H25 制御工学

Date . . No. 1

問1

(1) $s^2X(s) - sx(0) + 25X(s) = 0 \Rightarrow X(s) = \frac{s}{s^2+25}$

$\therefore x(t) = \cos 5t \quad , t \geq 0$ [10]

(2) $(s^2+25)X(s) = \frac{1}{s} \Rightarrow X(s) = \frac{1}{s(s^2+25)} = \frac{\frac{1}{25}(s^2+25-s^2)}{s(s^2+25)}$

$\Rightarrow X(s) = \frac{1}{25}\left(\frac{1}{s} - \frac{s}{s^2+25}\right) \quad \therefore x(t) = \frac{1}{25}(1-\cos 25t), \quad t \geq 0$ [10]

(3) $(s^2+25)X(s) = \frac{s}{s^2+25} \Rightarrow X(s) = \frac{s}{(s^2+25)^2} = -\frac{1}{2}\frac{d}{ds}\left(\frac{1}{s^2+25}\right)$

$\therefore x(t) = \frac{1}{2}t \cdot \frac{1}{5}\sin 5t = \frac{1}{10}t\sin 5t, \quad t \geq 0$

[10]

問2.

(1) $y(t)$, $u(t)$ をラプラス変換すると

$Y(s) = \frac{1}{s} - \frac{2}{(s+1)^2+2^2} - \frac{1}{s+4} = \frac{2(s^2+10)}{s(s+4)(s^2+2s+5)}$

$U(s) = \frac{1}{s}$

$\therefore P(s) = \frac{Y(s)}{U(s)} = \frac{2(s^2+10)}{(s+4)(s^2+2s+5)}$. [10]

(2) 極 $p = -4, -1 \pm j2$, 零点 $z = \pm j\sqrt{10}$ [10]

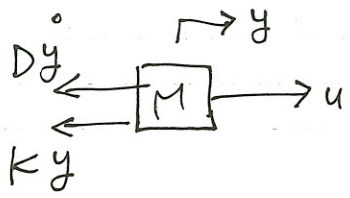
問3.

(1) 運動方程式

$M\ddot{y} = u - D\dot{y} - ky$

$\Rightarrow M\ddot{y} + D\dot{y} + ky = u$ ①

[10]



(2) 運動方程式をラプラス変換（零初期値のもと）

$(Ms^2+Ds+K)Y(s)=U(s)$

$\therefore\ G(s)=\dfrac{1/M}{s^2+\frac{D}{M}s+\frac{K}{M}}$ ② 5

(3) $\omega_n^2=\dfrac{K}{M}$, $2\zeta\omega_n=\dfrac{D}{M}$ $\Rightarrow$ $\omega_n=\sqrt{K/M}$, $\zeta=\dfrac{1}{2}\dfrac{D}{M}\sqrt{\dfrac{M}{K}}=\dfrac{1}{2}\dfrac{D}{\sqrt{MK}}$ 5

問4.

(1) $r\mapsto y$ の伝達関数 $G(s)=\dfrac{PK}{1+PK}=\dfrac{10(as+b)}{s^2+10as+10b}$ ①

$\zeta=0.75$, $\omega_n=10$ より 10

$10b=10^2$, $10a=2\times0.75\times10$ $\Rightarrow$ $a=1.5$, $b=10$ ②

(2) $G(s)$ は標準2次系ではないため，記号表の公式は使えない．

$Y(s)=\dfrac{10(1.5s+10)}{s^2+15s+100}\times\dfrac{1}{s}=\dfrac{1}{s}+\dfrac{C_1s+C_2}{s^2+15s+100}$

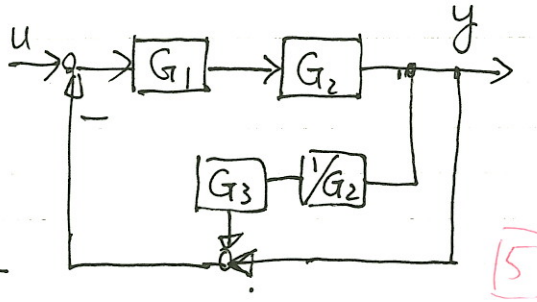
$=\dfrac{s^2+15s+100+s(C_1s+C_2)}{s(s^2+15s+100)}$ 5

$\Rightarrow$ $1+C_1=0$, $15+C_2=15$, $\therefore$ $C_1=-1$, $C_2=0$ 5

$\therefore\ Y(s)=\dfrac{1}{s}-\dfrac{(s+7.5)-7.5}{(s+7.5)^2+100-7.5^2}$

$\therefore\ y(t)=1-e^{-7.5t}\left(\cos 6.61t \mp 1.135\sin 6.61t\right)$, $t\geq0$ 10

問5.



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引出し点を出力端へ移動

$$H(s) = \frac{G_1 G_2}{1 + G_1 G_2 \times (1 + G_3/G_2)}$$

$$= \frac{G_1 G_2}{1 + G_1 G_2 + G_1 G_3}$$

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