14 Sin режим в RLC-двуполюсник...

Закона на Ом в комплексен вид

$$R_i + L\frac{di}{dt} + \frac{1}{C}\int idt = u(t)$$

$$u(t) = u_m \sin(\omega t + \psi_u)$$

Търсим стационарния ток:

$$i(t) = i_m \sin(\omega t + \psi_i) = \sqrt{2} I \sin(\omega t + \psi_i)$$

$$\sum U_k = \sum e_k$$

$$U_R + U_L + U_C - u = 0$$

$$R_i + L\frac{di}{dt} + \frac{1}{C}\int idt = 0$$

Метод на комплексната амплитуда:

$$K\left[R_i + L\frac{di}{dt} + \frac{1}{C}\int idt\right] = K\left[u(t)\right]$$

$$K\left[R_i\right] + K\left[L\frac{di}{dt}\right] + K\left[\frac{1}{C}\int idt\right] = \dot{u}(t)$$

$$K\left[u(t)\right] = \dot{u}(t) = u_m e^{j(\omega t + \psi_u)} =$$

$$= \sqrt{2} U e^{j(\omega t + \psi_i)}$$

$$R\underset{\cdot}{i}(t) + L\frac{di}{dt} + \frac{1}{C}\int \underset{\cdot}{i}dt = \dot{u}(t)$$

$$i(t) = I_m\left[\underset{\cdot}{i}(t)\right]; \quad u(t) = I_m\left[\dot{u}(t)\right]$$

$$R\underset{\cdot}{i}(t) + j\omega L i(t) + \frac{1}{j\omega C}\underset{\cdot}{i}(t) = \dot{u}(t)$$

$$R + j\omega L + \frac{1}{j\omega C}\int \underset{\cdot}{i}(t)dt = \dot{u}(t)$$

$$\frac{1}{j\omega C} = -j\frac{1}{\omega C}$$

$$i(t) = \sqrt{2}\dot{I}e^{j\omega t}; \quad u(t) = \sqrt{2}\dot{U}e^{j\omega t}$$

$$\dot{U} = Ue^{j\psi_u}$$

$$\left[R + j(\omega L - \frac{1}{\omega C})\right]\sqrt{2}\dot{I}e^{j\omega t}\sqrt{2}\dot{U}e^{j\omega t}$$

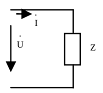
$$Z = R + j(\omega L - \frac{1}{\omega C}) \qquad \dot{U} = Z\dot{I}$$

Комплексен импеданс ≡ компл. съпротив.
Символичен метод (м. ч/з компл. образи)

$$\dot{I}\frac{\dot{U}}{Z}, \quad \dot{I} \to i(t)$$

$$Z = R + j(\omega L - \frac{1}{\omega C}) = R + j(X_L - X_C) =$$

$$= R + jX$$



$$X_L = \omega L - индуктивно$$

$$X_C = \frac{1}{\omega C} - капацитивно$$

$$X = X_L - X_C = \omega L - \frac{1}{\omega C} - реактивно$$

$$Z = R + j(\omega L - \frac{1}{\omega C}) = R + jX =$$

$$= \underbrace{\sqrt{R^2 + X^2}}_{z} e^{j\overbrace{arctg\frac{X}{R}}^{\varphi}} = ze^{j\varphi}$$

$$Z = ze^{j\varphi}$$

$$Z = ze^{j\varphi} = z\cos\varphi + jz\sin\varphi = R + jX$$

$$z = \mathrm{mod}\, Z$$

$R = z\cos\varphi$ - реална част на Z=Re[Z]

$$X = z\sin\varphi = I_m\left[Z\right]$$

$$z = \sqrt{R^2 + X^2}$$

Комплексен вид на закона на Ом

$$\dot{U} = Z\dot{I}, \quad Z = ze^{j\varphi}$$

$$\dot{U} = Ue^{j\psi_u}, \quad Ue^{j\psi_u} = zIe^{j(\psi_i + \varphi)}$$

$$\dot{I} = Ie^{j\psi_i} \quad U = zI \quad \psi_u = \psi_i + \varphi$$

$$\varphi = \psi_u - \psi_i = arctg\frac{X}{R}$$

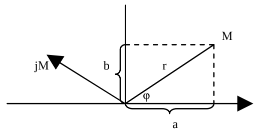
Елемент	Компл. импеданс
R	$Z_R = R$
L	$Z_L = j\omega L = jX_L$
C	$Z_C = -\frac{1}{j\omega C} = -jX_C$

Векторна диаграма с компл. величина.

$$M = a + jb = re^{j\psi}$$

$$j = e^{j\frac{\pi}{2}}, \quad M = re^{j\psi}$$

$$jM = e^{j\frac{\pi}{2}} re^{j\psi} = re^{j(\psi + \frac{\pi}{2})}$$



Умнож. по j е завъртане на 90 в права пос.

$$\dot{U} = Z\dot{I}$$

$$Z = R + j(\omega L - \frac{1}{\omega C}) = R + j\omega - j\frac{1}{\omega C}$$

$$\dot{U} = R\dot{I} + j\omega L\dot{I} - j\frac{1}{\omega C}\dot{I}$$

$$\dot{U}_R = R\dot{I}$$

$$\dot{U}_L = j\omega L\dot{I} \qquad \dot{U} = \dot{U}_R + \dot{U}_L + \dot{U}_C$$

$$\dot{U}_C = -j\frac{1}{\omega C}\dot{I}$$