07/11/23

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[Semana 08 - Redução de Sistemas e Projeto]

Questão ②: a) $\frac{k}{s+a}$ (transfer function)

$\left(x = \frac{550}{s}\right)$: $Y = \frac{550k}{s(s+a)}$

$$= \frac{550k}{as} - \frac{550k}{a(s+a)}$$

$$y(t) = \frac{550k}{a}(1 - e^{-at})$$

$\cdot\, y(1.1) = 20$

$$\frac{550k}{a} = 40$$

$$1 - e^{-at} = 0.5 \Rightarrow a = 9.9$$

$$\therefore k = \frac{40}{550 \times 9.9} = 0.72$$

$T = \frac{0.72}{s+9.9}$; $y = 40(1 - e^{9.9t})$

$\ulcorner\ y(0.17) = 32.57$ //

b)

$$y(t) = \int_0^t C\Phi(t-\tau)Bu(\tau)\,d\tau$$

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

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

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

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

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

c) $f(t) = 2x + f_v \frac{dx}{dt} \quad > F(s) = 2X(s) + f_v s X(s)$

$$\Rightarrow \frac{X(s)}{F(s)} = \frac{\frac{1}{f_v}}{s + \frac{2}{f_v}}$$

$T_s = \frac{4}{a}$, $a = \frac{2}{f_v}$ $\quad > T_s = 2f_v \; / \; f_v = 0.5 T_s$

$$\boxed{f_v = 0.5 T_s}$$ //

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

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

$\Rightarrow F(s) = f_v\, sX(s) + X(s) + s^2 M X(s)$

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

$e^{\frac{-\pi\delta}{\sqrt{1-\delta^2}}} \times 100 = 17 \rightarrow \delta = 0.49$

$T_s = \frac{4}{\delta\omega_n} \Rightarrow T_s = 4s \Rightarrow \delta\omega_n = 0.4$

$\omega_n = 0.815$

$\omega_n^2 = \frac{1}{M}$ ou $\boxed{M = \frac{1}{0.815^2} = 1.51}$

$2\delta\omega_n = \frac{f_v}{M} \Rightarrow 2 \times 0.4 = \frac{f_v}{1.51}$

$\boxed{f_v = 1.21}$

$\boxed{\therefore f_v = 1.21 \quad M = 1.51}$

e) $T(t) - 1\dfrac{d\theta}{dt} - k\theta = J\dfrac{d^2\theta}{dt^2}$

$\Rightarrow T(t) = 1\dfrac{d\theta}{dt} + k\theta + J\dfrac{d^2\theta}{dt^2}$

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

$$\Rightarrow \frac{\theta(s)}{F(s)} = \frac{\frac{1}{J}}{s^2 + \frac{1}{J}s + \frac{k}{J}}$$

$e^{\frac{-\pi\delta}{\sqrt{1-\delta^2}}} \times 100 = 30$

$\delta = 0.358$

$2\delta\omega_n = \dfrac{1}{J} \Rightarrow \delta\omega_n = \dfrac{1}{2J}$

$$T_s = \frac{4}{\delta\omega_n}$$

$T_s = 3s \Rightarrow \dfrac{4}{\delta\omega_n} = \dfrac{4}{\frac{1}{2J}} = 3$

$J = \dfrac{3}{8}$

$\delta\omega_n = \dfrac{4}{3}$, como $\delta = 0.358$, temos $\omega_n = 3.72$

$\omega_n^2 = \dfrac{k}{J}$ ou $k = 3.72^2 \times \dfrac{3}{8} = 5.20$

$J = \dfrac{3}{8}$, $k = 5.20$ //

Questão (4): a) $\frac{50}{s+1}$ e $\frac{2}{s}$ $\Rightarrow$ $\frac{50s}{s^2+s+100}$

x2 blocos paralelos (s e 2) $\Rightarrow$ s - 2

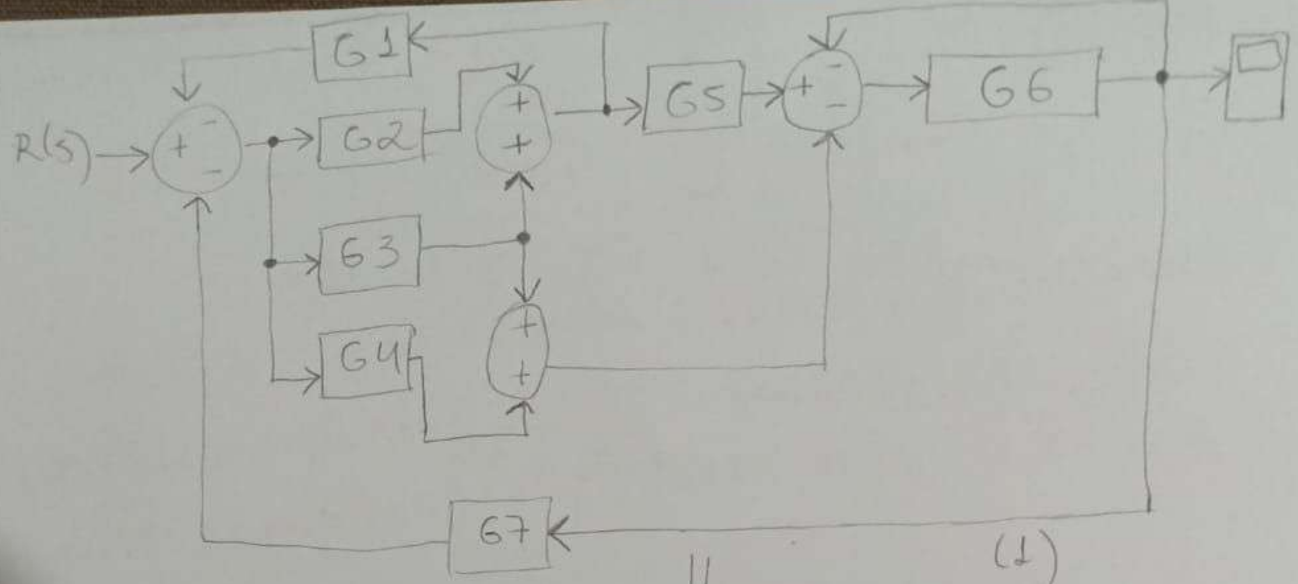
$\frac{1}{s^2}, \frac{50s}{s^2+s+100}, s-2 \Rightarrow \frac{50s(s-2)}{s^2(s^2+s+100)}$

$$\frac{\frac{50s(s-2)}{s^2(s^2+s+100)}}{1+\frac{50s(s-2)}{s^2(s^2+s+100)}} = \frac{50(s-2)}{s^3+s^2+150s-100}$$

```
s = tf('s');
num 1 = [50];
denm 1 = [1 1];
num 2 = [2];
den 2 = [1 0];
R1 = feedback(tf(num 1,den 1), tf(num2,den2),-1);
R2 = parallel(s,-2);
R3 = 1/s^2;
R4 = series(R1,R2);
R4 = series(R4,R3);
Final = minreal(feedback(R4,1,-1))
```

Final = $\frac{50s - 100}{s\text{^}3 + s\text{^}2 + 150s - 100}$

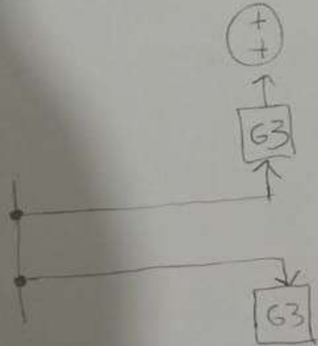
b)



G1
R(s)
G2
G5
G6
G3
G4
G7

(1)

⇓



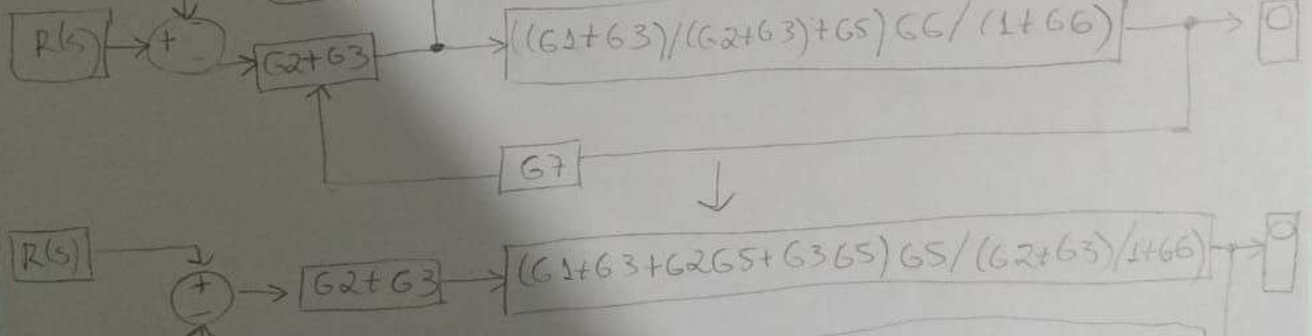
G3
G3

(2)

⇓

⋮

⇓



G1
R(s)
G2+G3
((G1+G3)/(G2+G3)+G5)G6/(1+G6)
G7
R(s)
G2+G3
(G1+G3+G2G5+G3G5)G5/(G2+G3)/1+G6)
G7+G1(G2+G3)(1+G6)/G6/(G1+G3+G2G5+G3G5)

continuação questão (21) b):

$\boxed{R(s)} \longrightarrow \boxed{\quad T \quad} \longrightarrow$

$T = (G2+G3+(G6(G1+G3+G2G5+G3G5))/((G6+1)(G2+G3)))/((G7+(G1(G6+1)(G2+G3))/(G6(G1+G3+G2G5+G3G5)))(G2+G3+(G6(G1+G3+G2G5+G3G5))/((G6+1)(G2+G3)))+1)$

c) $\boxed{R(s)} \longrightarrow \boxed{((G2+G3)G5+G4)G6/((1+G6)(1+G1(G2+G3))+G7((G2+G3)G5+G4)G6)} \longrightarrow$

d) $\boxed{R(s)} \longrightarrow \boxed{(G1G2G3)/(G1H1+G2H2+G1G2G3+G1G2H3+G2G3H4+1)} \longrightarrow$

e) função de transf. $\Rightarrow \dfrac{4s+1}{s}$

$\dfrac{s(20s+5)}{25s^2+18s+3}$

$\therefore \dfrac{-9 \pm \sqrt{6}}{25}$