Assignment 1, Control Systems, 7th Semester

Deadline: Wednesday, October 25, 2023 (in class)

Assignment should be hand written.
Write your name, registration no. and section, or else your assignment may not be marked.
Copied assignments will be awarded 0 marks.
Staple your pages properly (binding is not required)

Question 01:

Find the transfer function for each of the following systems represented in state space:

a)

$$\frac{dx}{dt} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -2 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$$

b)

$$\frac{dx}{dt} = -5x + 3u$$

$$y = 7x$$

Question 02:

Compute the poles, zeros and analyze stability of the following transfer functions.

a) $G(s) = \frac{s}{(s+1)(s+2)(s+3)}$ b) $G(s) = \frac{(s+3)^2}{s+10}$ c) $G(s) = \frac{s(s-3)}{(s-10)(s-1)}$

Question 03:

Convert the following transfer function to state-space domain using canonical form 1, canonical form 2, controller canonical form and observer canonical form.

$$G(s) = \frac{s+2}{s^3 + 8s^2 + 19s + 12}$$

Question 04:

Use MATLAB, to convert the following state-space model to transfer function.

$$\frac{dx}{dt} = \begin{bmatrix} 2 & -3 & -8 \\ 0 & 5 & 3 \\ -3 & -5 & -4 \end{bmatrix} x + \begin{bmatrix} 1 \\ 4 \\ 6 \end{bmatrix} u$$

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

Question 05:

A hard disk drive (HDD) is a data storage device. It is used almost in every computing device including laptops, desktop computers, video game consoles, digital video recorders, mobiles and tablets. A hard disk stores data and nowadays we have too much data to store. Therefore, we require hard disks which can store more data (more data per square inch), which means the storage density of data is high. A hard disk uses magnetic storage system along with electronic hardware to access the data.

The electronic circuit of a hard disk consists of a dc motor. A dc motor has the following state-space:

$$\begin{bmatrix} \dot{\theta} \\ \dot{\Theta} \\ \dot{i} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & \frac{-b}{J} & \frac{k}{J} \\ 0 & \frac{k}{L} & \frac{-R}{L} \end{bmatrix} \begin{bmatrix} \theta \\ \Theta \\ i \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \frac{1}{L} \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0.5 & 0 \end{bmatrix} \begin{bmatrix} \theta \\ \Theta \\ i \end{bmatrix}$$

The above state-space equation is taken from the website https://ctms.engin.umich.edu/CTMS/index.php?example=MotorPosition&section=ControlStateSpace

Using the values of J = 3.2, b = 3.5, k = 0.0274, R = 4 and L = 2.75, perform following tasks:

- Convert the state-space model to transfer function
- Check the stability of the hard disk system