Contents

***Abstract*—This manual is an introduction to control systems based on GATE problems.Links to sample Python codes are available in the text.**

Download python codes using

1 Stability

1.0.1. The impulse response of a system is h(t)= tu(t). For an input u($t-1$), the output is:

Solution: The Impulse response of the system is given by:

$$h(t) = tu(t) \tag{1.0.1.1}$$

Input:

$$x(t) = u(t-1) \tag{1.0.1.2}$$

The output will be given by:

$$y(t) = x(t) * h(t) \tag{1.0.1.3}$$

1.0.2. We find the output using Laplace Transformation.
In Laplace domain Convolution becomes Multiplication.

$$F(y(t)) = Fx(t)Fh(t) \tag{1.0.2.1}$$

$$\implies Y(s) = \frac{e^{-s}}{s}\frac{1}{s^2} \tag{1.0.2.2}$$

$$\implies Y(s) = \frac{e^{-s}}{s^3} \tag{1.0.2.3}$$

1.0.3. Since we want the output in time domain we find the inverse Laplace Transform using Contour Integration.
The Inverse Laplace Transform :

$$y(t) = \frac{1}{2i\pi}\oint_C Y(s)e^{st}\,ds \tag{1.0.3.1}$$

$$\implies y(t) = \frac{1}{2i\pi}2i\pi\sum ResY(s)e^{st} \tag{1.0.3.2}$$

1.0.4. Calculating the Residue.

$$Res_{s=s_o} = \frac{1}{(p-1)!}\lim_{s\to s_o}\frac{d^{p-1}}{dx^{p-1}}\left[(s-s_o)^p f(s)\right] \tag{1.0.4.1}$$

where p denotes the number of times the pole is repeated.

$$ResY(s)e^{st} = \frac{1}{(3-1)!}\lim_{s\to 0}\frac{d^{3-1}}{dx^{3-1}}(s-0)^3\frac{e^{s(t-1)}}{s^3} \tag{1.0.4.2}$$

$$\implies ResY(s)e^{st} = \frac{1}{2!}\lim_{s\to 0}\frac{d^2}{dx^2}e^{s(t-1)} \tag{1.0.4.3}$$

$$\implies ResY(s)e^{st} = \frac{1}{2}(t-1)^2 \tag{1.0.4.4}$$

$$Hence, y(t) = \frac{1}{2}(t-1)^2 \tag{1.0.4.5}$$

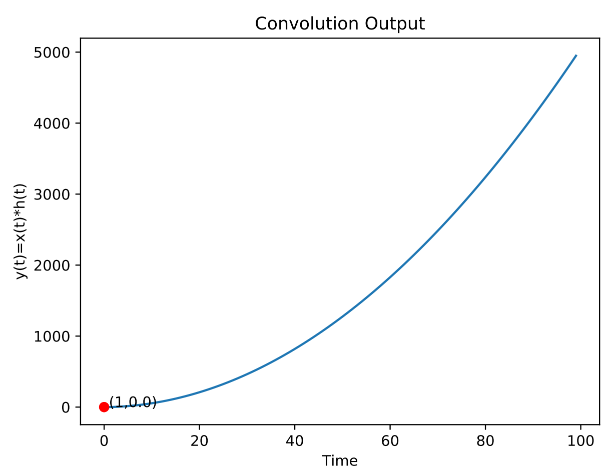

Fig. 1.0.4

The following code verifies the answer by performing convolution of the input and h(t) to obtain y(t) and plots the result . codes/ee18btech11048.py

2 Routh Hurwitz Criterion

3 Compensators

4 Nyquist Plot