Department of Electrical and Computer Engineering
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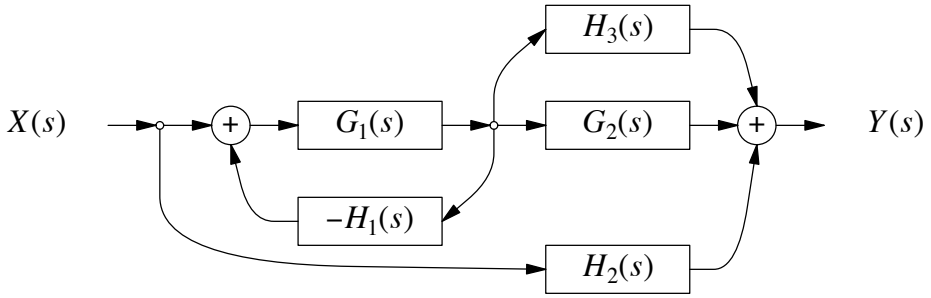
16.413 Problem Set #3

1. Consider the block diagram below.

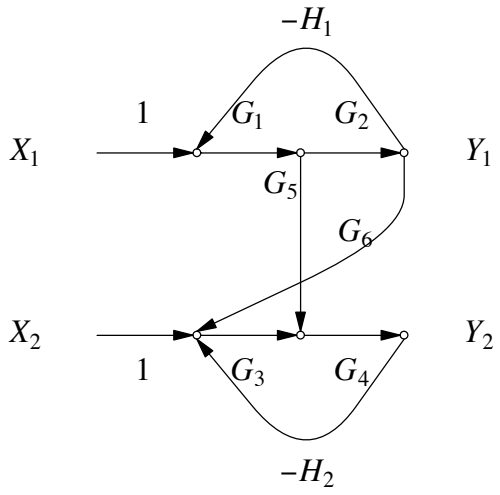


(a) Evaluate the signal flow graph
(b) Determine the transfer function $Y(s)/X(s)$.

2. Given the signal flow graph below determine the transfer matrix A where $A_{ij} = Y_i/X_j$.

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$$

Note that $A_{ij} = Y_i/X_j$ given that all other inputs are equal to zero.



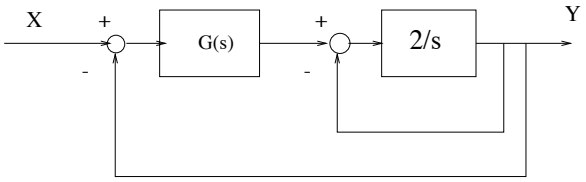
3. Given the system equations

$$\frac{dx_1}{dt} = x_1 + 3x_2$$
$$\frac{dx_2}{dt} = 2x_1 + u$$

a. Draw a signal-flow graph representation of the system where $U(s)$ is the input and $X_1(s)$ is the output. You may assume zero initial conditions.

b. Find the transfer function $X_1(s)/U(s)$ using Mason's Gain formula. Check your result using an algebraic approach.

4. For the system below



a. Determine the transfer function Y/X

b. If the error is defined as $e(t) = x(t) - y(t)$ determine a $G(s)$ such that $e(\infty) = 1/2$ when $x(t) = t^2u(t)$.