ESE 271 Second Exam Name:

Spring, 2002 ID Number:

Do not place your answers on this front page.

Prob. 1:

Prob. 2:

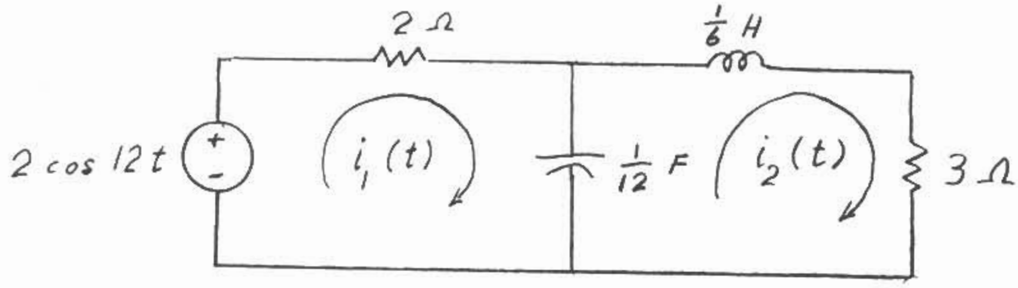
Prob. 3:

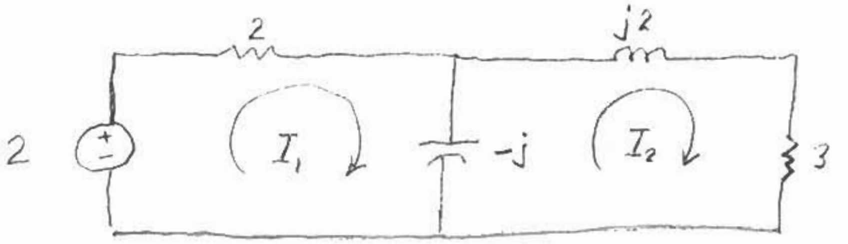
Prob. 4:

Prob. 1. (25 points):

Find the phasor for $i_1(t)$ by using Cramer's rule. Write your answer as a determinant over a determinant. You need not compute the determinants; just show the entries in the determinants as complex numbers in rectangular form.

(Write your answer neatly—otherwise, points may be taken off.)





$$\frac{1}{j\omega C} = -j\,\frac{1}{12\times\frac{1}{12}} = -j$$

$$j\omega L = j\times 12\times\frac{1}{6} = j2$$

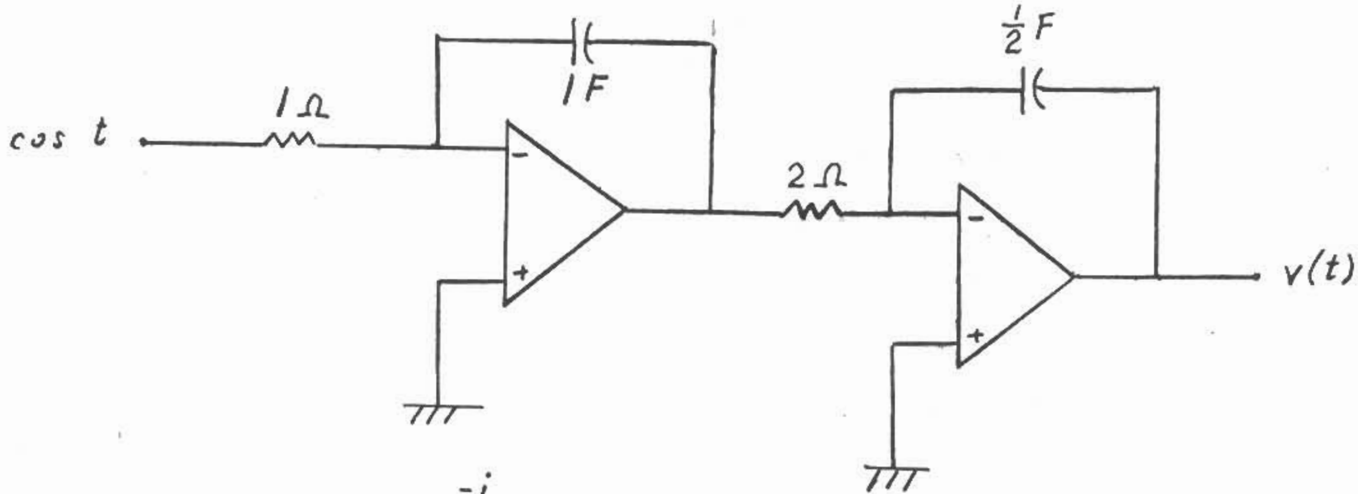
$$-2 + 2I_1 - j(I_1 - I_2) = 0 \Rightarrow (2-j)I_1 + jI_2 = 2$$

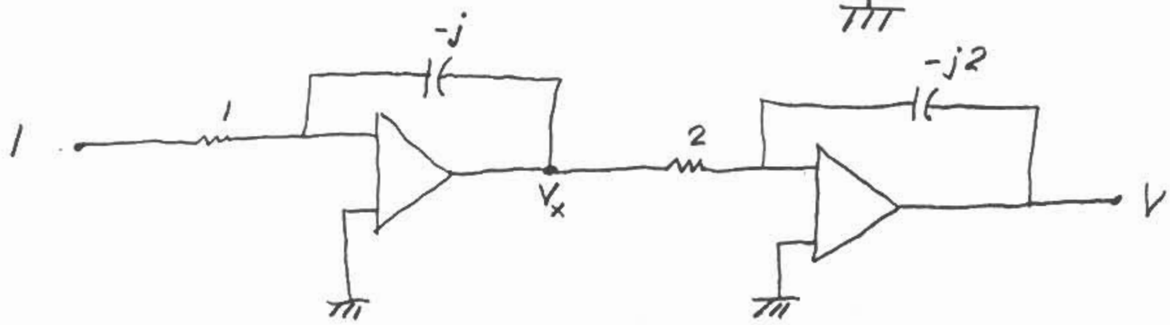
$$-j(I_2 - I_1) + (3+2j)I_2 = 0 \Rightarrow jI_1 + I_2(3+j) = 0$$

$$I_1 = \frac{\begin{vmatrix} 2 & j \\ 0 & 3+j \end{vmatrix}}{\begin{vmatrix} 2-j & j \\ j & 3+j \end{vmatrix}}$$

Prob. 2: (20 points):

Find $v(t)$ as a cosinusoidal function of time t.





$$\frac{1-0}{1} = \frac{0-V_x}{-j} \Rightarrow V_x = j$$

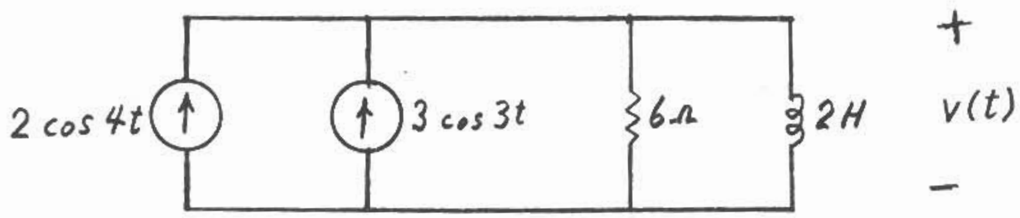
$$\frac{V_x-0}{2} = \frac{0-V}{-j2} \Rightarrow V_x = \frac{V}{j} \Rightarrow V = j\,V_x = j \times j = -1$$

So,

$$v(t) = -\cos t$$

Prob. 3: (30 points):

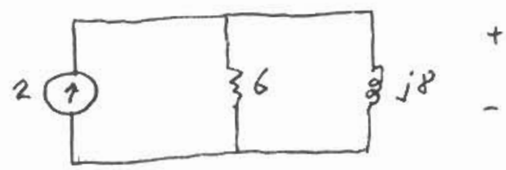
What is the RMS value of the voltage $v(t)$?



We must use superposition:

The 2 cos 4t source alone:

$\underline{\underline{\omega = 4}}$



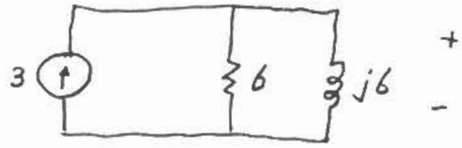
$$V = 2 \times \frac{(6)(j8)}{6+j8} = \frac{j48}{3+j4} = \frac{j48}{5\angle 53.1^\circ}$$

$$= 9.6 \angle 90^\circ - 53.1^\circ = 9.6 \angle 36.9^\circ$$

$$v(t) = 9.6 \cos(4t + 36.9^\circ)$$

The 3 cos 3t Source alone:

$\underline{\underline{\omega = 3}}$



$$V = 3 \times \frac{(6)(j6)}{6+j6} = \frac{j18}{1+j} = \frac{18\angle 90^\circ}{\sqrt{2}\angle 45^\circ}$$

$$= \frac{18}{\sqrt{2}} \angle 45^\circ$$

$$v(t) = 12.73 \cos(3t + 45^\circ)$$

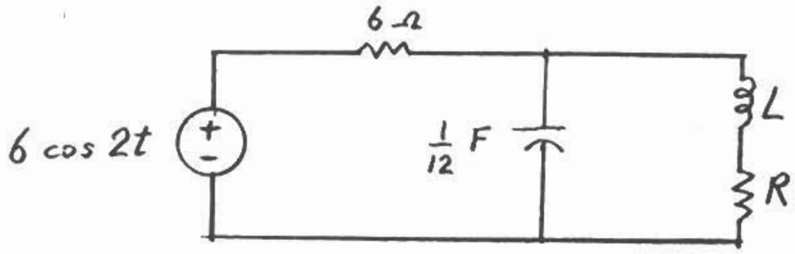
So,

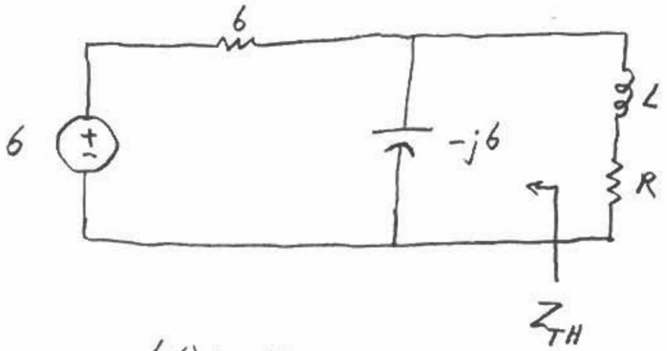
$$V_{rms} = \sqrt{\frac{(9.6)^2}{2} + \frac{(12.73)^2}{2}}$$

$$= \sqrt{127.08} = \underline{\underline{11.27 \text{ volts}}}$$

Prob. 4: (25 points):

For what values of L (in henries) and R (in ohms) will the power in R be a maximum? (You need not state what that maximum power is.)





$$\frac{1}{j\omega C} = -j\,\frac{1}{2\times\frac{1}{12}} = -j6$$

$$Z_{TH} = \frac{(6)(-j6)}{6-j6} = \frac{-j6}{1-j} \times \frac{1+j}{1+j} = \frac{6-j6}{2} = 3-j3$$

WE NEED: $R + j\omega L$ = COMPLEX CONJUGATE OF Z_{TH}

$$R + j\,2L = 3 + j3$$

So,

$$R = 3\ \Omega$$

$$\omega L = 3 \implies L = \frac{3}{2}\ H.$$