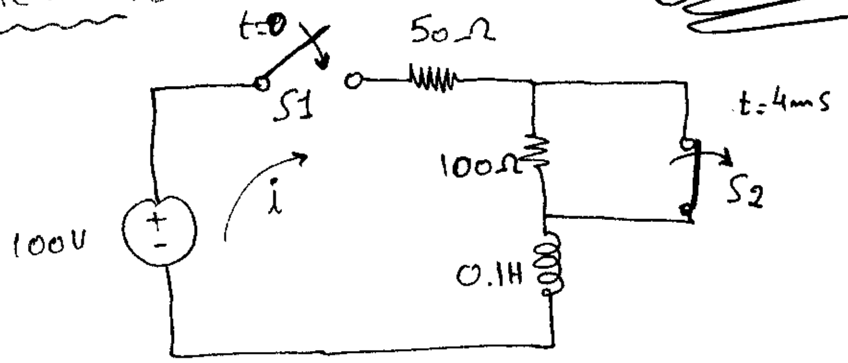
Solution:

EECE 210

Ch I, 2

Problem 1:



As there is always inductance in the circuit, the current is a continuous function at all times. In the interval $0 \leq t \leq 4ms$, with the 100 Ω shorted out and a time constant $\tau = (0.1\ H)/50\ \Omega = 2ms$, i starts at zero and builds toward $100V/50\Omega = 2A$, even through it never gets close to that value. Hence,

$$i = 2(1 - e^{-t/2})\ A \qquad (0 \leq t \leq 4)$$

where t is measured in ms. In particular,

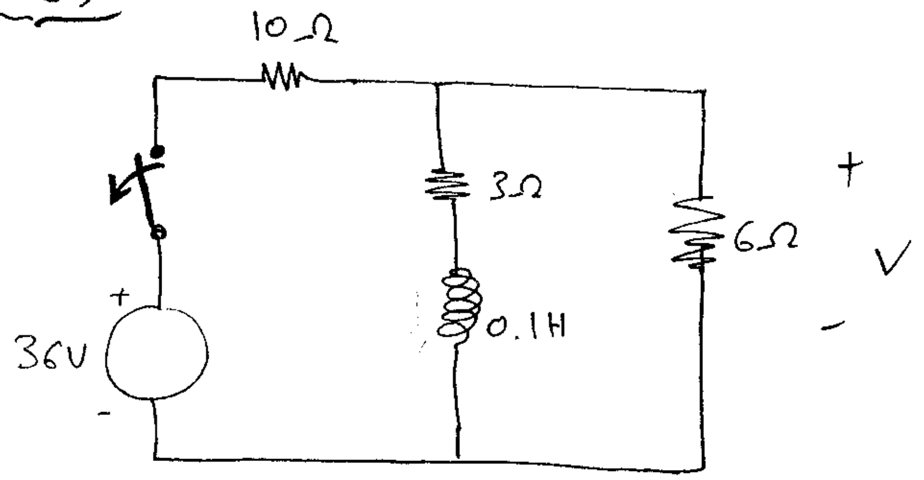
$$i(4) = 2(1 - e^{-2}) = 1.729A$$

In the interval $t \geq 4ms$, i starts at 1.729 A and decays toward $100/150 = 0.667$ A, with a time constant $0.1/150 = \frac{2}{3}$ ms. Therefore, with t again in ms

$$i = (1.729 - 0.667)\, e^{-(t-4)/(2/3)} + 0.667$$

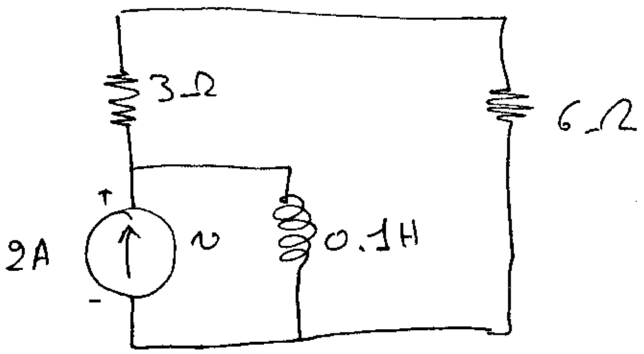
$$= 428.4\, e^{-3t/2} + 0.667\ A \qquad t \geq 4$$

Items 2 & 3



$$i_L(0^-) = \frac{36\,(6/9)}{10 + (3)(6)/(3+6)} = 2\ A$$

Then we will obtain

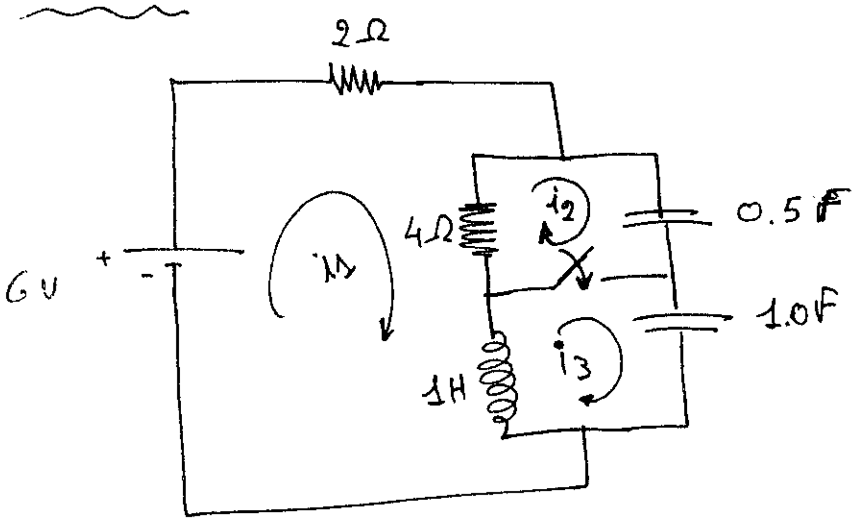


for which;

$$2 = \frac{v}{9} + \frac{1}{0.1}\int_0^t v\,dt \qquad (1)$$

The solution to Eq. (1) is $v = 18\,e^{-90t}$ V. Hence the voltage across the resistance becomes $v_{6\Omega} = \frac{6}{9}\left(18e^{-90t}\right) = 12\,e^{-90t}$ V

Problem 4



Before the switch is closed, $t < 0$

$$i_{4\Omega}(0_-) = i_{1H}(0_-) = \frac{6}{2+4} = 1\ A$$

$$v_{0.5F} + v_{1.0F} = \frac{(4)(6)}{4+2} = 4\ V. \quad \text{------}(1)$$

When the switch is closed, $t > 0$

$$2i_1 = 6 - (v_{0.5F} + v_{1.0F}) = 6 - 4 = 2 \quad \text{or} \quad i_1(0_+) = 1\ A$$

$$i_1(0_+) - i_3(0_+) = i_{1H}(0_+) = i_{1H}(0_-) = 1\ A$$

$$i_3(0_+) = i_1(0_+) - 1 = 1 - 1 = 0\ A$$

Since $v_{0.5F}(0_-) = v_{0.5F}(0_+)$ and $v_{1.0F}(0_-) = v_{1.0F}(0_+)$

$$i_1(0_+) - i_2(0_+) = \frac{v_{0.5F}(0_+)}{4} \quad \text{-----}(2)$$

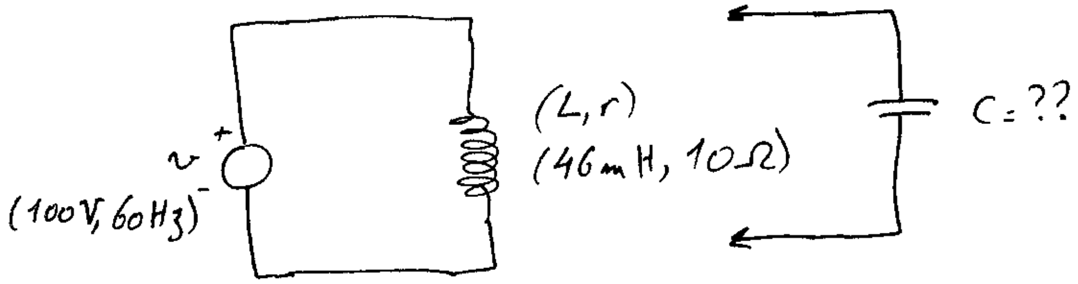
Because the capacitors are conneted in series

$$\frac{v_{0.5F}}{v_{1.0F}} = \frac{1}{0.5} = 2 \quad \text{or} \quad v_{0.5F} = 2v_{1.0F} \quad \text{-----}(3)$$

From (1)&(3) we finally obtain:

$$i_2(0_+) = \frac{1}{3} = 0.33\ A$$

Item 5:



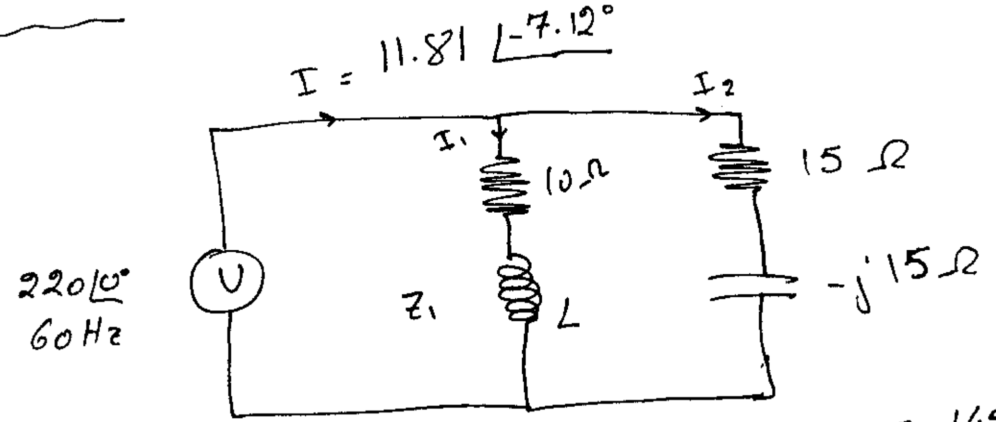
The admittance of the parallel combination will be

$$1/Z_L + j\omega C = 1/(10 + j\,17.34) + j\,377C =$$

$$= \frac{1}{40} + j(377C - 0.0434).$$

For unity power factor, the imaginary part must vanish, yielding $C = 0.0434/377 = 115\,\mu F$.

Problem 6:



$$I_2 = \frac{U}{Z_2} = \frac{220\angle 0^\circ}{15 - j15} = \frac{220\angle 0^\circ}{21.2\angle -45} = 10.35\angle 45^\circ = 7.34 + j\,7.34$$

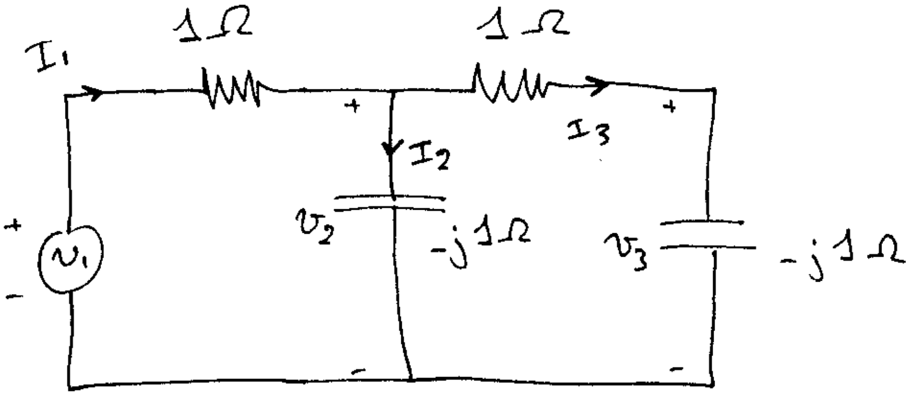
$$I_1 = I - I_2 = 11.81\angle -7.12 - (7.34 + j\,7.34) =$$

$$= 4.38 - j8.8 = 9.83\angle -63.6^\circ\ A = \frac{V}{Z_1} = \frac{220\angle 0^\circ}{10 + jX_L}$$

from which

$$X_L = 20\,\Omega = \omega L = 377L \quad \text{or} \quad L = 53.05\,mH$$

blem 7:



In term of maximum values,

$$v_2 = 2\angle 0^\circ \qquad v_3 = \frac{v_2}{1-j1}(-j1) = \frac{-j2}{1-j1} = 1.414\angle -45^\circ \text{ V}$$

or $v_3(t) = 1.414 \cos(2t - 45^\circ)$ V

$$I_1 = I_2 + I_3 = \frac{v_2}{-j1} + \frac{v_2}{1-j1} = \frac{2\angle 0^\circ}{-j} + \frac{2\angle 0^\circ}{1-j1} = j2 + 1 + j1$$

$$= 1 + j3 \text{ A}$$

$$v_1 = 1(1+j3) + v_2 = 1 + j3 + 2 = 3 + 3j = 4.24\angle 45^\circ \text{ V}$$

or $v_1(t) = 4.24 \cos(2t + 45^\circ)$ V.

Problem 8:

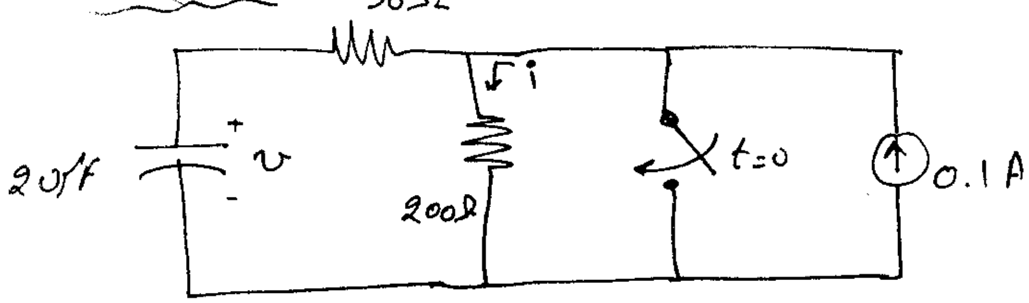
In this case, we have

$$4\angle 25^\circ = \frac{60\angle 0^\circ + I_2(j48)}{3.9 + j65} = \frac{60\angle 0^\circ + I_2(j48)}{65.11\angle 86.6^\circ}$$

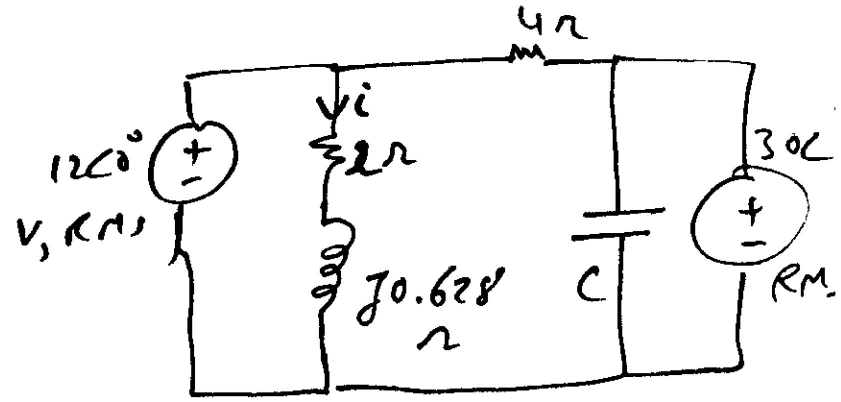
or $260.46\angle 111.6^\circ - 60\angle 0^\circ = I_2(48\angle 90^\circ)$

Hence, $I_2 = 6\angle 32.7^\circ$.

lem 4:



prob. 10 :



$$\mathbf{I} = \frac{12\angle 0^\circ}{2 + j\,0.628} = \ldots$$

Q, in the inductor

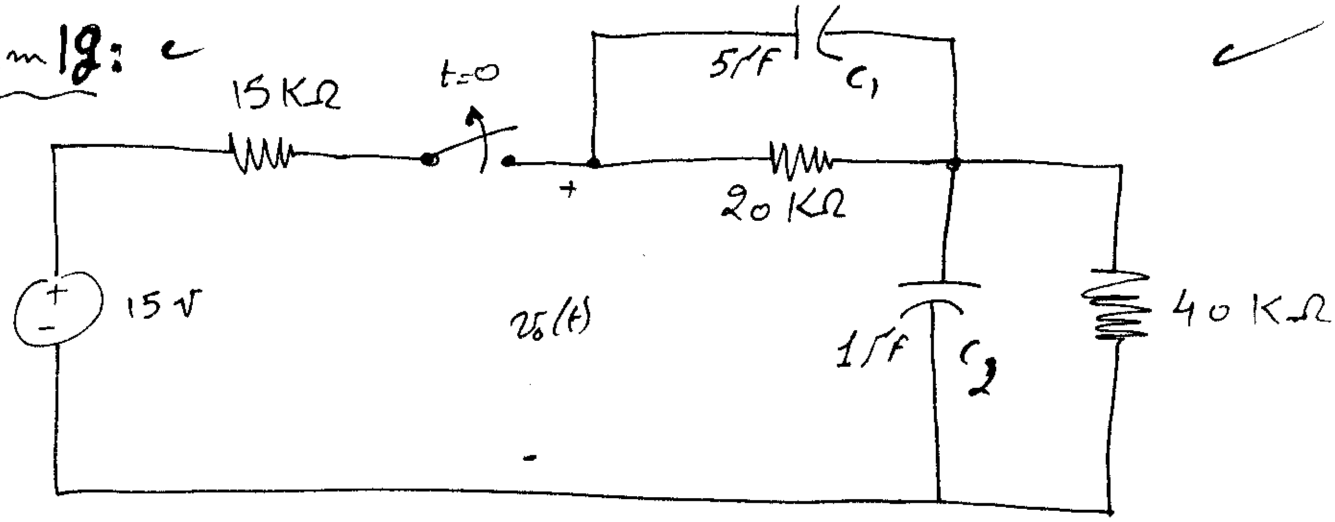
$$= |I|^2 X_L = -- \quad 20.59 \text{ VAR}$$

prob 11.

$$Q = \frac{V^2}{X_C} = \frac{\cancel{302}\ 30^2}{X_C} = 5\text{V}$$

$$\Rightarrow X_C = ---- \rightarrow X_C = \frac{1}{\omega C} \Rightarrow C = 14.$$

roblem 19: c



$$i(0^-) = \frac{15}{(15+60)10^3} = \frac{15}{75\times10^3} = 0.2\times10^{-3}$$

$$V(C_2 \text{ at } 0^-) = 0.2\times40\times10^3\times10^{-3} = 8\ V = V_{c_1}(0^+)$$

$$V(C_1 \text{ at } 0^-) = 0.2\times20\times10^3\times10^{-3} = 4\ V = V_{c_2}(0^+)$$

for $t \geq 0$; $\quad V_0(t) = V_{01}(t) + V_{02}(t)$

$$= 8\, e^{-\frac{t}{\tau_1}} + 4\, e^{-\frac{t}{\tau_2}}$$

$$\tau_2 = 20\times10^3\times5\times10^{-6} = 0.1$$

$$\tau_1 = 40\times10^3\times1\times10^{-6} = 0.04$$

4μf

so $v_0(t) = 8\, e^{-25t} + 4\, e^{-10t}$, V

$$= 8e^{-25t} + 4e^{-10t},\ V.$$