priprema SIS - labos

zad. 3.1. - 3 a)

impulsni odziv i odziv na jedinični skok

1) $y(n) - 0{,}8y(n-1) + 0{,}2y(n-2) = u(n)$

$\boxed{a.}$ $y(-1)=0$ $y(-2)=0$ $u(n)=\delta(n)$

$y(n) = u(n) + 0{,}8y(n-1) - 0{,}2y(n-2)$ $h(-2)=h(-1)=0$

$h(n) = \delta(n) + 0{,}8h(n-1) - 0{,}2h(n-2)$

$h(0) = \delta(0) + 0{,}8h(-1) - 0{,}2h(-2)$

$\boxed{h(0)=1}$

$\measuredangle \; \text{arc tg} \frac{0{,}2}{0{,}4} = \text{arc tg} \frac{1}{2} = 26{,}56^\circ$

$q^2 - 0{,}8q + 0{,}2 = 0$

$q_{1,2} = \frac{0{,}8 \pm j0{,}4}{2}$

$\boxed{\begin{matrix} q_1 = 0{,}4 + j0{,}2 \\ q_2 = 0{,}4 - j0{,}2 \end{matrix}}$

$h(n) = 0{,}447 \cdot \left[A \cos(26{,}56^\circ n) + B \sin(26{,}56^\circ n) \right]$

$h(0) = 0{,}447 \cdot A = 1 \rightarrow \boxed{A = 2{,}237}$

$h(-1) = 0{,}447 \cdot \left[2{,}237 \cos(+26{,}56^\circ) - B \sin(26{,}56^\circ) \right] = 0{,}447 \cdot (2{,}0009 - B\,0{,}447) = 0$

$= 0{,}8944 - B\,0{,}1998 = 0 \rightarrow 0{,}8944 = B\,0{,}1998$

$\boxed{B = 4{,}476}$

$h(n) = 0{,}447 \cdot \left[2{,}237 \cdot \cos(26{,}56^\circ n) + 4{,}476 \cdot \sin(26{,}56^\circ n) \right]$

$\boxed{b}$

$u(n) = \mu(n)$

$$y(n) - 0{,}8\,y(n-1) + 0{,}2\,y(n-2) = u(n)$$

$$y_{0H} = 0{,}447 \cdot \left[A\cos(26{,}56^\circ n) + B\sin(26{,}56^\circ n) \right]$$

$\boxed{\text{partikularno}}$

$\boxed{y_{0p} = K}$

$$K - 0{,}8K + 0{,}2K = 1$$
$$0{,}4K = 1$$
$$\boxed{K = 2{,}5}$$

$$y(n) = 0{,}447 \cdot A\cos(26{,}56^\circ n) + 0{,}447\,B\sin(26{,}56^\circ n) + 2{,}5$$

$y(0) = 1$

$$y(0) = 0{,}447A + 2{,}5 = 1$$
$$0{,}447A = -1{,}5$$
$$\boxed{A = -3{,}356}$$

$$y(-1) = 0 = -1{,}3418 - 0{,}1998B + 2{,}5 =$$
$$-0{,}1998B = -1{,}1582$$
$$\boxed{B = 5{,}797}$$

$$y(n) = 0{,}447 \left[-3{,}356 \cdot \cos(26{,}56^\circ n) + 5{,}797\sin(26{,}56^\circ n) \right]$$

2) $y(n) - \sqrt{3}\,y(n-1) + y(n-2) = u(n)$

$y(n) = u(n) + \sqrt{3}\,y(n-1) - y(n-2)$

$h(-1) = h(-2) = 0$

$\boxed{a}$ $u(n) = \delta(n)$

$h(n) - \sqrt{3}h(n-1) + h(n-2) = 0$

$z^2 - \sqrt{3}z + 1 = 0$

$z_{1,2} = \frac{\sqrt{3} \pm j}{2} = \frac{\sqrt{3}}{2} \pm j\frac{1}{2}$

$\sqrt{\frac{3}{4} + \frac{1}{4}} = 1$

$\operatorname{arc\,tg} \frac{\frac{1}{2}}{\frac{\sqrt{3}}{2}} = \operatorname{arc\,tg} \frac{\sqrt{3}}{3} = \frac{\pi}{6}$

$h(n) = A \cdot \cos\frac{\pi}{6}n + B\sin\frac{\pi}{6}n$

$h(0) = \delta(0) + \sqrt{3}h(-1) - h(-2)$

$\boxed{h(0) = 1}$

$h(-1) = A \cdot \frac{\sqrt{3}}{2} - B \cdot \frac{1}{2} = 0$

$h(0) = \boxed{A = 1}$

$\boxed{B = \sqrt{3}}$

$\frac{\sqrt{3}}{2} = B\frac{1}{2}$

$$\boxed{h(n) = \cos\frac{\pi}{6}n + \sqrt{3}\sin\frac{\pi}{6}n}$$

$\boxed{b}$ $u(n) = \mu(n)$

$\boxed{\text{homogeno rj.}}$

$y_H = A\cos\frac{\pi}{6}n + B\sin\frac{\pi}{6}n$

$\boxed{\text{partikularno rj.}}$

$y_p = K$

$K - \sqrt{3}K + K = 1$

$(2-\sqrt{3})K = 1$

$K = \frac{1}{2-\sqrt{3}}$

$y(n) = A\cos\frac{\pi}{6}n + B\sin\frac{\pi}{6}n + \frac{1}{2-\sqrt{3}}$

$y(-1) = 0 = A\frac{\sqrt{3}}{2} - B \cdot \frac{1}{2} + \frac{2+\sqrt{3}}{7}$

$\frac{(5-\sqrt{3})\cdot\sqrt{3}}{2 \cdot 7} + \frac{2(2+\sqrt{3})}{2 \cdot 7} = B\cdot\frac{1}{2}$

$y(0) = 1 = A + \frac{2+\sqrt{3}}{7}$

$5\sqrt{3} - 3 + 4 + 2\sqrt{3} = 7B$

$7\sqrt{3} + 1 = 7B$

$A = \frac{7}{7} - \frac{2+\sqrt{3}}{7} = \boxed{\frac{5-\sqrt{3}}{7} = A}$

$\boxed{B = \frac{7\sqrt{3}+1}{7}}$

$$\boxed{y(n) = \frac{5-\sqrt{3}}{7}\cdot\cos\frac{\pi}{6}n + \frac{7\sqrt{3}+1}{7}\sin\frac{\pi}{6}n + \frac{2+\sqrt{3}}{7}}$$

3) $y(n) - 2y(n-1) + y(n-2) = u(n)$

$\boxed{a}$ $u(n) = \delta(n)$

$h(0) = 1$
$h(-1) = h(-2) = 0$

$q^2 - 2q + q = 0$

$\boxed{q_1 = q_2 = 1}$

$h(n) = (c_1 + c_2 n) \cdot 1^n$

$h(0) = c_1 + 0 = 1$ $\boxed{c_1 = 1}$

$h(-1) = c_1 - c_2 = 0$ $\boxed{c_2 = 1}$

$h(n) = (1+n)(1)^n$

$\boxed{b}$ $u(n) = \mu(n)$

$\boxed{\text{напоgено}}$

$y_H = (c_1 + c_2 n) \cdot 1^n$

$\boxed{\text{partikularno}}$

$y_p = K \cdot (1)^n \cdot n^2$

$K \cdot n^2 - 2\, K(n-1)^2 + K \cdot (n-2)^2 = 1$

$Kn^2 - 2K(n^2 - 2n + 1) + K(n^2 - 4n + 4) = 1$

$\cancel{Kn^2} - \cancel{2Kn^2} + \cancel{4nK} - 2K + \cancel{n^2K} - \cancel{4nK} + 4K = 1$

$2K = 1$

$\boxed{K = \frac{1}{2}}$

$\boxed{y_p = \frac{1}{2} \cdot (1)^n \cdot n^2}$

$y(n) = (c_1 + c_2 \cdot n) \cdot 1^n + \frac{1}{2} \cdot 1^n \cdot n^2$

$y(0) = 1$
$y(-1) = 0$

$y(0) = 1 = c_1$

$y(-1) = 0 = 1 - c_2 + \frac{1}{2} =$

$-c_2 = -\frac{3}{2}$

$\boxed{c = \frac{3}{2}}$

$\boxed{y(n) = \left(1 + \frac{3}{2} n\right) \cdot 1^n + \frac{1}{2} \cdot 1^n n^2}$

4) $y(n) - 2y(n-1) + 5y(n-2) = u(n)$

$\boxed{a}$ $u(n) = \delta(n)$

$\sqrt{1+4} = \sqrt{5}$ $\quad$ $\measuredangle \operatorname{arc} tg\, 2 = 63{,}43°$

$z^2 - 2z + 5 = 0$

$z_{1,2} = \dfrac{2 \pm j\sqrt{4}}{2} = 1 \pm 2j$

$h(n) = \sqrt{5} \cdot \left[A\cos(63{,}43° n) + B \sin(63{,}43° n) \right]$

$h(0) = 1$
$h(-1) = 0$

$h(0) = \sqrt{5} \cdot A = 1 \quad \rightarrow \quad \boxed{A = \dfrac{\sqrt{5}}{5}}$

$h(-1) = 0{,}4473 - B\,1{,}9999 = 0$

$B\,1{,}9999 = 0{,}4473 \quad \rightarrow \quad \boxed{B = 0{,}224}$

$h(n) = \cos(63{,}43° n) + 0{,}501 \sin(63{,}43° n)$

$\boxed{b}$ $u(n) = \mu(n)$

$\boxed{\text{homogeno rj.}}$

$y_H = \sqrt{5} \cdot \left[A \cos(63{,}43° n) + B \sin(63{,}43° n) \right]$

$\boxed{\text{partikularno rj.}}$

$y_p = K$

$K - 2K + 5K = 1$

$\boxed{K = \dfrac{1}{4}}$

$y(n) = \sqrt{5} \left[A \cos(63{,}43° n) + B \sin(63{,}43° n) \right] + \dfrac{1}{4}$

$y(0) = 1$
$y(-1) = 0$

$y(-1) = 0{,}3355 - B\,1{,}9999 + \dfrac{1}{4} = 0$

$-B\,1{,}9999 = -0{,}5855$

$\boxed{B = 0{,}2928}$

$y(0) = 1 = \sqrt{5} \cdot A + \dfrac{1}{4} \rightarrow \quad A = \dfrac{3\sqrt{5}}{20}$

$\boxed{y(n) = 0{,}75 \cos(63{,}43° n) + 0{,}655 \sin(63{,}43° n)}$

Zad. 3.1-4.

- kada se frekv. pobude poklopi s vlastitom frekvencijom sustava, sustav postaje nestabilan
- pojavi se zona rezonancija

Zad 3.1.-5

a) $y(n) - 0{,}8y(n-1) + 0{,}2y(n-2) = u(n)$

$g_1 = 0{,}4 + j0{,}2$

$g_2 = 0{,}4 - j0{,}2$

Sustav je stabilan, karak. frekv. se nalaze unutar kružnice

b) $y(n) - \sqrt{3}\,y(n-1) + y(n-2) = u(n)$

$g_1 = \frac{\sqrt{3}}{2} + j\frac{1}{2}$

$g_2 = \frac{\sqrt{3}}{2} - j\frac{1}{2}$

točke se nalaze na rubovima kružnice pa je sustav marginalno stabilan

c) $y(n) - 2y(n-1) + y(n-2) = u(n)$

$g_1 = g_2 = 1$

Sustav je nestabilan

d) $y(n) - 2y(n-1) + 5y(n-2) = u(n)$

$g_1 = 1 + 2j$

$g_2 = 1 - 2j$

nestabilan sustav jer su izvan kružnice.

Zadatak 3.2-1. a)

1) $y(t) = \int_{-\infty}^{t} u(\tau)\, d\tau$ (integrator)

Za izlaz u trenutku t potrebno je poznavati "prošlost" sustava pa je sustav kauzalan

→ linearnost

$u(\tau) = \alpha u_1(\tau) + \beta u_2(\tau)$

$y_1(t) = \int_{-\infty}^{t} u_1(\tau)\, d\tau$

$y(t) = \int_{-\infty}^{t} (\alpha u_1(\tau) + \beta u_2(\tau))\, d\tau$

$y_2(t) = \int_{-\infty}^{t} u_2(\tau)\, d\tau$

$y(t) = \int_{-\infty}^{t} \alpha u_1(\tau)\, d\tau + \int_{-\infty}^{t} \beta u_2(\tau)\, d\tau$

$y(t) = \alpha y_1(t) + \beta y_2(t)$ — sustav je linearan

→ memorija sustava

→ integrator je memorijski sustav

$y(t) = \int_{-\infty}^{t} u(\tau)\, d\tau = \int_{-\infty}^{t_0} u(\tau)\, d\tau + \int_{t_0}^{t} u(\tau)\, d\tau$

$y(t_0) + \int_{t_0}^{t} u(\tau)\, d\tau$

2) $y(t) = \frac{d}{dt} u(t)$ derivator

→ kauzalnost

ako derivator ovako definiramo $y(t) = \lim_{\Delta t \to 0} \frac{f(t+\Delta t) - f(t)}{\Delta t}$

onda je nekauzalan

ako ga definiramo kao $y(t) = \lim_{\Delta t \to 0} \frac{f(t) - f(t-\Delta t)}{\Delta t}$

onda je kauzalan

→ linearnost

$u(t) = \alpha u_1(t) + \beta u_2(t)$

$y_1(t) = \frac{d}{dt} u_1(t)$

$y(t) = \frac{d}{dt}\left[\alpha u_1(t) + \beta u_2(t)\right]$

$y_2(t) = \frac{d}{dt} u_2(t)$

$y(t) = \alpha \frac{d}{dt} u_1(t) + \beta \frac{d}{dt} u_2(t)$

→ derivator je memorijski sustav

→ sustav je linearan

Zad. 3.2. - 2a)

1) $y''(t) + 2y'(t) + 25\, y(t) = u(t)$

$$\boxed{a_1 = 2 \quad a_2 = 25 \quad b_0 = 0 \quad b_1 = 0 \quad b_2 = 1}$$

$s^2 + 2s + 25 = 0$

$$s_{1,2} = \frac{-2 \pm j 4\sqrt{6}}{2} = -1 \pm j 2\sqrt{6}$$

$$\boxed{h_A(0^+) = 0 \quad h_A'(0^+) = 1}$$

$$y_H = e^{-t}\left(A \cos 2\sqrt{6}t + B \sin 2\sqrt{6}t\right)$$

$$h_A(t) = e^{-t}\left(A \cos 2\sqrt{6}t + B \sin 2\sqrt{6}t\right)$$

$$h_A'(t) = -e^{-t} A \cos(2\sqrt{6}t) + 2\sqrt{6} \cdot e^{-t} \cdot \sin 2\sqrt{6}t \cdot A - e^{-t} \cdot B \sin 2\sqrt{6}t - e^{-t}\, 2\sqrt{6} \cdot B \cos 2\sqrt{6}t$$

$$h_A'(0^+) = 1 \cdot A - 2\sqrt{6} \cdot B = 1$$

$$h_A(0^+) = 1 \cdot A = 0 \qquad B = -\frac{1}{2\sqrt{6}} \cdot \frac{\sqrt{6}}{\sqrt{6}} = -\frac{\sqrt{6}}{12}$$

$$\boxed{A = 0}$$

$$\boxed{h_A(t) = -e^{-t} \frac{\sqrt{6}}{12} \sin 2\sqrt{6}t}$$

$M = 1$
$N = 2$

$\boxed{N > M\ w}$

$$h(t) = \overbrace{b_0 \cdot \delta(t)}^{0} + \sum_{m=0}^{M} \left(b_{N-m} D^m\right) h_A(t)$$

$$= \sum_{m=0}^{0} \left(b_{2-m} D^m\right) \cdot h_A(t) = b_2 D^0 h_A(t)$$

$$h(t) = b_2 \cdot h_A(t)$$

$$h(t) = 1\, h_A(t)$$
$$= -e^{-t} \frac{\sqrt{6}}{12} \cdot \sin 2\sqrt{6}t \qquad t > 0$$

5

2) $y''(t) + 23y(t) = u(t)$

$a_1 = 0$ $\quad$ $b_0 = b_1 = 0$

$a_2 = 23$ $\quad$ $b_2 = 1$

$s^2 + 23s = 0$

$s(s+23) = 0$

$s_1 = 0$

$s_2 = -23$

$y_H = C_1 \cdot e^{-0t} + C_2 \cdot e^{-23t}$

$y_H = C_1 + C_2 \cdot e^{-23t} \quad t>0$

$h_A(t) = C_1 + C_2 \cdot e^{23t}$

$h_A'(0^+) = 1$

$h_A(0^+) = 0$

$h_A(0^+) = 0 = C_1 + C_2$

$h_A'(0^+) = -23C_2 = 1$

$\boxed{C_2 = -\frac{1}{23}}$ $\quad$ $\boxed{C_1 = \frac{1}{23}}$

$M = 0$

$N = 2$

$\boxed{h_A(t) = \frac{1}{23} - \frac{1}{23} \cdot e^{-23t} \quad t>0}$

$h(t) = \underbrace{b_0}_{0} \cdot \delta(t) + \sum_{m=0}^{M} (b_{N-m} D^m)\, h_A(t) = b_2 D^0 h_A(t)$

$\boxed{h(t) = \frac{1}{23} - \frac{1}{23} e^{-23t} \quad t>0}$

3) $y''(t) = u(t)$

$\boxed{\begin{array}{l} a_1 = a_2 = 0 \\ b_0 = b_1 = 0 \\ b_2 = 1 \end{array}}$

$h'(0^+) = 1$

$h(0^+) = 0$

$s^2 = 0$

$\boxed{s_1 = s_2 = 0}$

$y_H = (C_1 + C_2 t) \cdot e^{-0 \cdot t}$

$\boxed{h_A(t) = C_1 + C_2 t \quad t>0}$

$h_A'(t) = C_2 = 1$ $\quad$ $\boxed{h_A(t) = t, \quad t>0}$

$h_A(t) = C_1 = 0$

$h(t) = b_2 \cdot h_A(t) =$

$\boxed{h(t) = t \quad , t>0}$

4) $y''(t) - 2y'(t) + 17y(t) = u(t)$

$a_1 = -2$
$a_2 = 17$

$b_0 = b_1 = 0$
$b_2 = 1$

$s^2 - 2s + 17 = 0$

$s_{1,2} = \frac{2 \pm j8}{2}$

$\boxed{s_{1,2} = 1 \pm j4}$

$y_H = e^t (A\cos 4t + B\sin 4t)$

$h_A(0^+) = 0$

$h_A'(0^+) = 1$

$h_A(t) = e^t (A\cos 4t + B\sin 4t) \quad t>0$

$h_A(0^+) = \boxed{A = 0}$

$h_A'(t) = e^t . A\cos 4t - Ae^t . 4\sin 4t + e^t . B\sin 4t + e^t . 4 . B\cos 4t$

$h_A'(0^+) = 1 = A + 4B$

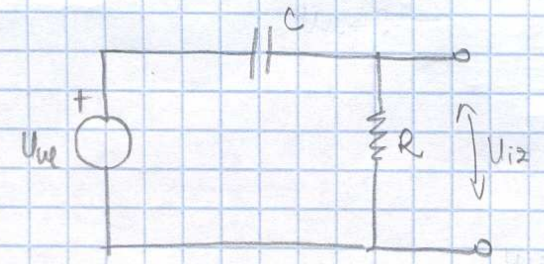
$\boxed{B = \frac{1}{4}}$

$\boxed{h_A(t) = e^t . \frac{1}{4} . \sin 4t \quad t>0}$

$\boxed{h(t) = b_2 . h_A(t) = e^t . \frac{1}{4} \sin 4t \quad , t>0}$

Zadatak 3.2.-5.

$R = 1k\,\Omega$
$C = 10\mu F$



$U_{ul} = U_C + U_R$

$U_{iz} = U_R$

$U_{iz} = i \cdot R$

$$\boxed{i = \frac{U_{iz}}{R}}$$

$$U_{ul} = \frac{1}{C}\int i\, d\tau + U_{iz}$$

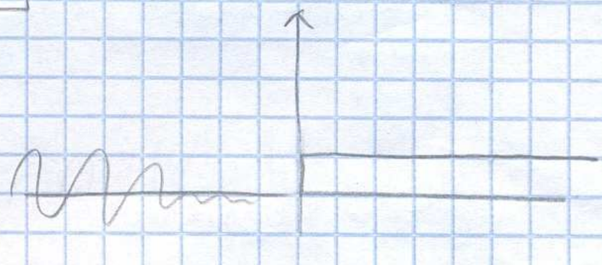
$$U_{ul} = \frac{1}{C} \cdot \int \frac{U_{iz}}{R}\, d\tau + U_{iz} \quad \Big/ \frac{d}{dt}$$

$$\frac{dU_{ul}}{dt} = \frac{1}{CR} U_{iz} + \frac{dU_{iz}}{dt}$$ → jednadžba je točna

$u = U_{ul}$
$y = U_{iz}$

$$u' = \frac{1}{CR} y + y' \qquad \boxed{b_0 = 1}$$

$$u(t) = \begin{cases} \sin t & -\infty < t < 0^- \\ 1 & 0^+ < t < +\infty \end{cases}$$



$u(0^-) = 0$

$u(0^+) = 1$

* Zbog istitravanja

$$y_p = K_1 \cos(t) + K_2 \sin(t)$$

$$y_p' = -K_1 \sin t + K_2 \cos t$$

$$-\cos t = \frac{1}{CR} \cdot \left[K_1 \cos t + K_2 \sin t\right] - K_1 \sin t + K_2 \cos t$$

$$\frac{1}{CR} = \frac{1}{10^3 \cdot 10 \cdot 10^{-6}} = 100$$

$$-\cos t = (100 K_1 + K_2)\cos t + \sin t\,(100 K_2 - K_1)$$

$100K_1 + K_2 = -1 \quad / \cdot 100$
$100K_2 - K_1 = 0 \quad / \cdot 100$

$\cancel{100K_1} + K_2 = -1$
$-\cancel{100K_1} + 1000K_2 = 0$

$10001 K_2 = -1$

$$\boxed{K_2 = -0{,}0001}$$

zad. 3.2-7.a)

a) $y''(t) + 2\xi\Omega_n y'(t) + \Omega_n^2 y(t) = A\Omega_n^2 u(t)$

$\Omega_n = 0,4$

$A = \Omega_n^{-2}$

$\boxed{\xi = -0,125}$

$y'(0) = 2$

$y(0) = -2$

$y''(t) - 0,1y'(t) + 0,16y(t) = u(t)$

$$H(s) = \frac{1}{s^2 - 0,1s + 0,16}$$

$$H(j\omega) = \frac{1}{-\omega^2 - 0,1j\omega + 0,16}$$

$$|H(j\omega)| = \frac{1}{\sqrt{(0,16-\omega^2)^2 + (0,1\omega)^2}}$$

b) $y''(t) + 0,2y'(t) + 0,16y(t) = u(t)$

$\boxed{\xi = 0,25}$

$$H(s) = \frac{1}{s^2 + 0,2s + 0,16}$$

$$H(j\omega) = \frac{1}{-\omega^2 + j0,2\omega + 0,16}$$

$$|H(j\omega)| = \frac{1}{\sqrt{(0,16-\omega^2)^2 + 0,4\omega^2}}$$

c) $y''(t) + 0,8y'(t) + 0,16y(t) = u(t)$

$\boxed{\xi = 1}$

$$H(s) = \frac{1}{s^2 + 0,8s + 0,16}$$

$$H(j\omega) = \frac{1}{-\omega^2 + j0,8\omega + 0,16}$$

$$|H(j\omega)| = \frac{1}{\sqrt{(0,16-\omega^2)^2 + 0,64\omega^2}}$$

nastavak 3.2-5.

$100K_1 - 0{,}0001 = -1$

$100K_1 = -0{,}9999$

$\boxed{K_1 = -0{,}01}$

$\boxed{y_p = -0{,}01\cos(t) - 0{,}0001\sin(t)}$

$y(0^-) = -0{,}01$

$\Delta y(t) = b_0 u(0^+)$

$y(0^+) - y(0^-) = 1 \cdot u(0^+)$

$y(0^+) = 1 + y(0^-)$

$\boxed{y(0^+) = 0{,}99}$

Zadatak 3.2-7.c

harmonijski signal $\sqrt{3}\cos(4t)$

a)

$$H(4j) = \frac{1}{-16 - 0{,}4j + 0{,}16} = \frac{1}{-15{,}84 - 0{,}4j}$$

novi signal $A_1\cos(4t + \varphi)$

$|H(4j)| = 0{,}0631$

$$\text{arc tg}\ \frac{0{,}4}{-15{,}84} = -91{,}44$$

$A = \sqrt{3} \cdot 0{,}0631 = 0{,}1093 \longrightarrow 0{,}1093\cos(4t + 91{,}44°)$

b)

$$H(4j) = \frac{1}{-16 + j0{,}8 + 0{,}16} = \frac{1}{0{,}8j - 15{,}84} \cdot \frac{-15{,}84 - 0{,}8j}{-15{,}84 - 0{,}8j}$$

$A = \sqrt{3} \cdot 0{,}06305 = 0{,}1092$

$|H(j4)| = 0{,}06305$

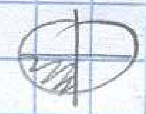
$$\text{arctg}\ \frac{-0{,}8}{-15{,}84} = 182{,}89° \longrightarrow 0{,}1092 \cdot \cos(4t + 182{,}89°)$$

c)

$$H(j4) = \frac{1}{-16 + 3{,}2j + 0{,}16} = \frac{1}{3{,}2j - 15{,}84}$$

$$|H(j4)| = 0{,}06188$$

$$\text{arc tg} \frac{-3{,}2}{-15{,}84} = 191{,}42^\circ$$



$$A = \sqrt{3} \cdot 0{,}06188 = 0{,}1072$$

$$\rightarrow 0{,}1072 \cos(4t + 191{,}42^\circ)$$