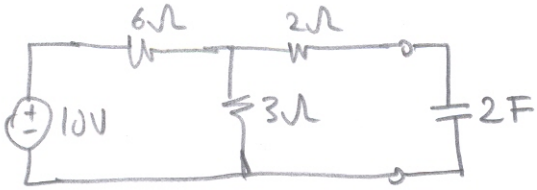
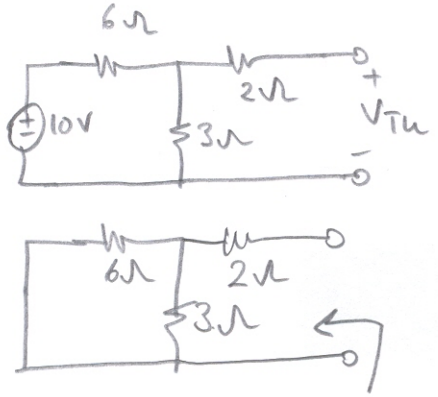
Problem 1:

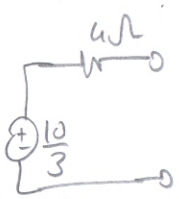


a)

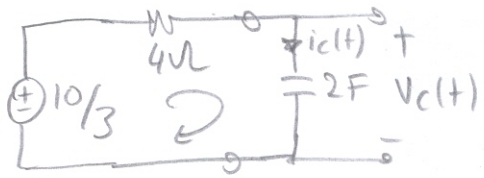


$$V_{Th} = 10 \cdot \frac{3}{9} = \frac{10}{3} V$$

$$R_{Th} = 6 // 3 + 2 = 4\Omega$$



b)



$$\frac{-10}{3} + 4 i_c(t) + V_c(t) = 0$$

$$i_c(t) = 2 \frac{dV_c(t)}{dt}$$

$$\boxed{8 \frac{dV_c(t)}{dt} + V_c(t) = \frac{10}{3}}$$

c)

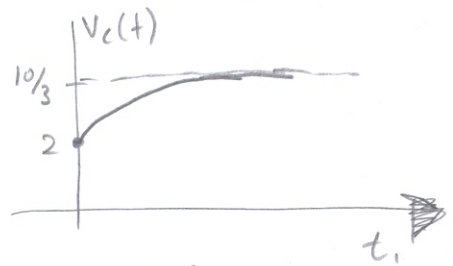
$$\frac{dV_c(t)}{dt} + \frac{1}{8} V_c(t) = \frac{5}{12}, \quad V_c(0) = 2$$

$$V_c^{homogeneous}(t) = c e^{-1/8 t}$$

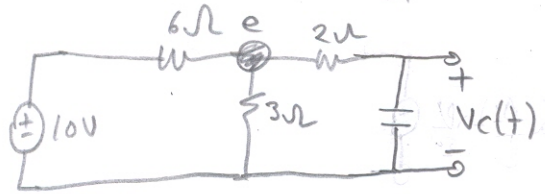
$$V_c^{particular}(t) = A$$

$$A = \frac{10}{3}, \quad c = -4/3$$

$$\boxed{V_c(t) = \frac{10}{3} - \frac{4}{3} e^{-1/8 t}}$$



d)



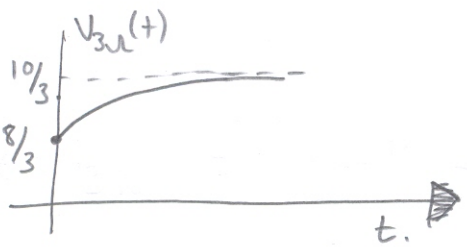
KCL at e:

$$\frac{e-10}{6} + \frac{e}{3} + \frac{e - V_c(t)}{2} = 0$$

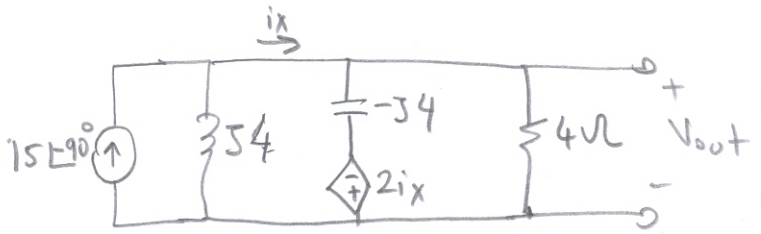
$$e\left(\frac{1}{6} + \frac{1}{3} + \frac{1}{2}\right) = \frac{10}{6} + \frac{V_c(t)}{2}$$

$$\boxed{e = \frac{10}{6} + \frac{V_c(t)}{2}}$$

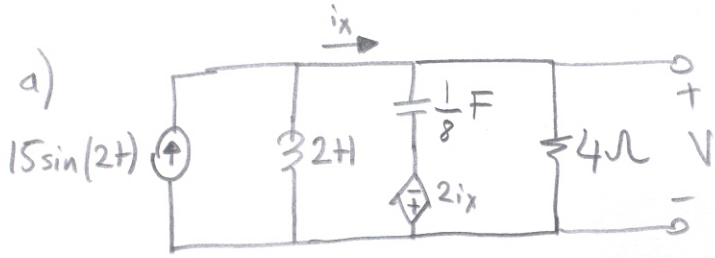
$$V_{3\Omega}(t) = e = \frac{10}{6} + \left(\frac{10}{6} - \frac{4}{6} e^{-1/8 t}\right) = \frac{10}{3} - \frac{2}{3} e^{-1/8 t}$$



Problem ②



a)



b) $$\frac{V_{out}}{4} + \frac{V_{out} - (-2i_x)}{-j4} + \frac{V_{out}}{j4} + 15j = 0 ;$$

$$i_x = -15j - \frac{V_{out}}{j4} ;$$

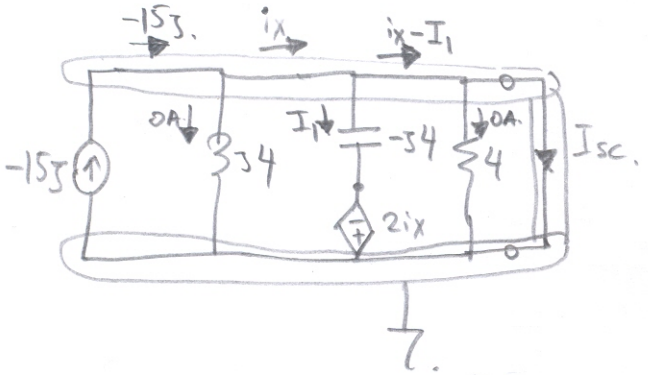
$$V_{out}\left(\frac{1}{4} + \frac{1}{-j4} + \frac{1}{j4} - \frac{1}{j4_2}\cdot\frac{2}{-j4}\right) = -15j + 15j\cdot\frac{2}{-j4}$$

$$V_{out}(1/8) = -15j - 15/2$$

$$V_{out} = -60 - j120 \quad *$$

c). $V_{out}(t) = -60\cos(2t) + 120\sin(2t) = 134.16\cos(2t + 243.43°)$ V

d)



$$I_1 = \frac{0 - (-2i_x)}{-j4} = \frac{j}{2} i_x .$$

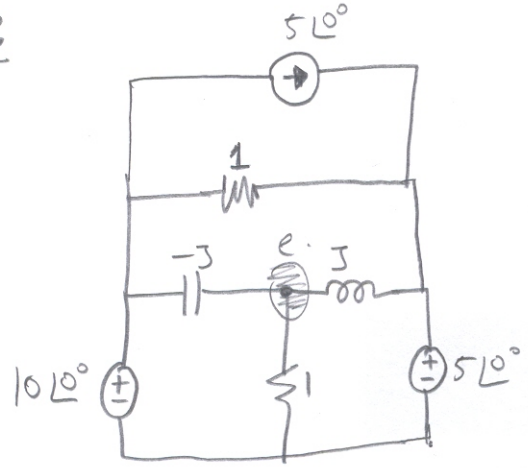
$$I_{sc} = i_x - I_1 = \left(1 - \frac{j}{2}\right) i_x .$$

$-15j$.

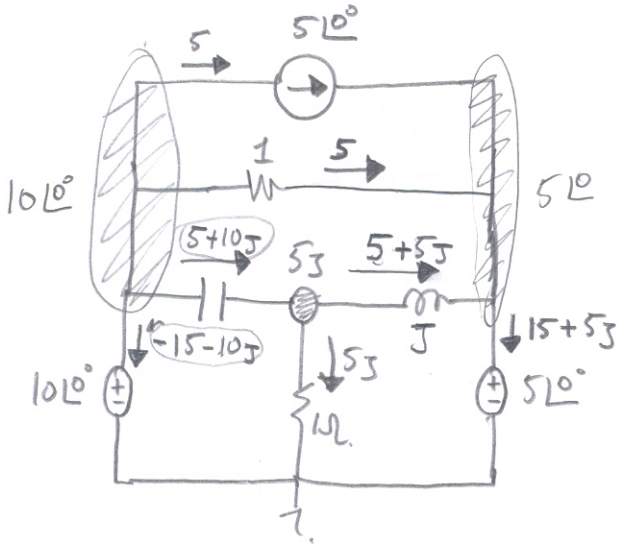
$$I_{sc} = -15j\,(1 - j/2)$$

$$Z_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{-60 - j120j}{-15j(1 - j/2)} = \frac{-60(1+2j)}{\frac{-15j}{2}(2-j)} = 8\,\frac{(1+2j)}{(1+2j)} = 8 \quad *.$$

Problem (3):



a) KCL at e: $\frac{e-10}{-J} + \frac{e}{1} + \frac{e-5}{J} = 0$ $\quad e = \frac{-10}{J} + \frac{5}{J} = 5J$



$S_{5A} = (10\angle 0° - 5\angle 0°)5^* = 25$

$S_{1\Omega} = 5.5^* = 25$

$S_{-J} = |5+10J|^2(-J) = -J125$

$S_J = |5+5J|^2(J) = J50$

$S_{1\Omega} = |5J|^2(1) = 25.$

$S_{10V} = (10\angle 0°)(-15-10J)^* = -150 + J100$

$S_{5V} = (5\angle 0°)(15+5J)^* = 75 - J25.$

b) $P_{5A} = 25W$ (absorbing)

$P_{10V} = -150W$ (supplying 150W's)

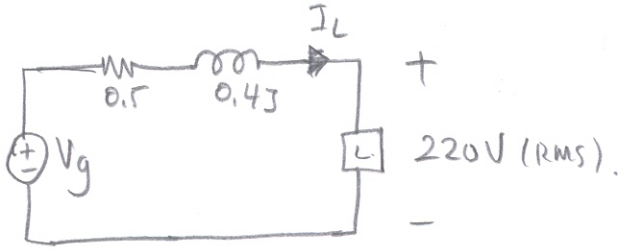
$P_{5V} = 75\,W$ (absorbing)

c) $p.f_{5A} \doteq 1$ (unity p.f.)

$p.f._{5V} = \frac{3}{\sqrt{10}} = 0.95$ (leading)

$p.f._{10V} = \frac{3}{\sqrt{13}} = 0.83$ (lagging)

Problem 4:



a) $S_L = 60{,}000 + j\,45{,}000$

$$|I_L| = \frac{|S_L|}{220} = \frac{75{,}000}{220} = 340.9 \text{ A (RMS)}.$$

$S_{line} = |I_L|^2\left(\frac{1}{2} + j\frac{2}{5}\right) = 58{,}106 + j\,46{,}485.$

$P_{0.5\Omega} = 58{,}106$ W.

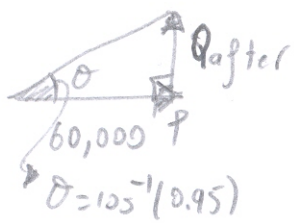
$S_{Total} = 118{,}106 + j\,91{,}485.$ $(S_L + S_{line})$

$$V_g = \frac{|S_{Total}|}{|I_L|} = \frac{|118106 + j91485|}{340.9} = 438.23 \text{ V (RMS)}$$

b)

$Q_{after} = 60{,}000 \cdot \tan(\cos^{-1}(0.95))$

$= 19721$ VARS.



$S_{combined\ load} = S_{com} = 60{,}000 + j\,19721$

$$|I_L| = \frac{|S_{com}|}{220} = \frac{63158}{220} = 287.08 \text{ A (RMS)}$$

$S_{line} = |I_L|^2\left(\frac{1}{2} + j\frac{2}{5}\right) = 41207 + j\,32966.$

$P_{0.5\Omega} = 41207$ Watts.

$S_{Total} = 101207 + j\,77966$

$$V_g = \frac{|101207 + j52687|}{287.08} = 397.45 \text{ V (RMS)}$$