First name:____________________

Last name: Solln

Student ID:____________________

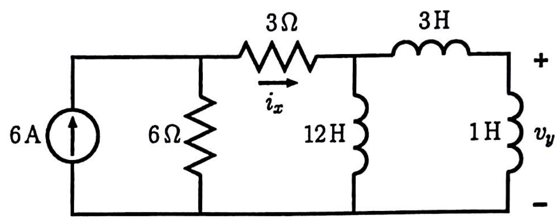
Signature:____________________

Read before you start:

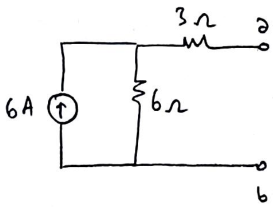
- There are four questions.
- The examination is closed-book.
- No computer/calculator is allowed.
- The duration of the examination is 120 minutes.
- Besides correctness, the CLARITY of your presentation will also be graded.

Q1	Q2	Q3	Q4	Total

Q1.



The initial inductor currents are zero in the above circuit. Find $i_x(t)$ and $v_y(t)$ for $t \geq 0$.



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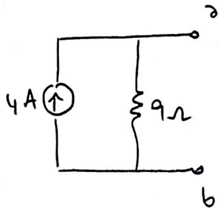
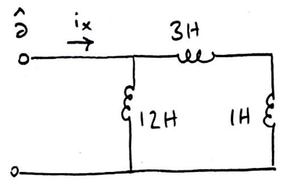
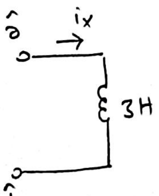




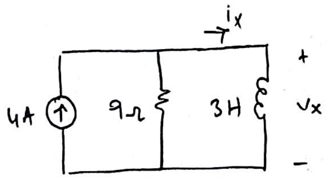
$i_x(0) = 0$

≡



$i_x(0) = 0$

Therefore we can work with



$i_x(0) = 0$

$\tau = \frac{L}{R} = \frac{3}{9} = \frac{1}{3}$ sec

$i_x(\infty) = 4A$

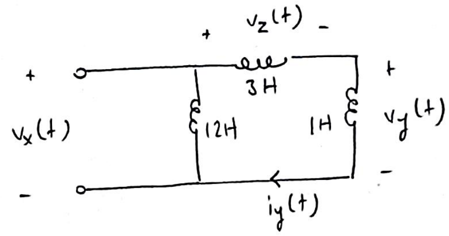
$\Rightarrow i_x(t) = i_x(\infty) + (i_x(0) - i_x(\infty))\, e^{-t/\tau}$

$= \boxed{4 - 4e^{-3t}\ A}$

Then $v_x(t) = L\,D i_x(t)$

$= 3 \frac{d}{dt}\{4 - 4e^{-3t}\} = 36e^{-3t}$ V

Now, we return to the original configuration



$v_y(t) = 1 D i_y(t)$

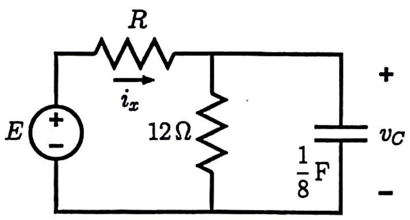
$v_z(t) = 3 D i_y(t)$

$\Big\} \; v_z(t) = 3 v_y(t)$

$v_x(t) = v_z(t) + v_y(t) = 4 v_y(t)$

$\Rightarrow v_y(t) = \frac{1}{4} v_x(t) = \boxed{9e^{-3t}\ V}$

Q2.

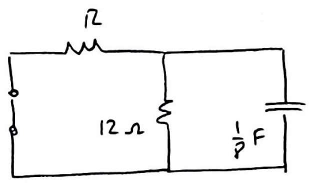


$i_x(t) = \frac{1}{2} + \frac{2}{3}e^{-2t}$ A

In the above circuit E is constant. Find R, E, and $v_C(0)$.

The time constant of the circuit is $\tau = \frac{1}{2}$ sec.

Now, τ is independent of the input. So, kill the voltage source.



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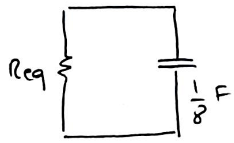
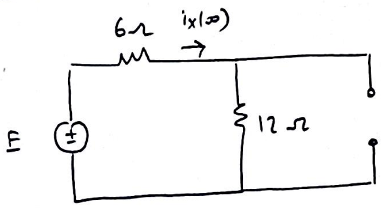


$R_{eq} = R \parallel 12$

$\tau = R_{eq} \cdot C \Rightarrow \frac{1}{2} = R_{eq} \cdot \frac{1}{8} \Rightarrow R_{eq} = 4\ \Omega$

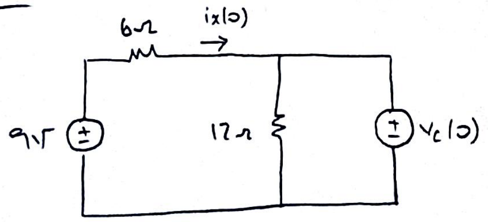
$\Rightarrow 12 \parallel R = 4 \Rightarrow \boxed{R = 6\ \Omega}$

$\underline{t = \infty}$



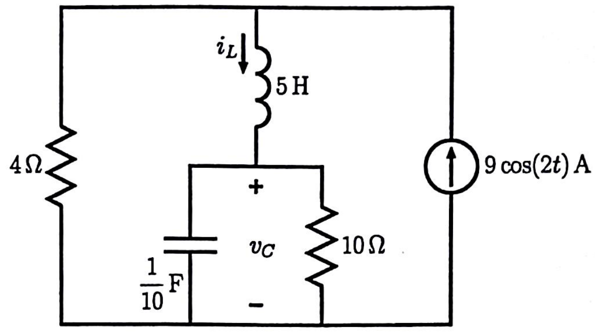
$i_x(\infty) = \frac{1}{2} = \frac{E}{6+12} \Rightarrow \boxed{E = 9V}$

$\underline{t = 0}$



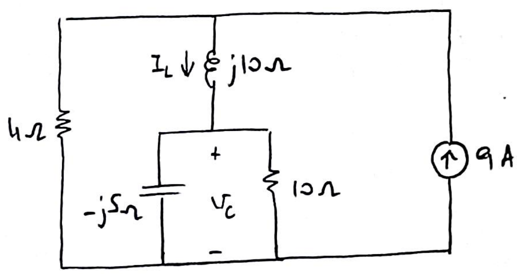
$i_x(0) = \frac{1}{2} + \frac{2}{3} = \frac{7}{6} = \frac{9 - v_c(0)}{6} \Rightarrow \boxed{v_c(0) = 2V}$

Q3.



The circuit above is in sinusoidal steady state. Find $i_L(t)$ and $v_C(t)$.

obtain the phasor-domain circuit [w = 2 rad/sec]



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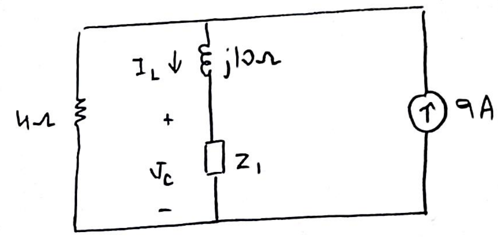
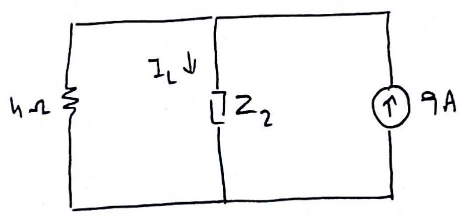


$$Z_1 = -j5 \parallel 10 = \frac{10(-j5)}{10-j5} = 2-j4\ \Omega$$

≡



$$Z_2 = Z_1 + j10 = 2+j6\ \Omega$$

By current division

$$I_L = \frac{4}{4+Z_2}\cdot 9 = \frac{4}{6+j6}\cdot 9 = 3-j3\ \text{A} \quad (1)$$

Then

$$V_C = Z_1 \cdot I_L = (2-j4)(3-j3) = -6-j18\ \text{V} \quad (2)$$

Now,

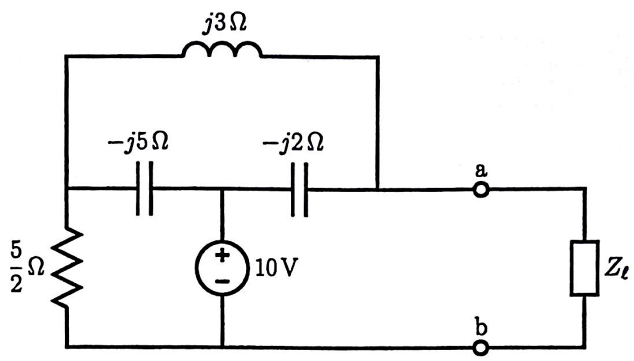
(1) => $I_L = 3\sqrt{2}\angle -\frac{\pi}{4}$ A

=> $\boxed{i_L(t) = 3\sqrt{2}\cos\left(2t - \frac{\pi}{4}\right)\ \text{A}}$

(2) => $V_C = 6\sqrt{10}\angle \pi + \tan^{-1}3$ V

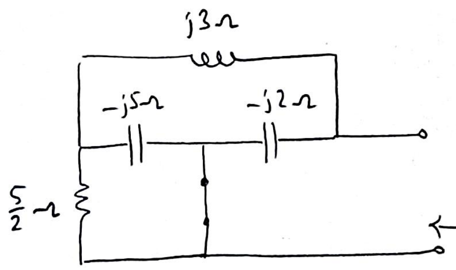
=> $\boxed{v_C(t) = 6\sqrt{10}\cos\left(2t + \pi + \tan^{-1}3\right)\ \text{V}}$

Q4.



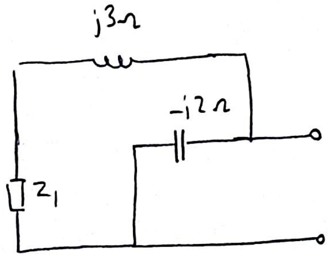
In the (phasor-domain) circuit above find the Thevenin equivalent circuit seen by the load impedance Z_ℓ.

Z_{th} (Kill the voltage source)



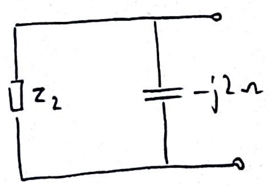
$Z_{in} = Z_{th}$

$\equiv$



$$Z_1 = -j5 \parallel \tfrac{5}{2} = \frac{-j5 \cdot \frac{5}{2}}{\frac{5}{2} - j5} = 2 - j\ \Omega$$

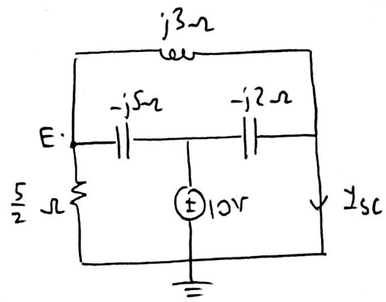
$\equiv$



$$Z_2 = Z_1 + j3 = 2 + j2\ \Omega$$

$$\Rightarrow Z_{th} = (2+j2) \parallel -j2 = \frac{-j2(2+j2)}{2} = \boxed{2 - j2\ \Omega}$$

Compute I_{sc}



$$\frac{E}{5/2} + \frac{E-10}{-j5} + \frac{E}{j3} = 0 \Rightarrow E = -\frac{3}{2} + j\frac{9}{2}\ V$$

$$\Rightarrow I_{sc} = \frac{E}{j3} + \frac{10}{-j2} = \frac{3}{2} + j\frac{11}{2}\ A$$

$$\Rightarrow V_{th} = Z_{th} I_{sc} = (2-j2)\left(\frac{3}{2} + j\frac{11}{2}\right) = \boxed{14 + j8\ V}$$

Hence, we have