The University of Texas at Austin

Mechanical Engineering Department

MODELING OF PHYSICAL SYSTEMS

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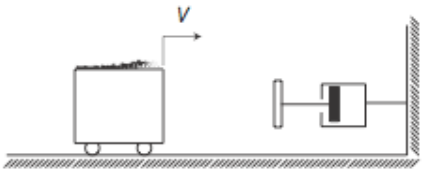
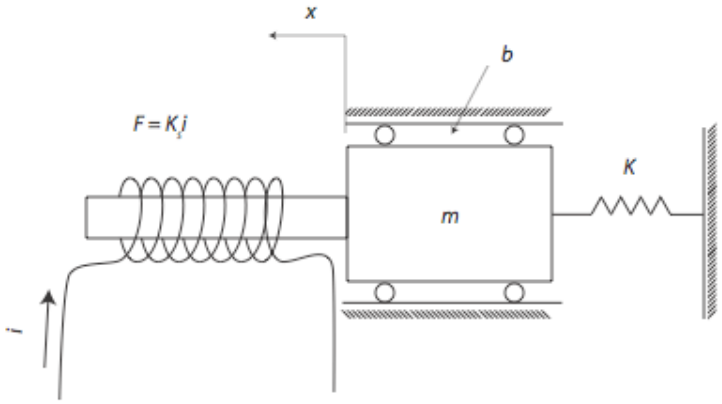
Assigned 2/24/2022	**Assignment 3**	Due 3/3/2022

Read Chapter 4 and Chapter sections 5.1 and 5.2

1) Shown below is a cart containing a load of scrap. You have been hired to design a damper to stop this cart in 10 seconds if the initial velocity of the cart is .5 m/s and the cart has a mass of 1,000 kg.
   (a) Calculate the necessary damping coefficient b.
   (b) How long does the damper stroke have to be?
   (c) How much heat is generated?

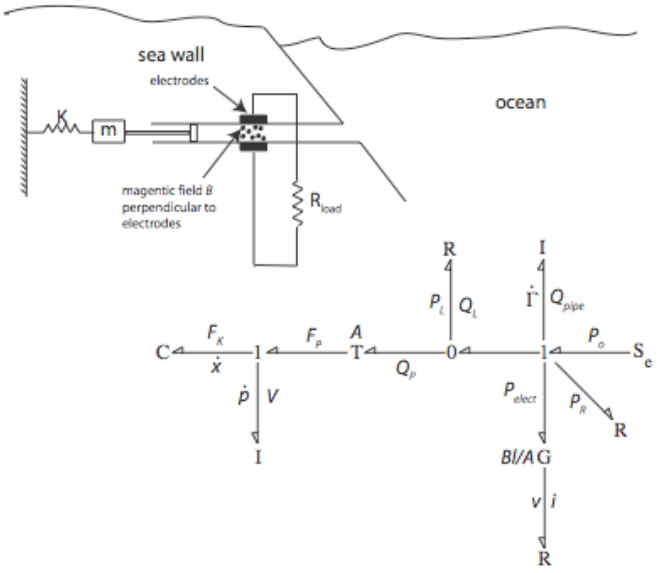


2) Shown below is a portion of a positioning mechanism in a machine. The parameters in the model have the values K_s = 1 N/A, k = 100 N/m, m = 1 kg, b = 10 N-sec/m.



   (a) Develop a bond graph model for this system.
   (b) Obtain state equations for your model.
   (c) Obtain a 2nd order differential equation x.
   (d) Is the system over damped or under damped?
   (e) For a step input in current, i = 1 A, find the maximum value of the position x.
   (f) At what time after the step does the maximum occur?
   (g) What is the steady state position of x?
   (h) It is desired that the maximum value of x never exceed the steady state value. Find the smallest value of b to achieve this result.

3) Shown below is a portion of a system and bond graph model for scavenging energy from waves and the tide.



The bond graph elements have the constitutive relations:

$P_o\ (t)$

$v = R_{load} i$

$P_R = R_{pipe} Q_{pipe}$

$Q_{pipe} = \Gamma / I$

$Q_L = P_L / R_L$

$V = p/m$

$F_K = Kx$

$P_{elect} = Bli/A$

Obtain a set of state equations for this bond graph model.