Theory Section

**1. Key Properties of a Normal Distribution**

* **Shape**: Symmetrical, bell-shaped curve.
* **Mean = Median = Mode**: All three are equal and located at the center.
* **Spread**: Determined by **standard deviation (σ)**.
* **Empirical Rule (68–95–99.7 rule)**:
  + 68% of values lie within 1σ of the mean.
  + 95% lie within 2σ.
  + 99.7% lie within 3σ.
* **Total Area under the curve = 1** (represents probability).
* **Tails**: Extend infinitely in both directions but never touch the x-axis.

**2. Definitions**

**a) Probability Density Function (PDF):**

* A mathematical function that describes the likelihood of a continuous random variable taking on a value.
* For the normal distribution:

f(x)=1σ2πe−(x−μ)22σ2f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}f(x)=σ2π​1​e−2σ2(x−μ)2​

* The area under the PDF curve between two points gives the probability of the variable falling in that interval.

**b) Z-Score:**

* A standardized score showing how many standard deviations a value is away from the mean.

Z=X−μσZ = \frac{X - \mu}{\sigma}Z=σX−μ​

* Positive Z = above mean, Negative Z = below mean.

**c) Standard Normal Distribution:**

* A **normal distribution with mean = 0 and standard deviation = 1**.
* Any normal distribution can be converted into the standard normal using Z-scores.

### ****3. Differences****

**a) Discrete vs. Continuous Distributions**

| **Feature** | **Discrete** | **Continuous** |
| --- | --- | --- |
| Values | Countable (finite or infinite) | Uncountable, infinite |
| Example | Number of students in a class, dice rolls | Heights, weights, time |
| Probability | Assigned to exact values | Assigned to ranges (area under PDF) |

**b) Binomial vs. Normal Distribution**

| **Feature** | **Binomial Distribution** | **Normal Distribution** |
| --- | --- | --- |
| Type | Discrete | Continuous |
| Scenario | Number of successes in *n* independent trials | Continuous variables (heights, marks, errors) |
| Parameters | n = number of trials, p = probability of success | μ = mean, σ = standard deviation |
| Shape | Approaches normal when *n* is large and *p* not too close to 0 or 1 | Always bell-shaped |
| Example | Coin tosses (heads count) | Heights of students |