P(A \cup B = P(A) + P(B)$ true? Explain briefly.
56. What is the formula for conditional probability $P(A|B)$? 1
57. What is the value of $P(A \cap B)$ if two events $A$ and $B$ are independent? 1
58. If events $A$ and $B$ are independent, what is the value of $P(A|B)$? 1
59. What is an independent event? 1
60. How does the additive law of probability apply when events $A$ and $B$ are mutually exclusive? 2

| | | |
|---|---|---|
| 61. | What is the additive law of probability for $n$ events, and how is it expressed mathematically? | 2 |
| 62. | What is the multiplicative law of probability for two events $A$ and $B$? | 1 |
| 63. | How does the multiplicative law of probability apply when events $A$ and $B$ are independent? | 2 |
| 64. | If two events $A$ and $A^c$ are complementary, what is the relationship between them? | 1 |
| 65. | Prove using Venn diagram $P(A \cap \bar{B}) = P(A) - P(A \cap B)$ | 2 |
| 66. | What is the relationship between independency and mutual excluvity? | 2 |
| 67. | What is the range of values that probability can take for any event? | 1 |
| 68. | Why is the probability of any event always between 0 and 1, inclusive? | 2 |
| 69. | Can the value of probability be 1.2? | 1 |
| 70. | Can the value of probability be -0.2? | 1 |
| 71. | How can the expression $P(A \cap B)$ be expanded in terms of conditional probability? | 2 |
| 72. | Expand $P(A' \cap B)$ | 2 |
| 73. | Expand $P(A \cap B')$ | 2 |
| 74. | Can two events be independent and mutually exclusive at once? | 2 |
| 75. | What is the probability of getting a head on a fair coin toss? | 1 |
| 76. | If a fair die is rolled, what is the probability of getting a number greater than 4? | 1 |
| 77. | If a coin is tossed 4 times, how many outcomes are generated? | 1 |
| 78. | If a die is thrown 3 times, how many outcomes are generated? | 1 |
| 79. | If 2 coins and a die are thrown together, how many outcomes are generated? | 1 |
| 80. | Is there any difference between tossin a coin thrice and tossing 3 coins together | 2 |
| 81. | Write down the formula of $P(\bar{A}\|\bar{B})$ | 1 |
| 82. | Write down and expand the formula of $P(\bar{A}\|B)$ | 2 |

# Chapter 2

# Random Variable and Probability Function

## 2.1 Creative Questions

1. **A deck of 52 card is well-shuffled and three cards are drawn from them at random. The number of kings obtained is denoted by x.**

   (a) What are equaly likely events? 1

   (b) Differentiate between with replacement and without replacement drawings. 2

   (c) Form the probability fucntion using the above information and then form the distribution. 3

   (d) Examine the statement: $P(1 \leq x \leq 3) = F(3) - F(1)$ 4

   (a) **The joint probability function of two random variables $X$ and $Y$ is given by:**

   $$P(X, Y) = \frac{x + 2y}{28}; \quad x = 0, 1; \quad y = 0, 1, 2, 3$$

   i. Write down the formula for conditional probability. 1

   ii. What is the relationship between marginal and joint probability? 2

   iii. Find $P(X)$. 3

   iv. Find $P(X|Y)$ and $P(X|Y = 0)$. 4

   (b) **The joint probability function of two random variables $X$ and $Y$ is described by:**

   $$P(X, Y) = \frac{2x + 3y}{45}; \quad x = 0, 1, 2; \quad y = 0, 1, 2$$

   i. Write down the formula for conditional probability. 1

   ii. What is the relationship between marginal and joint probability? 2

   iii. Find $P(X)$. 3

   iv. Find $P(X|Y)$ and $P(X|Y = 0)$. 4

2. **The joint probability function of two random variables $X$ and $Y$ is given by:**

   $$P(X, Y) = \frac{x + y + 1}{42}; \quad x = 0, 1, 2; \quad y = 0, 1, 2, 3$$

   (a) Calculate the marginal probability $P(Y)$. 3

   (b) Determine $P(Y|X = 1)$ and $P(Y|X = 0)$. 4

3. **The joint probability function of two random variables $X$ and $Y$ is described by:**

   $$P(X, Y) = \frac{2x + y + 1}{52}; \quad x = 1, 2; \quad y = 1, 2, 3, 4$$

   (a) Find the marginal distribution $P(X)$. 3

(b) Compute $P(Y|X)$ for $X = 2$. 4

4. **The joint probability function of two random variables $X$ and $Y$ is given by:**

$$P(X, Y) = \frac{3x + y}{48}; \quad x = 1, 2; \quad y = 0, 1, 2, 3$$

(a) Find $P(X)$. 3

(b) Calculate $P(X|Y)$ and $P(X|Y = 1)$. 4

5. **The probability distributions of a random variable X in two different cases are given below:**

Table 2.1: **Distribution - A**

| x | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| P(x) | 0.20 | 0.10 | 0.08 | w | 0.02 | 0.10 | 0.30 |

Table 2.2: **Distribution - B**

| x | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| P(x) | 0.20 | 0.10 | 0.30 | 0.50 | 0.20 |

(a) What is a probability mass function? 1

(b) Can we dtermine the probability of a certain value of a discrete random variable? 2

(c) What is the value of w? 3

(d) Which table is a proper probability distribution? Justify with mathematical reasoning. 4

6. **A continuos random variable X follows the following probability density function (pdf).**

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

(a) Give an example of a continous random variable. 1

(b) Examine whether the given function is a pdf. 2

(c) If $P(X > a) = P(X < a)$, find the value of a. 3

(d) Should $P(0.5 \leq X \leq 1)$ be equal to 0.5? 4

7. **The probability mass function (pmf) of a football striker scoring no. of hattricks during the course of a league season is given below**

$$P(x) = \frac{|2 - x|}{k}; x = 0, 1, 2, 3, 4, 5$$

(a) What is a random variable? 1

(b) Is probability a discrete variable? Explain in brief. 2

(c) Find the value of k. 3

(d) Find the probability that the no. of hattricks would be less than the expectation. 4

8. **The probability function of a discrete random variable is given below:**

$$P(x) = \frac{x - 3}{6}, \quad \text{for } x = 4, 5, 6$$

(a) Find $F(x)$ and hence find and explain $F(5)$ 3

(b) If the range of the function is modified to include 7, how can adjust the function to keep it valid? 4

9. **A fair coin is tossed five times. Number of heads appearing are noted, considering it a discrete random variable.**

(a) Give a real life example of a discrete random variable. 1

(b) Can discrete variable have infinite number of possible outcomes? 2

(c) Find the probability distribution from the stem. 3

(d) Construct thedistribution function and hence find $F(X \leq 3)$. 4

10. **The probability density function of a continuous random variable is**

$$f(x) = \begin{cases} f(z) = \frac{2}{9}(3z - z^2); 0 \leq z \leq 3 \\ 0, & otherwise \end{cases}$$

(a) Examine whether the probability density function is appropriate. 3

(b) Find the probability that the value of $z$ is not more than 2. 4

11. **The probability density function of a continuous random variable is**

$$f(x) = \begin{cases} k(x+1), & 0 \leq x \leq 1 \\ 0, & otherwise \end{cases}$$

(a) What is a random variable? 1

(b) Find the value of k 2

(c) Find the probability that the values of x would lie between 0 and 0.5. 3

(d) What is the probability that X is greater than 0.8? 4

12. **The probability density function of a continuous random variable is**

$$f(x) = \begin{cases} kx(x-1), & 1 \leq x \leq 4 \\ 0, & otherwise \end{cases}$$

(a) What is the range of probability? 1

(b) Find the value of k 2

(c) Justify the pdf property of the fucntion. 3

(d) What is the probability that X is greater than 3? 4

13. **The probability distribution of a discrete random variable X is given below:**

| x | -2 | -1 | 0 | 1 | 3 | 4 |
|---|---|---|---|---|---|---|
| P(x) | 0.1 | k | 2k | 3k | 4k | 0.2 |

(a) What is $\Sigma P(x)$? 1

(b) Find the value of k. 2

(c) Find $P(X \geq 0)$ and $P(X < 1)$. 3

(d) Find the cumulative distribution function, F(X) and F(2) and explain. 4

14. **The joint probability function of two random variables X & Y is given below:**

$$P(x,y) = \frac{1}{21}(x+y); x = 1,2,3 \;\&\; y = 1,2$$

(a) What is a probability density function (pdf)? 1

(b) What is P(X=a) in a pdf, where a is an aribitrary number? 2

(c) Find the marginal probabilities. 3

(d) Find $P(x|y), P(x|1)$ and $P(y|4)$ 4

15. **The probability density function of a continuos random variable X is given as:**

$$f(x) = \frac{1}{b-a}; a \leq x \leq b$$

(a) In this distribution, what is P(a)? 1

(b) What is the shape of the distribution? 2

(c) Find $P(a \leq x \leq b)$. 3

(d) Find and explain the median of the distribution. 4

16. **The probability density function of a continuous random variable is**

$$f(x) = \begin{cases} kx^2 + kx + \frac{1}{8}, & 0 \leq x \leq 2 \\ 0, & otherwise \end{cases}$$

(a) What is a continuous random variable? 1

(b) Find the value of k 2

(c) Find the probability that the values of x would lie between1 and 3. 3

(d) Find the 40th percentile of the distribution and explain. 4

## 2.2 Short Questions

1. What is a discrete random variable? 1
2. What is a continuous random variable? 1
3. Give an example of a continuous random variable 1
4. Is the number of cars passing through a toll booth in an hour an example of a discrete or continuous random variable? 1
5. Is the temperature in a city measured every hour an example of a discrete or continuous random variable? 1
6. Is the number of students in a classroom an example of a discrete or continuous random variable? 1
7. Is the amount of time it takes for a light bulb to burn out an example of a discrete or continuous random variable? 1
8. Is the number of emails received in a day an example of a discrete or continuous random variable? 1
9. Is the weight of a person an example of a discrete or continuous random variable? 1
10. What is the integral of $x^n$, where $n \neq -1$? 1
11. Compute the integral of $x^3$ with respect to $x$. 1
12. Find the integral of $x^5$ with respect to $x$. 1
13. Compute the definite integral of $x^2$ from 0 to 3. 2
14. Find the value of the definite integral $\int_1^4 x^4 \, dx$. 2

15. What is the property of a probability distribution regarding the sum of all probabilities? 1
16. What are the required properties of a probability distribution? 2
17. What is the formula of cumulative distribution function for a discrete variable? 1
18. What is the formula of cumulative distribution function for a continuous variable 1
19. If $a < b, F(b) - F(a) = ?$ where $F$ is cumulative distribution function? Derive mathematically. 2
20. How can you find $f(x)$ from $F(x)$ for a continuous distribution? 1
21. How can you find $f(x)$ from $F(x)$ for a discrete distribution? 1
22. How can calculate $P(X > 3)$ using the concept of complementary probability? 1

# Chapter 3

# Mathematical Expectation

## 3.1 Creative Questions

1. **The probability density function (pdf) of a continuous random variable is given below:**

$$f(x) = \frac{1}{30}(k + 2x); 2 < x < 5$$

   (a) What is a random variable? 1

   (b) Is probability a discrete variable? Explain in brief. 2

   (c) Find the value of k. 3

   (d) Determine the expectation and variance. 4

2. **The probability distribution of a random X is provided below:**

| X | -1 | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|
| P(x) | $\frac{3}{20}$ | $\frac{1}{5}$ | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{3}{20}$ |

   (a) What is the expectation of a constant m? 1

   (b) Find $E(X)$. 2

   (c) Find $E(Y)$, where $Y = \frac{X}{2}$ 3

   (d) Find Variance of (2X+3). 4

3. **A random variable is distributed as below:**

$$P(x) = \frac{3x + 4}{21}, \quad x = 0, 1, 2$$

   (a) Determine the value of the expectation. 3

   (b) Find $V(4X - 2)$ 4

4. **A random variable is distributed as below:**

$$P(X) = \frac{3 - |4 - x|}{k}; x = 2, 3, 4, 5, 6$$

   (a) What is the Expectation equivalent to? 1

   (b) Find the value of k. 2

   (c) Determine the value of the expectation. 3

   (d) Find $V(2X - 1)$ 4

5. **A random variable is distributed as below:**

$$P(X) = \frac{5-|6-x|}{k}; x = 1, 2, 3, 4, 5$$

   (a) Find the value of k. 2

   (b) Determine the value of the expectation. 3

   (c) Find $V(3X+2)$ 4

6. **A random variable is distributed as below:**

$$P(X) = \frac{7-|5-x|}{k}; x = 1, 2, 3, 4, 5, 6$$

   (a) Find the value of k. 2

   (b) Determine the value of the expectation. 3

   (c) Find $V(4X-3)$ 4

7. **The probability distributions of demand of mobile phones of two operating systems (OS) Android (X) and iPhone OS (iOS) (Y) are:**

| Demand | 100 | 200 | 300 | 400 | 500 |
|---|---|---|---|---|---|
| P(X) | 0.1 | 0.4 | m | 0.15 | 0.1 |
| P(Y) | 0.09 | 0.45 | 0.32 | 0.11 | 0.03 |

   (a) What is Expectation? 1

   (b) Can Expectation be negative? 2

   (c) Find m from the table. 3

   (d) Which OS has higher demand? Analyze. 4

8. **The probability distributions of daily sales of two popular coffee brands, Brand A (X) and Brand B (Y), are:**

| Sales (cups) | 50 | 100 | 150 | 200 | 250 |
|---|---|---|---|---|---|
| P(X) | 0.05 | 0.3 | p | 0.25 | 0.1 |
| P(Y) | 0.1 | 0.35 | 0.3 | 0.2 | 0.05 |

   (a) Find $p$ from the table. 3

   (b) Which brand has a more consistent daily sales distribution? Justify your answer. 4

9. **The probability distributions of sales for two different products, Product A (X) and Product B (Y), are:**

| Sales (units) | 100 | 200 | 300 | 400 | 500 |
|---|---|---|---|---|---|
| P(X) | 0.1 | 0.4 | p | 0.2 | 0.1 |
| P(Y) | 0.2 | 0.3 | 0.3 | 0.1 | 0.1 |

   (a) Find $p$ from the table. 3

   (b) Which product has a more concentrated sales distribution? Justify your answer. 4

10. **An umbrella seller earns a revenue of BDT. 5000 if it rains. If it does not rain, he loses BDT. 1000. The probability that it rains on a given day is 0.04.**

   (a) Write down the formula of Expectation for a continuous random variable. 1

   (b) Can the value of Expectation be zero? 2

(c) What is the umbrella seller's expected revenue? 3

(d) What should be the minimum probability of raining for him to achieve revenue greater than zero? 4

11. **A small business owner earns a profit of BDT. 3000 if a customer purchases a product. If no customer makes a purchase, he incurs a loss of BDT. 1500. The probability of a customer making a purchase on a given day is 0.10.**

    (a) What is the business owner's expected profit? 3

    (b) What should be the minimum probability of a customer making a purchase for the owner to have a profit greater than zero? 4

12. **A factory produces gadgets. If the demand is high, the factory earns BDT. 12000; if the demand is low, it loses BDT. 3000. The probability of high demand is 0.15.**

    (a) What is the expected revenue for the factory? 3

    (b) What is the minimum probability of high demand required for the factory to make a profit greater than 5,000? 4

13. **A box contains 5 red and 6 white balls. 3 balls are drawn at random. X is the number of white balls drawn.**

    (a) What does variance measure? 1

    (b) Can the variance be smaller than standard deviation? 2

    (c) Find the E(X) from the stem. 3

    (d) Find the variance from the stem assuming X is the number of red balls drawn. 4

14. **A professor showed a probability distribution in a class:**

| x | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| p(x) | 0.1 | a | 0.3 | b | 0.2 |

**The value of the arithmetic mean of the distribution is 3.**

    (a) What is the formula of expectation? 1

    (b) What is the variance of a constant? Explain logically. 2

    (c) What are the values of a & b? 3

    (d) Find and explain the variance of the distribution. 4

15. **X is a random variable having the below functional form:**

$$P(X) = \frac{6-|7-x|}{k}; x = 1, 2, \cdots, 10$$

Y is another variable having the relationship y = 3x+5

    (a) What is joint probability? 1

    (b) What is the minimum possible value of variance? Why? 2

    (c) Find the value of k. 3

    (d) Find E(X) and E(Y). Why are they different? 4

16. **Various sales and their probabilities of a grocery store is given below**

| | | | | | |
|---|---|---|---|---|---|
| Sales | 200 | 250 | 275 | 310 | 350 |
| Probability | 0.10 | 0.20 | 0.40 | 0.25 | 0.05 |

    (a) Can the expectation of a random variable be negative? 1

(b) Find the expected sales of the store on a given day. 2

(c) Compute the dispersion of sales f the store. 3

(d) To make the expected sale 280, what sale does the store need in place of 200? 4

17. **A survey of Television (TV) users at Gulshan in Dhaka was conducted to find how many sets each family use. The following data were obtained:**

| No of TV set | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| No of family | 10 | 75 | 10 | 5 |

(a) What is Expectation equivalent to? 1

(b) Can Variance be negative? Why or why not? 2

(c) Find the variance of the number of TV sets. 3

(d) Find and compoare between arithmetic mean and expectation. 4

## 3.2 Short Questions

1. Examine the statement: $E(3) = V(3)$ for an arbitrary distribution. 2
2. Write down the formula of $E(X^2)$
3. What is the formula for the expectation $E(X)$ of a discrete random variable $X$ 1
4. What is $E(X^2)$ equal to? 1
5. What is the relationship between expectation and arithmetic mean? 1
6. Derive Expectation from arithmetic mean. 2
7. Rewrite $E(2X)$. 1
8. Rewrite $E(4X + c)$. 1
9. Rewrite $E(4X + 7)$. 1
10. Rewrite $E(\frac{Y}{3} - 3)$. 1
11. How can you expand $E(x + y)$? 1
12. If $Y = 4X + 3, E(2Y - 5) =?$ 1
13. If $Y = 5X - 2$, Express $E\left(\frac{Y}{3} + 4\right)$ in terms of $E(X)$. 1
14. If $Z = 2Y + 7$ and $E(Y) = 10$, what is $E\left(\frac{Z}{2} - 3\right)$? 1
15. Given $W = \frac{3X}{2} + 5$, determine $E(4W - 6)$. 1
16. Between $\{E(x)\}^2$ and $E(x^2)$, which one is greater?
17. How can you expand $E(xy)$? 1
18. Between $E\left(\dfrac{1}{x}\right)$ and $\dfrac{1}{E(x)}$, which one is greater? 1
19. Determine the formula of variance in terms of expectation. 2
20. How is $E(x^2)$ found using $V(x)$ and $E(x)$? 1
21. What is the formula for the variance of a discrete random variable $X$? 1
22. How is the variance $V(X)$ related to the expectation $E(X)$? 1
23. What is the variance of a constant value? 1

24. How is the variance of the sum of two independent random variables calculated? 2
25. What is the relationship between variance and standard deviation? 1
26. $V(a) =?$, where a is an arbitrary constant? 1
27. $V(x-a) =?$ 1
28. $V(\frac{x}{3}) =?$ 1
29. $V(\frac{x}{4}+2) =?$ 1
30. If $V(x) = 1$, what is the value of standard deviation? 1
31. If $V(x) = -9$, what is the value of standard deviation? 1
32. If $V(x) = 10$, what is the value of standard deviation? 1
33. If $V(x) = 1$, what is the value of standard deviation? 1
34. Can variance be smaller than standard deviation? 2
35. When can variance and standard deviation be equal? 2
36. $V(x+y) =?$ 1
37. $V(x-y) =?$ 1
38. What covariance? 1
39. Write down the formula of covariance. 1

# Chapter 4

# Binomial Distribution

## 4.1 Creative Questions

1. **For a Binomial distribution, arithmetic mean = 4 and the variance is 3.**
   (a)
   (b) Find $P(X = 3)$ 3
   (c) Find and interpret the skewness of the distribution. 4

2. **A farmer selected a paddy field for seed collection. He found out that 10 out of each 25 paddies are damaged. He collected a sample of 15 paddies.**
   (a) What is a Bernoulli trial? 1
   (b) IF a Bernoulli trial is repeated n times, in how many ways are outcomes generated? Explain. 2
   (c) Find the probability that at least one paddy is damaged. 3
   (d) Comment on the skewness of the data. 4
   [Hint: For a binomial distribution, $\gamma_1 = \frac{q-p}{\sqrt{npq}}$]

3. **A biologist is studying a group of plants and notes that 8 out of every 20 plants are infected with a certain disease. She collects a sample of 12 plants.**
   (a) Find the probability that at least one plant is infected. 3
   (b) Determine the median of the distribution and explain its significance. 4

4. **The electric kettles produced by a certain manufacturer are 12% defective on average. The company supplies 20 kettles in a packet. A retailer bought 1000 packets.**
   (a) What is the probability that no. of defective kettles is at most 2? 3
   (b) In how many packtes, there are exactly 3 defective kettles? 4

5. **A smartphone company finds that 9% of its phones have minor defects. Each shipment contains 35 phones. A retailer purchases 500 shipments.**
   (a) What is the probability that a randomly selected shipment has at most 3 defective phones? 3
   (b) In how many shipments can we expect to find between 4 and 7 defective phones (inclusive)? 5

6. **A bottling factory reports that 6% of its bottles have minor defects. Each batch contains 45 bottles. A supplier purchases 700 batches.**
   (a) What is the probability that a randomly selected batch contains at most 4 defective bottles? 3

(b) How many batches are expected to have at least 6 defective bottles? 5

7. **A university finds that 8% of its printed course materials contain typographical errors. Each department orders 50 materials per term. Across the university, 600 departments place orders.**

   (a) What is the probability that a randomly selected department receives at most 3 erroneous materials? 3

   (b) How many departments are expected to receive at least 5 erroneous materials? 5

8. **A company produces smartphones, and it is known that 5% of the smartphones have a manufacturing defect on average. The company ships 15 smartphones in each box, and a retailer purchases 500 boxes.**

   (a) What is the probability that the number of defective smartphones in a box is at least 1? 3

   (b) How many boxes are expected to contain exactly 2 defective smartphones? 4

9. **A farmer plans to store rice seeds for future use. It was found that 8 out of 20 seeds are rotten. He then collected a sample of 15 seeds.**

   (a) What is Bernoulli trial? 1

   (b) How are Bernoulli and Binomial distributions related? 2

   (c) What is the probability that at least one seed is rotten out of 15? 3

   (d) What is the probability that the number of rotten seeds is greater than the arithmetic mean? 4

10. **The number of defective pen produced by a company follows a binomial distribution with expectation 1.5 and variance 1.125.**.

    (a) What is the mean of binomial distribution 1

    (b) Can variance be greater than mean in binomial distribution? 2

    (c) Determine the probability function of the number of defective items produced by the company. 3

    (d) What is the probability that the number of defective items is no less than 3? 4

11. **The number of faulty light bulbs produced by a factory follows a binomial distribution with an expectation of 2 and a variance of 1.6.**

    (a) Determine the probability function for the number of faulty light bulbs produced by the factory. 3

    (b) What is the probability that the number of faulty light bulbs is at least 4? 4

## 4.2 Short Questions

1. What is $p$ in a binomial distribution? 1
2. What is $q$ in a binomial distribution? 1
3. What is a Bernoulli trial? 1
4. How many outcomes are there in a Bernoulli trial? 1
5. How does n, p, and q affect the shape of binomial distribution? 2
6. What is the probability function of Bernoulli distribution? 1
7. Is Bernoulli distribution discrete or continuous? 1
8. What is the value of n (number of trial) in a Bernoulli distribution? 1

9. What is relationship between Bernoulli and Binomial distribution? 1
10. How many parameters does the Binomial distribution have? 1
11. What are the paremeters of Binomial distribution? 2
12. What happens if $n = 1$ in Binomial distribution? 2
13. What is denoted by $X$ in Binomial distribution? 1
14. What is the mean of a binomial distribution with parameters $n$ and $p$? 1
15. How is the variance of a binomial distribution with parameters $n$ and $p$ calculated? 1
16. What is the skewness of a binomial distribution $p$? 1
17. What is the kurtosis of a binomial distribution? 1
18. When is the binomial distribution symmetric? 1
19. How does the probability mass function (PMF) of a binomial distribution change with increasing $n$? 2
20. What is the relationship between the mean, variance, and skewness in a binomial distribution? 2
21. Is $E(X) < V(X)$ possible in binomial distribution? 1
22. Can $V(X)$ be equal to $E(X)$ in binomial distribution? Examine. 2
23. In a symmetric binomial distribution, what is the functional form of probability? 1

# Chapter 5

# Poisson Distribution

## 5.1 Creative Questions

1. **The standard deviation of a Poisson distribution is 2.**

   (a) Find $P(X \geq 2)$ 3

   (b) If P(a) = P(a+1), what is the value of a? 4

2. **The number of machine failures in a factory follows a Poisson distribution with a standard deviation of 2.5.**

   (a) Find $P(X \geq 4)$. 3

   (b) If $P(a) = P(a+2)$, what is the value of $a$? Does it hold for Poisson distribution? 4

3. **A call center records the number of customer complaints per day, which follows a Poisson distribution with a standard deviation of 3.**

   (a) Find $P(X \geq 3)$. 3

   (b) If $P(a) = P(a+1)$, what is the value of $a$? 4

4. **Between 1000hrs and 1700 hrs, the average number of phonce calls per minute received by a power distribution company is 2.5.**

   (a) Give an example where Poisson distribution is applicable. 1

   (b) Find the relationship between expectationa and standard deviation of Poisson distribution. 2

   (c) Find the probability that the number of calls is between 1 and 3 (inclusive). 3

   (d) What is the probability that the number of calls received is greater than the average? 4

5. **A customer service center receives an average of 4.2 calls per minute during peak hours (1200 hrs to 1800 hrs).**

   (a) Find the probability that the number of calls received in a minute is between 2 and 5 (inclusive). 3

   (b) What is the probability that the number of calls received is at least twice the average? 4

6. **An emergency room receives an average of 3.8 patient arrivals per hour during nighttime (2200 hrs to 0600 hrs).**

   (a) Find the probability that the number of patient arrivals in an hour is between 2 and 4 (inclusive). 3

   (b) What is the probability that the number of arrivals exceeds 2? 4

7. **The frequency distribution of defective items in packets of key rings is given below.**

| Number of defective items | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Number of packets | 76 | 74 | 29 | 17 | 3 | 1 |

(a) What is another way to write $P(X \geq 1)$? 1

(b) Can the mean of Poisson distribution be negative? 2

(c) From the given stem, find mean and variance. 3

(d) Find the expected frequencies and comment. 4

8. **A can manufacturer observes that 0.1% of the produced cans are faulty. The cans are packaged in carton boxes, with 500 cans in each box. A wholeseller purchases 100 boxes from the manufacturer.**

   (a) What is shape of Poisson distribution? 1

   (b) For a Poisson distribution, P(2) = P (3). What is P(2)? 2

   (c) Find the probability of exactly one defective can. 3

   (d) Find the expected number of boxes with no defective cans. 4

9. **In winter, the probability that it rains on a particular day is 0.015. An analyst observes 100 winter days.**

   (a) What is an experiment? 1

   (b) When can the Poisson distribution be approximated by the Binomial distribution? 2

   (c) Find, using Binomial distribution, the probability that it would not rain at all on the observed days. 3

   (d) Find the probability in 3(c) using Poisson distribution. 4

10. **BTCL receives 2.5 telephone calls on average from 4 pm to 6 pm. The number of calls received is a random variable.**

    (a) When is Poisson variate applicable? 1

    (b) Show conversion criteria and method from Binomial to Poisson distribution. 2

    (c) Find the probability of receiving no more than 3 calls. 3

    (d) Find the pattern of calls and show on graph paper. 4
    Hint: Find probabilities: P(0), P(1), $\cdots$

11. **The number of customers coming at supershop follows a Poisson distribution with mean 3.**

    (a) Determine the probability that in a particular minute, at least 1 customer arrives. 3

    (b) If $P(X = a) = P(X = b)$, find the value of $a$. What pattern do you get? 4

12. **The number of cars passing through a toll booth follows a Poisson distribution with a mean of 5 cars per minute.**

    (a) Determine the probability that exactly 3 cars pass through the toll booth in a minute. 3

    (b) If $P(X = a) = P(X = b)$, find the value of $a$ and $b$. What pattern do you observe? 4

13. **A website receives user sign-ups following a Poisson distribution, with a mean of 4 per hour.**

    (a) What is the probability that exactly 2 or 3 users sign up in an hour? 3

    (b) If $P(a) = P(b)$, comment on the combination of the values of $a$ and $b$. 4

14. **The number of customers coming at a shop per minute follows a Poisson distribution, whose mean is 3.**

| Value | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Frequency | 70 | 73 | 27 | 15 | 4 | 1 |

(a) Find the probability that the number of customers coming is between 1 and 2. 3

(b) Are the probabilities of coming to 2 and 3 customers equal? 4

15. **A random variable is distributed as follows:**

(a) What is the mean of Poisson distribution? 1

(b) What is the relationship between mean and standard deviation of Poisson distribution? 2

(c) Find the mean and variance of the given distribution. 3

(d) Compare the observed and expected frequencies, assuming a Possion distribution. 4

16. **A random variable is distributed as follows:**

| Value | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Frequency | 60 | 80 | 50 | 20 | 6 | 2 |

(a) Find the mean and standard deviation of the given distribution. 3

(b) Compare the observed and expected frequencies, assuming a Poisson. 4

## 5.2 Short Questions

1. What is a Poisson variate? 1
2. Can the mean of Poisson distribution be negative? 2
3. What is a Poisson variate? 1
4. What is a Poisson process? 1
5. What is the mean of a Poisson distribution with parameter $\lambda$? 1
6. What is the variance of a Poisson distribution with parameter $\lambda$? 1
7. How is the probability mass function (PMF) of a Poisson distribution expressed? 1
8. When can the Poisson distribution be used as an approximation to the binomial distribution? 1
9. What is $e$ in Poisson distribution? 1
10. What is the mean of Poisson distribution? 1
11. What is the variance of Poisson distribution? 1
12. Mean of a Poisson distribution is 2. What is its variance? 1
13. Mean of a Poisson distribution is 4. What is its standard deviation? 1
14. The mean of a Poisson distribution is 5. What is its standard deviation? 1
15. If the variance of a Poisson distribution is 9, what is its mean? 1
16. A Poisson distribution has a standard deviation of 3. What is its mean? 1
17. If the mean of a Poisson distribution is 7, what is its standard deviation? 1
18. In a a Poisson distribution, P(2) = P(3). What is its mean? 2
19. In a Poisson distribution, $P(3) = P(4)$. What is its mean? 2
20. If a Poisson distribution satisfies $P(1) = P(2)$, find its mean. 2

21. In a Poisson distribution, $P(2) = P(3)$. What is its standard deviation? 2
22. If a Poisson distribution has $P(1) = P(2)$, what is its variance? 2
23. A Poisson distribution has a mean of $\lambda = 4$. What is $P(1)$? 2
24. If a Poisson distribution has a mean of 5, find $P(2)$. 2
25. In a Poisson distribution with mean $\lambda$, find $P(1 < X < 4)$ when $\lambda = 3$. 2
26. If a Poisson distribution has $P(3) = P(4)$, find its standard deviation. 2
27. The variance of a Poisson distribution is 6. Find $P(2)$. 2
28. In a Poisson distribution, P(a) = P(a+1). What is the value of a if parameter is 3? 2
29. In a Poisson distribution, P(a) = P(a+1). What is the relationship between a and m (the parameter)? 4
30. What is the relationship between mean and variance of Poisson distribution? 1
31. Is Poisson distribution discrete or continuous? 1
32. What is the moment generating function of Poisson distribution? 1
33. If $x_1 \sim Poisson(m_1)$ and $x_2 \sim Poisson(m_2)$, $x_1 + x_2 \sim$? 2
34. How is Poisson distribution skewed? 1
35. What is the kurtosis of Poisson distribution? 1
36. If a Poisson distribution is $P(x) = \frac{e^{-m}m^x}{x!}$, $P(x+1) =$? Derive in terms of $P(x)$. 2
37. Prove $\sum_{i=1}^{\infty} P(x) = \sum_{i=1}^{\infty} \frac{e^{-m}m^x}{x!} = 1$ 2

## Chapter 6

# Normal Distribution

### 6.1 Creative Questions

### 6.2 Short Questions

Chapter 7

# Index Number

## 7.1 Creative Questions

## 7.2 Short Questions

# Chapter 8

# Sampling

## 8.1 Creative Questions

## 8.2 Short Questions

# Chapter 9

# Vital Statistics

## 9.1 Creative Questions

1. **A reseracher uses the following data to know about some demographic characterisics.**
   - (a) What is General Fertility Rate? 1
   - (b) What is the difference between GRR and NRR? 2
   - (c) Compute the population density. 3
   - (d) Are TFR and GRR same for this data? 4

2. **For projection of population in a future time period, demographers use simple, geometric or exponential growth technique. Each method has its advantages and disadvantages.**
   - (a) What is geometric growth? 1
   - (b) In geometric growth method, obtain the formula for time required for the population to get doubled [denote rate as r]. 2
   - (c) In exponential method, how much unit of time is required for the population to get tripled? 3
   - (d) For projecting (predicting future values), is geometric growth method better than the exponential method? Justify. 4

3. **Population of Dhaka and Sylhet by different age groups and areas are given below:**

| Division | Age | | | Area ($km^2$) |
|---|---|---|---|---|
| | 0-14 | 15-64 | 65+ | |
| Dhaka | 10,000,00 | 5,00,000 | 5,80,000 | 1,880 |
| Sylhet | 7,00,000 | 2,70,000 | 4,70,000 | 2,319 |

   - (a) Write down the formula of dependency ratio. 1
   - (b) What is meant by NRR = 0.983? 2
   - (c) Find and compare between the dependency ratios of the cities. 3
   - (d) Based on data, which city is more comfortable for living? 4

4. **Population of New York, Los Angeles, and Chicago by different age groups and areas are given below:**
   - (a) Find and compare the dependency ratios of New York and Chicago. 3
   - (b) Based on the data, which city is more comfortable for living? Justify your choice. 4

5. **As part of an analysis, a researcher collected data on women and live births.**

| City | Age | | | Area (sq. km) |
|---|---|---|---|---|
| | 0-14 | 15-64 | 65+ | |
| New York | 1,200,000 | 5,000,000 | 700,000 | 789 |
| Los Angeles | 1,000,000 | 4,500,000 | 500,000 | 1,302 |
| Chicago | 900,000 | 3,800,000 | 600,000 | 606 |

| Age | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 |
|---|---|---|---|---|---|---|---|
| No. of Women | 540 | 760 | 530 | 495 | 450 | 505 | 430 |
| No. of live births | 109 | 198 | 86 | 90 | 65 | 76 | 60 |

(a) What is the formula of death rate? 1

(b) Write down the uses of vital statistics. 2

(c) Find teh Age Specific Birth Rates (ASFR). 3

(d) Find the GFR and compare its concept and value with ASFRs. 4

6. **A study was conducted to analyze the relationship between women's age groups and live births. The following table presents the number of women surveyed in different age groups along with the corresponding number of live births.**

| Age Group | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 |
|---|---|---|---|---|---|---|---|
| No. of Women | 540 | 760 | 530 | 495 | 450 | 505 | 430 |
| No. of Live Births | 109 | 198 | 86 | 90 | 65 | 76 | 60 |

(a) Calculate the Age Specific Birth Rates (ASFR) for each age group. 3

(b) Compute the General Fertility Rate (GFR) and compare its value and concept with ASFR. 4

7. **The following dataset records the number of women in different age groups and their respective live births as part of a demographic study.**

| Age Group | 15–19 | 20–24 | 25–29 | 30–34 | 35–39 | 40–44 | 45–49 |
|---|---|---|---|---|---|---|---|
| No. of Women | 540 | 760 | 530 | 495 | 450 | 505 | 430 |
| No. of Live Births | 109 | 198 | 86 | 90 | 65 | 76 | 60 |

Table 9.1: Number of Women and Live Births by Age Group

(a) Determine the Age Specific Birth Rates (ASFR) for the given age groups. 3

(b) Find the General Fertility Rate (GFR) and explain its significance in relation to ASFR. 4

8. **The cities A and B have the following demographic characteristics:**

| City | Area (sq km) | Population | No. of Females |
|---|---|---|---|
| A | 10,000 | 3.2 million | 1.9 million |
| B | 15,000 | 2.15 million | 1.1 million |

(a) Which city has greater Sex Ratio? 3

(b) Which country is more comfortable for living? Justify your opinion. 4

## 9.2 Short Questions

1. What does vital statistics deal with? 1
2. Mention 4 sources of vital statistics. 2
3. What are the sources of vital statistics. 2
4. How is dependency ratio calculated? 1

5. What is the formula of sex ratio? 1
6. What does Age Specific Fertility Rate (ASFR) measure? 1
7. Why is ASFR calculated for specific age groups instead of the entire population? 1
8. Write down the formula of population density? 1
9. What is the formula of crude birth rate 1
10. How is General Fertility Rate calculated? 1
11. Distinguish between TFR and GFR. 2
12. Does population density alone determine the suitability of living in a city? 2
13. What is the purpose of Age-Specific Fertility Rate? 1
14. Two dependency ratios are $d_1 = 98\%$ and $d_2 = 104\%$. In which case are there more dependent people per 1000 individuals?

**Calculation**

15. A country has a population of 5,000,000, and the number of deaths in a year is 40,000. What is the crude death rate (CDR)? 2
16. In a certain region, the crude birth rate (CBR) is 25 per 1,000 population, and the total number of births in a year is 50,000. What is the total population of the region? 2
17. A city has a crude death rate (CDR) of 8 per 1,000 population. If the total population is 2,500,000, how many deaths occur annually? 2
18. A country has a crude death rate (CDR) of 10 per 1,000 population and recorded 90,000 deaths in a year. What is the estimated population of the country? 3
19. The population of a region is 3,200,000, and it recorded 64,000 births and 48,000 deaths in a year. Calculate both the crude birth rate (CBR) and the crude death rate (CDR). 2

# Conclusion

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