Questão (70) -

$$0{,}2\dot{w} = -w + \begin{bmatrix} 45 & -5 \end{bmatrix} \begin{bmatrix} e_a \\ t_c \end{bmatrix}$$

$$y = w$$

$$Ke^{-5t}, \quad \Phi(0) = I, \quad K = 1$$

$$y(t) = \int_0^t C\Phi(t-\tau) B u(\tau) d\tau$$

$$= \int_0^t e^{-5(t-\tau)} (45 e_a - 5 t_c) d\tau$$

$$= \int_0^t 45 e_a e^{-5(t-\tau)} d\tau - \int_0^t 5 t_c e^{-5(t-\tau)} d\tau$$

$$= \int_0^t 45 e_a e^{-5(t-\tau)} d\tau - \int_4^t 5 t_c e^{-5(t-\tau)} d\tau \quad (t > 4)$$

$$= 900 (1 - e^{-5t}) - 10 (1 - e^{-5(t-4)})$$

$$y(t) = \begin{cases} 900 (1 - e^{-5t}) & t \leq 4 \\ 890 - 900 e^{-5t} + 10 e^{-5(t-4)} & t \geq 4 \end{cases}$$

Questão (73) - $f(t) = 2x + fv\frac{dx}{dt}$

$F(s) = 2X(s) + fvsX(s)$

$$\frac{X(s)}{F(s)} = \frac{\frac{1}{fv}}{s + \frac{2}{fv}} \longrightarrow Ts = \frac{4}{a} \rightarrow a = \frac{2}{fv}$$

$Ts = 2fv$ ou $fv = 0{,}5\,Ts$

$$\boxed{fv = 0{,}5ts}$$

Questão (75) -

$$f(t) - fv\frac{dx}{dt} - kx = M\frac{d^2x}{dt^2}$$

$$f(t) = fv\frac{dx}{dt} + x + M\frac{d^2x}{dt^2}$$

$F(s) = fv\,sx(s) + X(s) + s^2MX(s)$

$$\frac{X(s)}{F(s)} = \frac{\frac{1}{M}}{s^2 + \frac{fv}{M}s + \frac{1}{M}}$$

$e^{\frac{-\pi\delta}{\sqrt{1-\delta^2}}} \cdot 100 = 17$ $\quad T_s = \frac{4}{\delta \omega_n}$

$\delta = 0,49$

$T_s = 4s \rightarrow \delta \omega_n = 0,4$

$\omega_n = 0,815$

$\omega_n^2 = \frac{1}{M} \rightarrow M = \frac{1}{0,815^2} = 1,5\,J$

$2\delta\omega_n = \frac{fv}{M} \rightarrow 2 \times 0,4 = \frac{fv}{1,5}$

$fv = 1,2$ e $M = 1,5$

Questão (46) - $T(t) - 1\frac{d\theta}{dt} - k\theta = J\frac{d^2\theta}{dt^2}$

$T(s) = s\theta(s) + k\theta(s) + s^2 J\theta(s)$

$\frac{\theta(s)}{F(s)} = \frac{\frac{1}{J}}{s^2 + \frac{1}{J^2} + \frac{k}{J}}$ $\quad e^{\frac{-\pi\delta}{\sqrt{1-\delta^2}}} \cdot 100 = 30$

$\delta = 0,358$

$2\delta\omega_n = \frac{1}{J} \rightarrow \delta\omega_n = \frac{1}{2J}$

$T_s = \frac{4}{\delta\omega_n} \rightarrow T_s = 3s \rightarrow \frac{4}{\delta\omega_n} = \frac{4}{\frac{1}{2J}} = 3 \rightarrow J = \frac{3}{8}$

$\delta \omega_n = \frac{4}{3}$, $\delta = 0,358$

$\omega_n = 3,72$

$\omega_n^2 = \frac{K}{J}$ ou $K = 3,72^2 \cdot \frac{3}{8} = 5,20$

$J = \frac{3}{8}$ | $K = 5,20$