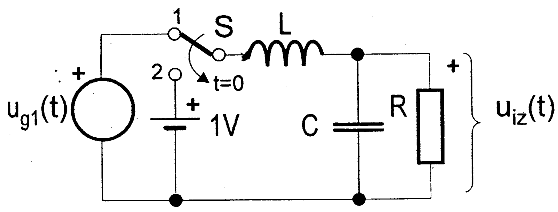
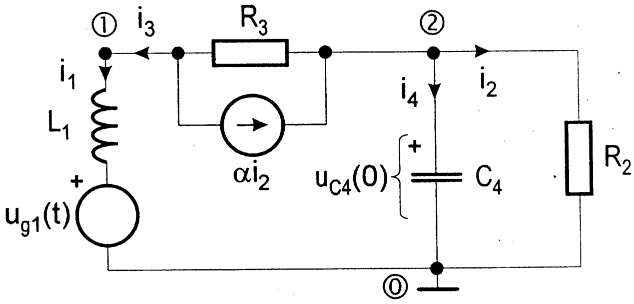
PISMENI ISPIT IZ ELEKTRIČNIH KRUGOVA 2010-2011

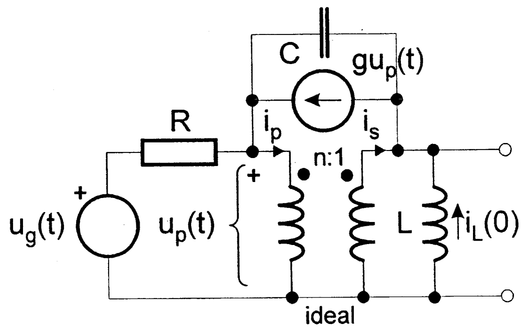
1. Za električni krug prikazan slikom se u trenutku t=0 prebaci sklopka S iz položaja 1 u 2. Zadane su normalizirane vrijednosti elemenata: R=1, L=1, C=2, $u_{g1}(t)$=2sin(t); $-\infty<t<\infty$ (sinusno stacionarno stanje) i napon baterije $u_{g2}(t)$=1V (istosmjerni izvor). Odrediti za t<0: a) fazore napona na kapacitetu C i struje kroz induktivitet L; b) valne oblike napona na kapacitetu $u_C(t)$ i struje kroz induktivitet $i_L(t)$; c) početne uvjete $u_C(0)$ i $i_L(0)$. Odrediti za t≥0: d) napon na izlazu $U_{iz}(s)$; e) valni oblik napona $u_{iz}(t)$.



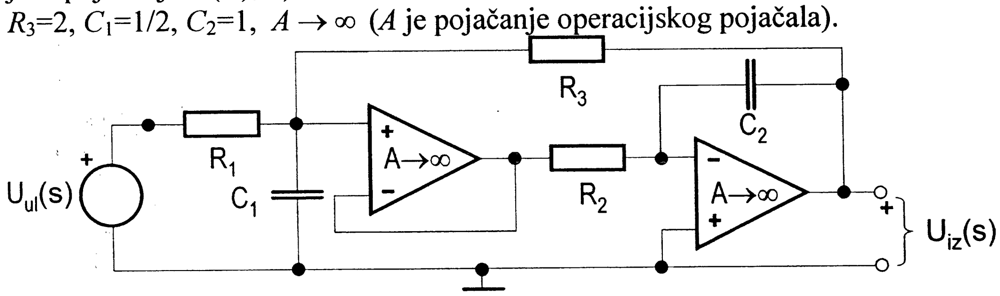
2. Za električni krug prikazan slikom i pridružene orijentacije grana i čvorove napisati: a) matricu incidencija $\mathbf{A}_a$; b) temeljnu spojnu matricu $\mathbf{S}$, temeljnu rastavnu matricu $\mathbf{Q}$; c) matricu impedancija grana $\mathbf{Z}_b$ i vektor početnih uvjeta i neovisnih izvora grana $\mathbf{U}_{0b}$; d) matricu admitancija grana $\mathbf{Y}_b$ i vektor početnih uvjeta i neovisnih strujnih izvora grana $\mathbf{I}_{0b}$; e) pomoću navedenih matrica odrediti sustav jednadžbi čvorova (matrice $\mathbf{Y}_v$ i $\mathbf{I}_{0v}$).



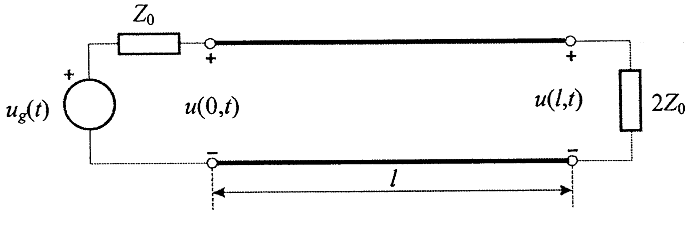
3. Za mrežu prikazanu slikom odrediti nadomjesne parametre mreže po Nortonu $I_N(s)$ i $Y_N(s)$ s obzirom na polove 1–1'. Koristiti metodu napona čvorova u proračunu. Zadane su normalizirane vrijednosti elemenata: L=1, C=1, R=1, g=2, n=2, $i_L(0)$=1, $u_C(0)$=0 te izvor $u_g(t)$=$S(t)$. Napisati: a) Jednadžbe čvorova za izračun struje $I_N(s)$; b) Jednadžbe čvorova za izračun $Y_N(s)$. Uz uvrštene vrijednosti elemenata: c) Nortonovu struju $I_N(s)$; d) Nortonovu admitanciju $Y_N(s)$; e) Nortonovu struju $i_N(t)$ ako je pobuda stacionarni sinusni signal $u_g(t)$=sin(t) i početni uvjeti jednaki nula.

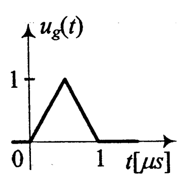


4. Za električni krug prikazan slikom: a) Odrediti prijenosnu funkciju napona $H(s)=U_{iz}(s)/U_{ul}(s)$; b) Izračunati polove i nule prijenosne funkcije; c) Izračunati amplitudno-frekvencijsku karakteristiku $|H(j\omega)|$; d) Izračunati logaritamsku mjeru pojačanja $\alpha(\omega)$; e) Izračunati fazno-frekvencijsku karakteristiku $\varphi(\omega)$ = arg $H(j\omega)$. Zadano je: R_1=2, R_2=1, R_3=2, C_1=1/2, C_2=1, $A\to\infty$ (A je pojačanje operacijskog pojačala).



5. Zadana je linija s primarnim parametrima R=5Ω/km, L=0.25mH/km, G=2mS/km, C=100nF/km, duljine l=5km. Na liniju je spojen naponski izvor $u_g(t)$=$S(t)$ i serijski otpor jednak valnoj impedanciji linije Z_0. Linija je zaključena s $2Z_0$. Odrediti: a) valnu impedanciju Z_0 i koeficijent prijenosa γ; b) brzinu i vrijeme propagacije signala na liniji; c) faktor refleksije signala na ulazu Γ_1 i na izlazu Γ_2 linije; d) izraz za polazni val na mjestu x linije; e) valni oblik napona na izlazu linije $u(l, t)$.





PISMENI ISPIT IZ ELEKTRIČNIH KRUGOVA - Ponuđeni odgovori

(svako pitanje je 1 bod, netočno zaokruženo je –0.25 bodova)

Pitanja: (npr. pitanju **1** odgovara potpitanje je u tekstu označeno sa (1.a)) Zaokružiti samo jedan odgovor (A–E)!

1 (1.a) A) $\begin{matrix} I_L(j\omega)=-1-j \\ U_C(j\omega)=-2+j \end{matrix}$; B) $\begin{matrix} I_L(j\omega)=1+j \\ U_C(j\omega)=1-j \end{matrix}$; C) $\begin{matrix} I_L(j\omega)=1-3j \\ U_C(j\omega)=-1-j \end{matrix}$; D) $\begin{matrix} I_L(j\omega)=3+3j \\ U_C(j\omega)=-2-2j \end{matrix}$; E) $\begin{matrix} I_L(j\omega)=1+3j \\ U_C(j\omega)=1+j \end{matrix}$.

2 (1.b) A) $\begin{matrix} i_L(t)=\sqrt{2}\sin(t-45°) \\ u_C(t)=\sqrt{5}\sin(t+135°) \end{matrix}$; B) $\begin{matrix} i_L(t)=\sqrt{10}\sin(t-71.56°) \\ u_C(t)=\sqrt{2}\sin(t-135°) \end{matrix}$; C) $\begin{matrix} i_L(t)=\sqrt{2}\sin(t) \\ u_C(t)=\sqrt{5}\cos(t) \end{matrix}$; D) $\begin{matrix} i_L(t)=\sqrt{10}\sin(t) \\ u_C(t)=\sqrt{2}\cos(t) \end{matrix}$; E) $\begin{matrix} i_L(t)=\sqrt{5}\sin(t-30°) \\ u_C(t)=\sqrt{2}\sin(t+45°) \end{matrix}$.

3 (1.c) A) $i_L(0)=-1[A],\ u_C(0)=2[V]$; B) $i_L(0)=5[A],\ u_C(0)=-3[V]$; C) $i_L(0)=1[A],\ u_C(0)=1[V]$; D) $i_L(0)=-3[A],\ u_C(0)=-1[V]$; E) $i_L(0)=4[A],\ u_C(0)=2[V]$.

4 (1.d) A) $U_{iz}(s)=\dfrac{1/s-3-2s}{1+s+2s^2}$; B) $U_{iz}(s)=\dfrac{1/s-1+2s}{1+2s+2s^2}$; C) $U_{iz}(s)=\dfrac{-3-2s}{2+s+2s^2}$; D) $U_{iz}(s)=\dfrac{1/s-3}{1+s+s^2}$; E) $U_{iz}(s)=\dfrac{1/s-3+s}{1+s+s^2}$.

5 (1.e) A) $u_{iz}(t)=S(t)-e^{-\frac{t}{2}}\left[\cos\left(\dfrac{\sqrt{3}}{2}\right)+\dfrac{1}{\sqrt{3}}\sin\left(\dfrac{\sqrt{3}}{2}\right)\right]\cdot S(t)$; B) $u_{iz}(t)=2e^{-t}\cos\left(\dfrac{\sqrt{7}}{4}\right)\cdot S(t)$; C) $u_{iz}(t)=2e^{-t}\sin\left(\dfrac{\sqrt{7}}{4}\right)\cdot S(t)$;

D) $u_{iz}(t)=2e^{-\frac{t}{4}}\left[1+\cos\left(\dfrac{\sqrt{5}}{4}\right)+\dfrac{3}{\sqrt{5}}\sin\left(\dfrac{\sqrt{5}}{4}\right)\right]\cdot S(t)$; E) $u_{iz}(t)=S(t)-2e^{-\frac{t}{4}}\left[\cos\left(\dfrac{\sqrt{7}}{4}\right)+\dfrac{3}{\sqrt{7}}\sin\left(\dfrac{\sqrt{7}}{4}\right)\right]\cdot S(t)$.

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6 (2.a) A) $\mathbf{A}_a=\begin{bmatrix}1&1&1&0\\0&0&-1&1\\1&1&0&-1\end{bmatrix}$; B) $\mathbf{A}_a=\begin{bmatrix}1&0&-1&0\\0&1&1&1\\-1&-1&0&-1\end{bmatrix}$; C) $\mathbf{A}_a=\begin{bmatrix}-1&0&1\\0&-1&0\\1&1&-1\end{bmatrix}$; D) $\mathbf{A}_a=\begin{bmatrix}-1&-1&1&1\\0&0&0&0\\1&1&-1&-1\end{bmatrix}$; E) $\mathbf{A}_a=\begin{bmatrix}1&0&-1\\0&-1&0\\-1&1&1\end{bmatrix}$.

7 (2.b) A) $\mathbf{S}=\begin{bmatrix}1&0&1&0\\0&-1&0&1\end{bmatrix}$, $\mathbf{Q}=\begin{bmatrix}1&0&0&0\\0&1&1&1\end{bmatrix}$; B) $\mathbf{S}=\begin{bmatrix}1&1&1&0\\0&1&0&1\end{bmatrix}$, $\mathbf{Q}=\begin{bmatrix}1&0&1&0\\0&1&1&1\end{bmatrix}$; C) $\mathbf{S}=\begin{bmatrix}-1&-1&1&0\\0&-1&0&1\end{bmatrix}$, $\mathbf{Q}=\begin{bmatrix}1&0&-1&0\\0&1&-1&-1\end{bmatrix}$; D) $\mathbf{S}=\begin{bmatrix}1&-1&1&0\\0&-1&0&1\end{bmatrix}$, $\mathbf{Q}=\begin{bmatrix}1&0&-1&0\\0&1&1&1\end{bmatrix}$; E) $\mathbf{S}=\begin{bmatrix}1&-1&1&0\\0&0&0&1\end{bmatrix}$, $\mathbf{Q}=\begin{bmatrix}1&0&-1&0\\0&1&0&1\end{bmatrix}$.

8 (2.c) A) $\mathbf{Z}_b=\begin{bmatrix}sL_1&0&0&0\\0&R_2&0&0\\0&\alpha R_3&R_3&0\\0&0&0&1/(sC_4)\end{bmatrix}$, $\mathbf{U}_{0b}=\begin{bmatrix}U_{g1}\\0\\0\\u_{C4}(0)/s\end{bmatrix}$; B) $\mathbf{Z}_b=\begin{bmatrix}sL_1&0&0&0\\0&R_2&0&0\\0&\alpha R_3&R_3&0\\0&0&0&1/(sC_4)\end{bmatrix}$, $\mathbf{U}_{0b}=\begin{bmatrix}U_{g1}\\0\\0\\C_4u_{C4}(0)\end{bmatrix}$;

C) $\mathbf{Z}_b=\begin{bmatrix}sL_1&0&0&0\\0&R_2&0&0\\0&0&R_3&0\\0&0&0&\alpha sC_4\end{bmatrix}$, $\mathbf{U}_{0b}=\begin{bmatrix}U_{g1}\\0\\u_{C4}(0)\\0\end{bmatrix}$; D) $\mathbf{Z}_b=\begin{bmatrix}sL_1&0&0&0\\\alpha&R_2&0&0\\0&0&R_3&0\\0&0&0&sC_4\end{bmatrix}$, $\mathbf{U}_{0b}=\begin{bmatrix}U_{g1}\\u_{C4}(0)\\0\\0\end{bmatrix}$; E) $\mathbf{Z}_b=\begin{bmatrix}1/(sL_1)&0&0&0\\0&R_2&0&0\\0&0&R_3&0\\0&0&0&sC_4\end{bmatrix}$, $\mathbf{U}_{0b}=\begin{bmatrix}U_{g1}\\0\\0\\C_4u_{C4}(0)\end{bmatrix}$.

9 (2.d) A) $\mathbf{Y}_b=\begin{bmatrix}sL_1&0&0&0\\0&R_2&0&0\\0&-\dfrac{\alpha}{sL_1}&\dfrac{1}{R_3}&0\\0&0&0&sC_4\end{bmatrix}$, $\mathbf{I}_{0b}=\begin{bmatrix}-U_{g1}/(sL_1)\\0\\0\\u_{C4}(0)\end{bmatrix}$; B) $\mathbf{Y}_b=\begin{bmatrix}1/(sL_1)&0&0&0\\0&1/R_2&0&0\\0&-\alpha/R_2&1/R_3&0\\0&0&0&sC_4\end{bmatrix}$, $\mathbf{I}_{0b}=\begin{bmatrix}-U_{g1}/(sL_1)\\0\\0-\\-C_4u_{C4}(0)\end{bmatrix}$;

C) $\mathbf{Y}_b=\begin{bmatrix}1/(sL_1)&0&0\\0&1/R_2&1/R_3\\0&-\alpha/(sL_1)&sC_4\end{bmatrix}$, $\mathbf{I}_{0b}=\begin{bmatrix}U_{g1}/(sL_1)\\0\\0\\C_4u_{C4}(0)\end{bmatrix}$; D) $\mathbf{Y}_b=\begin{bmatrix}1/(sL_1)&0&0&0\\0&1/R_2&0&0\\0&0&1/R_3&0\\0&0&0&sC_4\end{bmatrix}$, $\mathbf{I}_{0b}=\begin{bmatrix}-U_{g1}/(sL_1)\\0\\0\\u_{C4}(0)/s\end{bmatrix}$; E) $\mathbf{Y}_b=[0]$, $\mathbf{I}_{0b}=[0]$.

10 (2.e) A) $\mathbf{Y}_v=\begin{bmatrix}\dfrac{1}{sL_1}+\dfrac{1}{R_3}&-\dfrac{1}{R_3}\\-\dfrac{1}{R_3}&\dfrac{1}{R_2}+\dfrac{1}{R_3}+sC_4\end{bmatrix}$, $\mathbf{I}_{0v}=\begin{bmatrix}\dfrac{U_{g1}(s)}{sL_1}\\u_{C4}(0)\end{bmatrix}$; B) $\mathbf{Y}_v=\begin{bmatrix}\dfrac{1}{sL_1}+\dfrac{1}{R_3}&\dfrac{\alpha}{R_2}-\dfrac{1}{R_3}\\-\dfrac{1}{R_3}&\dfrac{1}{R_2}+\dfrac{1}{R_3}+sC_4\end{bmatrix}$, $\mathbf{I}_{0v}=\begin{bmatrix}\dfrac{U_{g1}(s)}{sL_1}\\u_{C4}(0)/s\end{bmatrix}$;

C) $\mathbf{Y}_v=\begin{bmatrix}\dfrac{1}{sL_1}+\dfrac{1}{R_3}&\dfrac{\alpha}{R_2}-\dfrac{1}{R_3}\\-\dfrac{1}{R_3}&\dfrac{1}{R_2}-\dfrac{\alpha}{R_2}+\dfrac{1}{R_3}+sC_4\end{bmatrix}$, $\mathbf{I}_{0v}=\begin{bmatrix}\dfrac{U_{g1}(s)}{sL_1}\\C_4u_{C4}(0)\end{bmatrix}$; D) $\mathbf{Y}_v=\begin{bmatrix}\dfrac{1}{sL_1}+\dfrac{1}{R_2}+\dfrac{1}{R_3}&-\dfrac{1}{R_3}\\-\dfrac{1}{R_3}&\dfrac{\alpha}{R_2}+\dfrac{1}{R_3}+sC_4\end{bmatrix}$; $\mathbf{I}_{0v}=\begin{bmatrix}\dfrac{U_{g1}(s)}{sL_1}\\0\end{bmatrix}$; E) $\mathbf{Y}_v=[0]$, $\mathbf{I}_{0v}=[0]$.

11 (3.a) A) $\begin{array}{l} I_s = nI_p = n\dfrac{U_g}{R} \\ I_N = I_s = n\dfrac{U_g}{R} \end{array}$; B) $\begin{array}{l} I_s = nI_p = n\dfrac{U_g}{R} \\ I_N = I_s + \dfrac{i_L(0)}{s} \end{array}$; C) $\begin{array}{l} I_s = \dfrac{U_g}{R} \\ I_N = I_s + \dfrac{i_L(0)}{s} \end{array}$; D) $\begin{array}{l} I_p = \dfrac{U_g}{R} \\ I_N = \dfrac{U_g}{sL} + \dfrac{i_L(0)}{s} \end{array}$; E) $\begin{array}{l} U_p = U_s = 0 \\ I_N = \dfrac{i_L(0)}{s} \end{array}$.

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12 (3.b) A) $I_N(s) = 1 + s$; B) $I_N(s) = \dfrac{1+s}{s}$; C) $I_N(s) = \dfrac{3}{s}$; D) $I_N(s) = \dfrac{1}{s}$; E) $I_N(s) = \dfrac{1}{s} + s$.

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13 (3.c) A) $\begin{array}{l} U_1\left(\dfrac{1}{R} + sC\right) - U_2 sC = gU_1 - I_p \\ -U_1 sC + U_2 sC = -gU_1 + I_s + I \end{array}$ B) $\begin{array}{l} U_1 sC - U_2 sC = gU_1 - I_p \\ -U_1 sC + U_2 sC = -gU_1 + I_s + I \end{array}$; C) $\begin{array}{l} U_1 sC - U_2 sC = -I_p \\ -U_1 sC + U_2 sC = I_s + I \end{array}$;

D) $\begin{array}{l} U_1 sC - U_2 sC = gU_1 + I_p \\ -U_1 sC + U_2\left(sC + \dfrac{1}{R}\right) = gU_1 + I_s + I \end{array}$; E) $\begin{array}{l} U_1\left(\dfrac{1}{R} + sC\right) + U_2 sC = -gU_1 - I_p \\ -U_1 sC + U_2 sC = gU_1 + I_s - I \end{array}$.

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14 (3.d) A) $Y_N(s) = s + 1$ B) $Y_N(s) = s^2 + s + 1$; C) $Y_N(s) = \dfrac{2}{s}$; D) $Y_N(s) = \dfrac{1}{s}$; E) $Y_N(s) = s + \dfrac{1}{s}$.

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15 (3.e) A) $i_N(t) = 2\sin(t - 45°)$ B) $i_N(t) = \sin(t + 45°)$; C) $i_N(t) = 2\cos(t + 45°)$; D) $i_N(t) = 2\sin(t)$; E) $i_N(t) = 2\cos(t)$.

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16 (4.a) A) $H(s) = -\dfrac{1}{(1+s)^2}$ B) $H(s) = \dfrac{s^2 - s + 1}{s^2 + s + 1}$; C) $H(s) = -\dfrac{s}{1 + 2s + s^2}$; D) $H(s) = -\dfrac{s^2 + s + 1}{s^2 + 3s + 2}$; E) $H(s) = \dfrac{1}{(1+s)^2}$.

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17 (4.b) A) $s_{p1,2} = -1, s_{o1} = 0, s_{o2} = \infty$; B) $s_{p1,2} = -1, s_{o1,2} = \infty$;; C) $s_{p1} = -1, s_{p2} = -2, s_{o1,2} = 0$; D) $s_{p1} = -1, s_{p2} = -2, s_{o1,2} = -\dfrac{1}{2} \pm \dfrac{\sqrt{3}}{2}$;

E) $s_{p1,2} = -\dfrac{1}{2} \pm \dfrac{\sqrt{3}}{2}, s_{o1} = 0, s_{o2} = \infty$.

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18 (4.c) A) $|H(j\omega)| = \dfrac{1}{\sqrt{1+\omega^2}}$; B) $|H(j\omega)| = \dfrac{\omega^2}{\sqrt{1-\omega^2}}$; C) $|H(j\omega)| = \dfrac{1}{(1-\omega^2)^2 + \omega^2}$; D) $|H(j\omega)| = \dfrac{\sqrt{(1-\omega^2)^2 - \omega^2}}{\sqrt{(1-\omega^2)^2 + \omega^2}}$; E) $|H(j\omega)| = \dfrac{1}{1+\omega^2}$.

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19 (4.d) A) $\alpha(\omega) = 20\log(\omega^2) - 10\log(\omega^2 - 1)$; B) $\alpha(\omega) = 40\log(\omega) - 10\log(\omega^2 - 1)$; C) $\alpha(\omega) = -10\log(\omega + 1)$;

D) $\alpha(\omega) = -20\log(\omega^2 + 1)$; E) $\alpha(\omega) = -20\log((1-\omega^2)^2 + \omega^2)$.

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20 (4.e) A) $\varphi(\omega) = -\arctan\left(\dfrac{\omega}{1-\omega^2}\right)$; B) $\varphi(\omega) = \arctan\left(\dfrac{\omega^2}{1-\omega^2}\right)$; C) $\varphi(\omega) = \pi - 2\arctan(\omega)$; D) $\varphi(\omega) = \arctan\left(\dfrac{1+\omega^2}{1-\omega^2}\right)$;

E) $\varphi(\omega) = \pi - \arctan(2\omega)$.

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21 (5.a) A) $Z_0 = 50\Omega$, $\gamma = 0.1 + s \cdot 25 \cdot 10^{-6}$; B) $Z_0 = 25\Omega$, $\gamma = 0.1 + s \cdot 15 \cdot 10^{-6}$; C) $Z_0 = 50\Omega$, $\gamma = 0.1 + s \cdot 5 \cdot 10^{-6}$;

D) $Z_0 = 75\Omega$, $\gamma = 1 + s \cdot 50 \cdot 10^{-6}$; E) $Z_0 = 100\Omega$, $\gamma = 1 + s \cdot 100 \cdot 10^{-6}$.

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22 (5.b) A) $v = 10 \cdot 10^3 \, km/s$, $T = 1\mu s$; B) $v = 200 \cdot 10^3 \, km/s$, $T = 25\mu s$; C) $v = 100 \cdot 10^3 \, km/s$, $T = 20\mu s$;

D) $v = 50 \cdot 10^3 \, km/s$, $T = 10\mu s$; E) $v = 150 \cdot 10^3 \, km/s$, $T = 50\mu s$.

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23 (5.c) A) $\Gamma_1 = 0$, $\Gamma_2 = \dfrac{1}{3}$; B) $\Gamma_1 = -1$, $\Gamma_2 = 1$; C) $\Gamma_1 = 0$, $\Gamma_2 = \dfrac{1}{6}$; D) $\Gamma_1 = -1$, $\Gamma_2 = \dfrac{2}{3}$; E) $\Gamma_1 = 0$, $\Gamma_2 = \dfrac{2}{3}$.

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24 (5.d) A) $u_p(x,t) = e^{-2 \cdot x} \cdot \dfrac{u_g(t - 50 \cdot 10^{-6} \cdot x)}{2}$; B) $u_p(x,t) = e^{-4 \cdot x} \cdot \dfrac{u_g(t - 100 \cdot 10^{-6} \cdot x)}{2}$; C) $u_p(x,t) = e^{-0.4 \cdot x} \cdot \dfrac{u_g(t - 10 \cdot 10^{-6} \cdot x)}{2}$;

D) $u_p(x,t) = e^{-0.1 \cdot x} \cdot \dfrac{u_g(t - 5 \cdot 10^{-6} \cdot x)}{2}$; E) $u_p(x,t) = e^{-0.2 \cdot x} \cdot \dfrac{u_g(t - 25 \cdot 10^{-6} \cdot x)}{2}$.

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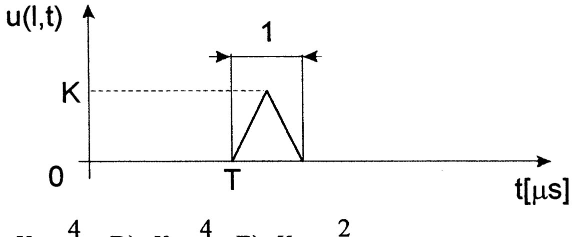
25 (5.e) $u(l,t) = K \cdot u_g(t - T)$



A) $K = \dfrac{2}{3e}$; B) $K = \dfrac{4}{3\sqrt{e}}$; C) $K = \dfrac{4}{3e}$; D) $K = \dfrac{4}{3}$; E) $K = \dfrac{2}{3\sqrt{e}}$.

- OVAJ OBRAZAC SE **MORA** PREDATI ZAJEDNO S OBRASCEM ZA ZACRNJIVANJE -