Quiz 1: Control Systems Eng.
2019/03/28

Student Number: [ ] Name:

1. (20 points = 2×10 pts)

(1) Solve the following differential equations with the given initial conditions:

$$y'' - y = 0 \text{ with initial conditions } y(0) = -1 \text{ and } y'(0) = 1.$$

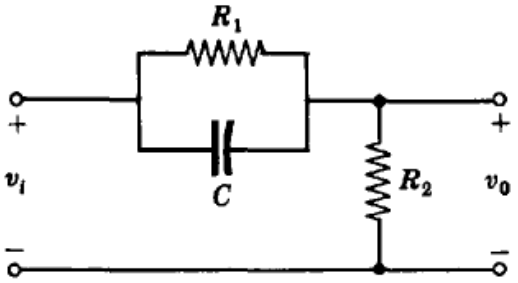
Hint: $L(f'(t)) = sL(f(t)) - f(0),\ L(f''(t)) = sL(f'(t)) - f'(0)$

(2) Write MATLAB code to find the transfer function, $G(s) = Y(s)/R(s)$, for the following system represented in state space.

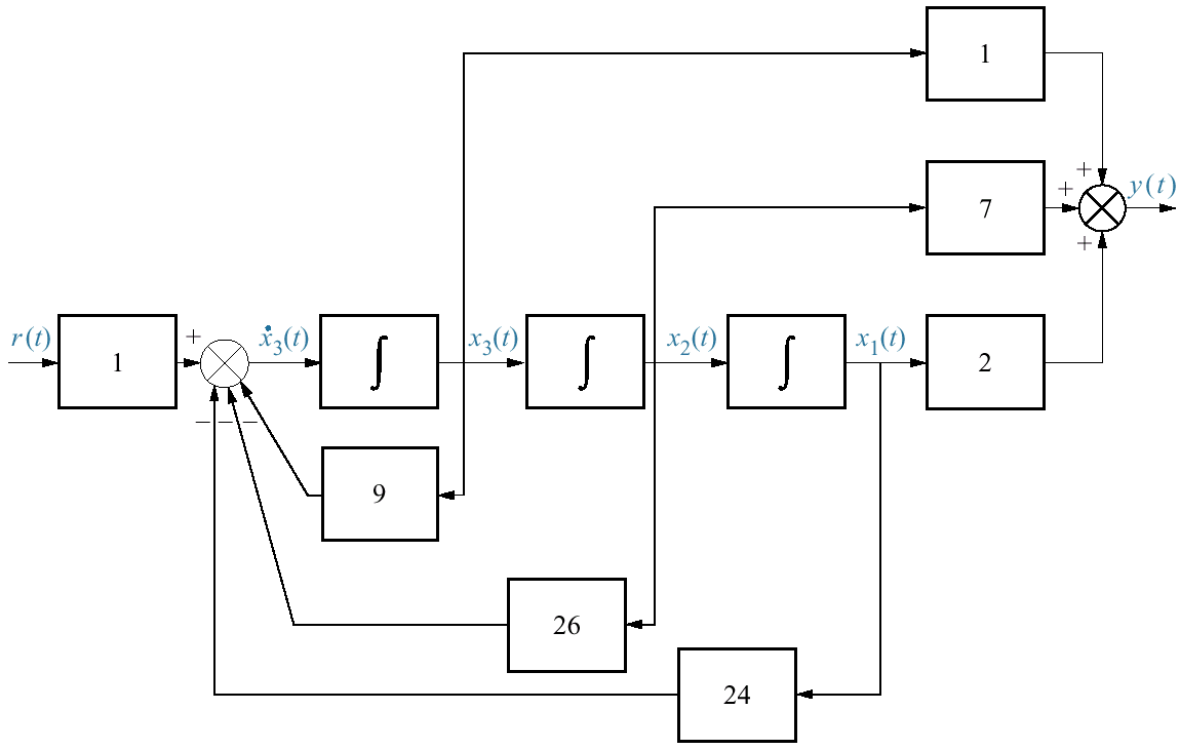
$$\dot{x} = \begin{bmatrix} 0 & 1 & 3 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -7 & -9 & -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 5 \\ 8 \\ 2 \end{bmatrix} r$$

$$y = \begin{bmatrix} 1 & 3 & 4 & 6 \end{bmatrix} x$$

2. (20 points) An *R-C* network mechanization of a lead compensator is shown in the following figure. Find its transfer function, $V_o(s)/V_i(s)$.



3. (20 points = 2×10 pts) Consider the following block diagram:



(1) Find a transfer function, $T(s) = \dfrac{Y(s)}{R(s)}$.

(2) Find a state-space representation of the block diagram.

4. (20 points) Find the transfer function of the following state-space representation.

$$\dot{\mathrm{x}} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \mathrm{x} + \begin{bmatrix} 0 \\ \dfrac{1}{m} \end{bmatrix} u, \qquad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \mathrm{x}$$

5. (20 points)

(1) (10 pts) Find the linear approximation of the function, $f(x) = \sqrt{1+2x}$ at $x = 4$.

(2) (5 pts) Use it to find an approximation for the value of $f(4.3)$.

(3) (5 pts) Calculate the absolute difference between real value and approximated value at $x = 4.3$. (use: the real value of $f(4.3) = 3.098$)