Concordia University
MECH 371 ANALYSIS AND DESIGN OF CONTROL SYSTEMS
Assignment 1

E2.5 A noninverting amplifier uses an op-amp as shown in Figure E2.5. Assume an ideal op-amp model and determine v_o/v_{in}.

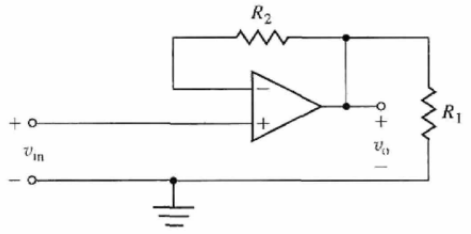

FIGURE E2.5 A noninverting amplifier using an op-amp.

E2.6 A nonlinear device is represented by the function

$$y = f(x) = e^x,$$

where the operating point for the input x is $x_o = 1$. Determine a linear approximation valid near the operating point.

E2.21 A high-precision positioning slide is shown in Figure E2.21. Determine the transfer function $X_p(s)/X_{in}(s)$ when the drive shaft friction is $b_d = 0.7$, the drive shaft spring constant is $k_d = 2$, $m_c = 1$, and the sliding friction is $b_s = 0.8$.

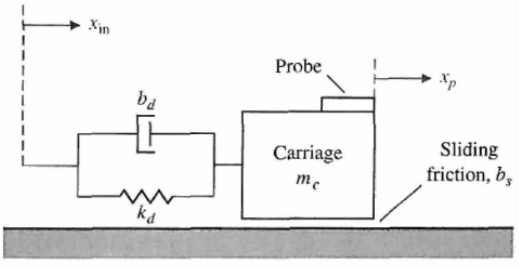

FIGURE E2.21 Precision slide.

P2.37 A two-mass system is shown in Figure P2.37 with an input force $u(t)$. When $m_1 = m_2 = 1$ and $K_1 = K_2 = 1$, find the set of differential equations describing the system.

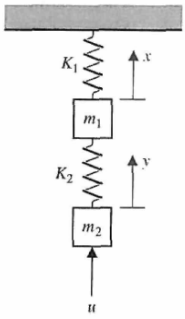

FIGURE P2.37 Two-mass system.

P2.46 A load added to a truck results in a force F on the support spring, and the tire flexes as shown in Figure P2.46(a). The model for the tire movement is shown in Figure P2.46(b). Determine the transfer function $X_1(s)/F(s)$.

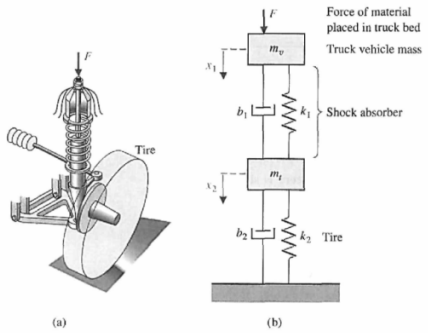

FIGURE P2.46 Truck support model.

AP2.5 For the three-cart system illustrated in Figure AP2.5, obtain the equations of motion. The system has three inputs u_1, u_2, and u_3 and three outputs x_1, x_2, and x_3. Obtain three second-order ordinary differential equations with constant coefficients. If possible, write the equations of motion in matrix form.

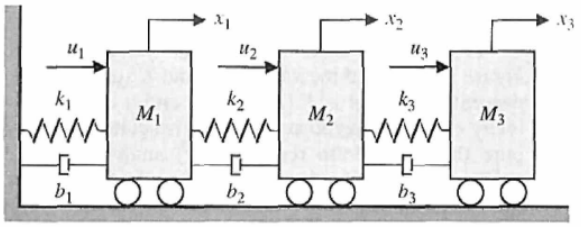

FIGURE AP2.5 Three-cart system with three inputs and three outputs.

CP2.4 Consider the mechanical system depicted in Figure CP2.4. The input is given by $f(t)$, and the output is $y(t)$. Determine the transfer function from $f(t)$ to $y(t)$ and, using an m-file, plot the system response to a unit step input. Let $m = 10$, $k = 1$, and $b = 0.5$. Show that the peak amplitude of the output is about 1.8.

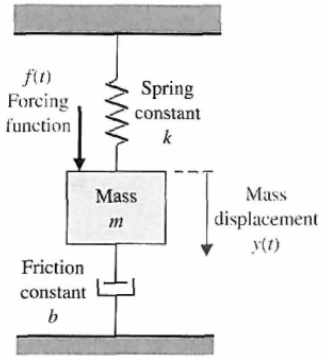

FIGURE CP2.4 A mechanical spring-mass-damper system.