ELEC-C8201 Control and Automation
Exercise 3

1. The system is given by the differential equation: $\ddot{y}(t)+3\dot{y}(t)+2y(t)=3u(t)$

a. Specify the system transfer function $G(s)=Y(s)/U(s)$

b. Find output $y(t)$, when input $u(t)$ is a unit impulse function.

c. Find output $y(t)$, when input $u(t)$ is a unit step function.

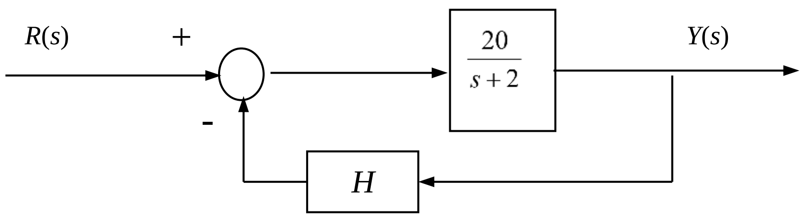
d. Find output $y(t)$, when input $u(t)$ is a unit ramp function.

2. Construct the differential equation and transfer function from the following state space representation.

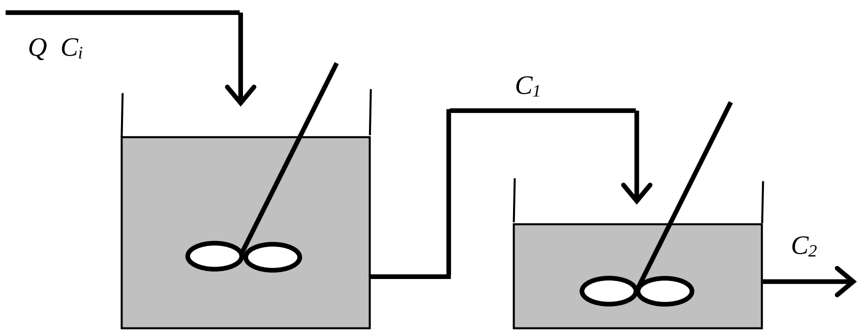
a. $\begin{cases} \dot{\mathbf{x}}(t)=\begin{bmatrix} -5 & 1 \\ -6 & 0 \end{bmatrix}\mathbf{x}(t)+\begin{bmatrix} 4 \\ 10 \end{bmatrix}u(t) \\ y(t)=\begin{bmatrix} 1 & 0 \end{bmatrix}\mathbf{x}(t) \end{cases}$

b. $\begin{cases} \dot{\mathbf{x}}(t)=\begin{bmatrix} -2 & 0 \\ 0 & -3 \end{bmatrix}\mathbf{x}(t)+\begin{bmatrix} 1 \\ 2 \end{bmatrix}u(t) \\ y(t)=\begin{bmatrix} 2 & 1 \end{bmatrix}\mathbf{x}(t) \end{cases}$

3. Calculate the system transfer function in the image below $Y(s)/R(s)$, when H = 0.4 and H = 0.9. Graphically show the locations of the closed loop poles and calculate the step and impulse responses.



4. The picture shows two ideal mixers in series. Concentrations $C_i(t)$, $C_1(t)$ and $C_2(t)$ are variables, and mixer volumes V_1, V_2 and volume flow Q are constant parameters (V_1 = 0.5 m^3 V_2 = 0.2 m^3 ja Q = 1 m^3/s). The input of the total process is $C_i(t)$ and output is $C_2(t)$.



Construct a differential equation, a state space representation and a transfer function describing the process and calculate:

a. Unit impulse response

b. Unit step response

c. the steady state value of step response
d. Static gain
e. Weighting function i.e. time domain impulse response