No :

Date: / /

Assignment 2

1)
a)

$x_1(n) = \cos(0.5\pi n)$

$E = \sum_{n=-\infty}^{\infty} |\cos(0.5\pi n)|^2$

$= \infty$

$x_1(n) = \cos[2\pi(0.25)n]$

$x_1(n+N) = \cos[2\pi(0.25)(N+n)]$

$\therefore x_1(n)$ is a power signal

$= \cos(0.5\pi n + 2\pi N)$

Since $\cos(0.5\pi n) = \cos(0.5\pi n + 2\pi N)$

$x(n) = x(n+N)$

$\therefore$ $x_1(n)$ is periodic

b) $x_2(n) = (0.5)^n u(n).$

$E = \sum_{n=-\infty}^{\infty} [0.5^n u(n)]^2$

$x_2(n+N) = (0.5)^{n+N} u(n+N)$

$= \sum_{n=0}^{\infty} 0.5^{2n}$

$\therefore$ $x_2(n)$ is aperiodic

$= \frac{1}{1-0.25} = \frac{4}{3}$

$\therefore x_2(n)$ is an energy signal

c). $x_3(n) = 1$

$E = \sum_{n=-\infty}^{\infty} 1^2$

this is periodic.

$= \infty$

$P = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} 1^2$

$= \lim_{N\to\infty} \frac{N+N+1}{2N+1} = \frac{2}{2} = 1$

Atlas

No: Date: / /

2). $y(n) - 0.5y(n-1) = x(n)$.

a). impulse response of $y(n)$

let $h(n) - 0.5\,h(n-1) = \delta(n)$.

$n=0$ $\quad h(0) - 0.5\,h(-1) = 1$ $\quad$ Since $h(-1) = 0$ due to Causa

$h(0) = 1$

$n=1$ $\quad h(1) - 0.5\,h(0) = 0$

$h(1) = 0.5$

$n=2$ $\quad \cancel{h(2)}$ $\quad h(2) - 0.5\,h(1) = 0$

$h(2) = 0.5^2$

$n=3)$ $\quad h(3) - 0.5\,h(2) = 0$

$h(3) = 0.5^3$

$\therefore$ $h(n) = 0.5^n u(n)$

b). Step response.

let $s(n) - 0.5s(n-1) = u(n)$.

at $n=0$. $\quad s(0) - 0.5\,s(-1) = 1$ $\quad$ Since $s(-1) = 0$

$s(0) = 1$

at $n=1$ $\quad s(1) - 0.5\,s(0) = 1$

$s(1) = 1 + 0.5$

$= 1.5$.

Atlas

No:

Date: / /

at $n = 2$ $\quad S(2) - 0.5\,S(1) = 1$

$S(2) = 1 + 0.75$

$= 1.75$

at $n = 3$ $\quad S(3) - 0.5\,S(2) = 1$

$S(3) = 1 + 0.875$

$= 1.875$

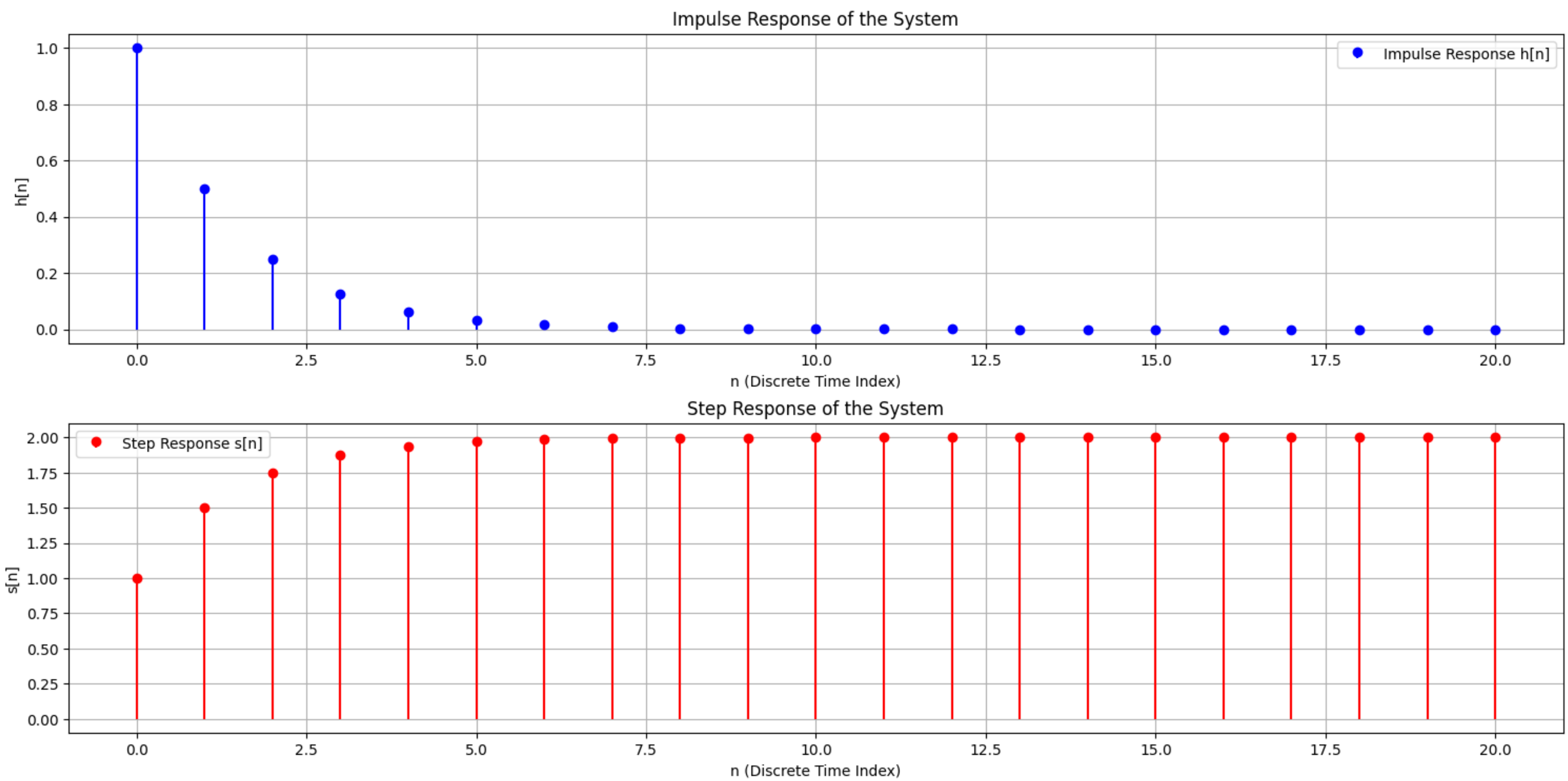
$$\underline{\underline{S[n] = (2 - 0.5^n)\,u[n]}}$$

c) $h[n]$ is decaying exponentialy while $S[n]$ is starting from 1 and converge to 2 when $n \to \infty$.

```python
import numpy as np
import matplotlib.pyplot as plt
# Discrete time indices
n = np.arange(0, 21)
# Define input signals
delta_n = np.zeros(21)
delta_n[0] = 1
u_n = np.ones(21)
#  y[n] = 0.5*y[n-1] + x[n]
a1 = 0.5
b0 = 1.0
# Initialize output arrays
h_n = np.zeros(21)
s_n = np.zeros(21)
# Simulate impulse response h[n]
for i in range(21):
    if i == 0:
        h_n[i] = b0 * delta_n[i]
    else:
        h_n[i] = a1 * h_n[i-1] + b0 * delta_n[i]
# Simulate step response s[n]
for i in range(21):
    if i == 0:
        s_n[i] = b0 * u_n[i]
    else:
        s_n[i] = a1 * s_n[i-1] + b0 * u_n[i]
# Plotting the results

#IMPULSE RESPONSE PLOT
plt.figure(figsize=(12, 8))
plt.subplot(2, 1, 1)
plt.stem(n, h_n, linefmt='b-', markerfmt='bo', basefmt=' ', label='Impulse Response h[n]')
plt.title('Impulse Response of the System')
plt.xlabel('n (Discrete Time Index)')
plt.ylabel('h[n]')
plt.legend()
plt.grid()

#STEP RESPONSE PLOT
plt.subplot(2, 1, 2)
plt.stem(n, s_n, linefmt='r-', markerfmt='ro', basefmt=' ', label='Step Response s[n]')
plt.title('Step Response of the System')
plt.xlabel('n (Discrete Time Index)')
plt.ylabel('s[n]')
plt.legend()
plt.grid()
plt.tight_layout()
plt.show()
```



Impulse Response of the System
Impulse Response h[n]
h[n]
1.0
0.8
0.6
0.4
0.2
0.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
n (Discrete Time Index)
Step Response of the System
Step Response s[n]
s[n]
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
n (Discrete Time Index)