LINEÁRNE ELEKTRONICKÉ OBVODY

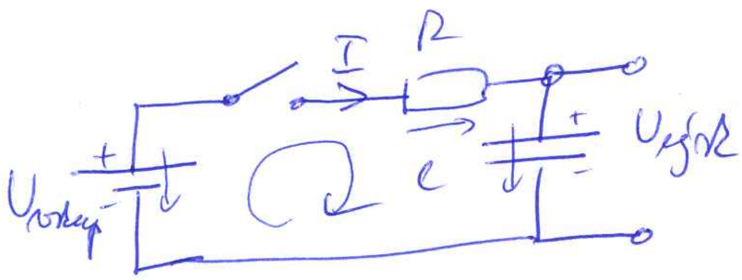
OBVODY S R, L, C

$U = RI \qquad \frac{U}{I} = R$

$U = \frac{Q}{C} = \frac{1}{C}\int_{-\infty}^{t} I(t)\,dt$

$U = L\frac{dI}{dt}$

Kirchhoffove rovnice – použitie:



$\oint \vec{E}\,d\vec{l} = 0$

$$-U_{vst} + RI + \frac{1}{C}\int_{-\infty}^{t} I\,dt = 0 \quad \Big| \frac{d}{dt}$$

$$R\frac{dI}{dt} + \frac{1}{C}I(t) = 0$$

Lineárna dif. rovnica s konšt. koeficientami

$$I = I_0 e^{-\frac{t}{RC}}$$

$t = 0 \Rightarrow C$ nenabitý, $U_C = 0 \Rightarrow U_R = U_{vstup}$

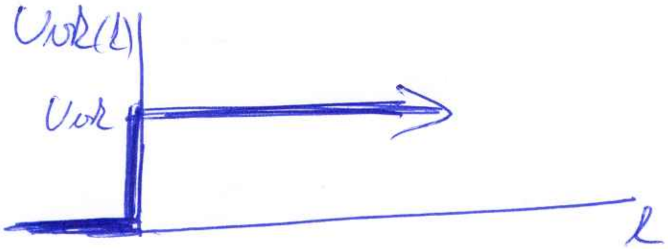
$$I(t=0) = \frac{U_{vst}}{R}$$

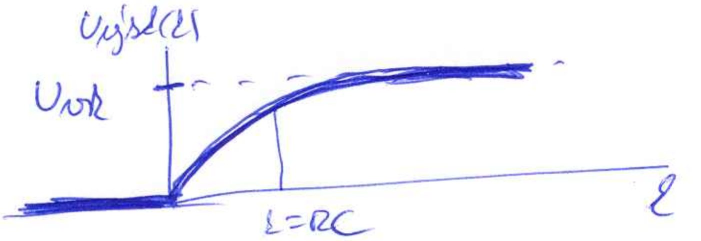
$$I = \frac{U_{vst}}{R} e^{-\frac{t}{RC}}$$

OBVODY S R, L, C

$$U_{výst} = \frac{1}{C}\int_{-\infty}^{t} I(t)\,dt = \frac{1}{C}\int_{0}^{t} \frac{U_{vst}}{R} e^{-t/RC}\,dt =$$

$$U_{výst} = U_{vst}\left(1 - e^{-\frac{t}{RC}}\right)$$





Riešenie diferenciálnych rovníc je nepohodlné, lepšie – komplexno-symbolická metóda:

$U_{vst} = \tilde{U}_{vst} e^{j\omega t}$ $\tilde{U}_{vst}$ – komplexné číslo

⇓

$I = \tilde{I} e^{j\omega t}$ ⇒ U, I – komplexné veličiny

$U_{výst} = \tilde{U}_{výst} e^{j\omega t}$

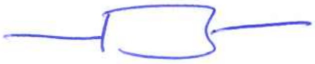
"Reálne" hodnoty komplexných veličín – napr. reálne časti

$U = \tilde{U} e^{j\omega t} = (U_{Re} + j U_{Im}) e^{j\omega t}$

$Re\{U\} = U_{Re}\cos\omega t - U_{Im}\sin\omega t$

OBVODY S R, L, C

Impedancia:



$$U = RI$$

$$\hat{U}\cancel{e^{j\omega t}} = R\tilde{I}\cancel{e^{j\omega t}}$$

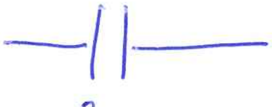
$$\frac{\hat{U}}{\tilde{I}} = \boxed{Z_R = R}$$

$$U = L\frac{dI}{dt}$$

$$\hat{U}\cancel{e^{j\omega t}} = L\frac{d}{dt}\left(\tilde{I}e^{j\omega t}\right) =$$

$$= L\tilde{I}j\omega\cancel{e^{j\omega t}}$$

$$\frac{\hat{U}}{\tilde{I}} = \boxed{Z_L = j\omega L}$$



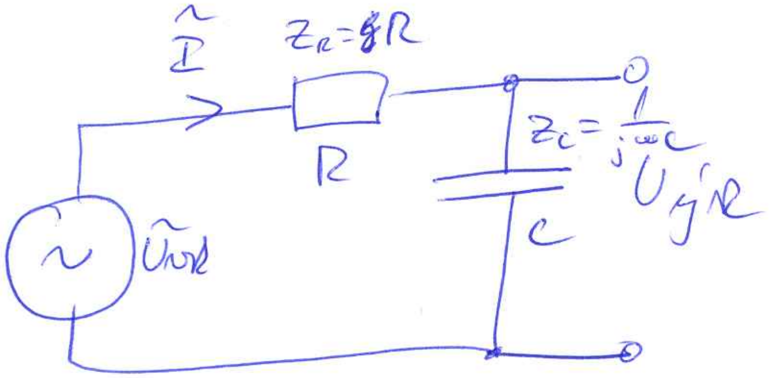
$$U = \frac{1}{C}\int_{-\infty}^{t} I\,dt$$

$$\hat{U}\cancel{e^{j\omega t}} = \frac{1}{C}\int_{-\infty}^{t}\tilde{I}e^{j\omega t}\,dt =$$

$$= \frac{1}{C}\tilde{I}\frac{\cancel{e^{j\omega t}}}{j\omega}$$

$$\frac{\hat{U}}{\tilde{I}} = \boxed{Z_C = \frac{1}{j\omega C}}$$

OBVODY S R, L, C



$$\tilde{I} = \frac{\tilde{U}_{vst}}{R + \frac{1}{j\omega C}}$$

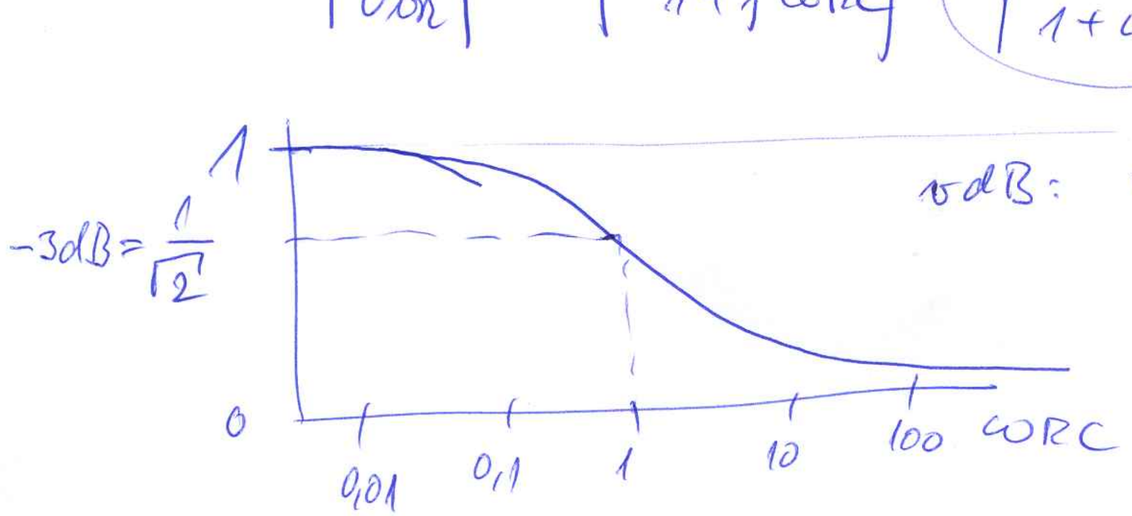
$$\tilde{U}_{výst} = \frac{1}{j\omega C} \cdot \tilde{I} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} \tilde{U}_{vst}$$

$$\tilde{U}_{výst} = \frac{1}{1 + j\omega RC} \tilde{U}_{vst}$$

súvis medzi $\tilde{U}_{vst}$ a $\tilde{U}_{výst}$

1. Podiel amplitúd

$$\frac{|U_{výst}|}{|U_{vst}|} = \left| \frac{1}{1 + j\omega RC} \right| = \frac{1}{\sqrt{1 + \omega^2 R^2 C^2}}$$



v dB: $20 \log \frac{|U_{výst}|}{|U_{vst}|} = -3\ dB$

Obvody s R, L, C

2. Fáza medzi U_{vst} a $U_{výst}$

$$\tan\varphi = \frac{\operatorname{Im}\left\{\frac{U_{výst}}{U_{vst}}\right\}}{\operatorname{Re}\left\{\frac{U_{výst}}{U_{vst}}\right\}}$$

$$\tan\varphi = -\omega RC$$