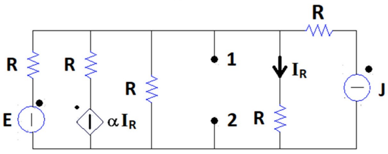
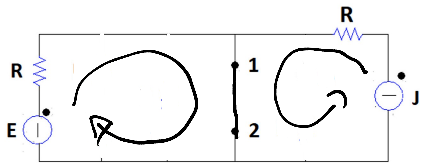
27/06/2018

lunedì 7 dicembre 2020 15:33

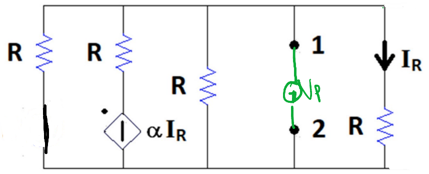
1) Determinare il **circuito equivalente di Norton** fra i punti **1** e **2** del circuito in figura.



E = 20 V;
J = 1 A;
R = 10 Ω;
α = 5 V/A.

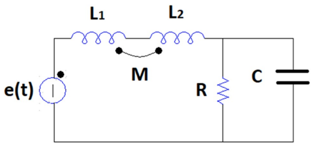


$$I_{No} = \frac{E}{R} + J = 3\,A$$



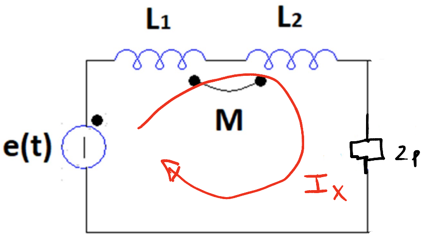
ES 2

2) Determinare **la potenza reattiva** impegnata negli induttori mutuamente accoppiati.



$e(t) = 10\sqrt{2}\cos(1000t)\,V$;
R = 10 Ω;
L_1 = 10 mH;
L_2 = 15 mH.
M = 12 mH;
C = 100 μF.

$$Q = \mathrm{Im}\{V \cdot I^*\}$$



$$Z_P = \frac{\frac{R}{j\omega C}}{R + \frac{1}{j\omega C}} = 5 - 5j$$

$$E = (j\omega L_1 - j\omega M + j\omega L_2 - j\omega M + Z_P)\, I_X$$

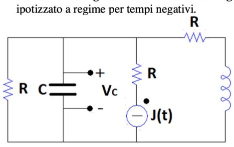
$$I_X = \frac{E}{DEN} = 1{,}2195 - 0{,}9756\,j$$

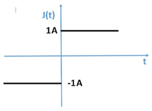
$$Q = L_1\omega I^2 + L_2\omega I^2 - \omega M I^2 - \omega M I^2$$

$$P = L_1\omega I^2 + L_2\omega I^2 - 2\omega M I^2 = VI = 2{,}439\ VAR$$

ES 3

3) Determinare l'andamento temporale della tensione $V_C(t)$ ai capi del condensatore per $-\infty < t < +\infty$, considerando l'**andamento a gradino della corrente erogata del generatore di corrente J(t)**, come in figura. Il circuito è ipotizzato a regime per tempi negativi.

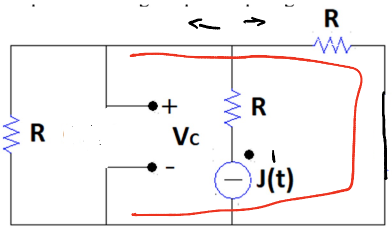




R = 30 Ω;
L = 10 mH;
C = 100 µF;

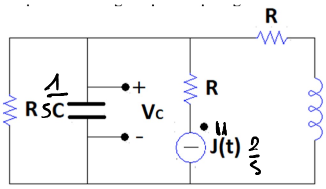
$$J(t) = -1 + 2\mu(t)$$

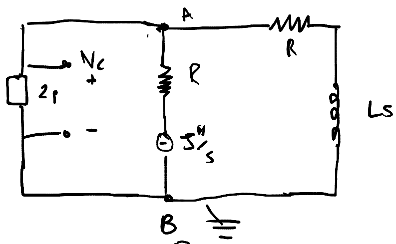
$$J(t) = J'(t) + J''(t)$$



$J'(t)$

$$V_c = +R\frac{J'(t)}{2} = \frac{R}{2} = -15\ V$$





$$Z_p = \frac{\frac{R}{Cs}}{R + \frac{1}{Cs}} = \frac{R}{RCs+1}$$

$$\frac{J''}{s} = V_A\left(\frac{1}{Z_p} + \frac{1}{R+Ls}\right)$$

$$V_A(s) = \frac{J''}{s\left(\frac{1}{Z_p} + \frac{1}{R+Ls}\right)} = \frac{s\,Z_p(R+Ls)}{s\,(R+Ls) + sZ_p}$$

$$V_A(s) = \frac{J''Z_p\,(R+Ls)}{s^2L + Rs + sZ_p} = \frac{J''Z_pR + J''Z_pLs}{s^2L + s(R+Z_p)}$$

$$V_A(s) = \frac{\frac{J''R^2}{RCs+1} + \frac{J''Ls}{RCs+1}}{s^2L + s\left(R + \frac{R}{RCs+1}\right)} = \frac{J''R^2 + J''LsR}{s^3RCL + s^2L + s\left(R^2Cs + R + R\right)}$$

$$V_A(s) = \frac{J''R^2 + J''Ls}{\quad} = \frac{2R^2 + 2LsR}{\quad}$$

$$V_\Delta(s) = \frac{J''R^2 + J''Ls}{s(s^2RCL + sL + R^2Cs + 2R)} = \frac{2R^2 + 2LsR}{s(s^2RCL + s(L+R^2C) + 2R)}$$

$$V_\Delta(s) = \frac{1800 + 0{,}6\,s}{s(3\cdot 10^{-5}s^2 + 0{,}1\,s + 60)} = \frac{6\cdot 10^7 + 2\cdot 10^4 s}{3\cdot 10^{-5} s(s^2 + 3333{,}33s + 2\cdot 10^6)}$$

$$s_1 = 0$$

$$s_{2,3} = \frac{-3333{,}33 \pm 1763{,}828}{2} = \begin{cases} -2548{,}579 \\ -784{,}751 \end{cases}$$

$$A_1 = \lim_{s\to 0} \frac{6\cdot 10^7}{2\cdot 10^6} = 30$$

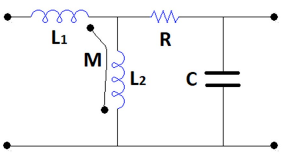
$$A_2 = \lim_{s\to s_2} \frac{6\cdot 10^7 + 10^4 s}{3\cdot 10^{-5} s(s + 784{,}751)} = 2{,}0084$$

$$A_3 = \lim_{s\to s_3} \quad = -32{,}0084$$

$$v_C(t) = v_C' + v_C'' = -15 + \left(30 + 2{,}0084\, e^{-2548{,}579t} - 32{,}0084\, e^{-784{,}751t}\right) u(t)$$

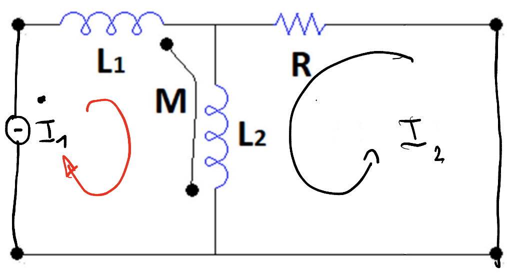
ES 4

4) Determinare la rappresentazione a parametri **h** della rete a due porte indicata in figura, ipotizzata a regime periodico sinusoidale a pulsazione ω.



R = 10 Ω;
L1 = 10 mH;
L2 = 15 mH.
M = 12 mH;
C = 300 μF;
ω = 1000 rad/s;

$$\begin{cases} V_1 = h_{11} I_1 + h_{12} V_2 \\ I_2 = h_{21} I_1 + h_{22} V_2 \end{cases}$$



$V_2 = 0$

$$(R + j\omega L_2) I_2 + j\omega M I_1 + j\omega L_2 I_1 = 0$$

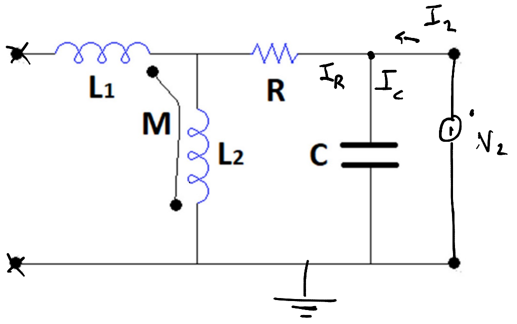
$$I_2 = \frac{-j\omega M I_1 - j\omega L_2 I_1}{R + j\omega L_2} = h_{21} I_1$$

$$h_{21} = -1,2461 - 0,8308\,j$$

$$V_1 = j\omega L_1 I_1 + j\omega M\, h_{21} I_1 - R\, h_{21} I_1$$

$$h_{11} = j\omega L_1 + j\omega M I_1 + j\omega M\, h_{21} I_1 - R\, h_{21} I_1 = 22,4306 + 15,3548\,j$$

$$I_1 = 0$$



$$I_c = V_2\, j\omega C$$

$$I_R = \frac{V_2}{j\omega L_2 + R}$$

$$I_2 = V_2 \left(j\omega C + \frac{1}{j\omega L_2 + R} \right) = h_{22} V_2$$

$$h_{22} = 0,0387 + 0,2538\,j$$

$$V_1 = j\omega M I_R + j\omega L_2 I_R = \frac{V_2}{j\omega L_2 + R} \left(j\omega M + j\omega L_2 \right) = V_2 \frac{(j\omega M + j\omega L_2)}{j\omega L_2 + R}$$

$$h_{12} = 1,2461 + 0,8307\,j$$