QUIZ1

Adarsh Sai - AI20BTECH11001

Download all python codes from

https://github.com/Adarsh541/EE3900/blob/main/quiz1/codes/quiz1.py

Download latex-tikz codes from

https://github.com/Adarsh541/EE3900/blob/main/quiz1/quiz1.tex

1 Problem(Q2.26)

Which of the following discrete time signals could be the eigenfunctions of stable LTI system?

1) 5^n
2) $5^n e^{j2\omega n}$

2 Solution

If $x[n]$ is an eigenfunction of the system, then the output signal must be a scaled version of the input signal: $y[n] = c.x[n]$

1)

$$y[n] = \sum_{k=-\infty}^{\infty} h[k]\, x[n-k] \tag{2.0.1}$$

$$= \sum_{k=-\infty}^{\infty} h[k]\, 5^{n-k} \tag{2.0.2}$$

$$= 5^n \sum_{k=-\infty}^{\infty} h[k]\, 5^{-k} \tag{2.0.3}$$

$$= c_1.x[n] \tag{2.0.4}$$

where $c_1 = \sum_{k=-\infty}^{\infty} h[k]\, 5^{-k}$ is the corresponding eigen value. $\therefore$ 5^n can be an eigenfunction.

2)

$$y[n] = \sum_{k=-\infty}^{\infty} h[k]\, x[n-k] \tag{2.0.5}$$

$$= \sum_{k=-\infty}^{\infty} h[k]\, 5^{n-k} e^{j2\omega(n-k)} \tag{2.0.6}$$

$$= 5^n e^{j2\omega n} \sum_{k=-\infty}^{\infty} h[k]\, 5^{-k} e^{-j2\omega k} \tag{2.0.7}$$

$$= c_2.x[n] \tag{2.0.8}$$

where $c_2 = \sum_{k=-\infty}^{\infty} h[k]\, 5^{-k} e^{-j2\omega k}$ is the corresponding eigen value. $\therefore$ $5^n e^{j2\omega n}$ can be an eigenfunction.

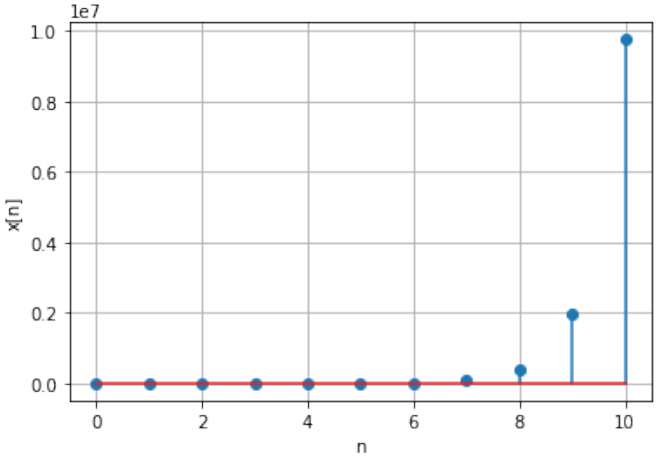

Fig. 2: Plot of $x[n] = 5^n$.

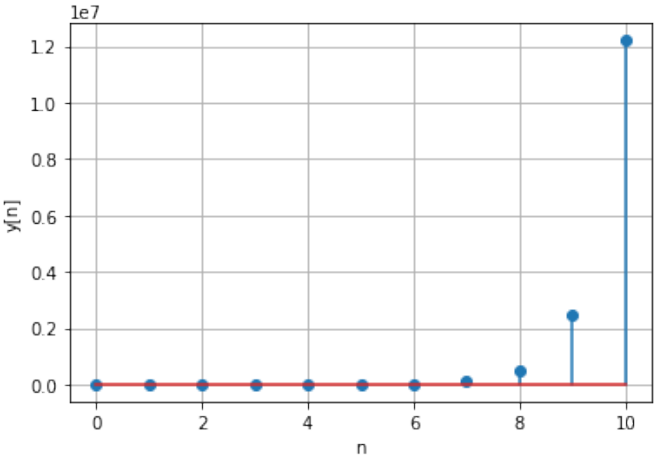

Fig. 2: Plot of $y[n]$. Took $h[n] = u[n]$. We get $c_1 = 1.25$. Verified in python