BAZE CURS 9 25.11.2016

DC:
- Kirchoff Theorems ① & ② — ① ✓ ② ✓ C_3
- Vaschy Theorems ① & ②
- Eq. generators { voltage (Thevenin) ✓ ; current (Norton) ✓ } ③ ✓ C_3, C_4
- Voltage divider (series conn) ④ ✓
- Current divider (parallel conn) ⑤ ✓
- The ★-Δ theorems passive ⑥ ✓ C_3
- Th. of eq. transformation (series / parallel ; current sources / voltage) ✓ ⑦
- Theorem of power conservation ⑧ ✓
- Theorem of the maximum power transfer ⑨ ✓
- System of eq { Potential of Node ; Loop Current } ⑩ ✓ C_4, C_5

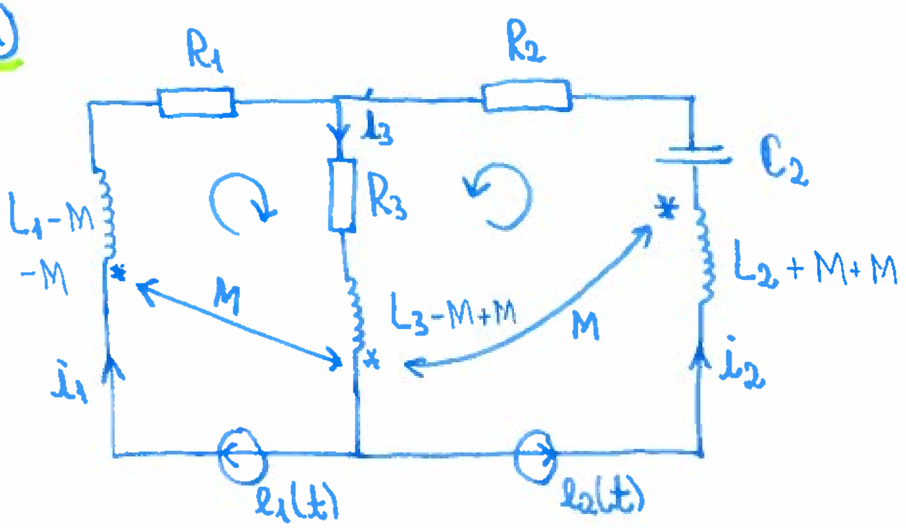
AC: {
- The equations of the elements ① C_7
- The complex transf. for sources ②
- The theorem of conservation for complex power ③
- { $R \to Z$; $G \to Y$ }

DC problem: {
- to solve using any kind of meth. liter + num.
- to express the voltage between 2 nodes (Ohm's Law)
- to find the eq. generator with respect to 2 nodes (Thevenin + Norton)
- Power Balance

AC circuit :
- 2 voltage source without coupled coils
- <3 branches, 1 source, with coupled coil

+ Power Balance
+ Kirchoff eq in time domain
+ to represent the phasors of the currents and one phasor for a reactive element

APL ①



$$e_1(t) = 60 \sin(100t + \pi/4)$$
$$e_2(t) = 35\sqrt{2} \sin(100t + \pi/2)$$
$R_1 = 20\,\Omega \qquad R_2 = 25\,\Omega \qquad R_3 = 5\,\Omega$

$L_1 = L_3 = 100$ mH $\qquad L_2 = M = 50$ mH

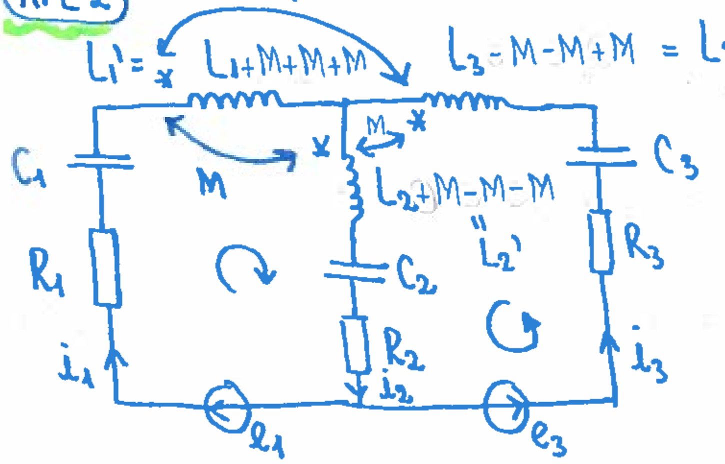
$C_2 = 0.5$ mF

$$i_3 = i_1 + i_2$$
$$e_1 = R_1 i_1 + \underbrace{L_1 \frac{di_1}{dt} - M \frac{di_3}{dt}}_{u_{L_1}} + \underbrace{R_3 i_3}_{u_{R_3}} + \underbrace{L_3 \frac{di_3}{dt} - M \frac{di_1}{dt} + M \frac{di_2}{dt}}_{u_{L_3}}$$
$$e_2 = \underbrace{R_2 i_2}_{u_{R_2}} + \underbrace{\frac{1}{C_2}\int i_2\, dt}_{u_{C_2}} + \underbrace{L_2 \frac{di_2}{dt} + M \frac{di_3}{dt}}_{u_{L_2}} + \underbrace{L_3 \frac{di_3}{dt} - M \frac{di_1}{dt} + M \frac{di_2}{dt}}_{u_{L_3}} + R_3 i_3$$

$$\begin{cases} L_1' = L_1 - 2M = 100 - 100 = 0 \\ L_3' = L_3 - M + M = L_3 = 100 \text{ mH} \\ L_2' = L_2 + 2M = 50 + 100 = 150 \text{ mH} \end{cases}$$

Homework: literally all methods + solve 1 + P.B check

APL 2



$e_1(t) = 240 \sin 1000t$

$e_3(t) = 60 \sin(1000t + \frac{\pi}{2})$

$R_1 = R_2 = R_3 = 10\Omega$ $\quad L_1 = 15$ mH

$L_2 = 35$ mH $\quad L_3 = M = 5$ mH

$C_1 = 100\ \mu F$ $\quad C_2 = C_3 = 50\ \mu F$

$i_2 = i_1 + i_3$

$$e_1 = i_1 R_1 + \frac{1}{C_1}\int i_1\,dt + \overbrace{L_1\frac{di_1}{dt} - M\frac{di_3}{dt} + M\frac{di_2}{dt}}^{u_{L_1}} + \frac{1}{C_2}\int i_2\,dt + R_2 i_2$$

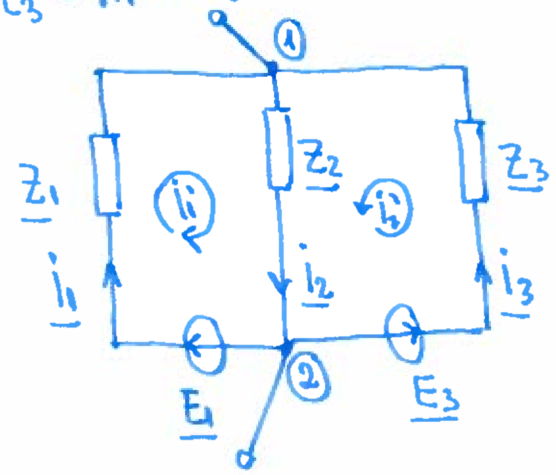
$$\underbrace{+ L_2\frac{di_2}{dt} + M\frac{di_1}{dt} - M\frac{di_3}{dt}}_{u_{L_2}}$$

$$e_2 = R_3 i_3 + \frac{1}{C_3}\int i_3\,dt + \underbrace{L_3\frac{di_3}{dt} - M\frac{di_2}{dt} - M\frac{di_1}{dt}}_{u_{L_3}} + u_{L_2} + u_{C_2} + u_{R_2}$$

$L_1' = L_1 + 3M = 30\ mH$

$L_2' = L_2 - M = 30\ mH$

$L_3' = L_3 - M = 0$



$\underline{Z_1} = R_1 + j\left(\omega L_1' + \frac{1}{\omega C_1}\right)$

$= 10 + j(30 - 10) = 10(1+2j)$

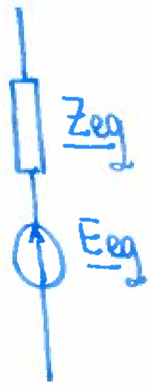
$\underline{Z_2} = R_2 + j\left(\omega L_2' + \frac{1}{\omega C_2}\right)$

$= 10 + j(30 - 20) = 10(1+j)$

$\underline{Z_3} = R_3 + j\left(\omega L_3' - \frac{1}{\omega C_3}\right) = 10(1-2j)$

$\underline{E_1} = 120\sqrt{2}\, e^{j0} = 120\sqrt{2}$

$\underline{E_3} = 30\sqrt{2}\, e^{j\frac{\pi}{2}} = 30\sqrt{2}\, j$



$$\underline{Z_{eq}} = \frac{1}{\frac{1}{\underline{Z_1}} + \frac{1}{\underline{Z_2}} + \frac{1}{\underline{Z_3}}} = \frac{1}{\underline{Y_1} + \underline{Y_2} + \underline{Y_3}}$$

$$= \frac{1}{\frac{1}{10(1+2j)} + \frac{1}{10(1+j)} + \frac{1}{10(1-2j)}} =$$

$$\frac{10}{\frac{1-2j}{5} + \frac{1-j}{2} + \frac{1+2j}{5}} = \frac{10}{\frac{2}{5} + \frac{1-j}{2}} = \frac{100}{9-5j} = \frac{100(9+5j)}{106}$$

$$\underline{E_{eq}} = \frac{\underline{E_1}\,\underline{Y_1} + 0 \cdot \underline{Y_2} + \underline{E_3} \cdot \underline{Y_3}}{\underline{Y_1} + \underline{Y_2} + \underline{Y_3}}$$

$$\begin{cases} \underline{I}_1 + \underline{I}_3 = \underline{I}_2 \\ \underline{E}_1 = \underline{Z}_1 \dot{I}_1 + \underline{Z}_2 \dot{I}_2 \\ \underline{E}_3 = \underline{Z}_3 \dot{I}_3 + \underline{Z}_2 \dot{I}_2 \end{cases}$$

N

$$\begin{cases} \underline{V}_2 = 0 \\ \underline{Y}_{11} \underline{V}_1 = \underline{I}_{sc1} \end{cases}$$

$$\begin{cases} \underline{Y}_{11} = \underline{Y}_1 + \underline{Y}_2 + \underline{Y}_3 \\ \dot{I}_{sc1} = \underline{\dot{I}_1} \cdot \underline{Y}_1 + \underline{\dot{I}_3} \underline{Y}_3 \end{cases}$$

$$\underline{V}_1 - \underline{V}_2 = \begin{cases} E_1 - Z_1 \dot{I}_1 \\ E_3 - Z_3 \dot{I}_3 \\ Z_2 \dot{I}_2 \end{cases}$$

Loop Current

$$Z_{11} \dot{I}_1' + Z_{12} \dot{I}_2' = \dot{E}_1'$$
$$Z_{21} \dot{I}_1' + Z_{22} \dot{I}_2' = E_2'$$

$$\underline{Z}_{11} = \underline{Z}_1 + \underline{Z}_2$$
$$\underline{Z}_{22} = \underline{Z}_2 + \underline{Z}_3$$
$$\underline{Z}_{12} = \underline{Z}_{21} = + \underline{Z}_2$$

$$E_1' = E_1$$
$$E_2' = E_3$$

$$\begin{cases} \dot{I}_1 = \dot{I}_1' \\ \dot{I}_3 = \dot{I}_2' \\ \dot{I}_2 = \dot{I}_1' + \dot{I}_2' \end{cases}$$

$$\underline{S}_{gen} = \underline{E}_1 \cdot \underline{\dot{I}}_1^* + \underline{E}_3 \cdot \underline{\dot{I}}_3^*$$
$$\underline{S}_{rec} = \underline{Z}_1 \cdot \dot{I}_1^2 + \underline{Z}_2 \dot{I}_2^2 + \underline{Z}_3 \dot{I}_3^2$$

$$P = Re\{\underline{S}\} \ (W) \qquad Q = Im\{\underline{S}\} \ \text{VAR}$$