Control System Design (Summer 2023)

AME 455: Homework 1

Due Sun, Jun 11th by midnight

Submission Guidelines: Complete the following problems and upload to D2L by the due date. You are allowed to use **Laplace Transform Table**.

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1. **(1.5 points)** Compute the Laplace transform for the following functions:
   (a) (**0.5 points**) $f(t) = e^{5t} + 5$
   (b) (**0.5 points**) $f(t) = \cos(3t) + 7\sin(3t)$
   (c) (**0.5 points**) $f(t) = e^{-4t}\cosh(5t) + 6e^{-4t}\sinh(5t)$
2. **(1.5 points)** Solve the following ODE's using Laplace transforms and find $y(t)$ subject to initial conditions:
   (a) (**0.5 points**) $\ddot{x} - 10\dot{x} + 25x = 24t^2e^{5t}, \qquad x(0) = -2, \quad \dot{x}(0) = -10$
   (b) (**0.5 points**) $\ddot{y} - 3\dot{y} - 10y = 1, \qquad y(0) = -1, \quad \dot{y}(0) = 2$
   (c) (**0.5 points**) $\ddot{y} + 16y = 1, \qquad y(0) = 1, \quad \dot{y}(0) = 2$
3. **(1.0 point)** Obtain mathematical models of the mechanical system shown in the following figures (Figure 1 & Figure 2):

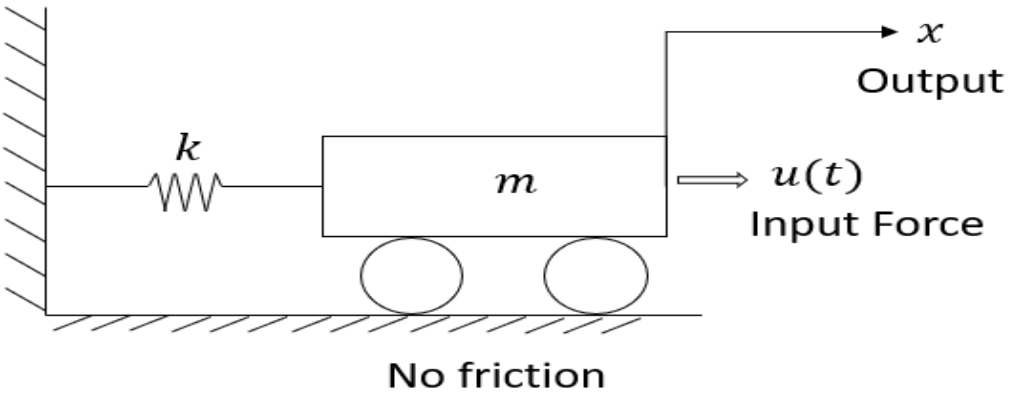

Figure 1: (a)

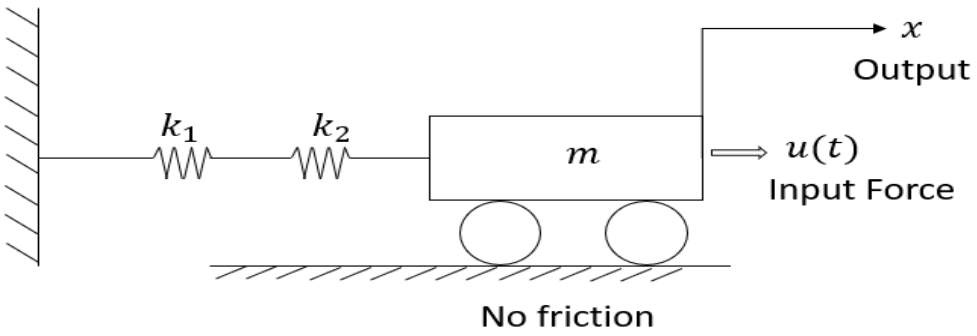

Figure 2: (b)

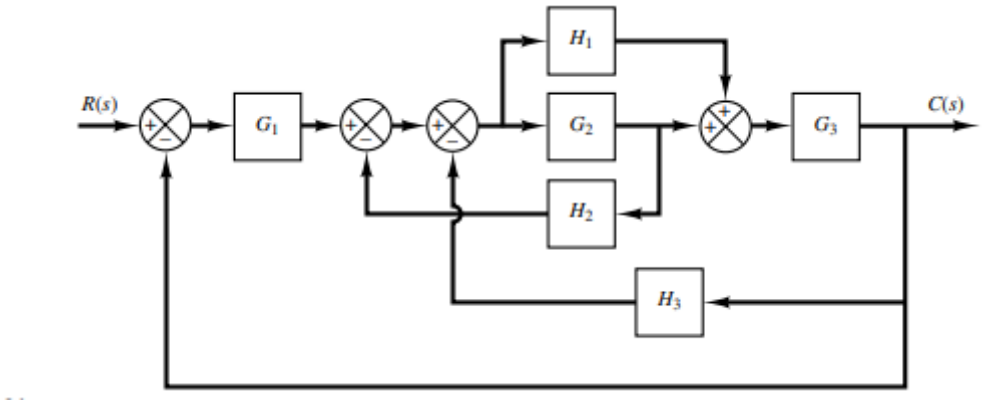

Figure 3: Block diagram of a system

4. **(1.0 point)** Find the closed-loop transfer function $\frac{C(s)}{R(s)}$ for the block diagram (Figure 3):