Q1. What are the Probability Mass Function (PMF) and Probability Density Function (PDF)?

Probability Mass Function (PMF)

- Used for **discrete random variables**
- Gives the probability that a random variable equals a specific value

Definition:

P(X=x)=f(x)P(X = x) = f(x)P(X=x)=f(x)

Example:
Tossing a coin

- P(X=1 (Head))=0.5P(X=1\text{ (Head)}) = 0.5P(X=1 (Head))=0.5
- P(X=0 (Tail))=0.5P(X=0\text{ (Tail)}) = 0.5P(X=0 (Tail))=0.5

Probability Density Function (PDF)

- Used for **continuous random variables**
- Probability at a single point is **zero**
- Probability is found over an interval

Definition:

P(a≤X≤b)=∫abf(x) dxP(a \le X \le b) = \int_a^b f(x)\,dxP(a≤X≤b)=∫abf(x)dx

Example:
Heights of people in a population (continuous data)

Q2. What is Cumulative Distribution Function (CDF)? Why is it used?

CDF

The **Cumulative Distribution Function** gives the probability that a random variable is **less than or equal to a value x**.

F(x)=P(X≤x)F(x) = P(X \le x)F(x)=P(X≤x)

Example

If XXX is the number from a fair die:

F(3)=P(X≤3)=36=0.5F(3) = P(X \le 3) = \frac{3}{6} = 0.5F(3)=P(X≤3)=63=0.5

Why CDF is used

- To compute probabilities easily
- To describe the complete distribution
- Works for both discrete and continuous data

Q3. Where is Normal Distribution used? How do its parameters affect shape?

Examples of usage

- Heights and weights of people
- Exam scores
- Measurement errors
- IQ scores

Parameters

- **Mean (μ):** Center of the distribution
- **Standard Deviation (σ):** Spread of the distribution

👉 Larger σ → wider curve
👉 Smaller σ → narrower curve

Q4. Importance of Normal Distribution with real-life examples

Importance

- Many natural phenomena follow it
- Simplifies statistical analysis
- Basis of inferential statistics

Real-life examples

- Human height
- Blood pressure
- Manufacturing errors
- Test scores

Q5. What is Bernoulli Distribution? Difference from Binomial Distribution

Bernoulli Distribution

- A single trial

- Two outcomes: success (1) or failure (0)

Example:
Tossing a coin once

Difference between Bernoulli and Binomial

Feature	Bernoulli	Binomial
Trials	1	n
Outcomes	2	0 to n
Example	One coin toss	Tossing coin 10 times

Q6. Normal distribution problem

Given:
Mean μ=50μ = 50μ=50
Standard deviation σ=10σ = 10σ=10
Find: P(X>60)P(X > 60)P(X>60)

Step 1: Calculate z-score

z=X−μσ=60−5010=1z = \frac{X - μ}{σ} = \frac{60 - 50}{10} = 1z=σX−μ=1060−50=1

Step 2: Use z-table

P(Z>1)=1−0.8413=0.1587P(Z > 1) = 1 - 0.8413 = \mathbf{0.1587}P(Z>1)=1−0.8413=0.1587

✅ Answer:

Probability = **0.1587 (15.87%)**

Q7. Explain Uniform Distribution with an example

Uniform Distribution

- All outcomes are **equally likely**
- PDF is constant

Example

Rolling a fair die
Each number (1–6) has probability 1/61/61/6

Q8. What is z-score? Importance

z-score

Measures how many standard deviations a value is from the mean.

z=X−μσz = \frac{X - μ}{σ}z=σX−μ

Importance

- Standardizes data
- Helps find probabilities
- Compares values from different distributions
- Detects outliers

Q9. What is the Central Limit Theorem (CLT)?

Definition

The **Central Limit Theorem** states that the sampling distribution of the sample mean approaches a **normal distribution** as the sample size increases, regardless of the population distribution.

Q10. Significance and assumptions of CLT

Significance

- Allows use of normal distribution
- Foundation of hypothesis testing
- Enables statistical inference

Assumptions

1. Sample size is sufficiently large ($n \geq 30$)
2. Observations are independent
3. Random sampling
4. Population has finite mean and variance
