



Course: Computer-Controlled Systems (CSE422)

Sheet No.: 6

Date: 29/4/2018

Due: 5/5/2018

Time: 2 Hours

Review of Matrix Operations:

1. Multiplication.
2. Matrix inverse.
3. Determine the rank of the following matrices:

a) $X = \begin{bmatrix} 1 & 2 & 4 & 4 \\ 3 & 4 & 8 & 0 \end{bmatrix}$

b) $Y = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & 5 \\ 3 & 4 & 7 \\ 4 & 5 & 9 \end{bmatrix}$

4. How to determine if a square matrix has a full rank?

Problems:

1. A block diagram is shown in Figure 1. The state variables are denoted by x_1 and x_2 . Determine a state variable representation of the closed-loop system where the output is denoted by $y(t)$ and the input is $r(t)$.

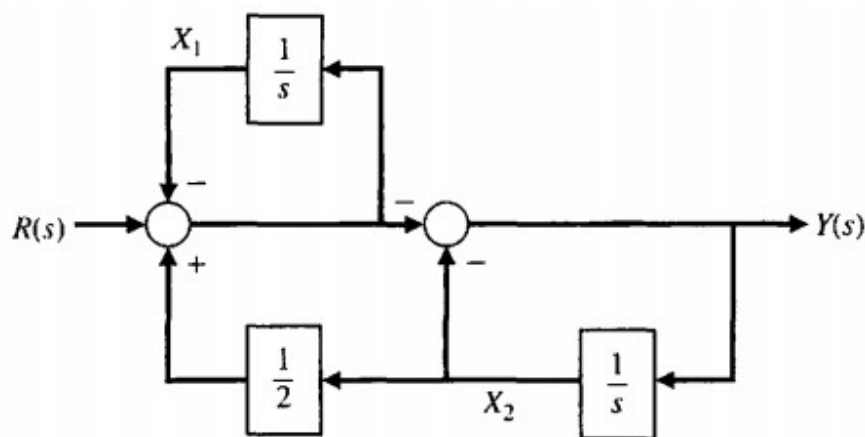


Figure 1

2. Two carts with negligible rolling friction are connected as shown in Figure 2. An input force is $u(t)$. The output is the position of cart 2, that is, $y(t) = q(t)$. Determine a state space representation of the system.

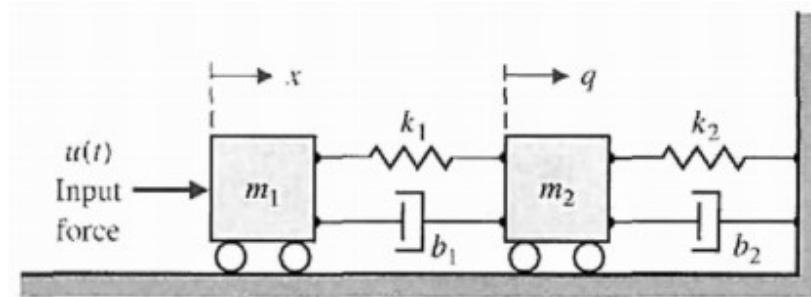


Figure 2

3. Determine a state variable differential matrix equation for the circuit shown in Figure 2.

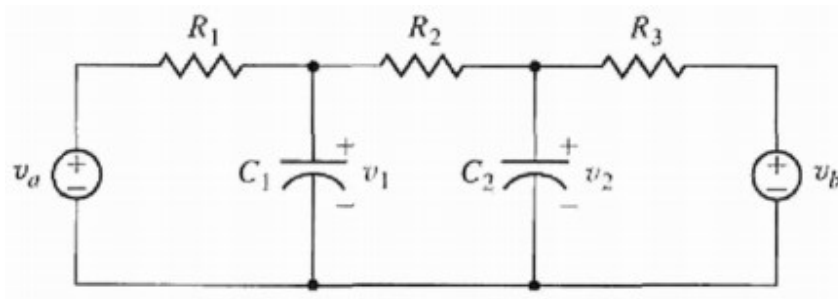
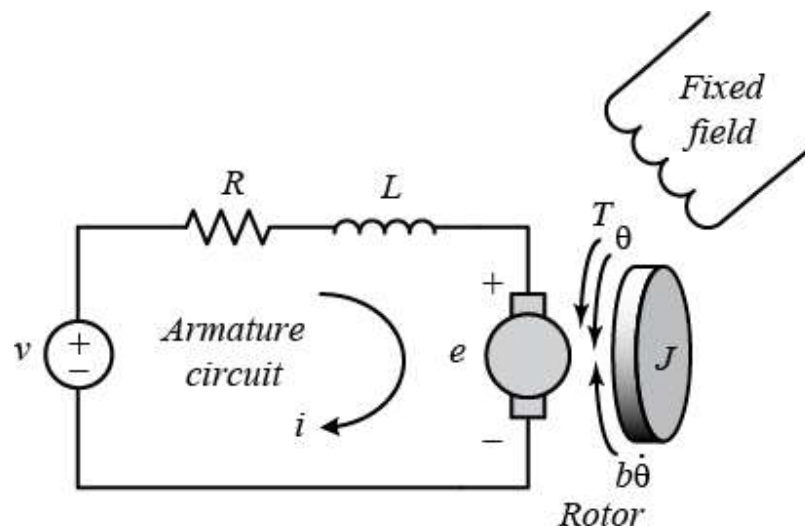


Figure 3

Homework:

1. Determine the state space model for the following DC motor block diagram.



2. Determine if the following RLC system is controllable and observable:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -\frac{R}{L} & -\frac{1}{L} \\ \frac{1}{C} & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix} u$$

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} R & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$