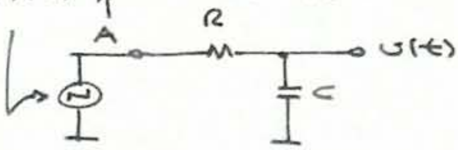
EEL315 — ELETRÔNICA I — 2018/1

LABORATÓRIO — (AULA #1L)

$v_{in}(t) = 1\sin(\omega t)\,u(t)$



$\frac{d}{dt}(q = Cv) \longrightarrow i = C\frac{dv}{dt}$

$v(t) + RC\frac{dv(t)}{dt} = v_{in}(t)$

$v(t)\Big|_{t=0} = 0$

① $v_h(t) = Ke^{-t/RC}$

$v_h(t) + RC\frac{dv_h(t)}{dt} = 0$

$Ke^{-t/RC} - \frac{K(RC)}{RC}e^{-t/RC} = 0 \ (\checkmark)$

② $v_p(t) = Ge^{j\omega t} \longleftarrow v_p(t) + RC\frac{dv_p(t)}{dt} = e^{j\omega t}$

$Ge^{j\omega t} + j\omega RCGe^{j\omega t} = e^{j\omega t}$

$G + j\omega RCG = 1$

$G = \frac{1}{1+j\omega RC} = \frac{1}{\sqrt{1+(\omega RC)^2}}e^{j\phi} \ ; \ \phi = -\mathrm{atan}(\omega RC)$

Da mesma forma:

$v_p(t) + RC\frac{dv_p(t)}{dt} = e^{-j\omega t} \longrightarrow v_p(t) = He^{-j\omega t}$

$He^{-j\omega t} - j\omega RCHe^{-j\omega t} = e^{-j\omega t}$

$H = \frac{1}{1-j\omega RC} = \frac{1}{\sqrt{1+(\omega RC)^2}}e^{-j\phi} \ ; \ \phi = -\mathrm{atan}(\omega RC)$

Considerando entrada senoidal:

$v_{in}(t) = A\frac{(e^{j\omega t} - e^{-j\omega t})}{2j}$

Saída particular: $\frac{A}{\sqrt{1+(\omega RC)^2}}\frac{(e^{j\phi}e^{j\omega t} - e^{-j\phi}e^{-j\omega t})}{2j} = v_p(t)$

$$\boxed{v_p(t) = \frac{A}{\sqrt{1+(\omega RC)^2}}\sin(\omega t + \phi) = B\sin(\omega t + \phi)}$$

③ Solução completa (homogênea + particular):

$v(t) = Ke^{-t/RC} + B\sin(\omega t + \phi)$

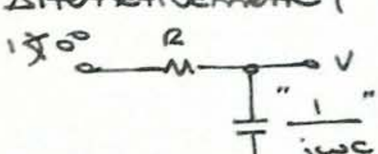
$t = 0 \longrightarrow v(0) = 0 \longrightarrow K + B\sin(\phi) = 0 \longrightarrow K = -B\sin\phi$

Ex.: $R = 18\,k\Omega$; $C = 22\,nF$ (18 "kilo ohms", 22 "nano farads")

$f = 400\,Hz$

$\omega = \frac{1}{RC} = 1\ rad/seg \longrightarrow 1 + \omega RC = 2 \longrightarrow B = \frac{A}{\sqrt{2}}$; $\phi = -45°$

Alternativamente ("método dos fasores"):



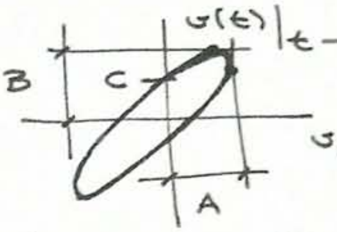
"$\frac{1}{j\omega C}$" ⟵ "reatância capacitiva"

$\frac{V}{1\angle 0°} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} \longrightarrow V = \frac{1}{1+j\omega RC} \longrightarrow v(t) = B\sin(\omega t + \phi)$

$B = |V|$; $\phi = \measuredangle V$

Figuras de Lissajous:

$v(t)\Big|_{t \to \infty} = v_p(t) = B\sin(\omega t + \phi)$



$t = 0 \longrightarrow v_{in}(t) = 0 \ \epsilon \ v_p(t) = B\sin\phi = C$

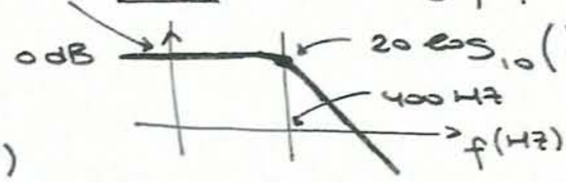
"Ganho" da resposta do filtro: $\frac{B}{A}$

↳ Em dB: $\boxed{20\log_{10}(B/A)}$

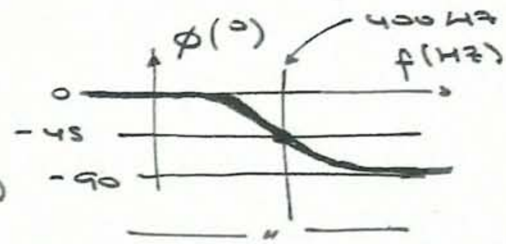
"Fase" da resposta do filtro: $C = B\sin\phi$

$$\boxed{\phi = \mathrm{asin}\left(\frac{C}{B}\right)}$$

Google: "semilog paper"



⟵ Eixo horizontal (logarítmico)



Observação:

Considere z = 1 + j:

Módulo de z:
|z| = sqrt(2)

Fase de z: atan(1)
= 45 graus

1/z = 1 / (1+j) = (1-j) / 2

Módulo de 1/z:
|1/z| = sqrt(2)/2

Note que o módulo de
1/z é igual a 1/|z|

Fase de 1/z: atan(-1)
= -45 graus

Note que a fase de
1/z é igual a -fase(z)