32140704
기계공학과 김석훈

E 2.4

$$Y(s) = \frac{4(s+50)}{s^2+30s+200} R(s)$$

$$= \frac{1}{s} \times \frac{4s+200}{(s+10)(s+20)}$$

$$= \frac{A}{s} + \frac{B}{s+10} + \frac{C}{s+20}$$

$$A = \lim_{s\to 0} sY(s)$$

$$= \left.\frac{4s+200}{(s+10)(s+20)}\right|_{s=0} = 1$$

$$B = \lim_{s\to -10} (s+10)Y(s)$$

$$= \left.\frac{4s+200}{s(s+20)}\right|_{s=-10} = -\frac{8}{5}$$

해답검토 : $-1.6e^{-10t}$

$$C = (s+20)Y(s)\Big|_{s=-20}$$

$$= \left.\frac{4s+200}{s(s+10)}\right|_{s=-20} = 0.6.$$

$$Y(s) = \frac{1}{s} + \frac{B}{s+10} + \frac{0.6}{s+20}$$

$$y(t) = 1 + Be^{-10t} + 0.6e^{-20t}$$

$y(\infty) = 1$ — ①방법

$\lim_{s\to 0} s(Y(s)) = 1$ — ②방법

검토 : B=-1.6추정

E 2.6

$y = Ae^{x}$.

y는 $x(0)$에서 출력.

$y \cong y'_{(0)}x + x(0)$에서,

$x(0) = A$, $y' = Axe^{x}$

☆ 왜 답이 $y \cong Ax + A$인지 모르겠습니다.

E 2.26

$$G(s) = \frac{X_2(s)}{F(s)}$$

$$F = m_1\ddot{x}_1 + \quad + k(x_1 - x_2) = \ddot{x}_1 + (x_1 - x_2)$$

$$0 = m_2\ddot{x}_2 + k(x_2 - x_1) = \ddot{x}_2 + (x_2 - x_1) = 0$$

$$x_1 = \ddot{x}_2 + x_2$$

$$F = \frac{d^2}{dt^2}(\ddot{x}_2 + x_2) + \ddot{x}_2 + x_2 - x_2$$

$$= x_2'''' + 2\ddot{x}_2$$

$F(s) = s^4X_2 + 2s^2X_2$ ∵ 초기값 : 0

$$\therefore \frac{X(s)}{F(s)} = \frac{1}{s^4+2s^2} = \frac{1}{s^2(s^2+2)}$$

3214-0104
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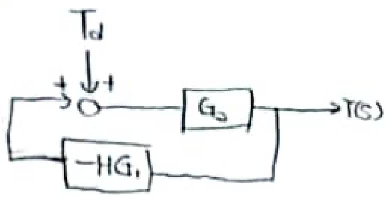
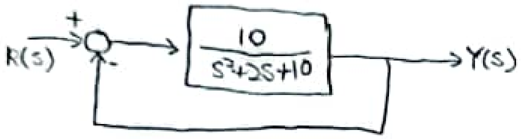
E 2.27



$G(S) \equiv \frac{G}{1+GH}$ 에서

$$\frac{Y(S)}{T_d(S)} = \frac{G_2}{1+HG_1G_2}$$

E 2.30



$G(s) \equiv \frac{G}{1+GH}$ 에서,

(1)

$$\frac{Y(S)}{R(S)} = \frac{\frac{10}{s^2+2s+10}}{1+\frac{10}{s^2+2s+10}} = \frac{10}{s^2+2s+20}$$

$$= \frac{3}{(s+1)^2+3^2} \times \frac{10}{3}$$

(2)

$$R(s) = \frac{1}{s}, \quad Y(S) = \frac{10}{3} \times \frac{1}{s} \times \frac{3}{(s+1)^2+3^2}$$

(3)

$$Y(S) = \frac{1}{s} \times \frac{10}{s^2+2s+20} = \frac{A}{s} + \frac{Bs+C}{s^2+2s+20}$$

$$A = sY(s)\Big|_{s=0} = \frac{10}{s^2+2s+20}\Big|_{s=0} = 0.5$$

$$\frac{0.5}{s} + \frac{Bs+C}{s^2+2s+20} = \frac{10}{s(s^2+2s+20)}$$

$$= \frac{(0.5s^2+s+10)+(Bs^2+Cs)}{s(s^2+2s+10)}$$

$B = -0.5, \; C = -1$

$$\therefore Y(S) = \frac{0.5}{s} - \frac{0.5s+1}{s^2+2s+20}$$

$$= \frac{0.5}{s} - \frac{0.5s+0.5}{(s+1)^2+3^2} - \frac{0.5}{(s+1)^2+3^2}$$

$$= \frac{0.5}{s} - 0.5 \times \frac{s+1}{(s+1)^2+3^2} - \frac{3}{(s+1)^2+3^2} \times \frac{0.5}{3}$$

$$y(t) = 0.5 - 0.5e^{-t}\cos 3t - \frac{1}{6}e^{-t}\sin 3t$$

P2.15

$$0 = m\ddot{x} + b\dot{x} + kx = f(t)$$

$$F(s) = (ms^2+bs+k)X(s)$$

$$X(s) = \frac{F}{s} \times \frac{1}{ms^2+bs+k} = F\left(\frac{A}{s} + \frac{Bs+C}{ms^2+bs+k}\right)$$

$$A = sX(s)\Big|_{s=0} = \frac{1}{k}$$

$$\frac{\frac{1}{k}}{s} + \frac{Bs+C}{ms^2+bs+k}$$

$$= \frac{\frac{1}{k}(ms^2+bs+k)+s(Bs+C)}{s(ms^2+bs+k)}$$

$$B = -\frac{m}{k}, \; C = -\frac{b}{k}$$

$$X(s) = F\left(\frac{1}{ks} - \frac{1}{k} \times \frac{ms+b}{ms^2+bs+k}\right)$$

$$\frac{ms+b}{ms^2+bs+k} = \frac{s+\frac{b}{m}}{s^2+\frac{b}{m}s+\frac{k}{m}}$$

$$= \frac{s+\frac{b}{2m}+\frac{b}{2m}}{\left(s+\frac{b}{2m}\right)^2+\frac{k}{m}-\frac{b^2}{4m^2}}$$

$$= \frac{s+\frac{b}{2m}}{\left(s+\frac{b}{2m}\right)^2+\sqrt{\left(\frac{k}{m}-\frac{b^2}{4m^2}\right)}^2} + \frac{\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}}{\left(s+\frac{b}{2m}\right)^2+\sqrt{\left(\frac{k}{m}-\frac{b^2}{4m^2}\right)}^2} \times \frac{\frac{b}{2m}}{\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}}$$

$$X(s) = \frac{F}{k}\left(\frac{1}{s} - \frac{s+\frac{b}{2m}}{\left(s+\frac{b}{2m}\right)^2+\sqrt{\left(\frac{k}{m}-\frac{b^2}{4m^2}\right)}^2} - \frac{\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}}{\left(s+\frac{b}{2m}\right)^2+\sqrt{\left(\frac{k}{m}-\frac{b^2}{4m^2}\right)}^2} \times \frac{\frac{b}{2m}}{\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}}\right)$$

$$x(t) = \frac{F}{k} - \frac{F}{k}e^{-\frac{b}{2m}t}\cos\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}\,t - \frac{Fb}{2mk\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}}e^{-\frac{b}{2m}t}\sin\sqrt{\frac{k}{m}-\frac{b^2}{4m^2}}\,t$$

☆출력단이 없어 연산이 맞는지 알 수 없습니다.

- 풀수 있는 것 먼저 풉니다

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P.2.49

(1)

$$T(s) = \frac{Y(s)}{R(s)} = \frac{G}{1+GH} \text{ 에서,}$$

$$T(s) = \frac{\frac{1000}{s(s^2+20s+100)}}{1+\frac{1000}{s(s^2+20s+100)}}$$

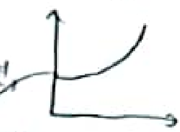
$$= \frac{1000}{s(s^2+20s+100)+1000}$$

(2)

극점 : $s(s^2+20s+100)+1000=0$

↓ 계산으로 풀 수가 없으니, 솔버로

★ 솔버가 답을 찾지 못한다.

매트랩으로 그래프를 그려보면  의 형태이므로

⊖축에 극점이 있음을 알 수 있다

↓ 솔버 결과

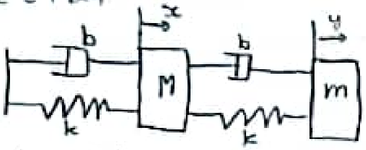
$S=-17.5488$ 에서 극점 , 영점은 없다

(3)

$$Y(s) = \frac{1}{s} \times \frac{1000}{s^3+20s^2+100s+1000}$$

★ 역수변환을 할 수 없다

E 3.1



$M\ddot{x}+b\dot{x}+b(\dot{y}-\dot{x})+kx+k(y-x)=0$

$m\ddot{y}+b(\dot{y}-\dot{x})+k(y-x)=0$

↓ 외력이 없다고 가정했다

$M\ddot{x}+b\dot{y}+ky=0$

★ u가 어디서 작용하는지를 알지 못한다.

$$\frac{d}{dt}\begin{bmatrix}\dot{x}\\x\\\dot{y}\\y\end{bmatrix} = \begin{bmatrix}0 & 0-\frac{b}{m} & -\frac{k}{m} & \\ 1 & 0 & 0 & 0\\ +\frac{b}{m} & \frac{k}{m} & -\frac{b}{m} & -\frac{k}{m}\\ 0 & 0 & 1 & 0\end{bmatrix}\begin{bmatrix}\dot{x}\\x\\\dot{y}\\y\end{bmatrix}$$

$\ddot{x}+\frac{b}{m}\dot{y}+ky=0$

$\ddot{y}+\frac{b}{m}\dot{y}-\frac{b}{m}\dot{x}+\frac{k}{m}y-\frac{k}{m}x=0$

E 3.2

$$V = i + \frac{di}{dt} + V_c$$

→ 직렬 RLC 방정식이다

$$i = \frac{V}{Z} = \frac{V}{j(\omega L - \frac{1}{\omega C})+R} \quad \text{∵ 직렬일 때 전류 공식}$$

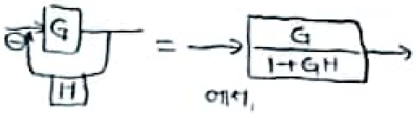
두 식 기준으로 미분 형태로 보면

$V' = i' + i'' + V_c'$

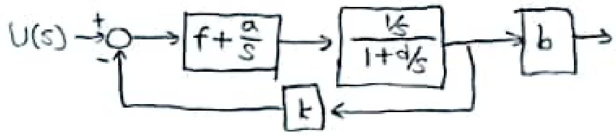
$$i' = \frac{V'}{R+j(\omega-\frac{1}{\omega})}$$

★ 행렬을 구할 수 없다.

E 3.5



에서,



$u(t)=\int x_1(t)dt \rightarrow x_1(t)=\frac{d}{dt}u(t)$

$(f+\frac{a}{s})U(s)dt = \int x_2(t)dt \rightarrow x_2(t) = \frac{d}{dt}(f+\frac{a}{s})U(s)$

★ 잘 모르겠습니다

E 3.6

$$\frac{d}{dt}\begin{bmatrix}x_1\\x_2\end{bmatrix} = \begin{bmatrix}0 & 1\\0 & 0\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix}+0$$

$\dot{x}=Ax+Bu$

$x=(sI-A)^{-1}x(0)+(sI-A)^{-1}Bu$

$x(t)=\Phi(t)x(0)$일 때 상태천이행렬

167P에서, $\Phi(t)=(sI-A)(t)$

$$\begin{bmatrix}x_1\\x_2\end{bmatrix} = \begin{bmatrix}s & -1\\0 & s\end{bmatrix}^{-1}\begin{bmatrix}x_1(0)\\x_2(0)\end{bmatrix} = \begin{bmatrix}s & -1\\0 & s\end{bmatrix}^{-1}\begin{bmatrix}1\\1\end{bmatrix}$$

$x_1 = s-1$

$x_2 = s$

★ 잘 모르겠습니다.

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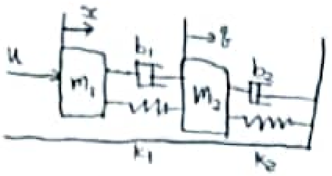
E 3.16



$$u = m_1 x'' + b_1(x' - y') + k_1(x - y)$$
$$0 = m_2 y'' + b_2 y' + b_1(y' - x') + k_2 y + k_1(y - x)$$
$$= m_2 y'' + y'(b_2 + b_1) - b_1 x' + y(k_2 + k_1) - k_1 x$$

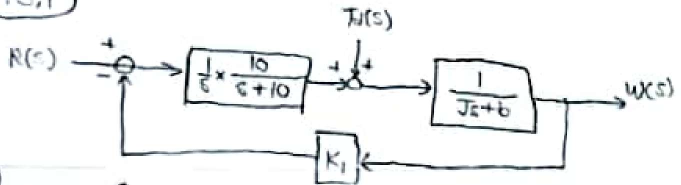
$$\frac{d}{dt}\begin{bmatrix} x' \\ x \\ y' \\ y \end{bmatrix} = \begin{bmatrix} -\frac{b_1}{m_1} & -\frac{k_1}{m_1} & +\frac{b_1}{m_1} & \frac{k_1}{m_1} \\ 1 & 0 & 0 & 0 \\ \frac{b_1}{m_2} & -\frac{b_1+b_2}{m_2} & \frac{k_1}{m_2} & -\frac{k_1+k_2}{m_2} \\ 0 & 0 & 1 & 0 \end{bmatrix}\begin{bmatrix} x' \\ x \\ y' \\ y \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} u$$

P.3.4 $T(s) = \frac{Y(s)}{R(s)} = \frac{s^2+4s+12}{s^3+4s^2+8s+12}$

$$R(s) \longrightarrow \boxed{\frac{s^2+4s+12}{s^3+4s^2+8s+12}} \longrightarrow Y(s)$$

※ 상태변수 모델은 구하지 못해 생략하겠습니다.

P.3.51



(a)
$G(s) \equiv \frac{G}{1+GH}$ 에서,

$$T(s) = \frac{\frac{10}{s(s+10)(Js+b)}}{1 + \frac{10K_1}{s(s+10)(Js+b)}} = \frac{10}{s(s+10)(Js+b)+10K_1}$$

→ 외란은 생략하고 작성한다

(b)
$$T(s) = \frac{10}{Js^3 + (10J+b)s^2 + 10bs + 10K_1} = \frac{10}{s^3+10.1s^2+s+0.5}$$

$F(s)=R(s)(ms^2+cs+k)$ 임을 참고하여,

$$W(s) = R(s)(0.1s^3+1.01s^2+0.1s+0.05)$$
$$w(t) = 0.1R'' + 1.01R' + 0.1R + 0.05R$$ ↓ 초기값이 $w(0)=0$으로 두고

$$\frac{d}{dt}\begin{bmatrix} r'' \\ r' \\ r \end{bmatrix} = \begin{bmatrix} -10.1 & -1 & -0.5 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}\begin{bmatrix} r'' \\ r' \\ r \end{bmatrix} + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} w(t)$$

↓ 다시풀어

P2.44

(a)
$$I \equiv \int r^2 dm \doteq \frac{1}{2} m r^2$$
$$= \frac{1}{2}(\rho L \pi r^2) r^2 = \frac{1}{2} \rho L \pi r^4$$

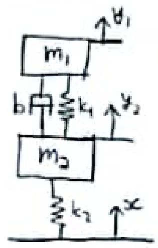
추가: $I_y = I_z \doteq \frac{1}{4} m r^2$

(b)
$$T_m = T_L + J_L \theta_1'' + b_L \theta_1' + \frac{N_1}{N_2} \times J_m \theta_2'' + \frac{N_1}{N_2} \times b_m \theta_2'$$

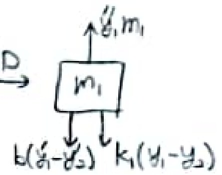
∵ $N_1 \omega_L = N_2 \omega_m$, 와 같다 책 참고

$$T_m = T_L + \theta_1''\left(J_L + \frac{N_1^2}{N_2^2} J_m\right) + \theta_1'\left(b_L + \frac{N_1^2}{N_2^2} b_m\right)$$

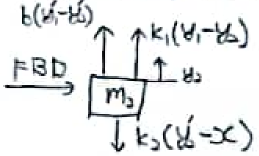
P.2.34



FBD →



$$m_1 y_1'' = -b(y_1' - y_2') - k(y_1 - y_2)$$
$$m_1 y_1'' + b(y_1' - y_2') + k_1(y_1 - y_2) = 0$$
$$m_1 y_1'' + b y_1' + k_1 y_1 = b y_2' + k_1 y_2$$



$$m_2 y_2'' = k_2(y_2 - x) - k_1(y_1 - y_2) - b(y_1' - y_2')$$
$$m_2 y_2'' = k_2 y_2 - k_2 x - k_1 y_1 + k_1 y_2 - b y_1' + b y_2'$$
$$m_2 y_2'' - b y_2' + (k_1 - k_2) y_2 = k_2 x - k_1 y_1 - b y_1'$$

※ 하나의 변수로 정리할 수 있는 미분방정식 입니다.

$$Y_1(m_1 s^2 + bs + k_1) = Y_2(b + k_1)$$
$$Y_2 = \frac{m_1 s^2 + bs + k_1}{b + k_1} Y_1$$

↓ 계속

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P.2.34 계속

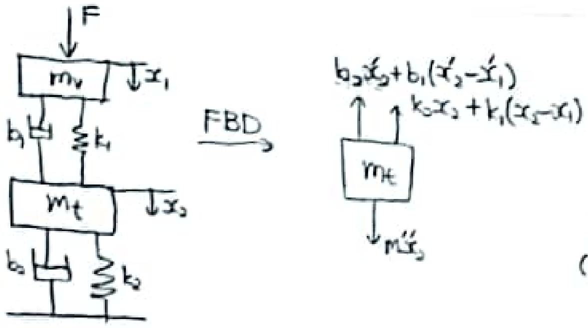
$$Y_2 = \frac{m_1 s^2 + bs + k_1}{b+k_1} Y_1$$

$$Y_2 \left(m_2 s^2 - bs + (k_1 - k_2)\right) = k_2 X - (k_1 - bs) Y_1$$

$$Y_1 \left(-bs + k_1 + \frac{m_1 s^2 + bs + k_1}{b+k_1} \times (m_2 s^2 - bs + k_1 - k_2)\right) = k_2 X$$

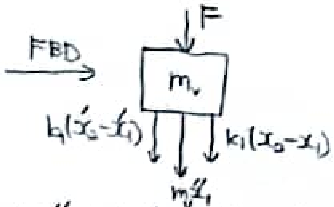
$$T(s) = \frac{Y_1(s)}{X(s)} = \frac{k_2}{-bs + k_1 + \frac{m_1 s^2 + bs + k_1}{b+k}(m_2 s^2 - bs + k_1 - k_2)}$$

P.2.46



$$-m_t \ddot{x}_2 = k_2 x_2 + k_1 x_2 - k_1 x_1 + b_2 \dot{x}_2 + b_1 \dot{x}_2 - b_1 \dot{x}_1$$

$$X_2\left(m_t s^2 + (b_1 + b_2)s + (k_1 + k_2)\right) = X_1 (b_1 s + k_1) \text{ —①}$$



$$m_v \ddot{x}_1 + b_1(\dot{x}_1 - \dot{x}_2) + k_1(x_1 - x_2) = -F(t).$$

$$X_1 (m_v s^2 + b_1 s + k_1) = X_2 (b_1 s + k_1) - F(s) \text{ —②}$$

①식에서,

$$X_2 = X_1 \left(\frac{b_1 s + k_1}{m_t s^2 + (b_1 + b_2)s + k_1 + k_2}\right)^{-1}$$

②식에서,

$$F(s) = X_1 \left(m_v s^2 + b_1 s + k_1 - \frac{(b_1 s + k_1)^2}{m_t s^2 + (b_1 + b_2)s + k_1 + k_2}\right)$$

$$T(s) = \frac{X_1(s)}{F(s)} = \frac{1}{m_v s^2 + b_1 s + k_1 - \frac{(b_1 s + k_1)^2}{m_t s^2 + (b_1 + b_2)s + k_1 + k_2}}$$

E 3.6 다시풀이

$$\bar{X}(s) = (sI - A)^{-1} x(0) + (sI - A)^{-1} Bu$$

$$x(t) = \phi(t)x(0) + \int_0^t \phi(t-\tau) Bu(\tau) \text{ 에서,}$$

(a)

$$\bar{X}(s) = \frac{1}{s^2+1} \begin{bmatrix} s & -1 \\ 0 & s \end{bmatrix} \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix}$$

(b)

$$x(t) = \mathcal{L}^{-1}\left(\frac{1}{s^2+1} \begin{bmatrix} s & -1 \\ 0 & s \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix}\right)$$

↓여기서 Bu부분은 없으므로 고려하지 않는다.

$$x_1(t) = \mathcal{L}^{-1}\left(-\frac{1}{s^2+1}\right) = -\sin t$$

$$x_2(t) = \mathcal{L}^{-1}\left(\frac{s}{s^2+1}\right) = \cos t.$$

P 2.49 다시풀이

(c) $\frac{1}{s} \times \frac{1000}{s^3 + 20s^2 + 100s + 1000}$ 의 부분분수 전개.

$s = -17.5488$에서 극점 이므로,

$$s^3 + 20s^2 + 100s + 1000 = (s + 17.5488)(s^2 + As + B)$$

$A + 17.5488 = 20$ $\therefore A = 2.4512$

$B \times 17.5488 = 1000$ $\therefore B = 56.984$

↓검산

$17.5488 \times A + B = 100$ 성립

$$Y(s) = \frac{A}{s} + \frac{B}{(s+17.5488)} + \frac{Cs + D}{s^2 + 2.4512 + 56.984}$$

$$A = sY(s)\big|_{s=0} = \frac{1000}{1000} = 1$$

$$B = (s + 17.5488)Y(s)\big|_{s=-17.5488}$$

$$= \frac{1000}{s \times (s^2 + 2.4512s + 56.984)}\Bigg|_{s=-17.5488}$$

↓계속

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P.2.49 다시풀이 계속

$$B = \left.\frac{1000}{s\times(s^2+2.4512s+56.984)}\right|_{s=-17.5488}$$

$$= \frac{1000}{-17.5488\times 321.9288} = -0.177$$

$$\frac{1000}{s(s+17.5488)(s^2+2.4512s+56.984)}$$

$$= \frac{1}{s} - \frac{0.177}{s+17.5488} + \frac{Cs+D}{s^2+2.4512s+56.984}$$

① $1+17.5488C=0 \quad \therefore C=-0.057$.

② $17.5488D - 0.177\times 56.984 + 2.4512\times 17.5488 = 0$

$= 17.5488D + 32.9295 = 0 \quad \therefore D = -1.8765$

↓검산

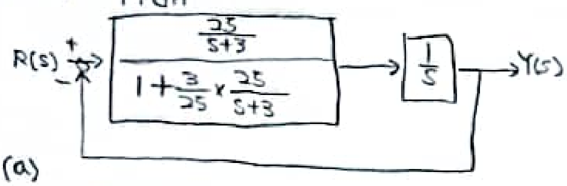
$17.5488 + 2.4512 - 0.177\times 2.4512 + 17.5488C + D = 0$

$= 19.5661 + 17.5488C + D = 0$

☆오류

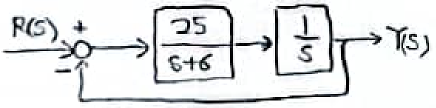
P 3.26

$G(s) = \frac{G}{1+GH}$ 에서



(a)

$$\frac{\frac{25}{s+3}}{1+\frac{3}{25}\times\frac{25}{s+3}} = \frac{25}{s+3+3} = \frac{25}{s+6}$$



$$T(s) = \frac{\frac{25}{s^2+6s}}{1+\frac{25}{s^2+6s}} = \frac{25}{s^2+6s+25}$$

$r(t) = \frac{1}{25}\ddot{x} + \frac{6}{25}\dot{x} + 1x$ ↓ $r(0)=0$이라 가정

$$\ddot{x} + 6\dot{x} + 25x = 0$$

$$\frac{d}{dt}\begin{bmatrix}\dot{x}\\ x\end{bmatrix} = \begin{bmatrix}6 & 25\\ 1 & 0\end{bmatrix}\begin{bmatrix}\dot{x}\\ x\end{bmatrix}$$

(b)

$\dot{x} = Ax + Bu$ 일때,

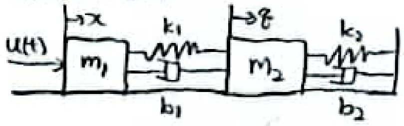
$\Phi(s) = (sI-A)^{-1}$

$$\begin{bmatrix}s-6 & -25\\ -1 & s\end{bmatrix}^{-1} = \frac{1}{(s-6)s-25}\begin{bmatrix}s & +25\\ 1 & s-6\end{bmatrix}$$

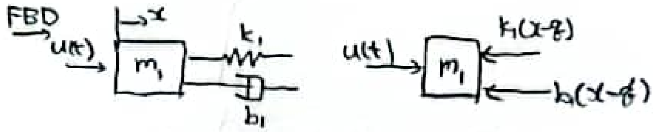
$$= \frac{1}{s^2-6s-25}\begin{bmatrix}s & +25\\ 1 & s-6\end{bmatrix} = \Phi(s)$$

E 3.16 다시풀이

$u(t)$가 힘일때



FBD

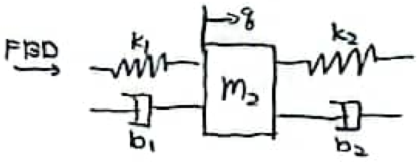


$$u(t) - k_1(x-q) - b_1(\dot{x}-\dot{q}) = m_1\ddot{x}$$

$$m_1\ddot{x} + b_1\dot{x} + k_1x = u + b_1\dot{q} + k_1q$$

$$X(m_1s^2+b_1s+k_1) = Q(b_1s+k_1) + U$$

FBD



↓다음페이지

2014010104
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E 3.16 다시풀이 계속

$k_1(x-q)-k_2q+b_1(x'-q')-b_2q'=m_2q''$

$m_2q''+(b_1+b_2)q'+(k_1+k_2)q=k_1x+b_1x'$

$Q(m_2s^2+(b_1+b_2)s+(k_1+k_2))=X(b_1s+k_1)$

$$\frac{d}{dt}\begin{bmatrix} x' \\ x \\ q' \\ q \end{bmatrix}=\begin{bmatrix} -\frac{b_1}{m_1} & -\frac{k_1}{m_1} & \frac{b_1}{m_1} & \frac{k_1}{m_1} \\ 1 & 0 & 0 & 0 \\ \frac{b_1}{m_2} & \frac{k_1}{m_2} & -\frac{b_1+b_2}{m_2} & -\frac{k_1+k_2}{m_2} \\ 0 & 0 & 1 & 0 \end{bmatrix}+\begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}u$$

P 3.4 다시풀이

$$T(s)=\frac{Y(s)}{R(s)}=\frac{s^2+4s+12}{s^3+4s^2+8s+12}$$

↓ 새로운 매개변수 $Z(s)$ 추가

$$T(s)=\frac{(s^2+4s+12)Z(s)}{(s^3+4s^2+8s+12)Z(s)}$$

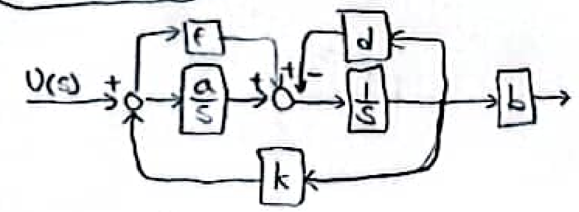
$y(t)=z''+4z'+12z$

$r(t)=z'''+4z''+8z'+12z$

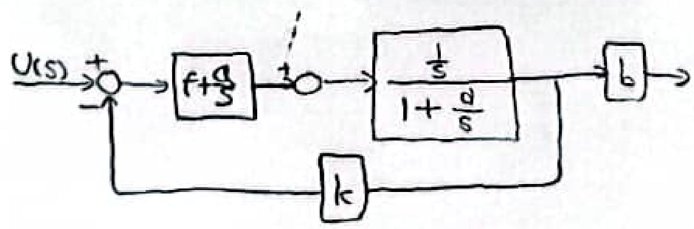
$$\frac{d}{dt}\begin{bmatrix} z'' \\ z' \\ z \end{bmatrix}=\begin{bmatrix} -4 & -8 & 12 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}\begin{bmatrix} z'' \\ z' \\ z \end{bmatrix}+\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}r(t)$$

$$y(t)=\begin{bmatrix} 1 & 4 & 12 \end{bmatrix}\begin{bmatrix} z'' \\ z' \\ z \end{bmatrix}+0$$

E 3.5 다시풀이



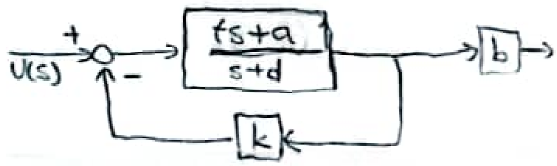
$$G(s)\equiv\frac{G}{1+GH}\text{에서,}$$



$$\left(f+\frac{a}{s}\right)\left(\frac{\frac{1}{s}}{1+\frac{d}{s}}\right)$$

$$=\left(f+\frac{a}{s}\right)\left(\frac{s}{s+d}\right)=\frac{s\left(f+\frac{a}{s}\right)}{s+d}$$

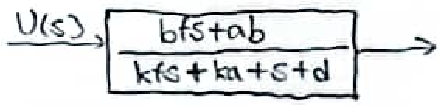
$$=\frac{fs+a}{s+d}$$



$$G(s)\equiv\frac{G}{1+GH}\text{에서,}$$

$$=\frac{\frac{fs+a}{s+d}}{1+\frac{k(fs+a)}{s+d}}=\frac{fs+a}{s+d+k(fs+a)}$$

$$=\frac{fs+a}{kfs+ka+s+d}$$



$$T(s)=\frac{C(s)}{U(s)}=\frac{bfs+ab}{kfs+(ka+s+d)}$$

↓ 새로운 매개변수 $Z(s)$ 추가

$$T(s)=\frac{(bfs+ab)Z(s)}{(kfs+(ka+s+d))Z(s)}$$

$c(t)=bf\cdot z'+abz$

$u(t)=kfz'+(ka+s+d)z$

⇒ 더 진행할 수 없습니다.

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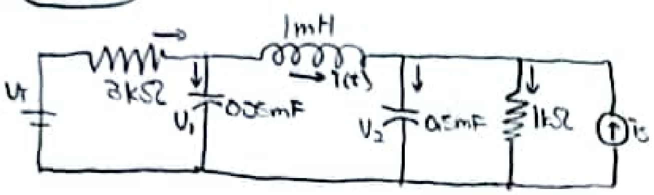
P 3.4



KCL 기준으로

$R_1=3k, R_2=1k, C_1=0.25m, C_2=0.5m, L=1m$ [SI]

$$i_{C_1}=\frac{V_T-V_1}{R_1}-i(t)=C_1\frac{dV_1}{dt} \rightarrow \underline{C_1\frac{dV_1}{dt}+\frac{V_1}{R_1}=\frac{V_T}{R_T}-i(t)} \text{ — ①식}$$

$$i_{C_2}=C_2\frac{dV_2}{dt}=i(t)-\frac{V_2}{R_2}+i_s \rightarrow \underline{C_2\frac{dV_2}{dt}+\frac{V_2}{R_2}=i(t)+i_s} \text{ — ②식}$$

↓ 여기서 i(t)

$$V_L=L\frac{di}{dt} \rightarrow i(t)=\frac{1}{L}\int V_L dt=\frac{1}{L}\int V_1-V_2\,dt$$

$$=\frac{1}{L}\int V_1 dt-\frac{1}{L}\int V_2 dt$$

①식 정리

$$C_1\frac{dV_1}{dt}+\frac{V_1}{R_1}=\frac{V_T}{R_T}-\frac{1}{L}\int V_1 dt+\frac{1}{L}\int V_2 dt$$

$$\hookrightarrow C_1\frac{dV_1}{dt}+\frac{V_1}{R_1}+\frac{1}{L}\int V_1 dt=\frac{V_T}{R_1}+\frac{1}{L}\int V_2 dt$$

②식 정리

$$C_2\frac{dV_2}{dt}+\frac{V_2}{R_2}=\frac{1}{L}\int V_1 dt-\frac{1}{L}\int V_2 dt+i_s$$

$$\hookrightarrow C_2\frac{dV_2}{dt}+\frac{V_2}{R_2}+\frac{1}{L}\int V_2 dt=\frac{1}{L}\int V_1 dt+i_s$$

※ 적분항은 행렬 식으로 표현할 수 없습니다