Department of Computer Systems Engineering, University of Engineering and Technology, Peshawar, Pakistan

Midterm Exam (Fall 2023)
Time Allowed: 2 hours
Total Pages: 2 (including this)

Course Title: Control Systems
Course Code: CSE-310
Max Marks: 30

INSTRUCTIONS:

1. Write your name and registration number on the question paper; and write your complete particulars/ details as required on the front sheet of answer sheet.
2. All questions are compulsory. There are total three questions. Any question attempted twice will be marked zero.
3. Please write the same question number while attempting it and do not renumber the questions yourself.
4. This paper is closed book. All answers must be supported by facts and calculations.
5. Use blue or black ink only. Any answer or part of answer written with pencil will be marked zero.

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The following formula might be helpful in solving the problems.

$$G(s) = C(sI - A)^{-1}B + D$$

Question 1 (10 Marks): Compute the zeros, poles and check the stability of the following three transfer functions:

$$G_1(s) = \frac{35.2s^2 + 14s - 365}{(s+3)(s-2)(s+15)}$$

$$G_{191}(s) = \frac{1}{(s+365.32)(s+298345)(s+15011)}$$

$$H_1(s) = (s - 365.32)(s - 298345)(s - 15011)$$

Question 2 (10 marks): A transfer function can be converted into state-space model using canonical form. We have different types of canonical forms. Let $G(s)$ be a transfer function whose canonical form is given as follows:

$$G(s) = \frac{b_3 s^3 + b_2 s^2 + b_1 s^1 + b_0}{s^4 + a_3 s^3 + a_2 s^2 + a_1 s^1 + a_0}$$

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -a_0 & -a_1 & -a_2 & -a_3 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} \tag{1}$$

$$C = \begin{bmatrix} b_0 & b_1 & b_2 & b_3 \end{bmatrix}, \qquad D = [0].$$

Consider the system as shown in Figure 1, where $R(s)$ is the input, $C(s)$ is the output and the symbol $\sum$ denotes the summer or summing junction. Obtain the state-space representation of the system shown in Figure 1, using the above canonical form expressed in Equation (1).

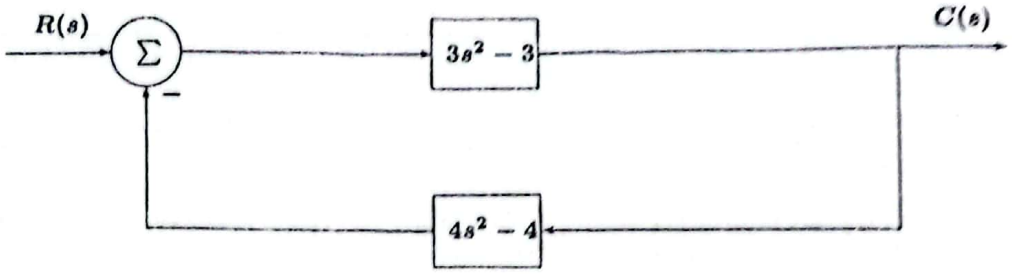

Figure 1: Figure to consider for solving Question 2

Question 3 - CLO2 (10 marks): The step response of a first order transfer function is shown in Figure 2. *Analyze* the step response and estimate the transfer function of the system from the step response shown in Figure 2.

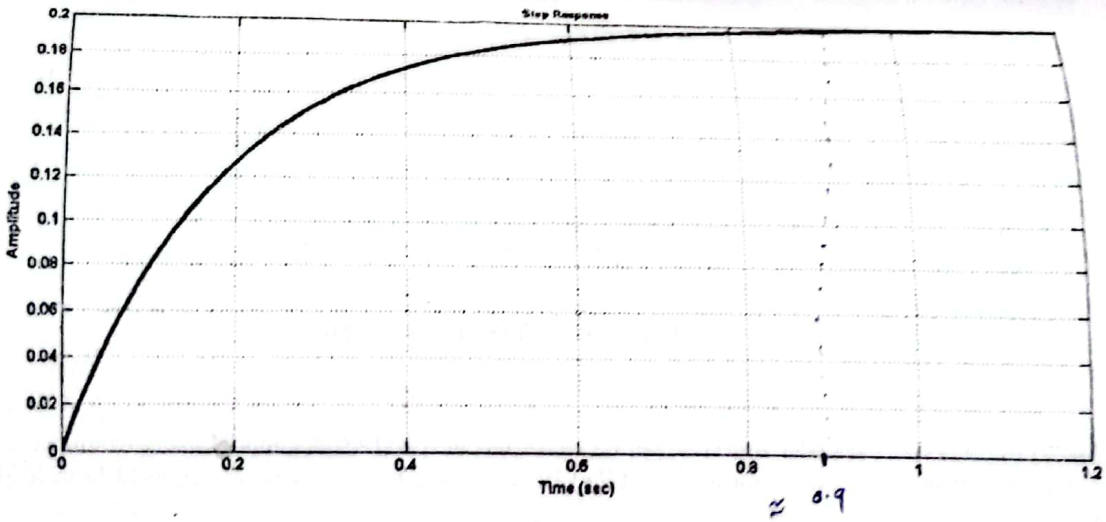

Figure 2: Figure to consider for Question 3