سمیه سقائی

حل سری ۳ — تئوری تحلیل مدار — نیمسال دوم ۹۴-۹۵

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مقاومت غیرخطی با مشخصه $v=50i^3$ ، $i=0{,}01\cos 377t$ A

$$v=50\times10^{-6}\cos^3 377t \quad,\quad \cos^3\theta=\cos\theta\cos^2\theta=\cos\theta\times\tfrac{1}{2}(1+\cos2\theta)$$

$$=\tfrac{1}{2}\cos\theta+\tfrac{1}{4}\cos\theta+\tfrac{1}{4}\cos3\theta=\tfrac{3}{4}\cos\theta+\tfrac{1}{4}\cos3\theta$$

$$\rightarrow v=\tfrac{3}{4}\times50\times10^{-6}\cos377t+\tfrac{1}{4}\times50\times10^{-6}\cos1131t$$

مولفه دوم هارمونیک سوم 60Hz است.

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$$e_s=0{,}5\frac{di_1}{dt}+v_c \;,\; i=0{,}5\frac{d}{dt}v_c \rightarrow e_s=0{,}25\frac{d^2v_c}{dt^2}+v_c$$

$$\rightarrow 0{,}25s^2+1=0 \rightarrow s=\pm j2 \rightarrow$$ پاسخ عمومی $$=A\cos2t+B\sin2t$$

اگر $e=\sin2t$ پاسخ مربوط به $e(s)$ برابر $t(C\cos2t+D\sin2t)$ است بنابراین

$$v_c=A\cos2t+B\sin2t+t(C\cos2t+D\sin2t)$$

$$\rightarrow \tfrac{1}{4}\ddot{v}_c+v_c=-C\sin2t+D\cos2t=\sin2t\rightarrow C=-1,\ D=0$$

$$v_c(0)=1\rightarrow A=1\;,\;\dot{v}_c(0)=2i_L(0)=4\rightarrow 2B-1=4\rightarrow B=5/2$$

$$\rightarrow v_c=\cos2t+5/2\sin2t-t\cos2t$$

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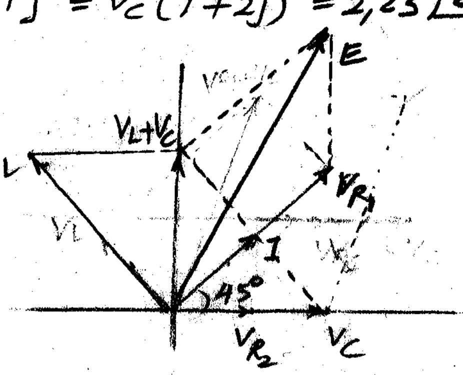
$$E=V_{R_1}+V_L+V_c \;,\; I=\tfrac{1}{2}V_c+j2\times\tfrac{1}{4}V_c=\tfrac{1}{2}V_c(1+j)$$

$$\rightarrow E=2I+j2\times I+V_c=V_c[1+j+j(1+j)+1]=V_c(1+2j)=2{,}23\angle63{,}4^\circ$$

$$\rightarrow e=2{,}23\cos(2t+63{,}4^\circ)$$

دیاگرام فیزوری →



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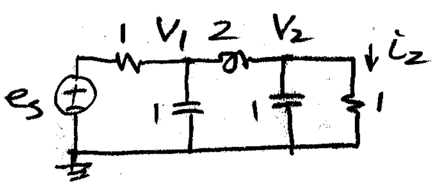
a) $$Z=Z_1+\cfrac{1}{j\omega Y_2+\cfrac{1}{Z_3+\cfrac{1}{Y_4+\frac{1}{Z_5}}}}=1+\cfrac{1}{j\omega+\cfrac{1}{j2\omega+\cfrac{1}{j\omega+1}}}=1+\cfrac{1}{j\omega+\cfrac{1+j\omega}{-2\omega^2+j2\omega+1}}$$

$$Z=1+\frac{1-2\omega^2+j2\omega}{-2\omega^2+j\omega(1-2\omega^2)+1+j\omega}=1+\frac{1-2\omega^2+j2\omega}{1-2\omega^2+j\omega(2-2\omega^2)}\Rightarrow Y=\frac{1-2\omega^2+j2\omega(1-\omega^2)}{2-4\omega^2+j\omega(4-2\omega^2)}$$

c)

$$\begin{bmatrix} 1+j\omega+\frac{1}{j2\omega} & -\frac{1}{j2\omega} \\ -\frac{1}{j2\omega} & 1+j\omega+\frac{1}{j2\omega} \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} E_s/1 \\ 0 \end{bmatrix}$$



$$V_2 = \frac{\begin{vmatrix} 1+j\omega+\frac{1}{j2\omega} & E_s \\ -1/j2\omega & 0 \end{vmatrix}}{\Delta} = \frac{\frac{1}{j2\omega}E_s}{\Delta}, \quad \Delta = \left(1+j\omega+\frac{1}{j2\omega}\right)^2 - \left(\frac{1}{j2\omega}\right)^2 = 2-\omega^2+j\left(2\omega-\frac{1}{\omega}\right)$$

$$Y_{21} = \frac{I_2}{E_s} = \frac{V_2/1}{E_s} = \frac{1}{2-4\omega^2+j(4\omega-2\omega^3)}, \quad \dots \begin{matrix} E_s = 2\angle 0 \\ \omega = 2 \end{matrix} \rightarrow I_2 = \frac{2}{-6+j8}$$

d) $I_2 = -0{,}2\angle -53{,}1^\circ = 0{,}2\angle 126{,}8^\circ \rightarrow i_2 = 0{,}2\cos(2t+126{,}8^\circ)$

b) $I_1 = E_s \times Y \Rightarrow Y(j2) = \frac{-7+j12}{-14+j8} = \sqrt{\frac{193}{260}}\angle 59{,}7^\circ - 29{,}7^\circ = 0{,}86\angle 30^\circ$

$\rightarrow I_1 = 2\angle 0^\circ \times 0{,}86\angle 30^\circ = 1{,}72\angle 30^\circ \rightarrow i_1 = 1{,}72\cos(2t+30^\circ)$

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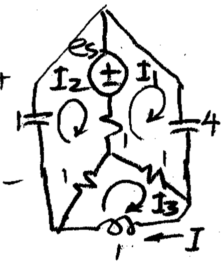
معادلات مش: $e_s = \cos 2t$

$$\begin{bmatrix} 2+\frac{1}{j8} & -1 & -1 \\ -1 & 2+\frac{1}{j2} & -1 \\ -1 & -1 & 2+j2 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} E_s \\ -E_s \\ 0 \end{bmatrix}, \quad \begin{matrix} E_s = 1\angle 0 \\ I = I_3 \\ V = -\frac{1}{j2}I_2 = 0{,}5\angle 90^\circ \times I_2 \end{matrix}$$



$$I_2 = \frac{\begin{vmatrix} 2+\frac{1}{j8} & E_s & -1 \\ -1 & -E_s & -1 \\ -1 & 0 & 2+j2 \end{vmatrix}}{\Delta}, \quad I_3 = \frac{\begin{vmatrix} 2+\frac{1}{j8} & -1 & E_s \\ -1 & 2+\frac{1}{j2} & -E_s \\ -1 & -1 & 0 \end{vmatrix}}{\Delta}$$

$$\Delta = \left(2+\frac{1}{j8}\right)\left(2+\frac{1}{j2}\right)(2+j2) - 1 - 1 - \left(2+\frac{1}{j2}\right) - (2+j2) - \left(2+\frac{1}{j8}\right) = 2{,}375+j4$$

$$I_2 = \frac{-E_s\begin{vmatrix} -1 & -1 \\ -1 & 2+j2 \end{vmatrix} - E_s\begin{vmatrix} 2+\frac{1}{j8} & -1 \\ -1 & 2+j2 \end{vmatrix}}{\Delta}, \quad I_3 = \frac{+E_s\begin{vmatrix} -1 & 2+\frac{1}{j2} \\ -1 & -1 \end{vmatrix} + E_s\begin{vmatrix} 2+\frac{1}{j8} & -1 \\ -1 & -1 \end{vmatrix}}{\Delta}$$

$$I_2 = \frac{-E_s(-2-j2-1) - E_s(4+j4-j\frac{1}{4}+\frac{1}{4}-1)}{\Delta}, \quad I_3 = \frac{E_s(1+2-j\frac{1}{2}) + E_s(-2+j\frac{1}{8}-1)}{\Delta}$$

$$I_2 = E_s\frac{-0{,}25-j1{,}75}{2{,}375+j4} = E_s \times 0{,}38\angle 157{,}4^\circ, \quad I_3 = E_s\frac{-j3/8}{2{,}375+j4} = E_s \times 0{,}0806\angle 149{,}3^\circ$$

$\rightarrow i_L = 0{,}0806\cos(2t+149{,}3^\circ), \; V_c = 0{,}19\angle -112{,}6^\circ \rightarrow v_c = 0{,}19\cos(2t-112{,}6^\circ)$

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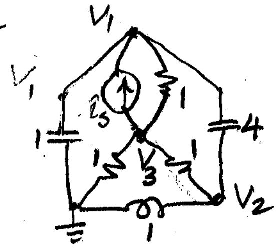
معادلات گره: $i_3 = \cos 2t$

$$\begin{bmatrix} 1+j10 & -j8 & -1 \\ -j8 & j8+\frac{1}{j2} & -1 \\ -1 & -1 & 3 \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} I_s \\ 0 \\ -I_s \end{bmatrix}$$

$V_c = V_1$

$I_L = V_2/j2 = -0{,}5jV_2$



$$V_1 = \frac{\begin{vmatrix} I_s & -j8 & -1 \\ 0 & j8+\frac{1}{j2} & -1 \\ -I_s & -1 & 3 \end{vmatrix}}{\Delta}, \quad V_2 = \frac{\begin{vmatrix} 1+j10 & I_s & -1 \\ -j8 & 0 & -1 \\ -1 & -I_s & 3 \end{vmatrix}}{\Delta}, \quad \Delta = (1+j10)(j7{,}5)\times 3 - j8 - j8 - j7{,}5 - (1+j10) - 3(j8)^2$$

$\rightarrow V_1 = 0{,}19\angle -112{,}6^\circ, \quad V_2 = 0{,}16\angle -120{,}9^\circ$