20 pts total

(Normalize to 20 points possible)

\[ i = 0.1 \cos(5000t) \text{ A} \]
\[ V(t) = V_mH \cdot I_L = 5000 \cdot 0.1 \cdot 0.5 \cos(5000t) = 25\cos(5000t) \text{ V} \]

3 pts

\[ i(t) = 10 \mu A, \quad V(t) = -10 \mu A \cdot 2.5 \cos(5000t) = -25 \cos(5000t) \text{ V} \]
\[ i(t) = i_L + i_C = 0 \mu A, \text{ non-zero} \]

What this means is that adding a current source to a parallel LC circuit cannot yield \( I_L = 0.1 \cos(5000t) \)

Total energy is \( \frac{1}{2} \cdot (0.1A)^2 \cdot 4 \mu H = 0.02 mJ = \frac{1}{500} \cdot (2V)^2 \)

3 pts

a) Position 1: \( V_C = 2, I_L = 0 \)

b) Position 2: Normal LC circuit with \( w_0 = \frac{1}{LC} = \frac{1}{10000} = 10 \text{ sec} \)

\( V_C(t) = 2 \cos(10t), \text{ so } i_C(t) = i_C(0) \cdot \cos(10t) = -0.02 \sin(10t) \)

Or the long way:
\[ I_C = I_L \]
\[ \frac{I_C}{C} + L \frac{dI_C}{dt} = 0 \]
\[ \frac{I_C}{C} + L I_C'' = 0 \]
\[ I'' = -\frac{I_C}{LC} \Rightarrow s^2 = -\frac{1}{LC}, \quad s^2 = \frac{1}{LC} = \pm j w_0 \]

Use initial condition to find constants...

etc, etc as we did in lecture 12 (July 16th)
2 pts

\[ V(t) = \begin{cases} 
V_0 & t \leq 0 \\
0 & t > 0 
\end{cases} \]

\[ i(t) = \frac{V(t)}{10} \]

\[ v_0 = -\int_{0}^{t} i(t) \, dt = -\int_{0}^{t} \frac{V(t)}{10} \, dt = -10 \int_{0}^{t} V(t) \, dt \]

\[ 100 \cos (\theta) \]

\[ -10 \]

\[ (9.82 \times 10^7) (5 e^{30^\circ}) (e^{-j39^\circ}) (0.3 - j0.1) \]

\[ (10.63 \times 0.798) (5/30^\circ) (-j39^\circ) (0.3162 \times -0.3218) \]

\[ 16.8 \times 0.2541 \]

\[ 16.8 \times 13.79 \]

1 pt

for all sins

4.

Don't count off

for no work
5) \( 0.583 \times 1.03 \times 4 \times 0.87 \times (7 \times -0.349) \)
\[ 1.63 \times 1.185 \]
\[ 1.63 \times 2.667 \times 1.534 \]
\[ 2.7461 + 163.2436 \]

Note that with such an extreme angle, rounding errors can be pretty big, so full credit is given within a factor of 5.

Keep this in mind if you're doing some design problem someday.

b) \( (10 \times 0.8727) \times (12 \times 0.349) = 10 \times 2.2218 \)
\[ 3.4935 + 9.3972 \]

c) \( 10 \times 0.8727 \cdot \varepsilon \cdot w \)
\[ 10 \times (w + 0.8727) \]
\[ 10 \cos(w + 0.8727) \]

d) \( |E| e^{j(\theta + \omega t)} \)
\[ |E| \cos(\omega t + \theta) \]

Note this is not \( |E| e^{j\theta} \) another way to write \( |E| e^{j\theta} \) this has an extra stuck to it.
7. Zero-input response is \( v_c = 0 \). 

\[ a = \frac{R}{2L} = \frac{15}{8\pi} = 1.95 \times 10^{-6} \] 

\[ \omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-14}}} = 10^{-7} - 10^{-7} \] 

\[ \omega > \omega_0 \text{ so underdamped} \]

1 pt

5. 50 mV 

These could also be -500, 323 mV, -75 mV, etc.

5. -5 + 0 j  

[not 5 + 0.5 j]!!

1 pt

\[ z(t) = 3 \cos(2\omega t + 0.588) \]

1 pt

\[ Z_L = j\omega L = 100 \Omega \]

1 pt

\[ Z_{eq} = \left( (100 + 100j) \begin{array}{cc} 100j & 200j \\ 3 & 1000j \end{array} - 100j \right) + 100j \]

\[ (200j, -1000j) = 250j \]

\[ (200j, 100j) = 100j \]

\[ Z_{eq} = 100 + 100j \]

So, for example, \( Z_{eq} \) could also be

From much simpler
\[ \frac{5L_0}{100+100} = \frac{5L_0 \cdot 45^\circ}{200+45^\circ} = \frac{1}{20\Omega} \implies L = 45^\circ = \frac{1}{1} \]

d) \( i_s(t) = \frac{1}{20\Omega} \cos(100t - 45^\circ) \)

e) \( i_s(t) = \frac{1}{20\Omega} \cos(100t - 45^\circ) \)

f) \( i_s(t) = \frac{5V}{100 \cdot 2} = 50mA \) since inductors are shorts and caps are open

\[ \begin{align*}
Z_e & \rightarrow \text{zero (short)} \quad \text{as } w \rightarrow \infty \\
Z_e & \rightarrow \text{infinity (open)} \quad \text{as } w \rightarrow 0
\end{align*} \]

\( Z_e \rightarrow \text{infinity (open)} \) as \( w \rightarrow \infty \)
\( Z_e \rightarrow \text{zero (short)} \) as \( w \rightarrow 0 \)

\[ \lim_{u \to \infty} i_s(t) = \frac{5\cos(wt)}{100} \]

\( \text{Node A:} \quad V_a - \frac{5\cos(100t)}{200} + \frac{V_b + 200V_a}{100} = 0 \)

\( \text{Node B:} \quad 200V_a + 10V_b^+ + \frac{V_b}{100} - \frac{V_c}{100} = 0 \)

\( \text{Node C:} \quad \frac{V_c}{100} - \frac{V_b}{100} + \frac{V_d}{200} = 0 \)

\( \text{Node D:} \quad (V_d - V_c) / 100\mu F + V_d / 100\mu F = 0 \)
3 pts.

\[ V_a = 0 \] so \[ V_a(t) = 0 \cdot \cos(100t + \theta) = 0V. \]

b. Impedance of \( C_1 \) and \( L_1 \) is change.

Thus, \[ V = \frac{Z_{\text{right}}}{Z_{\text{right}} + 3} \cdot 5 \Omega \]

Zero if the numerator is zero or denominator is infinite.
$w = -100$ is the same thing as $w = 100$, so I guess that's kind of another $w$.

Then checking $w = 0$, we have: $7 = \frac{0}{\infty}$

Could use L'Hopital's rule, but better way is to abandon phasors since $V(t)$ is no longer AC if $w = 0$.

Thus we just consider:

![Diagram]

In steady state, $V_a(t) = 0$.

So $w = -100$ and $w = 0$ give same answer, but this one is same as $w = 100$.

It decays to zero. Increasing $R$ makes it hit steady state faster.

No time to write solutions for extra problems. email me* or come to office hours.

* At first, it seemed bizarre to write a personal message on a piece of paper to be read by other people. Then I remembered that all those scribes before us actually did this as a primary form of communication.