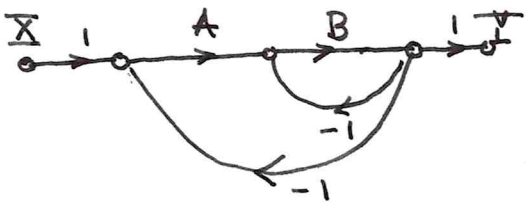
test 1

soln

(1)

(a)



(b) Forward path

$P_1 = AB$

Loops

$L_1 = -B$

$L_2 = -AB$

$$\Delta = 1 - (L_1 + L_2) = 1 + B + AB$$

$$\Delta_1 = 1$$

$$\frac{Y}{X} = \frac{P_1 \Delta_1}{\Delta} = \frac{AB}{1 + B + AB}$$

(2)

(a) $\frac{Y}{X} = \frac{G}{1+HG}$

(b) $E = X - YH \Rightarrow \frac{E}{X} = 1 - \frac{Y}{X}H = 1 - \frac{HG}{1+HG} = \frac{1}{1+HG}$

(c) $X(s) = \frac{12}{s} + \frac{6}{s^2} = \frac{12s+6}{s^2}$

$$E = \left[\frac{12s+6}{s^2}\right]\left[\frac{1}{1+H\left\{\frac{s+1}{s^2(s+5)}\right\}}\right]$$

$$e(\infty) = \uparrow_{s}^{0} sE = \uparrow_{s}^{0} \frac{6}{H\left\{\frac{s+1}{s(s+5)}\right\}} = \frac{1}{10}$$

$H(s) = ks$

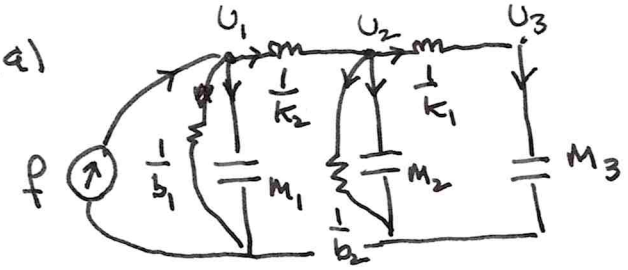
$$= \uparrow_{s}^{0} \frac{6}{k\left\{\frac{1}{5}\right\}} = \frac{1}{10} \Rightarrow \frac{30}{k} = \frac{1}{10}$$

$$\boxed{k = 300}$$

$$\boxed{H = 300s}$$

(3)

(a)



10

(b)

node U_1: $F = b_1 U_1 + U_1 M_1 s + \frac{(U_1 - U_2)}{s} K_2$

node U_2: $\frac{(U_1 - U_2)}{s} K_2 = U_2 b_2 + M_2 s U_2 + \frac{(U_2 - U_3)}{s} K_1$ 10

node U_3: $\frac{(U_2 - U_3)}{s} K_1 = U_3 M_3 s$

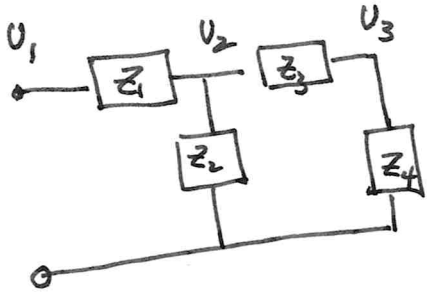
(c)

$f = b_1 \dot{u}_1 + M_1 \ddot{u}_1 + (u_1 - u_2) K_2$

$(u_1 - u_2) K_2 = \dot{u}_2 b_2 + M_2 \ddot{u}_2 + (u_2 - u_1) K_1$ 10

$(u_2 - u_3) K_1 = \ddot{u}_3 M_3$

(d)



$$Z_1 = \frac{s}{k_2}$$

$$Z_2 = \frac{1}{m_2 s} \parallel \frac{1}{b_2} = \frac{1}{m_2 s + b_2}$$

$$Z_3 = \frac{s}{k_1}$$

$$Z_4 = \frac{1}{m_3 s}$$

$$\frac{U_2}{U_1} = \frac{Z_2 \parallel (Z_3 + Z_4)}{Z_1 + Z_2 \parallel (Z_3 + Z_4)} = \frac{k_2 m_3 s^2 + k_1 k_2}{m_3 (s^4 m_2 + b_2 s^3 + (k_2 + k_1) s^2) + k_1 m_3 s^2 + b_2 k_1 s + k_1 k_2}$$

$$\frac{U_3}{U_2} = \frac{Z_4}{Z_3 + Z_4}$$

$$\frac{U_2}{U_1}\frac{U_3}{U_2} = \frac{U_3}{U_2} = \left[\frac{Z_4}{Z_3 + Z_4}\right]\left[\frac{Z_2 \parallel (Z_3 + Z_4)}{Z_1 + Z_2 \parallel (Z_3 + Z_4)}\right]$$

$$\frac{s m_2 + b_2}{s(m_3 + m_2) + b_2}$$