O K L A H O M A S T A T E U N I V E R S I T Y

S C H O O L O F E L E C T R I C A L A N D C O M P U T E R E N G I N E E R I N G

ECEN 4413/MAE 4053
Automatic Control Systems
Spring 2010
Final Exam

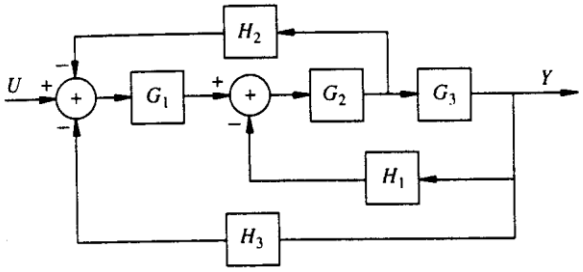
Choose any four out of five problems.
Please specify which four listed below to be graded:
1)_____; 2)_____; 3)_____; 4)_____;

Name : _____

E-Mail Address:_____

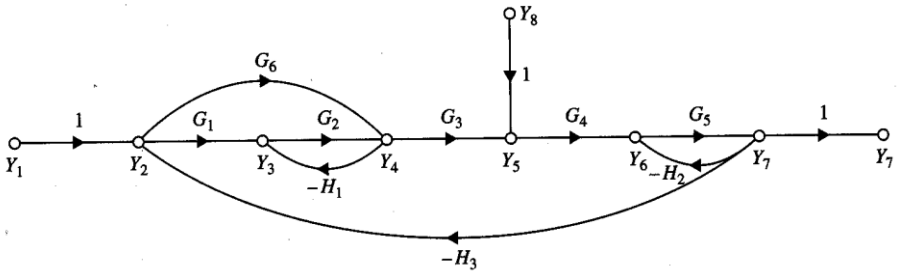
Problem 1:

For the plant shown below, please find the closed-loop transfer function, $Y(s)/U(s)$, using *block diagram reduction*.



Problem 2:

Apply the gain formula to the SFG shown below to find the transfer functions of $\left.\frac{Y_7}{Y_1}\right|_{Y_8=0}$ and $\left.\frac{Y_7}{Y_4}\right|_{Y_1=0}$.



Problem 3:

Choose state variables *ad hoc* to express the following system in which *u* is the input and *y* is the output,

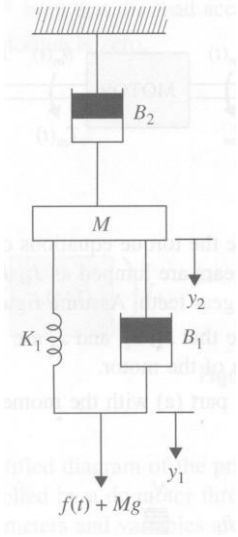
$$\frac{d^3y(t)}{dt^3} + 2\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 4y(t) = 5\frac{d^3u(t)}{dt^3} + 6\frac{d^2u(t)}{dt^2} + 7\frac{du(t)}{dt} + 8u(t)$$

into a state space representation as

$$\dot{x}(t) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t) + Du(t)$$.

Problem 4:

Write the equation of motion for the linear translational system shown below. Draw the state diagram. Write the state equation from the state diagram. Find the transfer functions $Y_1(s)/F(s)$ and $Y_2(s)/F(s)$. Set $Mg = 0$ for the transfer function.



Problem 5:

An inventory-control system is modeled by the following differential equations,

$$\dot{x}_1(t) = -x_2(t) + u(t)$$

$$\dot{x}_2(t) = -Ku(t)$$

where $x_1(t)$ is the level of inventory; $x_2(t)$, the rate of sales of product; $u(t)$, the production rate; and K, a real constant. Let the output of the system by $y(t) = x_1(t)$ and $r(t)$ be the reference set point for the desired inventory level. Let $u(t) = r(t) - y(t)$. Determine the constraint on K so that the closed-loop system is stable.