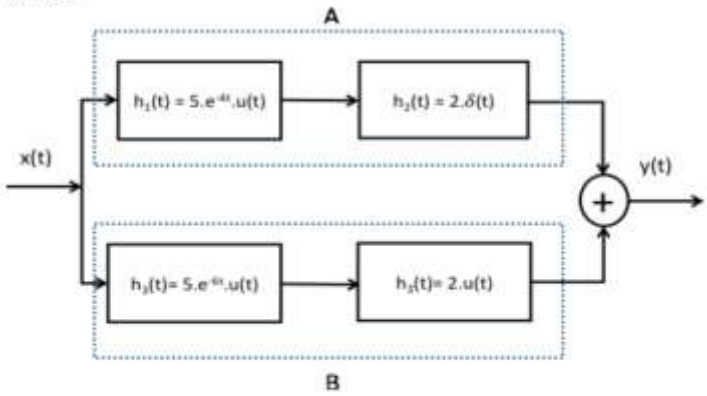
Soal no 1. (25)



Dengan alat bantu Transformasi Laplace,

a) Tentukan respons impuls sistem gabungan bagian atas (A)
b) Tentukan respons impuls sistem gabungan bagian bawah (B)
c) Tentukan respons impuls total sistem, h(t)
d) Gambarkan pole-zero sistem. Apakah sistem stabil ?, jelaskan
e) Jika sistem diberikan masukan $x(t) = 2.e^{-2t}.u(t)$, tentukan keluaran, y(t).

$h(t) = h_1(t) * h_2(t)$
$H(s) = H_1(s) \cdot H_2(s)$

$h(t) = h_1(t) + h_2(t)$
$H(s) = H_1(s) + H_2(s)$

a.

$h_1(t) = 5 \cdot e^{-4t} \cdot u(t)$

$H_1(s) = 5 \cdot \frac{1}{s+4}$

$H_1(s) = \frac{5}{s+4}$

$h_2(t) = 2\,\delta(t) \longrightarrow 1$

$H_2(s) = 2$

$h_A(t) = h_1(t) * h_2(t)$

$H_A(s) = H_1(s) \cdot H_2(s)$

$H_A(s) = \frac{5}{s+4} \cdot 2$

$H_A(s) = \frac{10}{s+4}$

$H_A(s) = 10 \cdot \frac{1}{s+4}$

$h_A(t) = 10\, e^{-4t} \cdot u(t)$

b.

$h_3(t) = 5 \cdot e^{-6t} \cdot u(t)$

$H_3(s) = 5 \cdot \frac{1}{s+6}$

$H_3(s) = \frac{5}{s+6}$

$h_4(t) = 2\,u(t) \longrightarrow \frac{1}{s}$

$H_4(s) = \frac{2}{s}$

$h_B(t) = h_3(t) * h_4(t)$

$H_B(s) = H_3(s) \cdot H_4(s)$

$$H_B(s) = \frac{5}{s+6} \cdot \frac{2}{s}$$

$$H_B(s) = \frac{10}{s(s+6)} \longrightarrow \frac{A}{s} + \frac{B}{s+6} = \frac{A(s+6) + Bs}{s(s+6)}$$

$$As + 6A + Bs = 10 + 0.s$$

$$(A+B)s + 6A = 10 + 0.s$$

$$A = \frac{5}{3}, \quad B = -\frac{5}{3}$$

$$H_B(s) = \frac{5}{3} \cdot \frac{1}{s} - \frac{5}{3} \cdot \frac{1}{s+6}$$

$$h_B(t) = \frac{5}{3} u(t) - \frac{5}{3} e^{-6t} u(t)$$

c. $h(t) = h_A(t) + h_B(t)$

$$h(t) = 10e^{-4t} u(t) + \frac{5}{3} u(t) - \frac{5}{3} e^{-6t} u(t)$$

d. $h(t) \longrightarrow H(s)$

$$H(s) = \frac{10}{s+4} + \left| \frac{5}{3} \cdot \frac{1}{s} - \frac{5}{3} \cdot \frac{1}{s+6} \right| \longrightarrow \frac{10}{s(s+6)}$$

$$H(s) = \frac{10}{s+4} + \frac{10}{s(s+6)}$$

$$H(s) = \frac{10s(s+6) + 10(s+4)}{s(s+4)(s+6)}$$

$$H(s) = \frac{10s^2 + 60s + 10s + 40}{s(s+4)(s+6)}$$

$$H(s) = \frac{10s^2 + 70s + 40}{s(s+4)(s+6)}$$

Pole :

$s(s+4)(s+6) = 0$

$s_1 = 0$

$s_2 = -4$

$s_3 = -6$

Zero :

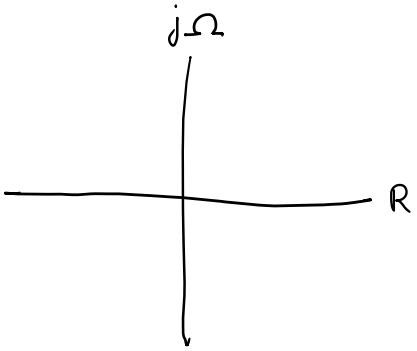
$10s^2 + 70s + 40 = 0$

$s^2 + 7s + 4 = 0$

$$s_{1,2} = \frac{-7 \pm \sqrt{7^2 - 4.1.4}}{2.1}$$

$s_1 = -0{,}63$

$s_2 = -6{,}37$



Agar stabil maka Pole < 0

∴ Sistem tidak stabil karena ada pole yg bernilai 0

e. $x(t) = 2e^{-2t}u(t) \rightarrow X(s) = 2.\frac{1}{s+2}$

$Y(t) = x(t) * h(t)$

$Y(s) = X(s).H(s)$

$Y(s) = \frac{2}{s+2} \cdot \frac{10s^2+20s+40}{s(s+4)(s+6)}$

$Y(s) = \frac{20s^2+140s+80}{s(s+2)(s+4)(s+6)} \rightarrow \frac{A}{s} + \frac{B}{s+2} + \frac{C}{s+4} + \frac{D}{s+6}$

$A(s+2)(s+4)(s+6) + Bs(s+4)(s+6) + Cs(s+2)(s+6) + Ds(s+2)(s+4) = 20s^2+140s+80$

$(As+2A)(s^2+10s+24) + Bs(s^2+10s+24) + Cs(s^2+8s+12) + Ds(s^2+6s+8) = \_\_$

$As^3+2As^2+10As^2+20As+24As+48A + Bs^3+10Bs^2+24Bs + Cs^3+8Cs^2+12Cs + Ds^3+6Ds^2+8Ds = \_\_$

$(A+B+C+D)s^3 + (22A+10B+8C+6D)s^2 + (44A+24B+12C+8D)s + 48A = \_\_$

$A+B+C+D = 0$

$22A+10B+8C+6D = 20$

$11A+5B+4C+3D = 10$

$44A+24B+12C+8D = 140$

$11A+6B+3C+2D = 35$

$48A = 8D$

$\boxed{A = \frac{5}{3}}$

$11A+6B+3C+2D = 35$

$11A+5B+4C+3D = 10$

$B-C-D = 25$

$A+B+C+D = 0$

$A+2B = 25$

$\frac{5}{3}+2B = 25$

$\boxed{B = \frac{35}{3}}$

$\frac{35}{3}-C-D = 25$

$-C-D = \frac{40}{3}$

$C+D = -\frac{40}{3} \rightarrow \boxed{D = \frac{40}{3}}$

$11A+6B+3C+2D = 35$

$11A+5B+4C+3D = 10$

$3C+2D = 35 - \frac{55}{3} - 1.\frac{35}{3}$

$4C+3D = 10 - \frac{55}{3} - 5.\frac{35}{3}$

$3C+2D = -\frac{160}{3}$

$4C+3D = -\frac{200}{3}$

$\times 3 \quad \times 2$

$9C+6D = -160$

$8C+6D = -\frac{400}{3}$

$\boxed{C = -\frac{80}{3}}$

$$Y(s) = \frac{A}{s} + \frac{B}{s+2} + \frac{C}{s+4} + \frac{D}{s+6}$$

$$Y(s) = \frac{5}{3}\cdot\frac{1}{s} + \frac{35}{3}\cdot\frac{1}{s+2} - \frac{80}{3}\cdot\frac{1}{s+4} + \frac{40}{3}\cdot\frac{1}{s+6}$$

$$y(t) = \frac{5}{3}u(t) + \frac{35}{3}e^{-2t}\cdot u(t) - \frac{80}{3}e^{-4t}\cdot u(t) + \frac{40}{3}e^{-6t}\cdot u(t)$$

Soal no 2. (30)

Sebuah sistem waktu kontinyu, hubungan input/outputnya ditunjukkan oleh persamaan differensial sebagai berikut :

$$0{,}823\frac{d^2y(t)}{dt^2} + 50{,}5\frac{dy(t)}{dt} + 3948y(t) = 0{,}653\frac{d^2x(t)}{dt^2}$$

$$H(s) = \frac{Y(s)}{X(s)}$$

a. Dapatkan fungsi transfer system: $H(s)$
b. Gambarkan pole dan zero dan daerah konvergensinya.
c. Gambarkan struktur realisasi sistem menggunakan integrator
d. Tentukan respon frekuensi: $H(j\Omega)$.
e. Tuliskan persamaan $|H(j\Omega)|$ dan $arg[H(j\Omega)]$.
f. Jika sistem diberi input $x(t) = \cos(62{,}83t)$, tentukan respons steady-state nya: $y(t)$.

a. $0{,}823\frac{d^2}{dt^2}Y(t) + 50{,}5\frac{d}{dt}Y(t) + 3948\,Y(t) = 0{,}653\frac{d^2}{dt^2}X(t)$

$0{,}823\,s^2\,Y(s) + 50{,}5\,s\,Y(s) + 3948\,Y(s) = 0{,}653\,s^2\,X(s)$

$(0{,}823\,s^2 + 50{,}5\,s + 3948)\,Y(s) = 0{,}653\,s^2\,X(s)$

$H(s) = \frac{Y(s)}{X(s)} = \frac{0{,}653\,s^2}{0{,}823\,s^2 + 50{,}5\,s + 3948}$

b. Zero :

$0{,}653\,s^2 = 0$

$s^2 = 0$

$s = 0$

Pole :

$0{,}823\,s^2 + 50{,}5\,s + 3948 = 0$

$s_1 = -30{,}6P - 62{,}1\,i$

$s_2 = -30{,}6P + 62{,}1\,i$

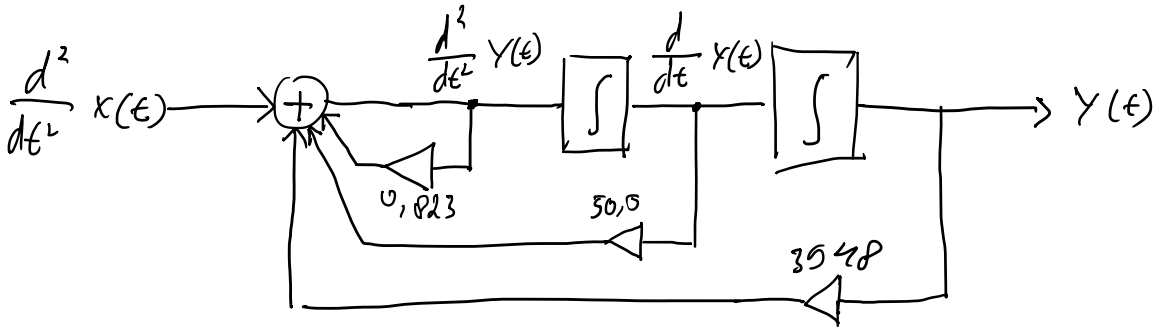
ROC :

$Re(s) = -30{,}6P$

Karena nilai real dari pole condong ke kiri ($Re(s) < 0$) maka :

$Re(s) < -30{,}6P$

c.



d. $H(s) = \dfrac{0{,}653 s^2}{0{,}823 s^2 + 50{,}5 s + 3948}$

$H(j\Omega) = \dfrac{0{,}653 (j\Omega)^2}{0{,}823 (j\Omega)^2 + 50{,}5 (j\Omega) + 3948}$

$H(j\Omega) = \dfrac{-0{,}653 \Omega^2}{-0{,}823 \Omega^2 + 50{,}5 j\Omega + 3948}$

e. $H(j\Omega) = \dfrac{-0{,}653 \Omega^2 + j(0)}{(3948 - 0{,}823 \Omega^2) + j(50{,}5\,\Omega)}$

$|H(j\Omega)| = \dfrac{\sqrt{(-0{,}653 \Omega^2)^2 + 0^2}}{\sqrt{(3948 - 0{,}823\Omega^2)^2 + (50{,}5\Omega)^2}}$

$|H(j\Omega)| = \dfrac{0{,}653 \Omega^2}{\sqrt{0{,}67732 \Omega^4 - 390{,}65 \Omega^2 + 1{,}54 \times 10^7}}$

$H(j\Omega) = \dfrac{-0{,}653 \Omega^2}{(3948 - 0{,}823 \Omega^2) + j(50{,}5\Omega)} \cdot \dfrac{(3948 - 0{,}823\Omega^2) - j(50{,}5\Omega)}{(3948 - 0{,}823\Omega^2) - j(50{,}5\Omega)}$

$H(j\Omega) = \dfrac{(0{,}54\Omega^4 - 2578{,}04\Omega^2) + j(32{,}98\Omega^3)}{0{,}68\Omega^4 - 390{,}65\Omega^2 + 1{,}54 \times 10^7}$

$\arg\{H(j\Omega)\} = \tan^{-1}\left(\dfrac{\text{Im } H(j\Omega)}{\text{Re } H(j\Omega)}\right)$

$= \tan^{-1}\left(\dfrac{32{,}98\Omega^3}{0{,}54\Omega^4 - 2578{,}04\Omega^2}\right)$

$= \tan^{-1}\left(\dfrac{32{,}98\Omega}{0{,}54\Omega^2 - 2578{,}04}\right)$

Sebuah filter analog dengan fungsi transfer:

$$H(s) = \frac{3141{,}59s}{s^2 + 3769{,}91s + 1973920{,}9}$$

a) Gambarkan letak pole dan zero filter analog ini dibidang s
b) Apakah filter analog stabil? Jelaskan jawaban anda.
c) Tuliskan persamaan respons impuls filter $h(t)$
d) Tuliskan persamaan differensial filter analog ini.
e) Gambarkan realisasi filter analog dengan memakai integrator.
f) Tuliskan persamaan respons frekuensi filter $H(j\Omega)$
g) Gambarkan magnituda respons frekuensi $|H(j\Omega)|$
h) Gambarkan respons phasa $arg[H(j\Omega)]$
i) Sebutkan jenis filter analog ini, apakah low-pass, high-pass, bandpass, atau bandstop? Jelaskan jawaban anda.

i. $H(s) = \dfrac{3141,59\,s}{s^2 + 3769,91\,s + 1973920,9}$

Fungsi transfer filter :

$LPF = \dfrac{\Omega_u}{s + \Omega_u}$ $\qquad$ $BPF = \dfrac{s(\Omega_u - \Omega_l)}{s^2 + s(\Omega_u - \Omega_l) + \Omega_u \Omega_l}$

$HPF = \dfrac{s}{s + \Omega_u}$ $\qquad$ $BSF = \dfrac{s^2 + \Omega_u \Omega_l}{s^2 + s(\Omega_u - \Omega_l) + \Omega_u \Omega_l}$

∴ $H(s)$ merupakan BPF (Band-Pass Filter) karena fungsi $H(s)$ paling sesuai dengan fungsi transfer BPF