SIGNAL PROCESSING

Through GATE

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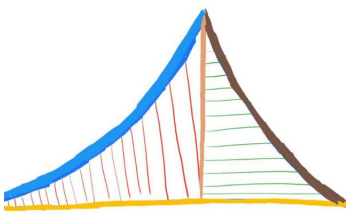

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Introduction

This book provides solutions to signal processing problems in GATE.

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Sequences

4.1 Consider the discrete time signal $x[n] = u[-n+5] - u[n+3]$, where

$$u[n] = \begin{cases} 1; n \geq 0 \\ 0; n < 0 \end{cases}$$

The smallest n for which $x[n] = 0$ is?

Solution: From Fig. 1, the minimum value of n is given as

$$n = -3 \tag{4.1}$$

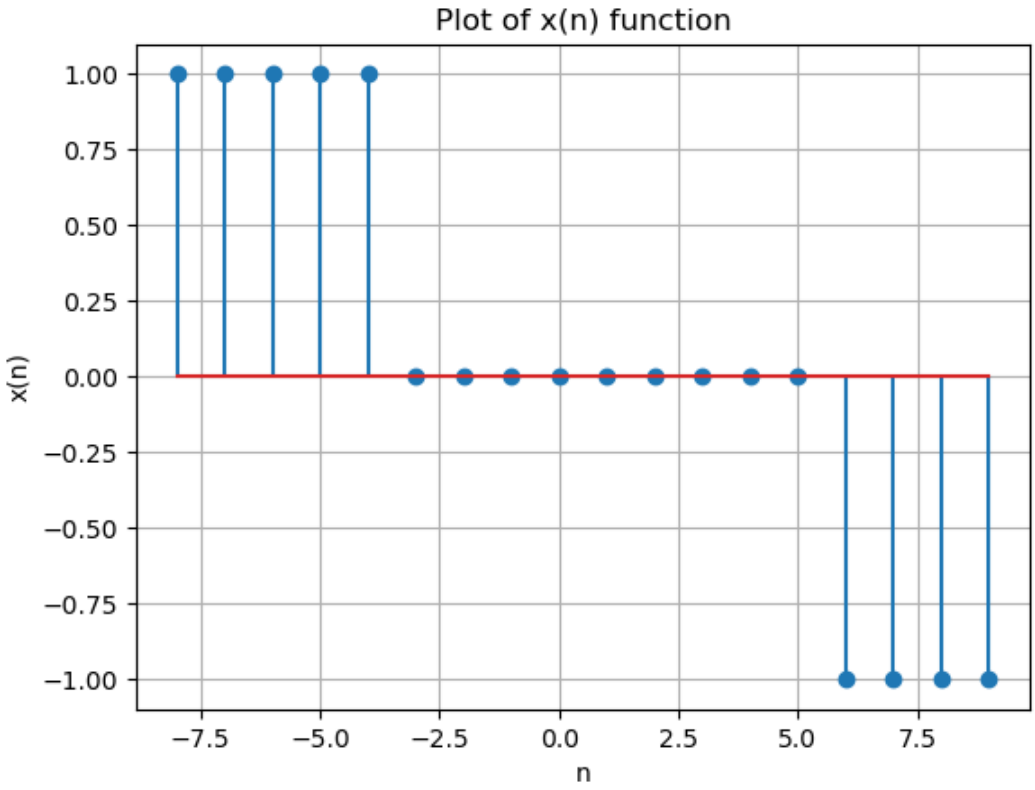

Figure 1: Plot of function $x\,(n)$ taken from python3

Chapter 5

Contour Integration

Chapter 6

Laplace Transform

6.1 The number of zeroes of the polynomial $P(s) = s^3 + 2s^2 + 5s + 80$ in the right side of the plane? (GATE IN 2023)

Solution: The table below shows the Routh array of the n^{th}- order characteristic polynomial :

$$a_0 s^n + a_1 s^{n-1} ..... + a_{n-1} s^1 + a_n s^0 \tag{6.1}$$

s^n	a_0	a_2	a_4	...
s^{n-1}	a_1	a_3	a_5	...
s^{n-2}	$b_1 = \frac{a_1 a_2 - a_3 a_0}{a_1}$	$b_2 = \frac{a_1 a_4 - a_5 a_0}{a_1}$	...	..
s^{n-3}	$c_1 = \frac{b_1 a_3 - b_2 a_1}{b_1}$	$\vdots$		
$\vdots$	$\vdots$	$\vdots$		
s^1	$\vdots$	$\vdots$		
s^0	a_n			

Table 6.1: Routh Array

Characteristic Equation:

$$s^3 + 2s^2 + 5s + 80 = 0 \tag{6.2}$$

From Table 6.1:

s^3	1	5
s^2	2	80
s^1	$\frac{2 \times 5 - 80 \times 1}{2} = -35$	
s^0	$\frac{-35 \times 80}{-35} = 80$	

Table 6.2:

From Table 6.2:

Since there are 2 sign changes in the first column of the Routh tabulation. So, the number of zeros in the right half of the s-plane will be 2.

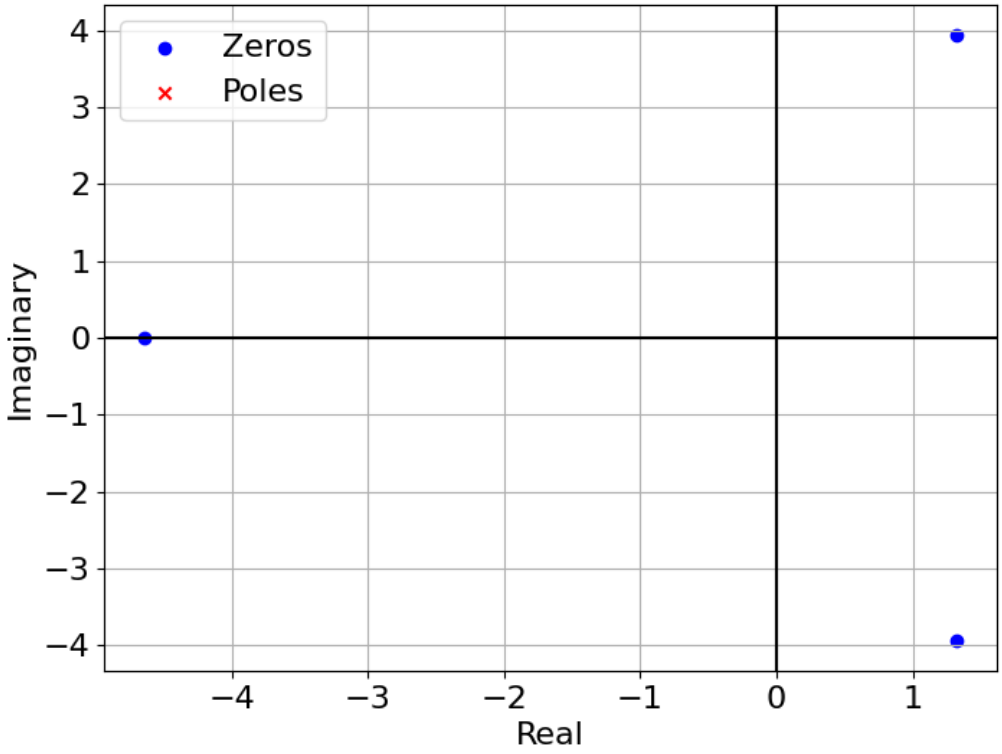

Figure 6.1:

6.2 The circuit shown in the figure is initially in the steady state with the switch K in open condition and $\overline{K}$ in closed condition. The switch K is closed and $\overline{K}$ is opened simultaneously at the instant $t = t_1$, where $t_1 > 0$. The minimum value of t_1 in milliseconds such that there is no transient in the voltage across the 100 μF capacitor, is _____ (Round off to 2 decimal places) (GATE EE 2023)