

BANGLADESH UNIVERSITY OF BUSINESS AND TECHNOLOGY (BUBT)
Faculty of Engineering and Applied Sciences
Department of Electrical and Electronic Engineering
Program: B.Sc. in EEE
EEE 401: Control System Design
(Section: 1 & 2; Shift: Day; Intake: 26)

Mid Term

Fall 2021-22

Total Marks: 30

Time: 2 hrs.

Course Instructor: Sk. Hasibul Alam

Instructions:

- 'M' is the last digit of your student ID.
- Answer all questions. Q1 includes five short questions in total with two marks each.
- The marks on the right-hand side in square brackets indicate marks for that question only.
- Attach your answer script in PDF format in Google Classroom.
- Do not forget to rename your file as: **ID.pdf**
(Example: 16173208999.pdf)
- Capture your answer script in portrait orientation.

CO1: Demonstrate the basic understanding of dynamic control systems [PO1]

Q1. (a) Calculate the Laplace transform of $(M + 5)e^{-2t}tu(t)$. [2]

(b) Find the expression $Y(s)/X(s)$ for the following differential equation: [2]

$$\frac{d^2y}{dt^2} + (M + 15)y = (M + 15)\frac{d^2x}{dt^2} + \frac{dx}{dt}$$

(c) Determine the settling time for the following system: [2]

$$G(s) = \frac{M + 1}{s + M + 1}$$

(d) A 1st-order system with no zeros has unity DC gain and rise time of $(M+0.1)$ second. Find its pole location. [2]

(e) Find the impulse response for the following transfer function: [2]

$$G(s) = \frac{M + 5}{s + M + 5}$$

CO2: Develop the mathematical models of physical systems in forms suitable for use in the analysis and design of control systems [PO2]

- Q2. (a)** Determine the transfer function $X_1(s)/F(s)$ for the mechanical system shown in Fig. Q2(a). [5]
Here, each spring has a constant of $(M+5)$ N/m. Simplify your answer.

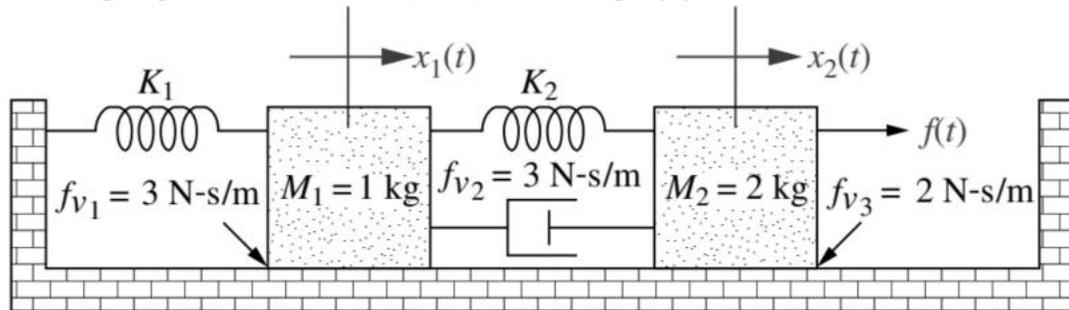


Fig. Q2(a)

- (b)** Determine the transfer function $V_o(s)/V_i(s)$ for the operational amplifier shown in Fig. Q2(b). [5]
Here, each resistor has a value of $(M+10)$ Ω , and each capacitor has a value of 0.5 F. Simplify your answer.

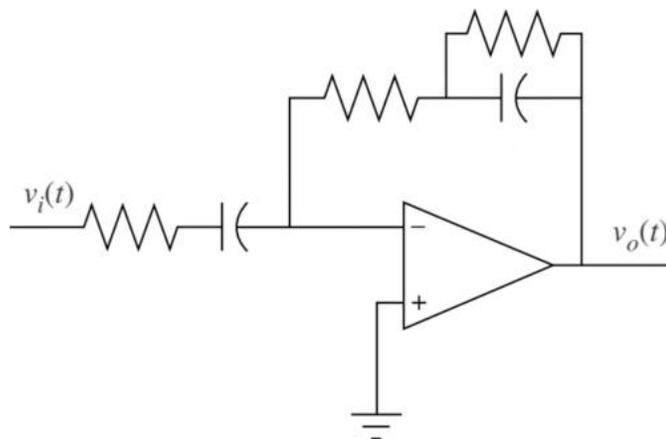


Fig. Q2(b)

- Q3. (a)** Draw the equivalent block diagram of state-space representation for the following transfer function: [5]

$$G(s) = \frac{s^2 + 5s + M + 10}{s^3 + 8s^2 + 10s + 12}$$

- (b)** Find the transfer function $G(s) = Y(s)/R(s)$ for the following system represented in state-space. Simplify your answer. [5]

$$\dot{\mathbf{x}} = \begin{bmatrix} (M+5) & -1 & 0 \\ 2 & 4 & -2 \\ 0 & 1 & 2 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 7 \\ 0 \\ 0 \end{bmatrix} r$$

$$y = [5 \quad 0 \quad 0] \mathbf{x}$$

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CO1: Demonstrate the basic understanding of dynamic control systems [PO1]

Q1. (a) Calculate the Laplace transform of $\cos((M + 5)t) u(t)$. [1]

(b) Find the expression $Y(s)/X(s)$ for the following differential equation: [1]

$$\frac{dy}{dt} + (M + 5)y = (M + 5) \frac{d^2x}{dt^2} + x$$

(c) Write the differential equation for the following transfer function: [1]

$$\frac{X(s)}{F(s)} = \frac{s + M + 2}{s^2 + 2}$$

(d) Calculate the inverse Laplace transform of the following: [1]

$$F(s) = \frac{M + 15}{(s + 15)^2}$$

(e) Find the ramp response for the following transfer function: [1]

$$G(s) = \frac{7s^2}{s + M + 7}$$

- Q2. (a)** Determine the transfer function $V_o(s)/V_i(s)$ for the operational amplifier circuit shown in Fig. Q2(a). Each resistor has a value of $(M+50) \Omega$, and each capacitor has a value of 1 F. Simplify your answer. [5]

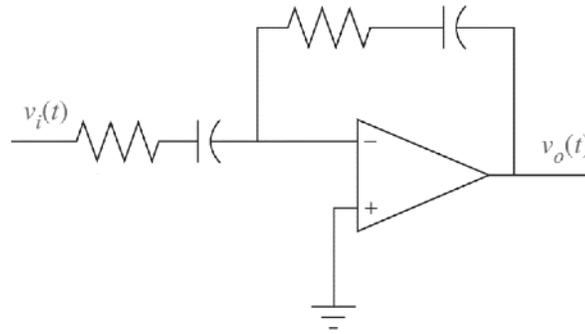


Fig. Q2(a)

- (b)** Determine the transfer function $\theta_1(s)/T(s)$ for the rotational mechanical system shown in Fig. Q2(b). Each spring has a spring constant of $(M+2) \text{ N-m/rad}$. Simplify your answer. [5]

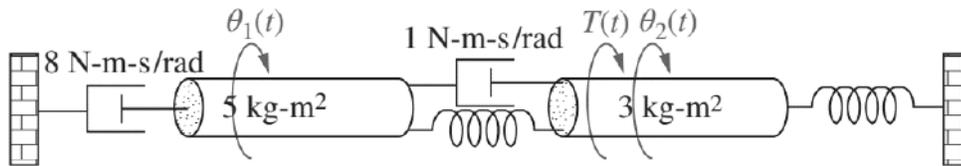


Fig. Q2(b)

CO2: Develop the mathematical models of physical systems in forms suitable for use in the analysis and design of control systems [PO2]

- Q3. (a)** Find the equivalent block diagram of state-space representation for the following transfer function: [5]

$$G(s) = \frac{s^2 + s + M + 10}{(s + 5)(s^2 + 2s + 5)}$$

- (b)** Find the transfer function $G(s) = Y(s)/R(s)$ for the following system represented in state-space. Simplify your answer. [5]

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 \\ 4 & 7 \end{bmatrix} \mathbf{x} + \begin{bmatrix} M \\ 15 \end{bmatrix} r$$

$$y = [1 \quad M] \mathbf{x}$$

- (c)** Draw the approximate step response curve of the following 1st-order system (from 0 to 5 seconds). [5]

$$G(s) = \frac{5(s + (4/(M + 5)))}{s + (3/4)}$$