Day 14 – Assignment Questions

1. What is Probability? Why does the value lie between 0 and 1?

Probability is a numerical measure that describes the chance of occurrence of an event.
It helps us quantify uncertainty in real-life situations such as weather prediction, medical diagnosis, and risk analysis.
The value of probability always lies between 0 and 1 because 0 represents an impossible event and 1 represents a certain event.
Any value between 0 and 1 indicates the likelihood of occurrence, where values closer to 1 show higher chance and values closer to 0 show lower chance.

2. Difference Between Mutually Exclusive and Independent Events

Mutually Exclusive Events:
Two events are mutually exclusive if they cannot occur at the same time.
If one event happens, the other event cannot happen. For such events, $P(A \cap B) = 0$.

Independent Events:
Two events are independent if the occurrence of one event does not influence the occurrence of the other event.
For independent events, $P(A \cap B) = P(A) \times P(B)$.

The key difference is that mutually exclusive events cannot occur together,
whereas independent events can occur together but do not affect each other.

3. Can Two Events Be Mutually Exclusive and Independent at the Same Time?

In general, two events cannot be both mutually exclusive and independent at the same time.
If events are mutually exclusive, their intersection probability is zero.
But for independent events, the intersection equals the product of their probabilities.
Both conditions can only be satisfied if one of the probabilities is zero.
Hence, in practical situations, they are not both mutually exclusive and independent.

4. Addition Rule of Probability

The addition rule is used to calculate the probability that at least one of two events occurs.

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

This formula ensures that the overlapping part is not counted twice.
It is widely used in solving real-world probability problems involving multiple events.

5. When Do We Subtract Intersection in Addition Rule?

We subtract $P(A \cap B)$ when the events are not mutually exclusive.
If two events can occur together, their common probability must be removed once to avoid double counting.
If events are mutually exclusive, then $P(A \cap B) = 0$ and subtraction is not required.

6. Multiplication Rule

The multiplication rule is used to find the probability of two events occurring together.

General formula:
$P(A \cap B) = P(A) \times P(B|A)$

If events are independent:
$P(A \cap B) = P(A) \times P(B)$

This rule is useful when events happen in sequence or depend on each other.

7. What is Conditional Probability?

Conditional probability is the probability of event A occurring given that event B has already occurred.
It helps update probability when new information becomes available.

Formula:
$P(A|B) = P(A \cap B) / P(B)$

This concept is widely used in medical testing, machine learning, and risk analysis.

8. Explain Independence Using Formula

Two events A and B are independent if:

$P(A \cap B) = P(A) \times P(B)$

This means knowing that one event occurred does not change the probability of the other event.
Independence is an important assumption in many statistical models.

9. Define Conditional Probability

Conditional probability is formally defined as:

$P(A|B) = P(A \cap B) / P(B)$, where $P(B) \neq 0$.

It measures how the probability of event A changes when event B is already known to have occurred.

10. Real Example of Conditional Probability

Suppose 40% of patients in a hospital are diabetic. Among diabetic patients, 30% have high blood pressure.
Then the probability of having high blood pressure given that a patient is diabetic is 0.30.
Conditional probability is applied when prior information or background condition is known.

11. Difference Between Discrete and Continuous Distribution

Discrete distribution deals with countable values such as number of students, number of cars, etc.
Examples include binomial and Poisson distributions.

Continuous distribution deals with measurable quantities such as height, weight, time, and temperature.
Examples include normal and exponential distributions.

12. When to Use Binomial Distribution?

Binomial distribution is used when:
- There is a fixed number of trials.
- Each trial has only two outcomes (success or failure).
- Probability of success remains constant.

- Trials are independent.

It is commonly used in quality testing, survey analysis, and success-failure experiments.

13. What is Exponential Distribution?

Exponential distribution is a continuous probability distribution used to model the time between events.
It is useful when events occur independently at a constant average rate.
For example, waiting time between customer arrivals or machine failure time.

14. Difference Between Variance and Standard Deviation

Variance measures the average squared deviation from the mean.
It shows how much the data is spread out.

Standard deviation is the square root of variance and is expressed in the same unit as the data.
Because of this, standard deviation is easier to interpret in practical situations.

15. Bayes Theorem

Bayes theorem is used to update probability when new evidence is available.

Formula:
$P(A|B) = [P(B|A) \times P(A)] / P(B)$

It plays a major role in machine learning algorithms, spam filtering, and medical diagnosis systems.

16. Central Limit Theorem

The Central Limit Theorem states that the distribution of sample means approaches a normal distribution
as the sample size becomes large, regardless of the original population distribution.
It is very important in inferential statistics because it allows us to apply normal distribution methods
even when the population distribution is unknown.