1)

The generate\_binomial function generates a list of random variables following a binomial distribution. Here's an explanation of the parameters and the function:

1. **n:** This parameter represents the number of trials in each binomial experiment. In a binomial distribution, each experiment consists of a fixed number of trials, and 'n' specifies how many trials are conducted.
2. **p:** This parameter is the probability of success in each trial. In a binomial distribution, there are two possible outcomes in each trial – success or failure. 'p' represents the probability of achieving success in a single trial.
3. **size:** This parameter determines the number of random variables to generate. The function will produce a list/array of random variables, and 'size' indicates how many elements this list should contain.

The function uses NumPy's random.binomial function, which generates random variables following a binomial distribution. It takes 'n', 'p', and 'size' as arguments and returns a list/array of random variables based on the specified binomial distribution.

2)

The function binomial\_pmf calculates the probability mass function (PMF) for a binomial distribution. Here's an explanation of the parameters and the formula used:

1. **k:** This parameter represents the number of successes (or positive outcomes) in the binomial distribution. The PMF is calculated for a specific number of successes 'k' out of 'n' trials.
2. **n:** This parameter is the total number of trials in the binomial experiment. It represents the number of times an event is repeated, and each trial has only two possible outcomes (success or failure).
3. **p:** This parameter is the probability of success in a single trial. It represents the likelihood of the event being a success in each individual trial.

The formula used to calculate the binomial PMF is:

P(X=k)=(nk)⋅pk⋅(1−p)n−kP(X=k)=(kn​)⋅pk⋅(1−p)n−k

where:

* (nk)(kn​) is the binomial coefficient, representing the number of ways to choose 'k' successes from 'n' trials. It is often calculated using the combination formula: (nk)=n!k!(n−k)!(kn​)=k!(n−k)!n!​, where '!' denotes factorial.
* pkpk is the probability of 'k' successes.
* (1−p)n−k(1−p)n−k is the probability of 'n - k' failures.

3)

The function binomial\_cdf calculates the cumulative distribution function (CDF) for a binomial distribution. The CDF gives the probability that a random variable X takes a value less than or equal to a specified value kk. Here's an explanation of the parameters and the logic used in the function:

1. **k:** This parameter represents the value for which we want to calculate the cumulative probability. The CDF gives the probability that the random variable is less than or equal to kk.
2. **n:** The total number of trials in the binomial experiment.
3. **p:** The probability of success in a single trial.

The function uses a loop to iterate through all possible values of the random variable from 0 to k (inclusive) and accumulates the probabilities using the binomial\_pmf function for each value. The loop adds up the individual probabilities to calculate the cumulative probability up to k.

4)

The function binomial\_expectation calculates the expected value (or mean) of a binomial distribution. The expected value is a measure of the center or average of the distribution. Here's an explanation of the parameters and the logic used in the function:

1. **n:** This parameter represents the number of trials in the binomial experiment. It is the total number of times the event is repeated.
2. **p:** This parameter is the probability of success in a single trial. It represents the likelihood of the event being a success in each individual trial.

The formula for the expected value of a binomial distribution is given by:

E(X)=n⋅pE(X)=n⋅p

where:

* E(X)E(X) is the expected value of the binomial distribution.
* nn is the number of trials.
* pp is the probability of success in a single trial.

The function simply returns the product of the number of trials (n) and the probability of success (p), which gives the expected number of successes in the binomial distribution.

5)

The function binomial\_variance calculates the variance of a binomial distribution. Variance is a measure of the spread or dispersion of a distribution. Here's an explanation of the parameters and the logic used in the function:

1. **n:** This parameter represents the number of trials in the binomial experiment. It is the total number of times the event is repeated.
2. **p:** This parameter is the probability of success in a single trial. It represents the likelihood of the event being a success in each individual trial.

The formula for the variance of a binomial distribution is given by:

Var(X)=n⋅p⋅(1−p)Var(X)=n⋅p⋅(1−p)

where:

* Var(X)Var(X) is the variance of the binomial distribution.
* nn is the number of trials.
* pp is the probability of success in a single trial.

The function returns the product of the number of trials (nn), the probability of success (pp), and the probability of failure (1−p1−p). This formula represents the spread or variability in the number of successes in a binomial distribution.

6)

1. **PMF Calculation:** The function computes the Probability Mass Function (PMF) values for a binomial distribution with parameters n (number of trials) and p (probability of success in each trial) for a range of unique values.
2. **Visualization:** It uses Matplotlib to create a bar plot and scatter plot of the PMF values, showing the probability of each unique value. The x-axis represents the random variable, and the y-axis represents the PMF.
3. **Title and Labels:** The function sets appropriate labels and a title for the plot, including the specified probability of success (p). It then displays the plot.

7)

1. **CDF Calculation:** The function calculates the Cumulative Distribution Function (CDF) values for a binomial distribution with parameters n (number of trials) and p (probability of success in each trial) for a range of unique values.
2. **Visualization:** Using Matplotlib, it creates a step plot of the CDF values, illustrating the cumulative probability up to each unique value. The x-axis represents the random variable, and the y-axis represents the CDF.
3. **Title and Labels:** The function sets appropriate labels and a title for the plot, indicating the specified probability of success (p). Finally, it displays the plot.