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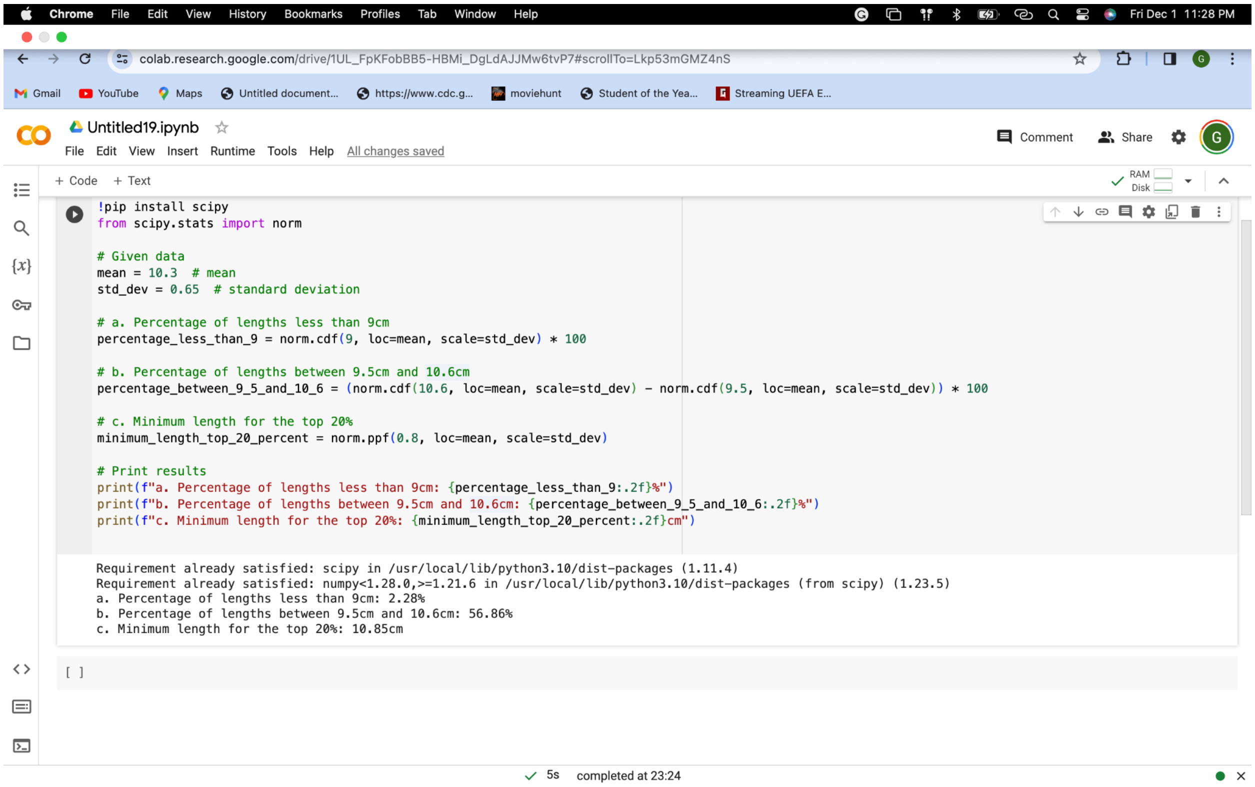
Probability and Statics
Week 4 Assignment:

Qno.1)

Code:

```
#     Qno.1
!pip install scipy
from scipy.stats import norm

# Given data
mean = 10.3  # mean
std_dev = 0.65  # standard deviation

# a. Percentage of lengths less than 9cm
percentage_less_than_9 = norm.cdf(9, loc=mean, scale=std_dev) * 100

# b. Percentage of lengths between 9.5cm and 10.6cm
percentage_between_9_5_and_10_6 = (norm.cdf(10.6, loc=mean, scale=std_dev)
- norm.cdf(9.5, loc=mean, scale=std_dev)) * 100

# c. Minimum length for the top 20%
minimum_length_top_20_percent = norm.ppf(0.8, loc=mean, scale=std_dev)

# Print results
print(f"a. Percentage of lengths less than 9cm:
{percentage_less_than_9:.2f}%")
print(f"b. Percentage of lengths between 9.5cm and 10.6cm:
{percentage_between_9_5_and_10_6:.2f}%")
print(f"c. Minimum length for the top 20%:
{minimum_length_top_20_percent:.2f}cm")
```

Output:

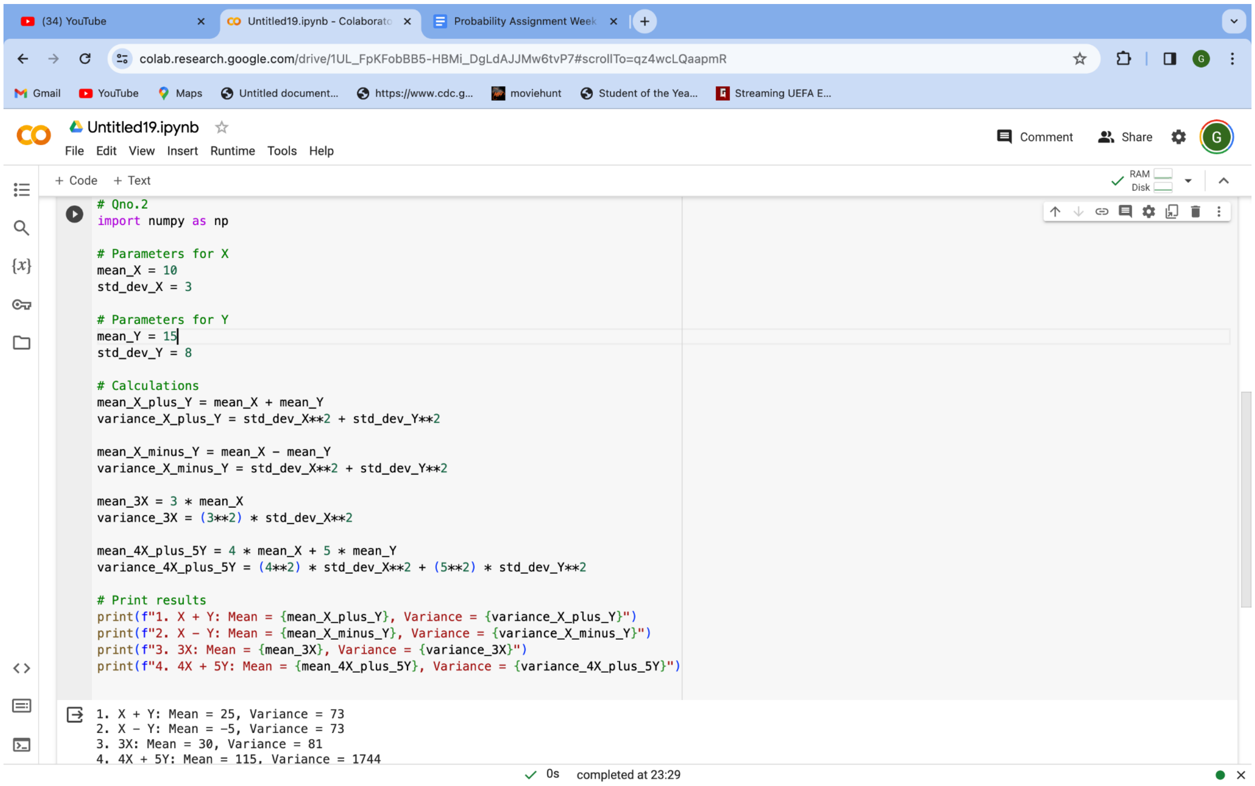


Qno2)

```
# Qno.2
import numpy as np

# Parameters for X
mean_X = 10
std_dev_X = 3

# Parameters for Y
mean_Y = 15
std_dev_Y = 8

# Calculations
```

```python
mean_X_plus_Y = mean_X + mean_Y
variance_X_plus_Y = std_dev_X**2 + std_dev_Y**2

mean_X_minus_Y = mean_X - mean_Y
variance_X_minus_Y = std_dev_X**2 + std_dev_Y**2

mean_3X = 3 * mean_X
variance_3X = (3**2) * std_dev_X**2

mean_4X_plus_5Y = 4 * mean_X + 5 * mean_Y
variance_4X_plus_5Y = (4**2) * std_dev_X**2 + (5**2) * std_dev_Y**2

# Print results
print(f"1. X + Y: Mean = {mean_X_plus_Y}, Variance = {variance_X_plus_Y}")
print(f"2. X - Y: Mean = {mean_X_minus_Y}, Variance =
{variance_X_minus_Y}")
print(f"3. 3X: Mean = {mean_3X}, Variance = {variance_3X}")
print(f"4. 4X + 5Y: Mean = {mean_4X_plus_5Y}, Variance =
{variance_4X_plus_5Y}")
```

Output:



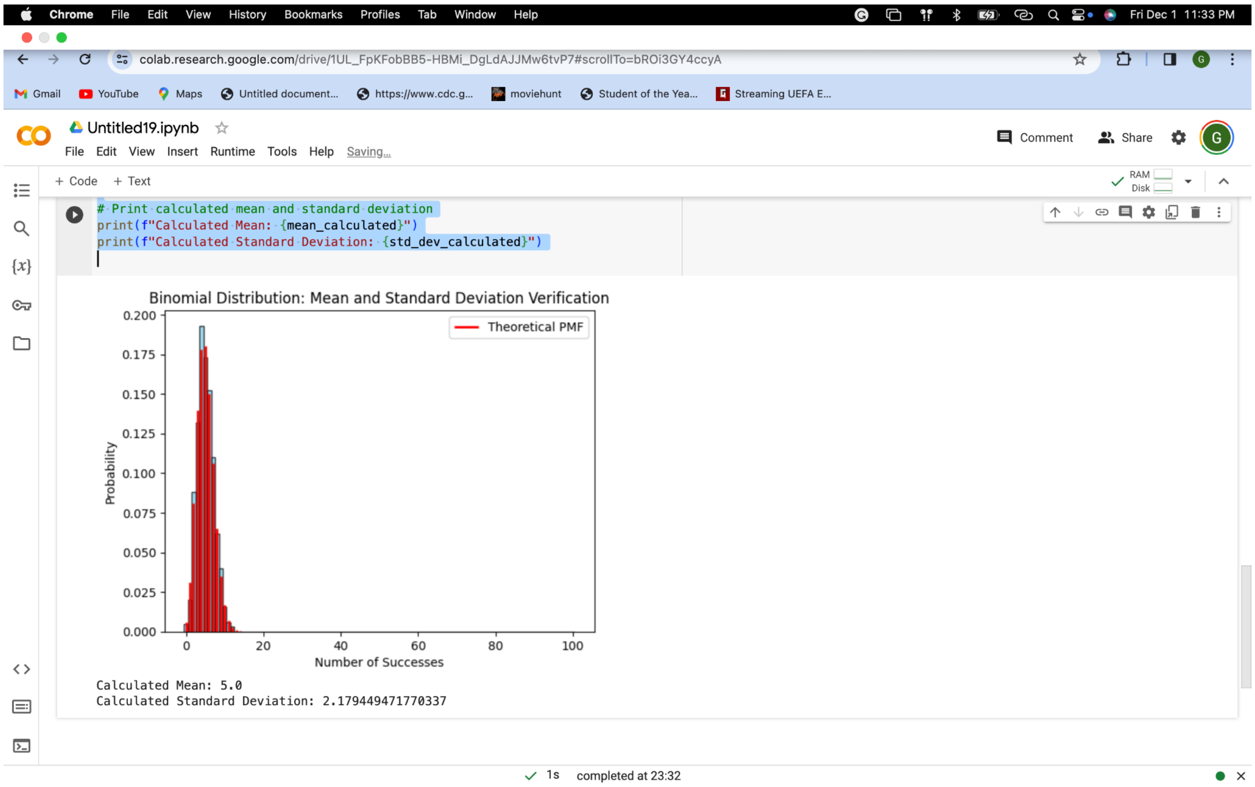
Qno.3)

Code:

```
#Qno.3
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import binom

# Parameters
p = 0.05
n = 100

# Generate binomial distribution
binomial_dist = binom(n, p)
```

```python
# Calculate mean and standard deviation
mean_calculated = n * p
std_dev_calculated = np.sqrt(n * p * (1 - p))

# Generate random samples from the binomial distribution
samples = binomial_dist.rvs(size=1000)

# Plot histogram of the samples
plt.hist(samples, bins=np.arange(0, n+2)-0.5, density=True, alpha=0.75,
color='skyblue', edgecolor='black')

# Plot the theoretical probability mass function
x = np.arange(0, n+1)
pmf = binomial_dist.pmf(x)
plt.vlines(x, 0, pmf, colors='red', linewidth=2, label='Theoretical PMF')

# Add labels and title
plt.xlabel('Number of Successes')
plt.ylabel('Probability')
plt.title('Binomial Distribution: Mean and Standard Deviation
Verification')
plt.legend()

# Show the plot
plt.show()

# Print calculated mean and standard deviation
print(f"Calculated Mean: {mean_calculated}")
print(f"Calculated Standard Deviation: {std_dev_calculated}")
```

Output:



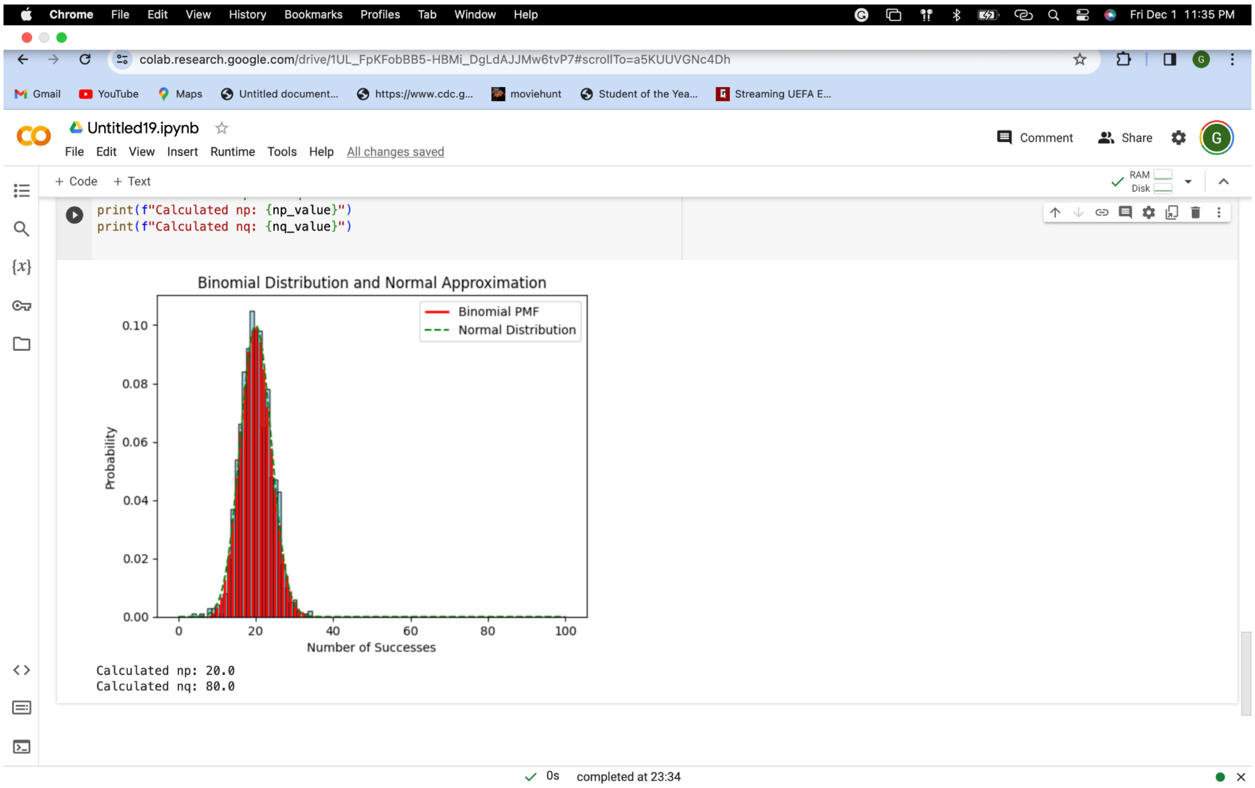
Qno.4)

Code:

```
#Qno4
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import binom, norm

# Parameters
n = 100
p = 0.2

# Calculate np and nq
np_value = n * p
```

```
nq_value = n * (1 - p)

# Generate binomial distribution
binomial_dist = binom(n, p)

# Generate random samples from the binomial distribution
samples = binomial_dist.rvs(size=1000)

# Plot histogram of the samples
plt.hist(samples, bins=np.arange(0, n+2)-0.5, density=True, alpha=0.75,
color='skyblue', edgecolor='black')

# Plot the theoretical probability mass function
x = np.arange(0, n+1)
pmf = binomial_dist.pmf(x)
plt.vlines(x, 0, pmf, colors='red', linewidth=2, label='Binomial PMF')

# Plot the normal distribution for comparison
x_normal = np.linspace(0, n, 1000)
pdf_normal = norm.pdf(x_normal, loc=np_value, scale=np.sqrt(n * p * (1 -
p)))
plt.plot(x_normal, pdf_normal, label='Normal Distribution', color='green',
linestyle='dashed')

# Add labels and title
plt.xlabel('Number of Successes')
plt.ylabel('Probability')
plt.title('Binomial Distribution and Normal Approximation')
plt.legend()

# Show the plot
plt.show()

# Print calculated np and nq
print(f"Calculated np: {np_value}")
print(f"Calculated nq: {nq_value}")
```

Output:



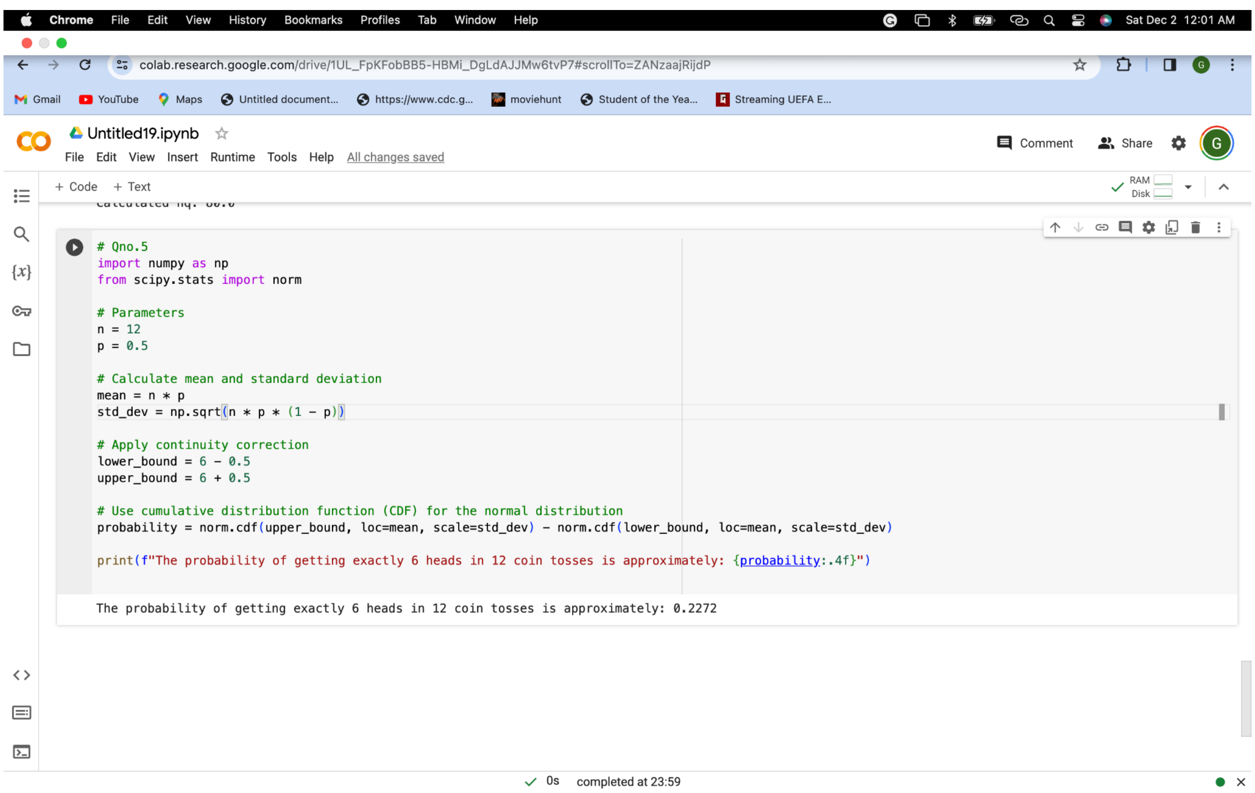
Qno.5)

Code:

```
import numpy as np
from scipy.stats import norm

# Parameters
n = 12
p = 0.5

# Calculate mean and standard deviation
```

```
mean = n * p
std_dev = np.sqrt(n * p * (1 - p))

# Apply continuity correction
lower_bound = 6 - 0.5
upper_bound = 6 + 0.5

# Use cumulative distribution function (CDF) for the normal distribution
probability = norm.cdf(upper_bound, loc=mean, scale=std_dev) -
norm.cdf(lower_bound, loc=mean, scale=std_dev)

print(f"The probability of getting exactly 6 heads in 12 coin tosses is
approximately: {probability:.4f}")
```

Output:

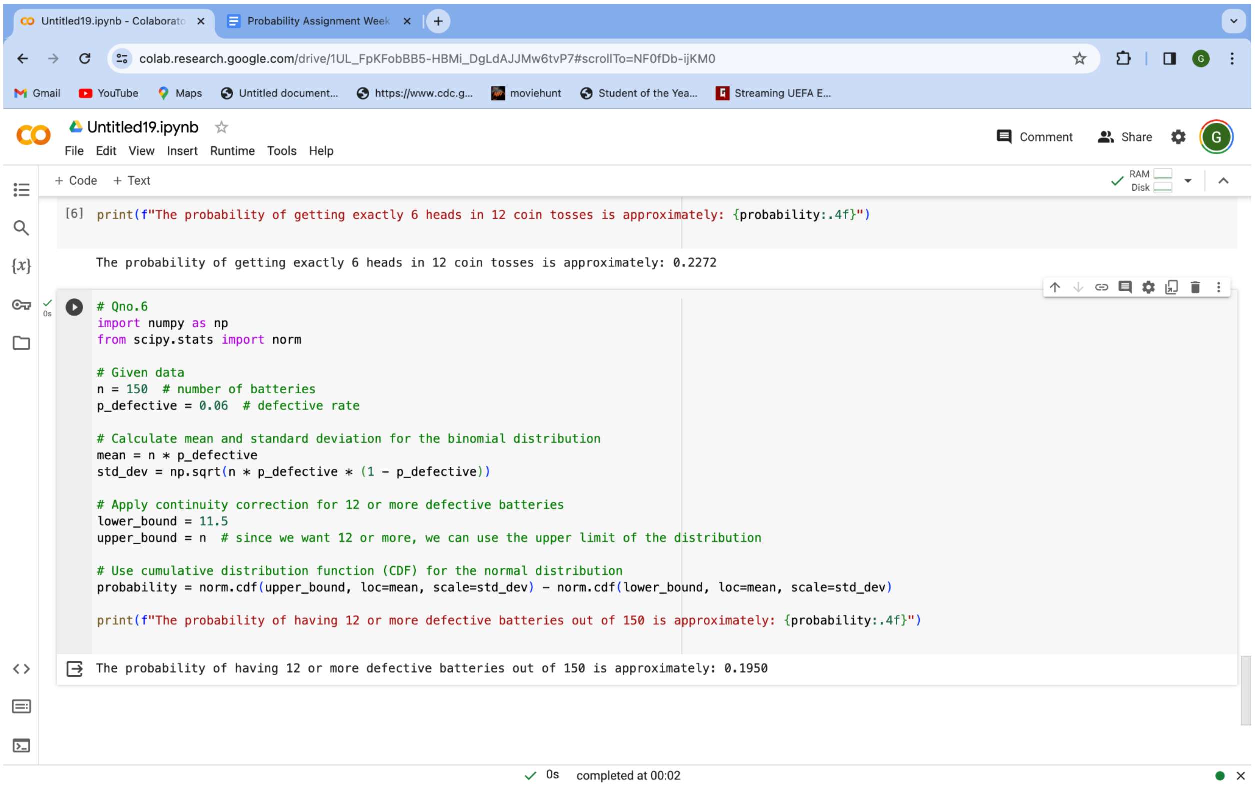


Qno.6)

Code:

```
import numpy as np
from scipy.stats import norm

# Given data
n = 150  # number of batteries
p_defective = 0.06  # defective rate

# Calculate mean and standard deviation for the binomial distribution
mean = n * p_defective
std_dev = np.sqrt(n * p_defective * (1 - p_defective))

# Apply continuity correction for 12 or more defective batteries
lower_bound = 11.5
upper_bound = n  # since we want 12 or more, we can use the upper limit of
the distribution

# Use cumulative distribution function (CDF) for the normal distribution
probability = norm.cdf(upper_bound, loc=mean, scale=std_dev) -
norm.cdf(lower_bound, loc=mean, scale=std_dev)

print(f"The probability of having 12 or more defective batteries out of
150 is approximately: {probability:.4f}")
```

Output:



Qno.7)

Code:

```
# Qno.7
import numpy as np
import matplotlib.pyplot as plt

# Function to generate random numbers from a t-distribution
def generate_t_distribution_samples(size, df):
    return np.random.standard_t(df, size=size)

# Parameters
```

```python
total_samples = 15
sample_size = 30
degrees_of_freedom = 10

# Generate 100 random numbers from t-distribution
population = generate_t_distribution_samples(100, degrees_of_freedom)

# Create 15 sampling groups
sampling_groups = [np.random.choice(population, size=sample_size,
replace=False) for _ in range(total_samples)]

# Calculate mean and standard deviation for each sampling group
means = [np.mean(group) for group in sampling_groups]
std_devs = [np.std(group, ddof=1) for group in sampling_groups]

# Calculate overall mean and standard deviation based on CLT
overall_mean = np.mean(means)
overall_std_dev = np.std(means, ddof=1) / np.sqrt(sample_size)

# Plot histogram of means
plt.hist(means, bins=15, density=True, alpha=0.75, color='skyblue',
edgecolor='black')
plt.xlabel('Sample Mean')
plt.ylabel('Probability Density')
plt.title('Distribution of Sample Means')
plt.show()

# Print results
print(f"Overall Mean: {overall_mean}")
print(f"Overall Standard Deviation (CLT): {overall_std_dev}")
```

Output: