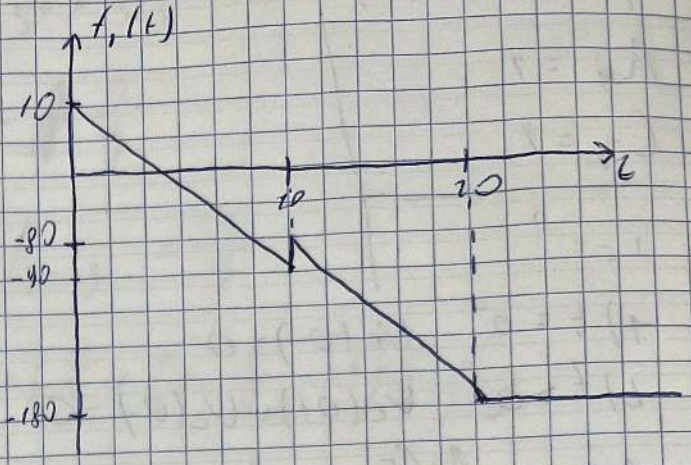
№1.4.6 (17)

$h(t) = 6\delta(t) - 2e^{-\frac{t}{3}}\delta_1(t)$

$f_1(t) = (10 - 10t)\delta_1(t) + 10\delta_1(t-10) +$

$+ 10(t-20)\delta_1(t-20)$



$H(s) = \mathcal{L}\{h(t)\} = 6 - \frac{2}{s+\frac{1}{3}} = \frac{6s}{s+\frac{1}{3}}$

$F_1(s) = \frac{10}{s} - \frac{10}{s^2} + \frac{10}{s}e^{-10s} +$

$+ \left(\frac{10}{s^2} - \frac{200}{s}\right)e^{-20s} \Rightarrow$

$\Rightarrow F_1(s) = 10F_{14}(s) = 10F_{24}(s) + 10F_{34}(s)e^{-10s} +$

$+ \left(10F_{24}(s) - 200F_{14}(s)\right)e^{-20s}$

$F_{14} = \frac{1}{s}$; $F_{24}(s) = \frac{1}{s^2}$

$F_2(s) = F_1(s)H(s) = 10F_{24}(s) - 10F_{224}(s) + 10F_{234}(s)e^{-10s} +$

$+ \left(10F_{234}(s) - 200F_{234}(s)\right)e^{-20s}$

$F_{234}(s) = \frac{6}{s(s+\frac{1}{3})}$; $F_{224}(s) = \frac{6}{s(s+\frac{1}{3})}$

$f_2(t) = \mathcal{L}^{-1}\{F_2(s)\} = 10f_{24}(t) - 10f_{224}(t) + 10f_{234}(10) + 10f_2(t-20) -$

$- 200f_1(t-20)$

$F_{14}(t) = \mathcal{L}^{-1}\{F_{234}(s)\} = \mathcal{L}^{-1}\left\{\frac{6}{s+\frac{1}{3}}\right\} = 6e^{-\frac{1}{3}t}\delta_1(t)$

$F_{24}(t) = \mathcal{L}^{-1}\{F_{224}(s)\} = \mathcal{L}^{-1}\left\{\frac{6}{s(s+\frac{1}{3})}\right\}$

$\frac{6}{s(s+\frac{1}{3})} = \frac{A}{s} + \frac{B}{s+\frac{1}{3}}$; $A = \frac{6}{s+\frac{1}{3}}\Big|_{s=0} = 18$; $B = \frac{6}{s}\Big|_{s=-\frac{1}{3}} = -18$

$F_{24}(t) = (18 - 18e^{-\frac{1}{3}t})\delta_1(t)$

$f_2(t) = (14e^{-\frac{1}{3}t} - 18)\delta_1(t) + 60e^{-\frac{1}{3}(t-10)}\delta_1(t-10) + \frac{t}{2}$

$+ \left(\frac{9}{10} - 14e^{-\frac{1}{3}(t-20)}\right)\delta_1(t-20)$

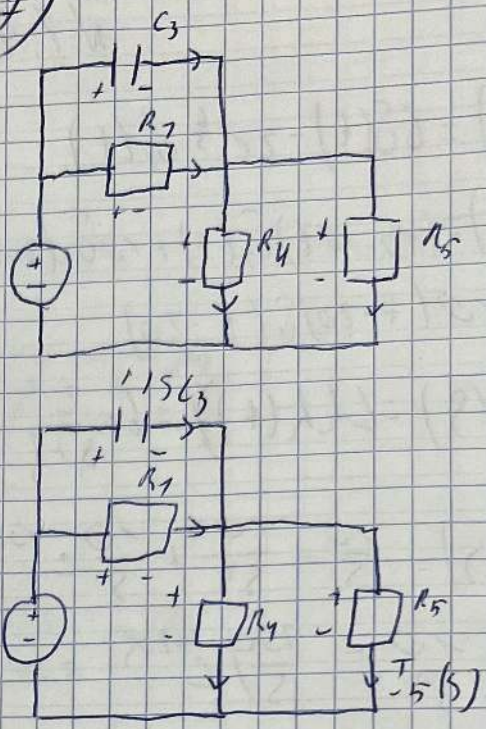
№1.9.7(17)

$u_1 = 4e^{-4t}\delta_1(t)$

$R_4 = 1$

$C_3 = 1$

$i_5 = ?$



1) $t = 0^-$ $\quad u_c(0-) = 0$

2) $t > 0$ $\quad u_c(0+) = u_c(0-) = 0$

$R_{45} = \dfrac{R_4 R_5}{R_4 + R_5} = \dfrac{1}{2}$

$Z_{13} = \dfrac{R_1 \cdot \frac{1}{sC_3}}{R_1 + \frac{1}{sC_3}} = \dfrac{\frac{1}{s}}{1 + \frac{1}{s}} = \dfrac{1}{s+1}$

$U_5(s) = U_{45}(s) = \dfrac{R_{45}}{R_{45} + Z_{13}} U_1(s) = \dfrac{\frac{1}{2}}{\frac{1}{2} + \frac{1}{s+1}} U_1(s) =$

$= \dfrac{s+1}{s+3} U_1(s)$

$I_5(s) = \dfrac{U_5(s)}{R_5} = \dfrac{s+1}{s+3} U_1(s)$

$H(s) = \dfrac{I_5(s)}{U_1(s)} = \dfrac{s+1}{s+3}$

$h(t) = L^{-1}\{H(s)\} = L^{-1}\left\{\dfrac{s+1}{s+3}\right\} = L^{-1}\left\{1 - \dfrac{2}{s+3}\right\}$

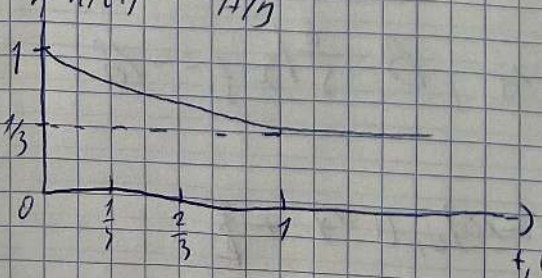
$h(t) = \delta(t) - 2e^{-3t}\delta_1(t)$

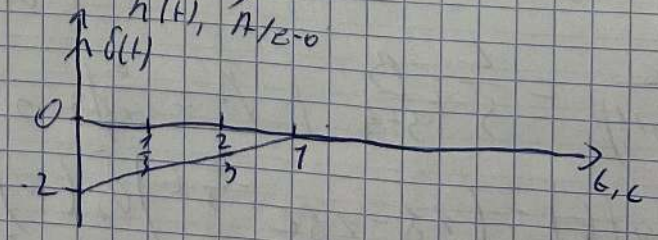
$H_1(s) = \dfrac{H(s)}{s} = \dfrac{s+1}{s(s+3)} = \dfrac{A}{s} + \dfrac{B}{s+3}$

$A = \left.\dfrac{s+1}{s+3}\right|_{s=0} = \dfrac{1}{3}$

$B = \left.\dfrac{s+1}{s}\right|_{s=-3} = \dfrac{2}{3}$

$h_1(t) = L^{-1}\{H_1(s)\} = \left(\dfrac{1}{3} + \dfrac{2}{3}e^{-3t}\right)\delta_1(t)$





$$H_2(s) = \frac{Y(s)}{s^2} = \frac{s+1}{s^2(s+3)} = \frac{A}{s} + \frac{B}{s^2} + \frac{C}{s+3}$$

$$A = \left(\frac{s+1}{s+3}\right)'\Big|_{s=0} = \frac{2}{(s+3)^2}\Big|_{s=0} = \frac{2}{9}$$

$$B = \frac{s+1}{s+3}\Big|_{s=0} = \frac{1}{3} \; ; \; C = \frac{s+1}{s^2}\Big|_{s=-3} = \frac{-2}{9}$$

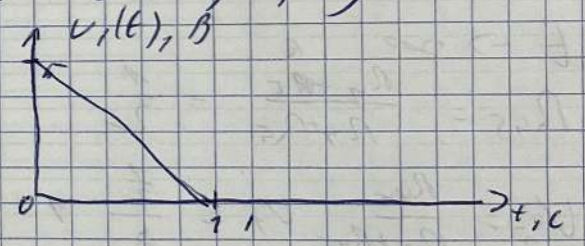
$$\Leftrightarrow \frac{2/9}{s} + \frac{1/3}{s^2} - \frac{2/9}{s+3} \Rightarrow h_2(t) = \left(\frac{2}{9} + \frac{1}{3}t - \frac{2}{9}e^{-3t}\right)\delta_1(t)$$

$$U_1(s) = L\{u_1(t)\} = \frac{4}{s+4}$$

$$I_5(s) = Y(s)\,U_1(s) = \frac{4(s+1)}{(s+3)(s+4)} = \frac{A}{s+4} + \frac{B}{s+3}$$

$$A = \frac{4(s+1)}{s+3}\Big|_{s=-4} = \frac{-12}{-1} = 12 \; ; \; B = \frac{4(s+1)}{s+4}\Big|_{s=-3} = -8$$

$$I_5(s) = \frac{12}{s+4} + \frac{-8}{s+3} \Rightarrow i_5(t) = \left(12e^{-4t} - 8e^{-3t}\right)\delta_1(t)$$



$$u_1''(t) = 5\delta'(t) = 5\delta(t) + 5\delta(t-1)$$

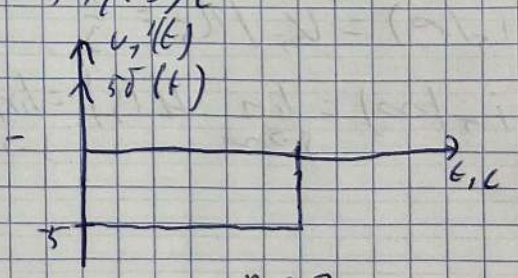
$$U_1(s) = \frac{L\{u_1''(t)\}}{s^2} = \frac{5}{s} - \frac{5}{s^2} + \frac{5}{s^2}e^{-s}$$

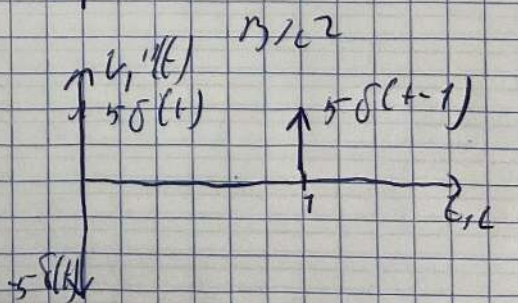
$$I_5(s) = U_1(s)\,Y(s) = 5Y_1(s) - 5Y_1(s) + 5Y_2(s)e^{-s}$$

$$i_5(t) = L^{-1}\{I_5(s)\} = 5h_1(t) + 5h_2(t) + 5h_2(t-1) = 5\left(\frac{1}{3} + \frac{2}{3}e^{-3t}\right)\delta_1(t) -$$

$$- 5\left(\frac{t}{3} - \frac{2}{9}e^{-3t} + \frac{2}{9}\right)\delta_1(t) +$$

$$+ 5\left(\frac{t-1}{3} - \frac{2}{9}e^{-3(t-1)} + \frac{2}{9}\right)\cdot\delta_1(t)$$

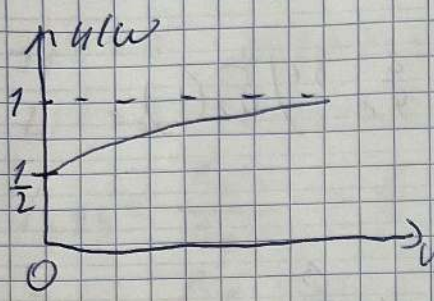


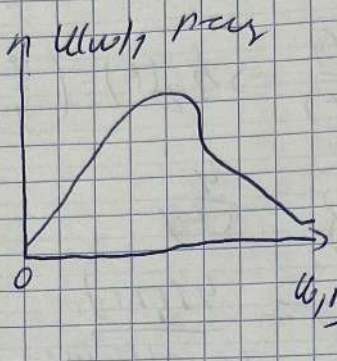


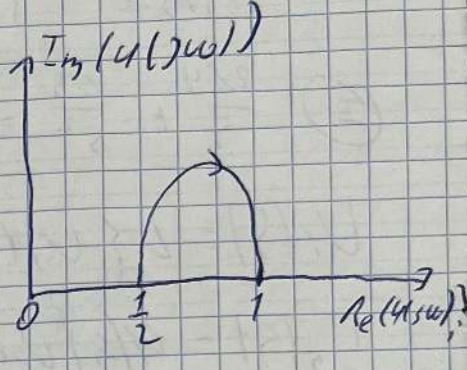
$$H(j\omega) = H(s)|_{s=j\omega} = \frac{j\omega+1}{j\omega+2}$$

АЧХ: $H(\omega) = |H(j\omega)| = \sqrt{\frac{\omega^2+1}{\omega^2+4}}$

ФЧХ: $\varphi(\omega) = \arg(H(j\omega)) = \operatorname{arctg}\omega - \operatorname{arctg}\frac{\omega}{2}$



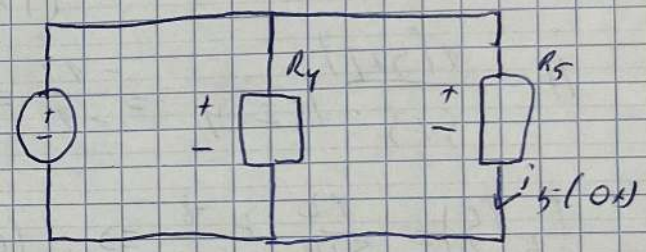




$t = 0^+$; $U_C(0+) = U_C(0-) = 0$

$i_5(0+) = U_1 / R_5 = 1$

$i_5(0+) = \lim_{j\to\infty} H(s) = \lim_{s\to\infty} \frac{s+1}{s+3} = 1$



$t \to \infty$

$R_{45} = \frac{R_4 \overset{R}{\cancel{R_5}}}{R_4+R_5} = \frac{1}{2}$

$U_5 = \frac{R_{45}}{R_2+R_{45}} U_1 = \frac{\frac{1}{2}}{\frac{3}{2}} \cdot 1 = \frac{1}{3}$

$i_5(\infty) = U_5 / R_5 = \frac{1}{3}$

$i_5(\infty) = \lim_{s\to\infty} H(s) = \lim_{s\to 0} \frac{s+1}{s+3} = \frac{1}{3}$