Control Systems

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***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

```
svn co https://github.com/gadepall/school/trunk/
    control/codes
```

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4.3 Stability

4.1. Unit Step response of a linear time invariant (LTI) system is given by

$$y(t) = (1 - e^{-2t})u(t) \tag{4.1.1}$$

Assuming zero initial condition, the transfer function of the system is
Solution: We can convert this step response into s-domain using the Laplace Transform

$$Y(s) = \mathcal{L}(y(t)) \tag{4.1.2}$$

$$where \quad \mathcal{L}(y(t)) = \int_{-\infty}^{\infty} y(t)e^{-st}dt \tag{4.1.3}$$

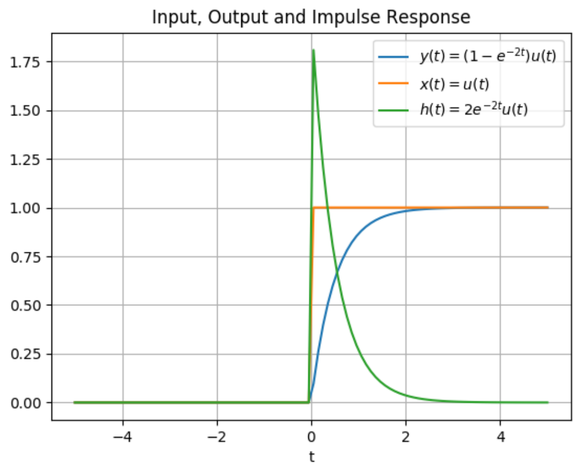
$$Y(s) = \mathcal{L}(y(t)) \tag{4.1.4}$$

$$\implies Y(s) = \mathcal{L}(u(t) - e^{-2t}u(t)) \tag{4.1.5}$$

$$\implies Y(s) = \mathcal{L}(u(t)) - \mathcal{L}(e^{-2t}u(t)) \tag{4.1.6}$$

$$\implies Y(s) = \frac{1}{s} - \frac{1}{s+2} \tag{4.1.7}$$

$$\implies Y(s) = \frac{2}{s(s+2)} \tag{4.1.8}$$



$$X(s) = \frac{1}{s} \tag{4.1.9}$$

The Transfer Function $H(s)$ is given by

$$H(s) = \frac{Y(s)}{X(s)} \tag{4.1.10}$$

$$H(s) = \frac{2}{s+2} \tag{4.1.11}$$

Hence the Transfer Function $H(s)$ is $\frac{2}{s+2}$

4.2. Plotting the input, output and impulse response using Python **Solution:**

codes/EE18BTECH11021.py

4.3. Comment on the stabilty of the system from the obtained transfer function
Solution: The Transfer Function is

$$H(s) = \frac{2}{s+2} \tag{4.3.1}$$

which has only 1 pole at s = -2, which is on the left half of s-plane therefore the system is stable
We can see that the output function attains a steady state of y = 1 as t tends to infinity, this is the verification that the system is stable

5 State-Space Model

5.1 *Controllability and Observabiity*

5.2 *Second Order System*

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