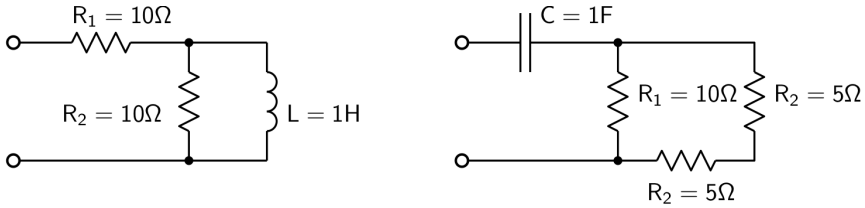
DUT Mesures Physiques 1ère année

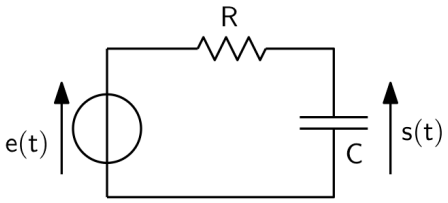
2ème devoir d'Electricité 1

Exercice 1 – Impédance équivalente



Calculer l'impédance équivalente complexe (module et argument) vue entre les deux bornes des deux circuits donnés ci-dessus, à une pulsation de 5 rad/s.

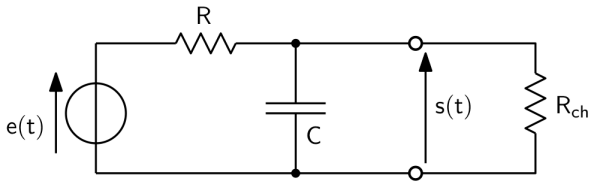
Exercice 2 – Calcul d'une tension



R=10 kΩ, C=1 μF

1. Soit e(t) une tension sinusoïdale d'amplitude 10 V et de pulsation 100 rad/s. Donner l'expression de la tension de sortie s(t). Donner son amplitude (en volt), et son déphasage (en degrés).
2. A partir de s(t), calculer le courant i(t) circulant dans ce montage.

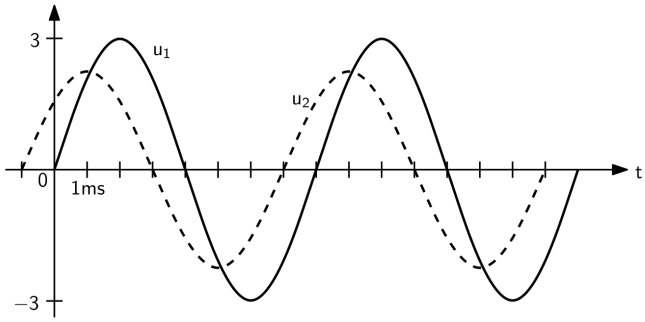
Exercice 3 – Source de Thevenin



R=1 Ω, C=1 F, e(t)=1 sin(t)

1. Calculer la source de Thevenin ($\underline{e}_{th}$ et $\underline{Z}_{th}$) équivalente vue par la charge (résistance R_{ch}). Faire l'application numérique.
2. Calculer la tension s(t) aux bornes de la charge.

Exercice 4 – Exercice supplémentaire



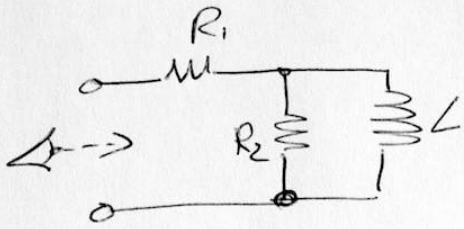
1. Donner l'expression temporelle des tensions $u_1(t)$ et $u_2(t)$ (amplitude et phase)

Correction du 2e devoir d'Electricité

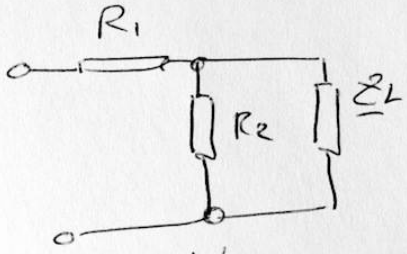
17/11/2011

Exercice 1

circuit 1 :



en complexe



$\underline{Z}_{eq} = R_1 + (R_2 // \underline{Z}_L)$

$\underline{Z}_{eq} = R_1 + \dfrac{R_2 \underline{Z}_L}{R_2 + \underline{Z}_L} = R_1 + \dfrac{j R_2 L\omega}{R_2 + jL\omega}$

$\underline{Z}_L = jL\omega$

$$\boxed{\underline{Z}_{eq} = \frac{R_1 R_2 + j(R_1+R_2)L\omega}{R_2 + jL\omega}}$$

A.N : $\begin{cases} R_1 = R_2 = 10\,\Omega \\ L = 1\,H \\ \omega = 5\ rad/s \end{cases}$

$$\boxed{\underline{Z}_{eq} = \frac{100 + j100}{10 + j5}}$$

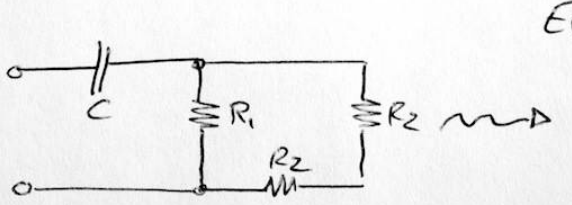
Module : $|\underline{Z}_{eq}| = \dfrac{100\sqrt{2}}{\sqrt{125}} = 12{,}6\,\Omega$

Argument : $\varphi_{Z_{eq}} = \text{Arctan}(1) - \text{Arctan}\left(\frac{1}{2}\right)$

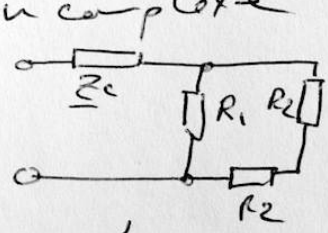
$\varphi_{Z_{eq}} = 18{,}43°$

$$\boxed{\underline{Z}_{eq} = 12{,}6\, e^{j18{,}43°}}$$

circuit 2 :



En complexe



$\underline{Z}_{eq} = \underbrace{([R_1+R_2] // R_1)}_{R_{eq}=5\,\Omega} + \underline{Z}_c = R_{eq} + \underline{Z}_c = R_{eq} + \dfrac{1}{jC\omega}$

$= R_{eq} - j\dfrac{1}{C\omega}$

A.N : $\begin{cases} R_{eq} = 5\,\Omega \\ C = 1\,F \\ \omega = 5\ rad/s \end{cases}$

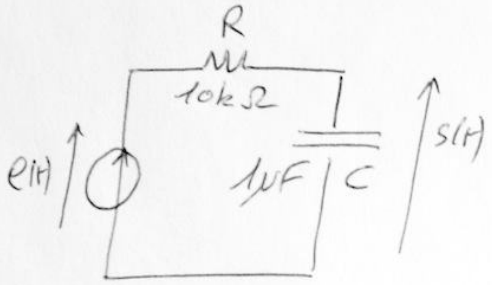
$$\boxed{\underline{Z}_{eq} = 5 - j\frac{1}{5}}$$

Module : $|\underline{Z}_{eq}| = \sqrt{5^2 + \frac{1}{5^2}} \simeq 5\ \Omega$

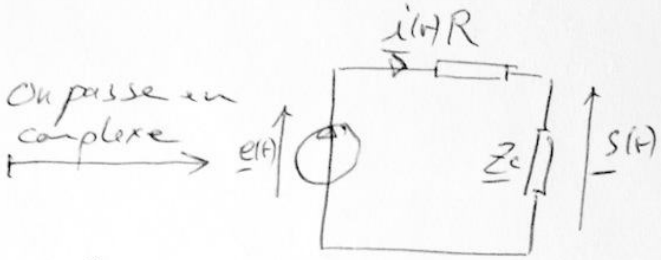
Argument : $\varphi_{Z_{eq}} = \text{Arctan}\left(-\frac{1}{25}\right) = -2,3°$

$$\boxed{\underline{Z}_{eq} = 5\, e^{-j2,3°}}$$

Exercice 2 : Calcul d'une tension



On passe en complexe →



$e(t) = 10 \sin(100t)$

Loi des mailles : $\underline{e}(t) = R\,\underline{i}(t) - \underline{Z}_c\,\underline{i}(t) = 0$

$$\underline{i}(t) = \frac{\underline{e}(t)}{R + \underline{Z}_c}$$

Loi d'ohm : $\underline{S}(t) = \underline{Z}_c \times \underline{i}(t)$

$$\underline{S}(t) = \frac{\underline{Z}_c}{\underline{Z}_c + R} \times \underline{e}(t)$$

$$\boxed{\underline{S}(t) = \underbrace{\frac{1}{1 + jRC\omega}}_{\underline{H}} \times \underline{e}(t)}$$

$$\underline{H} = \frac{1}{1 + jRC\omega}$$

Module de $\underline{H}$: $|\underline{H}| = \frac{1}{\sqrt{1 + (RC\omega)^2}} = \frac{1}{\sqrt{2}}$

Argument de $\underline{H}$ $\varphi_H = -\text{Arctan}(RC\omega) = -\frac{\pi}{4} = -45°$

$$\boxed{\underline{H} = \frac{1}{\sqrt{2}}\, e^{-j45°}}$$

$\underline{e}(t) = 10\, e^{j100t} \rightarrow \underline{S}(t) = \frac{1}{\sqrt{2}} e^{-j45°} \cdot 10 \cdot e^{j100t}$

$\underline{S}(t) = \frac{10}{\sqrt{2}} e^{j(100t - 45°)}$

on repasse à $s(t)$ en transformant $e^{j()}$ en $\sin(\,)$

$$\boxed{s(t) = 7{,}07 \sin(100t - 45°)}$$

Calcul du courant $i(t)$:

on repasse en complexe : $\underline{i}(t) = \frac{\underline{S}(t)}{\underline{Z}_C}$

$\underline{i}(t) = \frac{10}{\sqrt{2}} e^{j(100t - 45°)} \cdot \frac{1}{\frac{1}{jC\omega}}$

$= \underbrace{jC\omega} \times \frac{10}{\sqrt{2}} e^{j(100t - 45°)}$

$|| = C\omega$

$\varphi = +\frac{\pi}{2} = +90°$ $\Big\}\ C\omega\, e^{j90°}$

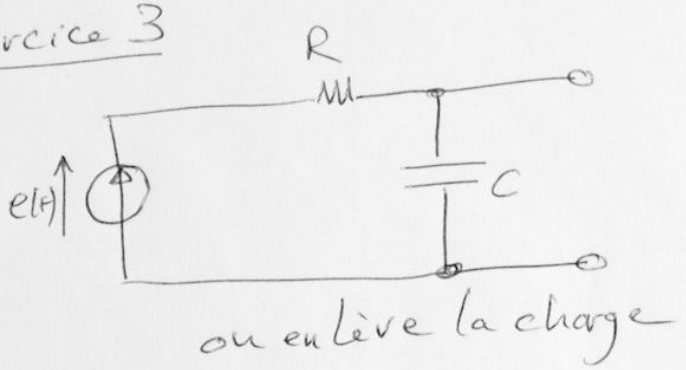
$\underline{i}(t) = \frac{C\omega 10}{\sqrt{2}} e^{j(100t - 45° + 90°)}$

$$\boxed{\underline{i}(t) = 0{,}707 \cdot 10^{-3} e^{j(100t + 45°)}}$$

transformation de $e^{j()} \rightarrow \sin(\,)$

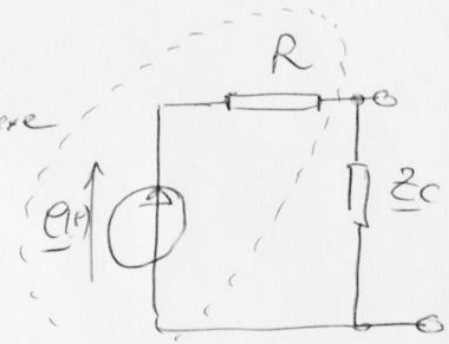
$$i(t) = 0{,}707 \cdot 10^{-3} \sin(100t + 45°)$$

Exercice 3

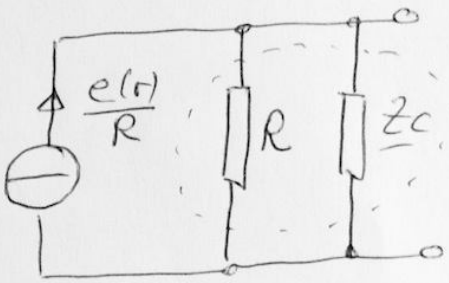


ou enlève la charge

en Complexe

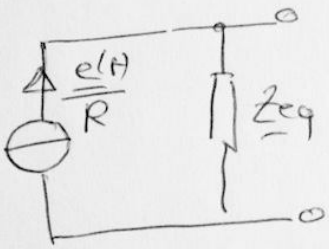


Thevenin → Norton



$$\underline{Z}_{eq} = R // \underline{Z}_C = \frac{\frac{R}{jC\omega}}{R + \frac{1}{jC\omega}}$$

$$\underline{Z}_{eq} = \frac{R}{1 + jRC\omega}$$

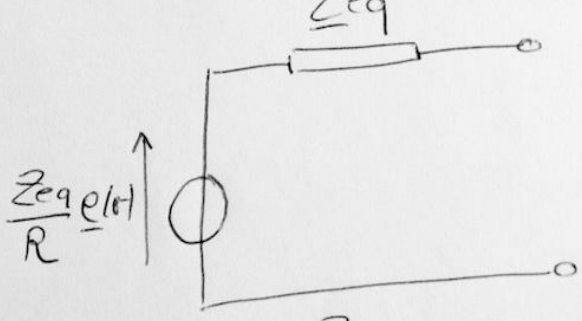


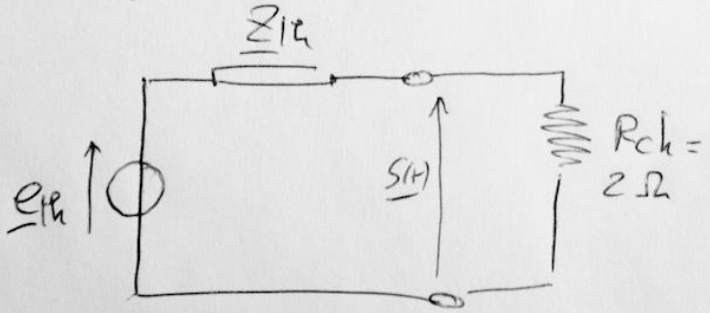
Norton → Thevenin

$1e^{jt}$

$$\underline{e}_{th}(t) = \underline{e}(t) \cdot \frac{1}{1 + jRC\omega}$$

$$\underline{Z}_{th} = \frac{R}{1 + jRC\omega}$$





$$\underline{S}(t) = \underline{e}_{th} \times \frac{R_{ch}}{\underline{Z}_{th} + R_{ch}}$$

A.N : $R = 1\Omega$, $C = 1F$, $\omega = 1 rad/s$

$$\underline{Z}_{th} = \frac{1}{1+j} = \frac{1}{\sqrt{2}} e^{-j45°}$$

$$\underline{e}_{th} = 1e^{jt} \times \frac{1}{\sqrt{2}} e^{-j45°}$$

$$\frac{R_{ch}}{\underline{Z}_{lg} + R_{ch}} = \frac{2}{\frac{1}{1+j} + 2} = \frac{2+2j}{1+2+2j}$$

$$= 2\,\frac{1+j}{3+2j} = 2\,\frac{\sqrt{2}}{\sqrt{13}}\,e^{j(45° - 33,7°)}$$

$$\frac{R_{ch}}{\underline{Z}_{lg} + R_{ch}} = 0,784\, e^{j\,11,3°}$$

$$\underline{S}(t) = \frac{1}{\sqrt{2}}\, e^{j(t-45°)} \times 0,784 \times e^{j\,11,3°}$$

$$\underline{S}(t) = 0,554\, e^{j(t-33,1°)}$$

$e^{j(\,)} \longrightarrow \sin(\,)$

$$\boxed{s(t) = 0,554 \sin(t - 33,1°)}$$

Exercice 4

* Période des signaux : 8 ms

$$\boxed{T = 8\,ms} \quad f = 125\,Hz$$

* Décalage entre u_1 et u_2 :

$$\boxed{\Delta T = 1\,ms}$$

$$\left.\begin{array}{l} T \longrightarrow 360° \\ \Delta T \longrightarrow x° \end{array}\right\} \quad x° = \frac{\Delta T}{T} \times 360°$$

$$x° = 45°$$

* Sommet de u_2 avant sommet de u_1 :
u_2 en avance de 45° par rapport à u_1

$$\boxed{u_1(t) = 3 \sin(2\pi \cdot 125 t)} \quad \boxed{u_2(t) = 2 \sin(2\pi\, 125 t + 45°)}$$