1 MI 2009

1 MI / -2009

(0, 20)
(200, 0)

$\delta = \frac{P T_0}{P_0 T}$

① $U = 220\sqrt{2}\ V$

$2r = 14\ mm \Rightarrow r = 0{,}7\ cm$

$h = 2\ cm$

$m_v = 0{,}78$

$h = 2$

$U_v = 30\,\delta\, m_v \left(1 + \frac{0{,}3}{\sqrt{\delta r}}\right) \cdot r \cdot \ln \frac{2h}{r}$

$y - 20 = \frac{0-20}{2}(x-0)$

$T = -10z + 293{,}15$

$\frac{220\sqrt{2}}{\sqrt{3}} = 30\,\delta \cdot 0{,}78 \left(1 + \frac{0{,}3}{\sqrt{\delta \cdot 0{,}7}}\right) \cdot 0{,}7 \cdot \ln \frac{5^2}{7 \cdot 10^{-3}}$

$\delta = 0{,}8917$

$\delta = \frac{P T_0}{P_0 T}$

$0{,}8917 = \frac{P_0 \cdot e^{-\frac{z}{7{,}4}} \cdot 293{,}15}{P_0 \cdot (-10z + 293{,}15)}$

$z = 1{,}142\ km$

6) $r_1 = 10{,}5\ mm$
$r_2 = 18{,}8\ mm$
$\sigma = 20\ °C$
$\lambda = 0{,}17\ W/mK$
$\sigma = 0{,}042\ K^{-1}$
$\gamma_{20} = 56\ Sm/mm^2$
$f_m = 0{,}65$
$I = 2$

$$f_m = e^{\frac{P'_{str} \cdot S \cdot \sigma}{4 \cdot r_{mi} \cdot \lambda}}$$

$$r_{mi} = \frac{r_1 + r_2}{2} = 14{,}65\ mm$$

$$S = r_2 - r_1 = 8{,}3\ mm$$

$$P'_{str} = \frac{I^2}{A \cdot \gamma}$$

$$A = \frac{r^2 \pi}{2} = \frac{10{,}5^2 \pi}{2}$$

$$A = r^2 \pi = 10{,}5^2 \pi = 346{,}36\ mm^2$$

$$f_m = e^{-\frac{\frac{I^2}{A \cdot \gamma} \cdot S \cdot \sigma}{4 \cdot r_{mi} \cdot \lambda}}$$

$$0{,}65 = e^{-\frac{\frac{I^2}{346{,}36 \cdot 56} \cdot 8{,}3 \cdot 0{,}042}{4 \cdot 14{,}65 \cdot 0{,}17}}$$

$$I = 465\ A$$

② $U = 12\,kV$

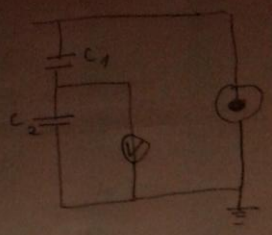
$r_1 = 0{,}5\,m$ $\quad \varepsilon_{r1} = 7{,}3$

$r_2 = 2\,m$ $\quad \varepsilon_{r2} = 1{,}85$

$r_3 = 8\,m$

$C_1 = 230\,pF$

$C_2 = 560\,nF$



$E_{max}, r_{max} = 2$

$$U = U_n\left(1 + \frac{C_2}{C_1}\right) = 12\left(1 + \frac{560 \cdot 10^{-9}}{230\,10^{-12}}\right) = 29{,}23\,kV$$

$$K = \frac{1}{\varepsilon_{r1}} \ln\frac{r_2}{r_1} + \frac{1}{\varepsilon_{r2}} \ln\frac{r_3}{r_2} = 0{,}0342$$

$$E(r_1) = \frac{U}{\varepsilon_{r1} \cdot r_1 \cdot K} = 8{,}343\,kV/m$$

$$E(r_2) = \frac{U}{\varepsilon_{r2} \cdot r_2 \cdot K} = 8{,}456\,kV/m$$

$$E(r_2) = \frac{U}{\varepsilon_{r1} \cdot r_2 \cdot K} = 2{,}086\,kV/m$$

$$E(r_3) = \frac{U}{\varepsilon_{r2}\, r_3 \cdot K} = 2{,}114\,kV/m$$

$E_{max} = 5\,kV/m$

$$E_{max} = \frac{U}{\varepsilon_{r1} \cdot r_1 \cdot K} \Rightarrow r_1 = 0{,}834\,m$$

$$E_{max} = \frac{U}{\varepsilon_{r2} \cdot r_2 \cdot K} \Rightarrow r_2 = 3{,}382\,m$$

$C_a = 30\,pF$

$C_b = 100\,pF$

$\operatorname{tg}\delta_a = 9 \cdot 10^{-3}$

$\operatorname{tg}\delta_b = 3 \cdot 10^{-2}$

$\operatorname{tg}\delta_u = ?$

$$\frac{\operatorname{tg}\delta_u}{C} = \frac{\operatorname{tg}\delta_a}{C_a} + \frac{\operatorname{tg}\delta_b}{C_b}$$

$$\frac{1}{C} = \frac{1}{C_a} + \frac{1}{C_b}$$

$C_b = 42{,}86\,pF$

$\operatorname{tg}\delta_u = 2{,}37 \cdot 10^{-2}$

$L_1 = 19{,}5\,\mu H$

$C_1 = 6\,nF$

$C_2 = 7{,}1\,pF$

$L_2 = ?$

$f_1 = f_2$

$$\frac{1}{2\pi\sqrt{L_1 C_1}} = \frac{1}{2\pi\sqrt{L_2 C_2}}$$

$L_2 C_2 = L_1 C_1$

$L_2 = 0{,}0165\,H$

$$\frac{U_2}{U_1} = \sqrt{\frac{L_2}{L_1}}$$

$$\frac{U_2}{U_1} = 29{,}09$$

$$f_2 = \frac{1}{2\pi\sqrt{L_2 C_2}} = 464905\,Hz$$

2 MI 2009

2 MI - 2009

① a) $r_2 = 70$ cm
$r_1 = 52$ mm
$S = 18$ mm $= 18$ cm

$$\eta = \frac{\ln \frac{r_2}{r_1}}{\frac{r_2}{r_1} - 1} = 0,8387 > 0,8 \Rightarrow \text{HOMOGÉNEO}$$

$$U' = \frac{B\,P\,S}{\ln \frac{A\,P\,S}{K}} = \frac{19 \cdot 0,999 \cdot 18}{\ln \frac{64,5 \cdot 0,999\,18}{13}}$$

$U' = 50,3$ KV

b) $r_2 = 70$ m
$r_1 = 20$ m
$S = 5$ cm
$P = 0,999$ bar
$T = 294,15$

$$\delta = \frac{P T_0}{P_0 T} = \frac{0,999 \cdot 293,15}{1,013 \cdot 294,15} = 0,9828$$

$\eta = 0,501 < 0,8$

$$U' = \delta k_1 \left(1 + \frac{k_2}{\sqrt{\delta r_1}}\right) \cdot S \cdot \eta = 0,9828 \cdot 30 \left(1 + \frac{0,33}{\sqrt{0,9828 \cdot 2}}\right) \cdot 5$$

$U' = 91,26$ KV

$U = 50kV/cm$

$r_M = 0,13mm$

$l = 1,2m$

$\lambda_m = \frac{k \cdot T}{\pi \cdot r_M^2 \cdot p}$

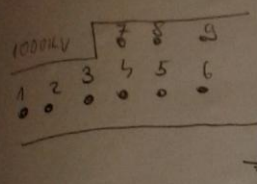
$\lambda_m = \frac{1,39\,10^{-23} \cdot 295,15}{\pi \cdot (0,13\,10^{-3})^2 \cdot 0,999 \cdot 10^5}$

$\lambda_m = 7,558 \cdot 10^{-7}\,m$

20) $\lambda = 2$

$z_0 = \frac{l}{\lambda_m} = \frac{0,012}{7,558\,10^{-7}} = 15793$

$\lambda = PAC^{-\frac{BA}{U}} = 0,999 \cdot 645 \cdot e^{-\frac{10 \cdot 0,999}{3}} = 1,13$



$U_{01} = 100kV$

$U_{10} = 0kV$

$\varphi_1 = 50kV$

$\varphi_4 = 40kV$

$\varphi_2, \varphi_3 = ?$

$\varphi_2 = \frac{\varphi_1 + \varphi_3 + 100 + 0}{4}$

$\varphi_3 = \frac{\varphi_2 + \varphi_4 + 100 + 0}{4}$

$4\varphi_2 = 50 + \varphi_3 + 100$

$4\varphi_3 = \varphi_2 + 40 + 100$

$4\varphi_2 - \varphi_3 = 150$

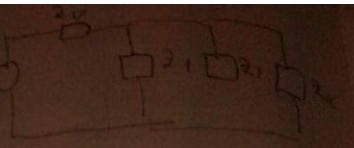
$-\varphi_2 + 4\varphi_3 = 140$

$\varphi_2 = 49,33kV$

$\varphi_3 = 47,33kV$

ZI 2009

ZI - 2009



① $Z_1 = 200\Omega$
$Z_4 = 60\Omega$
$Z_V = 420\Omega$
$Z_2 = 380\Omega$
$U_0 = 120kV$
$T_1 = 2\mu s$
$S_1 = 2$

$U_T = 2U_0 \frac{Z_P}{2V + Z_P}$

$\frac{1}{Z_P} = \frac{1}{Z_4} + \frac{1}{Z_1} + \frac{1}{Z_2}$

$Z_P = 51,39\Omega$

$U_T = 2 \cdot 120 \cdot \frac{51,39}{420 + 51,39}$

$U_T = 26,16kV$

$S_t = \frac{U_T}{T_1} = \frac{26,16}{2} = 13,08\ kV/\mu s$

② $U_{PM} = 90kV$

$t_p = \frac{150}{\frac{300}{v_4}} = 1\mu s$

$p_{1,2} = 0,261$, $r_{1,2} = -0,739$

$p_{2,3} = 1,765$, $r_{2,3} = 0,765$

$p_{2,1} = 1,739$, $r_{2,1} = 0,739$

$U(0) = 0$

$U_1 = 225$

$U_2 = 450$

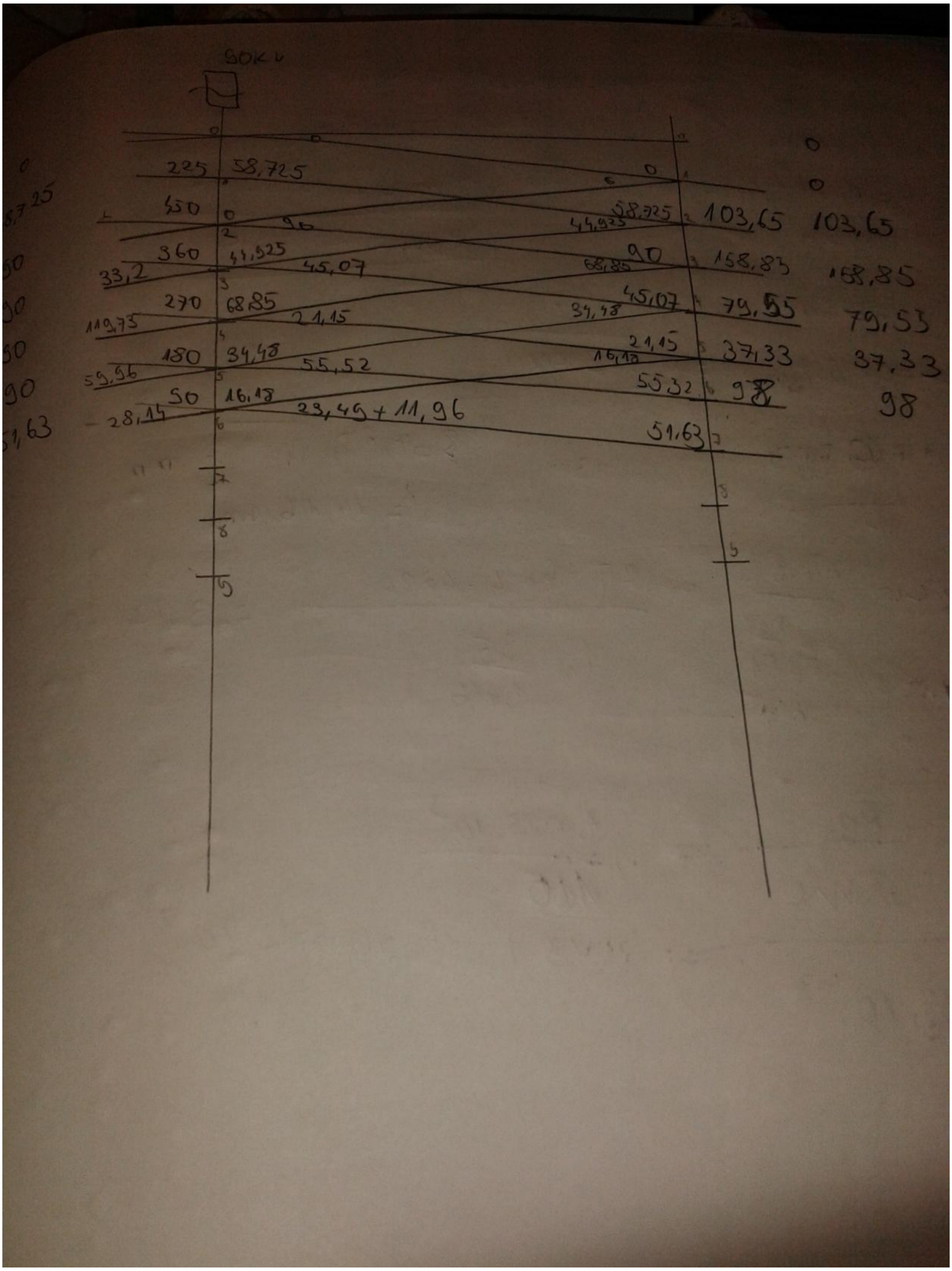
$U_3 = 360$

$U_4 = 270$

$U_5 = 180$

$U_6 = 90$

$U_7 = 0$



SOK
225
58,725
150
360
33,2
45,07
270
68,85
21,15
180
34,48
55,52
50
16,18
28,15
23,49 + 11,96
58,725
90
68,85
45,07
34,48
21,15
55,32
51,63
103,65
158,83
79,55
37,33
98
0
103,65
158,85
79,53
37,33
98
51,63

③ $l = 4,5\,km$

$S = 630\,mm^2$

$U = 110\,kV$

$Z = 0,028 + j\,0,42\,\Omega/km$

$I = 403\,A$

$\varepsilon_r = 4$

$r_2 = 35\,cm$

$R_v = 0,028 \cdot 4,5 = 0,126\,\Omega$

$P_{gvoo} = I^2 \cdot R_v$

$P_{gvoo} = 4,03^2 \cdot 0,126$

$P_{gvoo} = 20,463\,kW$

$P_{gisol} = 0,05\, P_{gvoo} = 1,023\,kW$

$P_g = U^2 \omega C \operatorname{tg}\delta$

$S = r_1^2 \pi$

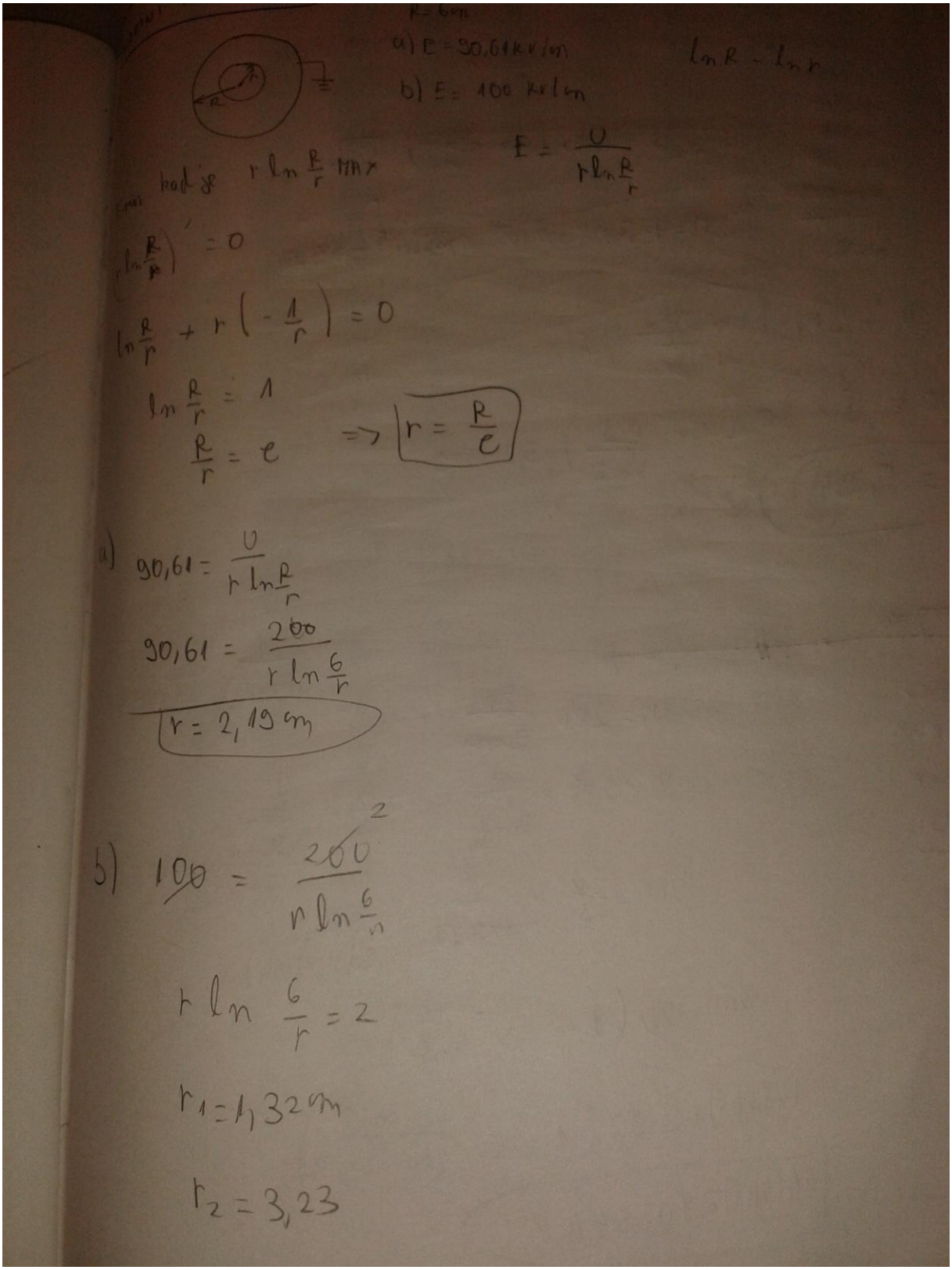
$r_1 = 14,16\,mm$

$$C = \frac{2\pi \varepsilon l}{\ln \frac{r_2}{r_1}} = \frac{2\pi \cdot 8,0 \cdot 4 \cdot 4500}{\ln \frac{35}{1,416}} = 3,12\,10^{-7}$$

$$\operatorname{tg}\delta = \frac{P_g}{U^2 \omega C} = \frac{1,023 \cdot 10^3}{\left(\frac{110}{\sqrt{3}}\right)^2 \cdot 2\pi \cdot 50\, 3,12\, 10^{-7}}$$

$\operatorname{tg}\delta = 2,59\,10^{-3}$

Ljetni rok 11/12



① $r_1 = 20mm$
$r_2 = 72mm$
$I = 350\mu A$
$A = 645$
$B = 19$
$K = 13$
$K_1 = 30$
$K_2 = 0,3$

$\delta = ?$

$$\Omega = \frac{\ln \frac{r_2}{r_1}}{\frac{r_2}{r_1} - 1} = 0,49 < 0,10$$

$$U' = SK_1 \left(1 + \frac{K_2}{\sqrt{\delta r_1}}\right) \cdot S \cdot \Omega$$

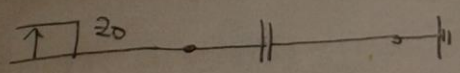
$$U = I \cdot R = 350 \cdot 10^{-6} \cdot 200 \cdot 10^6 = 70\,kV$$

$$U' = SK_1 \left(1 + \frac{K_2}{\sqrt{\delta r_1}}\right) \cdot S \cdot \Omega$$

$$70 = S \cdot 30 \left(1 + \frac{0,3}{\sqrt{8 \cdot 2}}\right) \cdot 3,2 \cdot 0,49$$

$$\boxed{S = 0,734}$$

③



$U = 80kV$
$20 = 400\Omega$
$C = 12mF$
$t = 5\mu s$

$U_t, it = ?$

$$\frac{1}{s(1+1s)} \circ\!\!-\!\!\bullet 1 - e^{-}$$

$$U_T = 2U_0 \frac{2p}{2v+2p}$$

$$U_T = 2\frac{V}{S} \cdot \frac{\frac{1}{sc}}{20 - \frac{1}{sc}} = 2\frac{V}{S} \cdot \frac{\frac{1}{sc}}{\frac{20sc+1}{sc}}$$

$$U_T = 2 \cdot \frac{V}{S} \cdot \frac{1}{20sc+1} = \frac{2V}{S(1+20sc)}$$

$$U_T(t) = 2V\left(1 - e^{-\frac{t}{20c}}\right)$$

$$U_T(5\mu s) = 2 \cdot 80\left(1 - e^{\frac{-5 \cdot 10^{-6}}{400 \cdot 12 \cdot 10^{-3}}}\right)$$

$$\boxed{U_T(5\mu s) = 103,54\,kV}$$

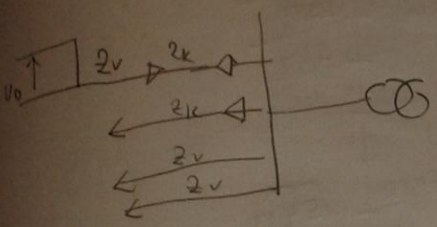
$I \cdot Z = \frac{I}{sC}$

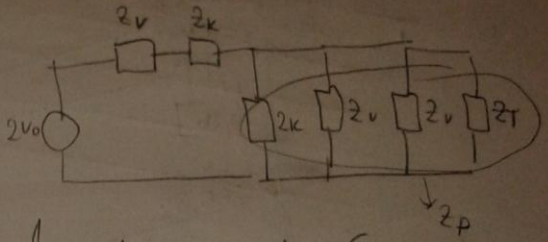
$V_0 \cdot sC = \frac{2V}{s(1+2sC)} \cdot sC = \frac{2VC}{1+2sC}$

$I = \frac{2V}{Z_0} e^{\frac{-t}{2\alpha}}$

$I(5\mu s) = \frac{2 \cdot 80}{400} e^{\frac{-3\,10^{-6}}{400\ 1240^{-5}}}$

$I(5\mu s) = 141,146A$





$\frac{1}{Z_p} = \frac{1}{Z_k} + \frac{1}{Z_v} + \frac{1}{Z_v} + \left(\frac{1}{Z_r}\right) \to 0$

$Z_k = 50\Omega$

$Z_v = 400\Omega$

$U = 300kV$

$l = 300m$

$v = 150\ m/\mu s$

$t_p = \frac{l}{v} = 2\mu s$

$Z_p = 40\Omega$

$p_{12} = \frac{2\,Z_k}{Z_v + Z_k} = 0,22 \quad r_{12} = -0,78$

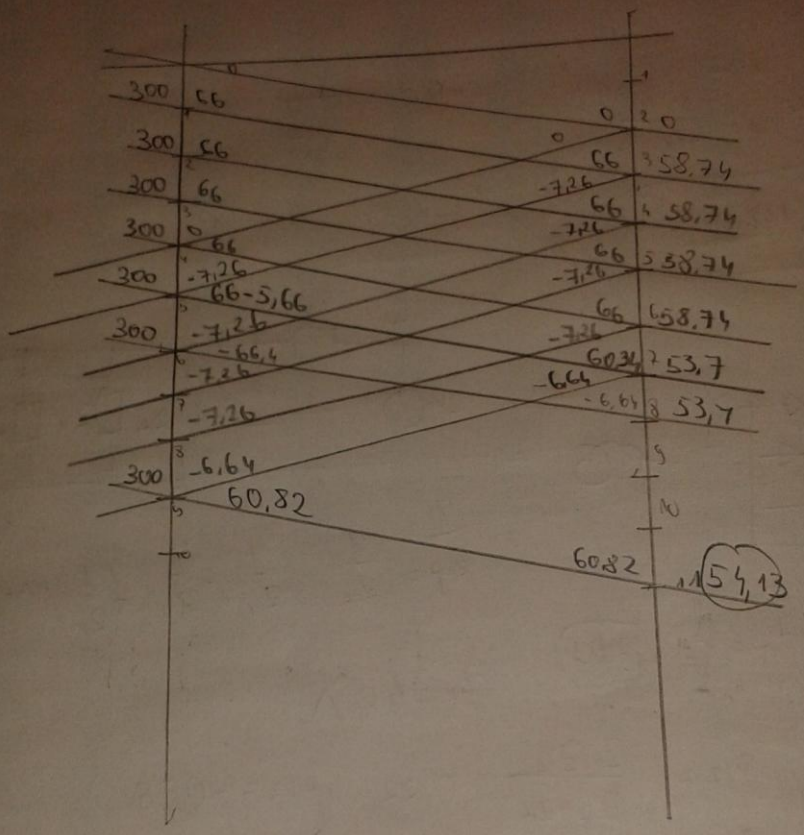
$p_{23} = \frac{2\,Z_p}{Z_p + Z_k} = 0,89 \quad r_{23} = -0,11$

$p_{21} = \frac{2\,Z_v}{Z_v + Z_k} = 1,78 \quad r_{21} = 0,78$

$P_{12} = 0{,}22$, $r_{12} = -0{,}78$

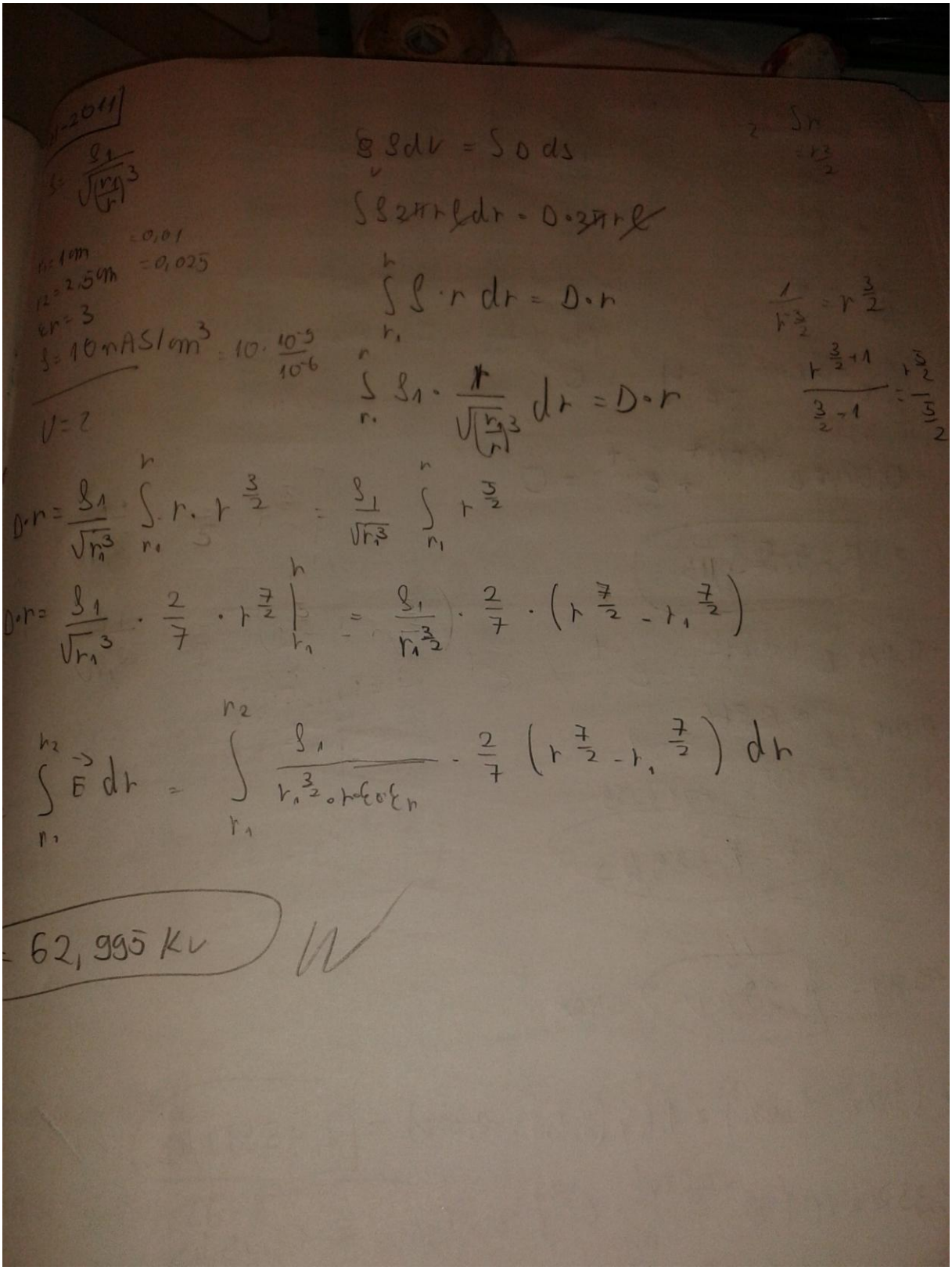
$P_{23} = 0{,}89$, $r_{23} = -0{,}11$

$P_{21} = 1{,}78$ $r_{21} = 0{,}78$



$U_f = 34\,kV$

PZI 2011


PZI-2011
$\int \rho dV = \int D\, ds$
$\int \rho \cdot r\, dr = D \cdot r$
$\int \rho_1 \cdot \frac{r}{\sqrt{\left(\frac{r_2}{r_1}\right)^3}}\, dr = D \cdot r$
$r_1 = 1m = 0{,}01$
$r_2 = 2{,}5m = 0{,}025$
$\varepsilon_r = 3$
$\rho = 10 nAS/m^3 = 10 \cdot \frac{10^{-9}}{10^{-6}}$
$U = ?$
$D \cdot r = \frac{\rho_1}{\sqrt{r_1^3}} \int_{r_1}^{r} r \cdot r^{\frac{3}{2}} = \frac{\rho_1}{\sqrt{r_1^3}} \int_{r_1}^{r} r^{\frac{3}{2}}$
$D \cdot r = \frac{\rho_1}{\sqrt{r_1^3}} \cdot \frac{2}{7} \cdot r^{\frac{7}{2}} \Big|_{r_1}^{r} = \frac{\rho_1}{r_1^{\frac{3}{2}}} \cdot \frac{2}{7} \cdot \left(r^{\frac{7}{2}} - r_1^{\frac{7}{2}}\right)$
$\int_{r_1}^{r_2} \vec{E}\, dr = \int_{r_1}^{r_2} \frac{\rho_1}{r_1^{\frac{3}{2}} \cdot \varepsilon_0 \varepsilon_r} \cdot \frac{2}{7} \left(r^{\frac{7}{2}} - r_1^{\frac{7}{2}}\right) dr$
$= 62{,}995\ kV$

② $u(t) = 10 \cdot (e^{-0,014t} - e^{-t})$

$U_{max} = 2$

$T_1 = 2$

$\frac{du}{dt} = 0$

$(e^{-0,014t} - e^{-t})' = 0$

$-0,014 \cdot e^{-0,014t} + e^{-t} = 0$

$t = 4,329\,\mu s$

$-0,014 \cdot e^{-0,014t} = -e^{-t} \;/ : e^{-t}$

$-0,014 \cdot e^{0,986t} = -1$

$e^{0,986t} = +71,4285$

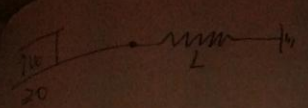
$t = 4,329\,\mu s$

$u(4,329\,\mu s) = 8,281\,kV \rightarrow MAX$

$T_1 = 1,67\,(t_{90\%} - t_{30\%}) = 1,67\,(1,985 - 0,333) = 2,75884\,\mu s$

$0,9U_{MAX} = 8,352 = 10\,(e^{-0,014t} - e^{-t}) \Rightarrow t_{90\%} = 1,985\,\mu s$

$0,3U_{MAX} = 2,784 = 10\,(e^{-0,014t} - e^{-t}) \Rightarrow t_{30\%} = 0,333\,\mu s$



$U = 50kV$
$Z_0 = 430\Omega$
$L = 15mH$

$t_1 = 20\mu s$
$t_2 = \infty \mu s$
$Z_p = SL$

$$U_t = 2U_0 \cdot \frac{Z_p}{Z_v + Z_p}$$

$$U_t = 2\frac{V}{S} \cdot \frac{SL}{Z_0 + SL} = \frac{2VL}{Z_0 + SL} = \frac{2VK}{K(\frac{Z_0}{L} + S)} = \frac{2V}{S + \frac{Z_0}{L}}$$

$$\boxed{U_t(t) = 2U_0 \cdot e^{-\frac{Z_0}{L} \cdot t}}$$

$$\frac{1}{S(1+KS)} \circ\!\!-\!\!\bullet\; 1 - e^{-\frac{t}{K}}$$

$$U = I \cdot Z$$

$$U_t = I \cdot Z_T$$

$$I_t = \frac{U_I}{Z_T} = \frac{2V}{SL(S + \frac{Z_0}{L})} = \frac{2\frac{V}{L}}{S(S + \frac{Z_0}{L})} =$$

$$\frac{1}{S(S+a)} \circ\!\!-\!\!\bullet\; \frac{1}{a}(1 - e^{-ta})$$

$$I_t(t) = 2\frac{V}{L} \cdot \frac{L}{Z_0}\left(1 - e^{-t \cdot \frac{Z_0}{L}}\right)$$

$$\boxed{I_t(t) = \frac{2U_0}{Z_0}\left(1 - e^{-t\frac{Z_0}{L}}\right)}$$

$t_1 = 20\mu s$

$U_t(20\mu s) = 54,88 kV$

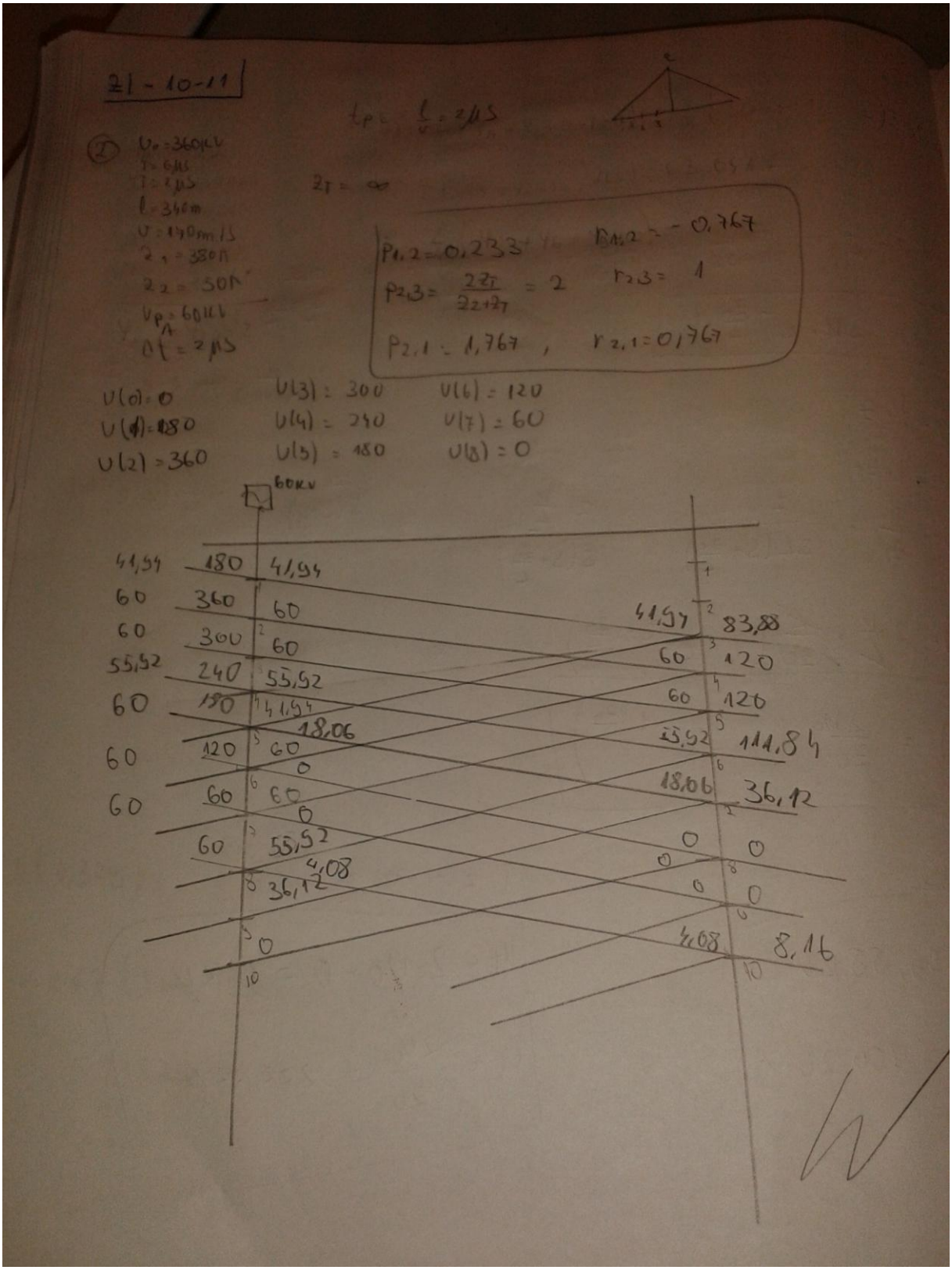
$i_t(20\mu s) = 100,264 A$

$t_2 = \infty$

$U_t = 2 \cdot U_0 - 0 = 0 kV$

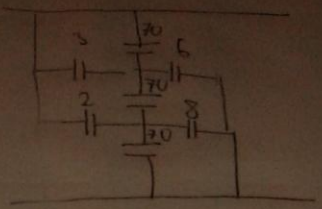
$i_t = \frac{2U_0}{Z_0} = 222,22 A$

ZI 10/11


21 - 10 - 11
$t_p = \frac{l}{v} = 2\mu s$
① $U_0 = 360kV$
$\tau = 6\mu s$
$T = 2\mu s$
$l = 340m$
$v = 170m/s$
$Z_1 = 350\Omega$
$Z_2 = 50\Omega$
$U_{P_A} = 60kV$
$\Delta t = 2\mu s$
$Z_T = \infty$
$P_{1,2} = 0,233$
$B_{1,2} = -0,767$
$P_{2,3} = \frac{2Z_T}{Z_2+Z_T} = 2$
$r_{2,3} = 1$
$P_{2,1} = 1,767$, $r_{2,1} = 0,767$
U(0) = 0
U(1) = 180
U(2) = 360
U(3) = 300
U(4) = 240
U(5) = 180
U(6) = 120
U(7) = 60
U(8) = 0
60kV
41,94
60
60
55,52
60
60
60
180
360
300
240
180
120
60
60
60
41,94
60
60
55,52
18,06
0
0
36,12
4,08
0
41,94
60
60
55,52
18,06
0
0
4,08
0
83,88
120
120
111,84
36,12
0
0
8,16

$C_1 = 70pF$
$C_a = 3pF$
$C_b = 2pF$
$C_c = 6pF$
$C_d = 8pF$

$U_0 = 35kV$



2 · U - I

$$\begin{bmatrix} 2\cdot 70+3+6 & -70 \\ -70 & 2\cdot 70+26 \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} 35\cdot 3+35\cdot 70 \\ 35\cdot 2 \end{bmatrix}$$

$$\begin{bmatrix} 149 & -70 \\ -70 & 156 \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} 2555 \\ 70 \end{bmatrix}$$

$149U_1 - 70U_2 = 2555$

$-70U_1 + 150U_2 = 70$

$U_1 = 22,24\,kV$

$U_2 = 10,84\,kV$

$\Delta U_1 = U_0 - U_1 = 35 - 22,24$

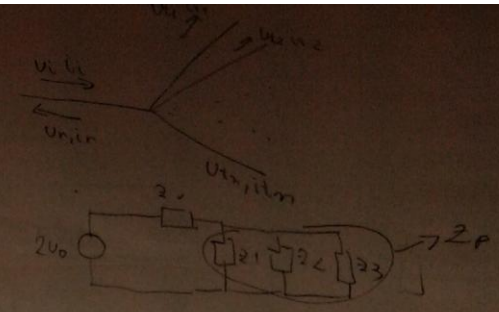
$\Delta U_1 = 12,76\,kV$

$\Delta U_2 = U_1 - U_2 = 11,4\,kV$

$\Delta U_3 = U_2 - U_3 = 10,84\,kV$

ZI 11/12

I = 3,5KA
TC = 60μs
h = 20m
h = 1,6m
Z = 420Ω



a) level n+1 = 2

$$\begin{cases} U_i + U_r = U_t \Rightarrow U_r = U_t - U_i \\ i_i - i_r = i_{t1} + i_{t2} + \dots + i_{tn} \end{cases}$$

$$\frac{U_i}{Z_v} - \left(\frac{U_t - U_i}{Z_v}\right) = U_t \left(\frac{1}{Z_1} + \frac{1}{Z_2} + \dots + \frac{1}{Z_n}\right) \cdot \frac{1}{Z_p}$$

$$\frac{2U_i}{Z_v} - \frac{U_t}{Z_v} = \frac{U_t}{Z_p}$$

$$\frac{2U_i}{Z_v} = U_t \left(\frac{Z_v + Z_p}{Z_v Z_p}\right)$$

$$2U_i = U_t \frac{Z_v + Z_p}{Z_p} \Rightarrow U_t = 2U_i \cdot \frac{Z_p}{Z_v + Z_p} \rightarrow P$$

$$U_t = U_i \cdot P$$

$r = p - 1$

b) t = 30μs

$$U_t = 2 \cdot U_0' \cdot \frac{\frac{Z}{3}}{Z + \frac{Z}{3}}$$

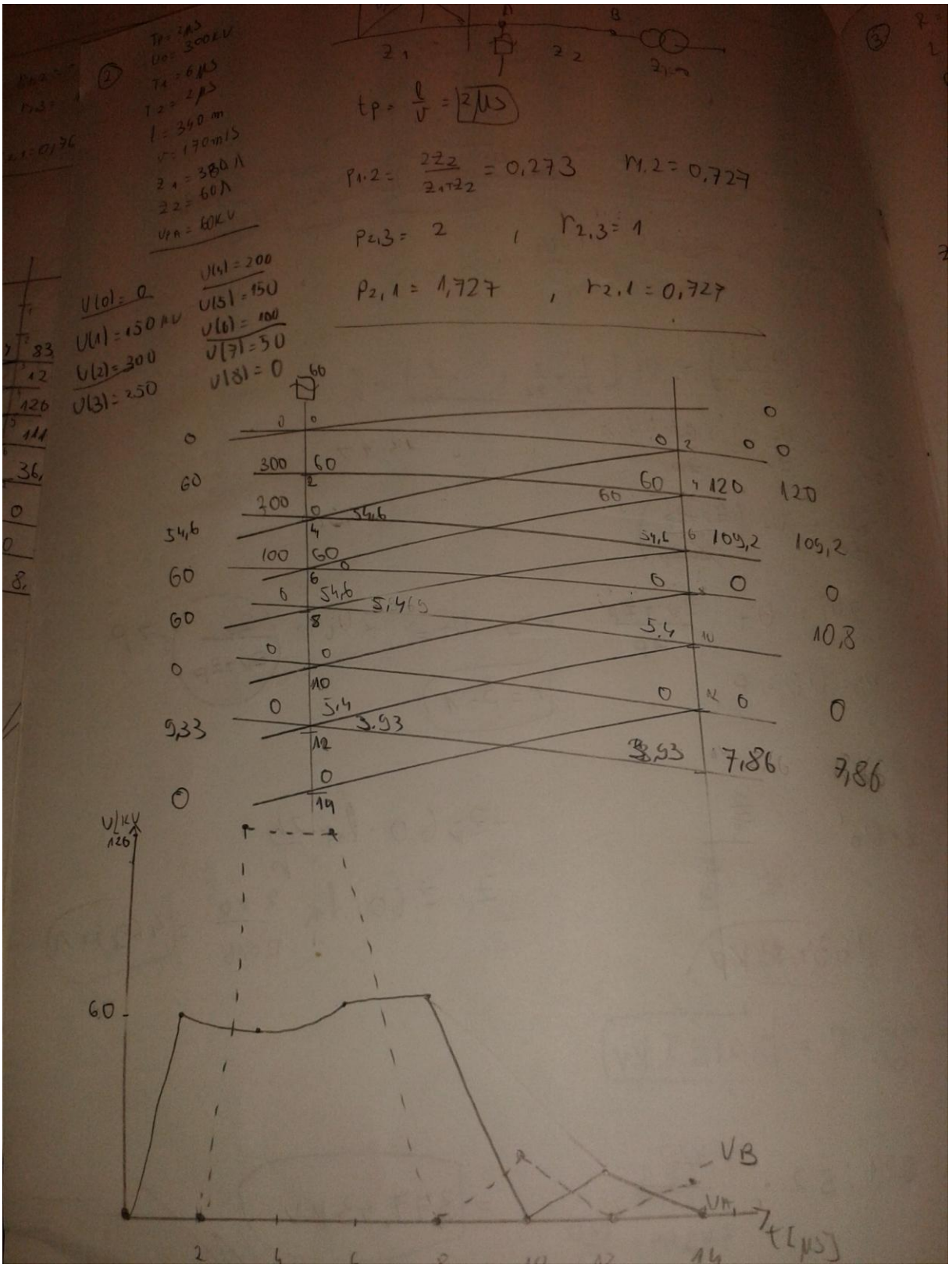
$$Z_v = 60 \cdot \ln \frac{2h}{r}$$

$$Z_v = 60 \ln \frac{2 \cdot 20}{0{,}016} = 469$$

$U = I \cdot Z = 1634{,}04\,KV$

$U_0' = \frac{30}{60} \cdot U = 821{,}52\,KV$

$$U_t = 2 \cdot 821{,}52 \cdot \frac{\frac{420}{3}}{469{,}44 + \frac{420}{3}} = 377{,}43\,KV$$


Z1
Z2
Z1,2
A
B
tp = l/v = 2 µs
p1,2 = Z2/(Z1+Z2) = 0,273
r1,2 = 0,727
p2,3 = 2 , r2,3 = 1
p2,1 = 1,727 , r2,1 = 0,727
U(0) = 0
U(1) = 150 kV
U(2) = 300
U(3) = 250
U(4) = 200
U(5) = 150
U(6) = 100
U(7) = 50
U(8) = 0
60
0
60
54,6
60
60
0
9,33
0
300
200
100
0
54,6
5,46
5,4
5,93
60
120
109,2
0
10,8
0
7,86
120
109,2
0
10,8
0
7,86
U/kV
126
60
VB
VA
t[µs]
2
4
6
14

$L = 0{,}9906$ mH/km

$C = 10{,}876$ nF/km

$G = 0{,}1605$ µS/km

$R_v = \sqrt{\frac{L}{C}} = \sqrt{\frac{0{,}9906 \cdot 10^{-3}}{10{,}876 \cdot 10^{-9}}}$

$R_v = 301{,}79\,\Omega$

R_v ? Z_v

$$Z_v = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

$$Z_v = \sqrt{\frac{0{,}0409 + j\,2\pi \cdot 50 \cdot 0{,}9906 \cdot 10^{-3}}{0{,}1605 \cdot 10^{-6} + j\,2\pi \cdot 50 \cdot 10{,}876 \cdot 10^{-9}}} = 91763\,\Omega$$

$Z_v = 91441{,}8 - j\,7674{,}9$

$x^2 - y^2 = 91441{,}8$

$2xy = -7674{,}9$

$y = 13{,}17$

$x = 291{,}38$

$x = \frac{-7674{,}9}{2y}$

$\frac{7674{,}9^2}{4y^2} - y^2 = 91441{,}8 \;/\cdot 4y^2$

$4y^4 + 365761{,}2y^2 - 7674{,}9^2 = 0$

$y^2 = t \qquad t_1 = 173{,}54 \quad , t_2 =$

$y = 13{,}17$

$Z_v = 302{,}66 - j\,12{,}679$