Mechanical System Modeling and Design Exam 1   Spring 2005

The FE reference book may be used during this exam. 4:10-5:50, 152 B.

1. For the equations (or set of equations) below, assuming all greek characters are known constants, list the numbers of the equations that are:

   (a) linear

   (b) time invariant (autonomous)

$$\dot{x} = \sigma x + \beta y$$
$$\dot{y} = \gamma y + \alpha xy \tag{1}$$

$$\dot{x} = \sigma x + \beta y$$
$$\dot{y} = \gamma y + \alpha x \tag{2}$$

$$\dot{x} = \sigma x + t\beta y$$
$$\dot{y} = \sin(\gamma) y + \alpha x \tag{3}$$

$$\dot{x} = \sigma x + \beta y$$
$$\dot{y} = \sin(t) y + \alpha \sin(x) \tag{4}$$

2. Create the block diagram for the following system of equations using the blocks below. Signs, # of ports, and directions may be changed, of course. *Don't forget the outputs!*

$$\dot{T}_1 + \alpha T_1^4 - \beta T_2^4 = Q_1$$
$$\dot{T}_2 + \alpha T_2^4 - \beta T_1^4 = Q_2$$

   Print it or email it to me.

3. Consider the following system inputs. Discuss under what conditions they are flow sources, and under what conditions they are potential sources.

   (a) Battery

   (b) Space heater

   (c) Motor

4. An actuator drives a system with the equation

$$10\ddot{x} + 0.1\dot{x} + 100x = F(t) \tag{5}$$

   where units are kg, kg/s, and N/m. It is limited to a stroke of 2 cm.

   (a) Generate the simulink block diagram incorporating this limitation using a "simulation failure" warning.

   (b) Generate the simulink block diagram incorporating this limitation by forcing it to be met. (This is hard, expect it to be curved. There are numerous "correct approaches".)