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Programme: Computer Engineering

1) Problem 23c

$$\dot{x} = \begin{bmatrix} 7 & 1 & 0 \\ -3 & 2 & -1 \\ -1 & 0 & 2 \end{bmatrix} x + \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} r \qquad y = \begin{bmatrix} 1 & 3 & 2 \end{bmatrix} x$$

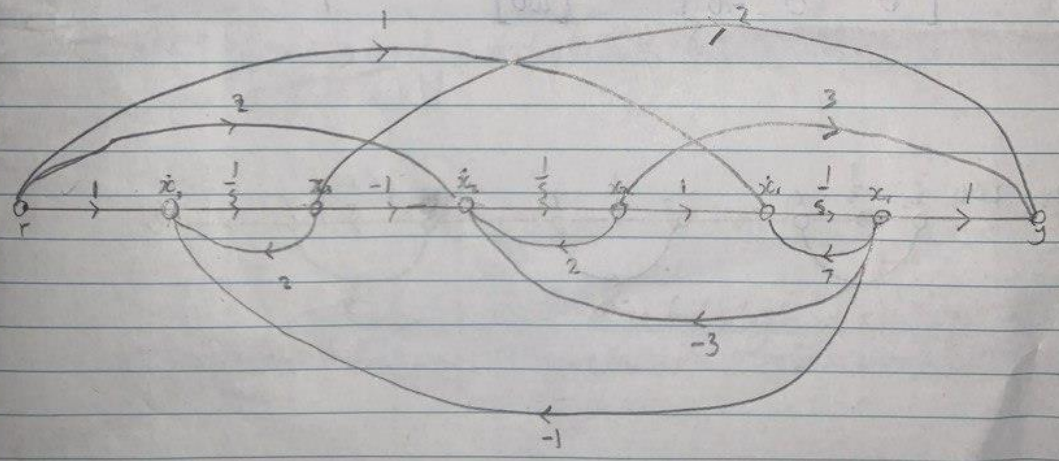
Solution

$\dot{x}_1 = 7x_1 + x_2 + r$ ✓

$\dot{x}_2 = -3x_1 + 2x_2 - x_3 + 2r$ ✓

$\dot{x}_3 = -x_1 + 2x_3 + r$ ✓

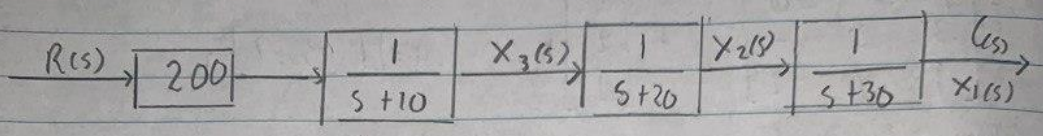
$y = x_1 + 3x_2 + 2x_3$



29) Problem 24b

$$G(s) = \frac{200}{(s+10)(s+20)(s+30)}$$

Using matlab



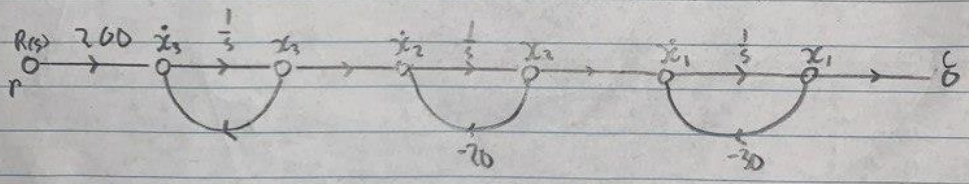
$\dot{x}_1 = -30x_1 + x_2$

$\dot{x}_2 = -20x_2 + x_3$

$\dot{x}_3 = -10x_3 + 200r$

$y = x_1$

$$\dot{x} = \begin{bmatrix} -30 & 1 & 0 \\ 0 & -20 & 1 \\ 0 & 0 & -10 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 200 \end{bmatrix} r \quad , \quad y = [1\ 0\ 0]x + [0]r$$



3) Problem 27

(E) I. Forward-path gains

$T_1 = G_1 G_2 G_4 G_6 G_7$

$T_2 = G_1 G_2 G_5 G_6 G_7$

$T_3 = G_1 G_3 G_4 G_6 G_7$

$T_4 = G_1 G_3 G_5 G_6 G_7$

II. Loop-Gains

$G_6 H_1$ $\quad G_2 G_4 G_6 G_7 H_3$ $\quad G_3 G_4 G_6 G_7 H_3$

$G_7 H_2$ $\quad G_2 G_5 G_6 G_7 H_3$ $\quad G_3 G_5 G_6 G_7 H_3$

III Non-touching loop gain

Two-at-a-time: $G_6 H_1$ & $G_7 H_2$

$$T(s) = \frac{T_1 \Delta_1 + T_2 \Delta_2 + T_3 \Delta_3 + T_4 \Delta_4}{\Delta}$$

$$\Delta = 1 - [G_2 G_4 G_6 G_7 H_3 + G_3 G_4 G_6 G_7 H_3 + G_2 G_5 G_6 G_7 H_3 + G_3 G_5 G_6 G_7 H_3] + [G_6 H_1 G_7 H_2]$$

$$\Delta_1 = \Delta_2 = \Delta_3 = \Delta_4 = 1$$

$$T(s) = \frac{G_1 G_2 G_4 G_6 G_7 + G_1 G_2 G_5 G_6 G_7 + G_1 G_3 G_4 G_6 G_7 + G_1 G_3 G_5 G_6 G_7}{1 - [G_2 G_4 G_6 G_7 H_3 + G_3 G_4 G_6 G_7 H_3 + G_2 G_5 G_6 G_7 H_3 + G_3 G_5 G_6 G_7 H_3] + [G_6 H_1 G_7 H_2]}$$

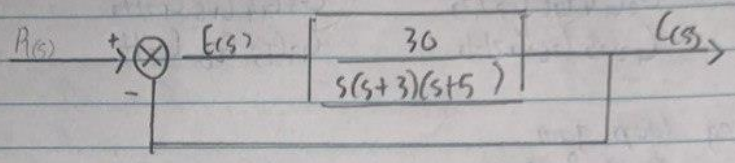
SINARLINE

4) Problem 34

$$\frac{1 \quad 30}{s(s+3)(s+5)} =$$

Phase- Variable

$$A = \dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



$$\frac{C(s)}{R(s)} = \frac{30}{s^3 + 8s^2 + 15s + 30}$$

Phase Variable form

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -30 & -15 & -8 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 30 \end{bmatrix} r \qquad y = [1 \ 0 \ 0] x$$

Controller Canonical

$$\dot{x} = \begin{bmatrix} -8 & -15 & -30 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} x + \begin{bmatrix} 30 \\ 0 \\ 0 \end{bmatrix} r \qquad y = [0 \ 0 \ 1] x$$

Observer Canonical

$$\dot{x} = \begin{bmatrix} -8 & 1 & 0 \\ -15 & 0 & 1 \\ -30 & 0 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r \qquad y = [30 \ 0 \ 0] x$$