NCERT Discrete 11.9.3.30

EE23BTECH11007 - Aneesh K*

The number of bacteria in a certain culture doubles every hour. If there were 30 bacteria present in the culture originally, how many bacteria will be present at the end of 2nd hour, 4th hour and n^{th} hour?

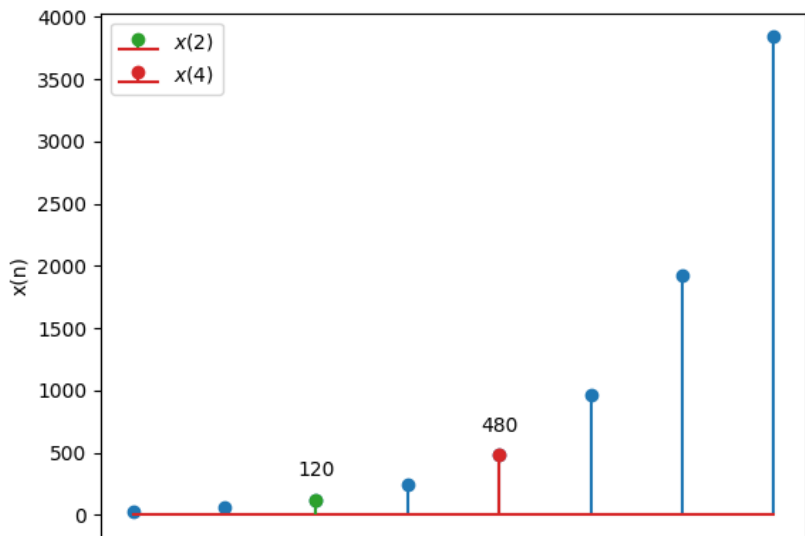| Parameter	Value	Description
$x(0)$	30	Initial no. of bacteria
r	2	Ratio of no. of bacteria at end of
		hour to start of hour (Common Ratio)
$x(n)$	$r^n x(0) u(n)$	n^{th} term of the GP

Table: Input Parameters

Solution

From Table **??**:

$$x(2) = 120 \tag{1}$$
$$x(4) = 480 \tag{2}$$
$$x(n) = 30(2^n)u(n) \tag{3}$$

Plot

Code

```c
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
// Number of terms to compute
#define NUMBER_OF_TERMS 8
const int FIRST_TERM = 30;
const int COMMON_RATIO = 2;
// Function that calculates x(n) = (30 * 2^n)u(n)
unsigned long long x(int n) {
    if (n < 0) {
        // 0 for all negative values
        return 0;
    }
    return FIRST_TERM * pow(COMMON_RATIO, n);
}
int main() {
    // File pointer
    FILE* out;
    // Open the file.
    fopen_s(&out, "11_9_3_30cout.txt", "w");
    // Character pointer to store the formatted string.
    for (int i = 0; i < NUMBER_OF_TERMS; i++) {
        // Format the string.
        fprintf(out, "%llu-", x(i));
    }
    // Close the file.
    fclose(out);
}
```

Code

```python
import matplotlib.pyplot as plt
import numpy as np

# X-axis
n = np.linspace(0, 7, 8)

# Y-axis
x = np.loadtxt("11_9_3_30cout.txt")

# Plot graph
plt.stem(n, x)

# Plot (2, 120) and (4, 480) in a separate color and mark them.
plt.stem(2, 120, linefmt="C2", label="$x(2)$")
plt.stem(4, 480, linefmt="C3", label="$x(4)$")
plt.annotate("120", (2, 120), ha="center", va="bottom", xytext=(0, 10), textcoords="offset-points")
plt.annotate("480", (4, 480), ha="center", va="bottom", xytext=(0, 10), textcoords="offset-points")

# Label axes
plt.xlabel("n")
plt.ylabel("x(n)")

plt.legend()

plt.savefig("../figs/11_9_3_30.png")
```

Z-transform

$$X(z) = \frac{30z^{-1}}{1 - 2z^{-1}} \quad |z| > 2 \tag{4}$$