ESE 271 Second Exam Name:

Spring, 2003 ID Number:

Do not place your answers on this front page.

Prob. 1 (20 points):

Prob. 2 (35 points):

Prob. 3 (25 points):

Prob. 4 (10 points):

Prob 5: (10 points):

Prob. 1 (20 points):

Find the single cosinusoid that is equal to

$$4\cos(3t - 30^\circ) + 5\sin(3t + 45^\circ)$$

$f(t) = 4\cos(3t - 30^\circ) + 5\cos(3t + 45^\circ - 90^\circ)$

$F = 4\angle -30^\circ + 5\angle -45^\circ$

$= 4\cos 30 - 4j\sin 30 + 5\cos 45 - j5\sin 45$

$= 3.464 - j2 + 3.536 - j3.536$

$= 7 - j5.536$

$= \sqrt{7^2 + 5.536^2}\,\angle \tan^{-1}\frac{-5.536}{7}$

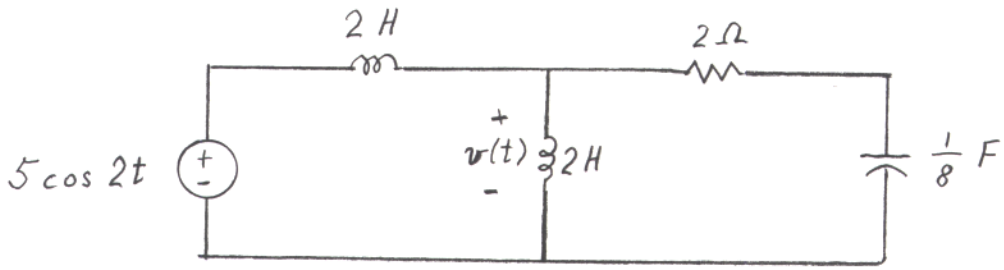
$= 8.92\angle -38.3^\circ$

$f(t) = 8.92\cos(3t - 38.3^\circ)$

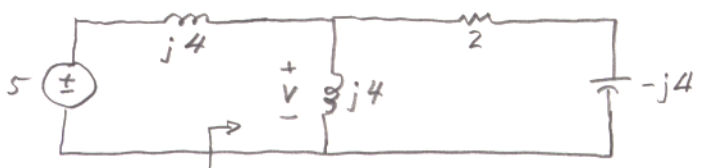
Prob. 2 (35 points):

Find the phasor voltage V for the cosinusoid voltage $v(t)$.

(Your answer must be as a single complex number, but you may give it either in rectangular or polar form.)



ONE SOLUTION:

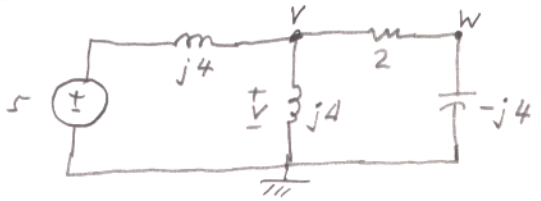


$$Z_1 = \frac{j4\,(2-j4)}{j4+2-j4} = 8+j4$$

So, $$V = 5\,\frac{Z_1}{Z_1+j4} = 5\,\frac{8+j4}{8+j4+j4} = 3.75-j1.25$$

$$= 3.95\angle -18.4^\circ$$

ANOTHER SOLUTION: DO A NODAL ANALYSIS



$$\frac{V-5}{j4} + \frac{V}{j4} + \frac{V-W}{2} = 0 \quad \Rightarrow \quad (2+j2)V - j2W = 5$$

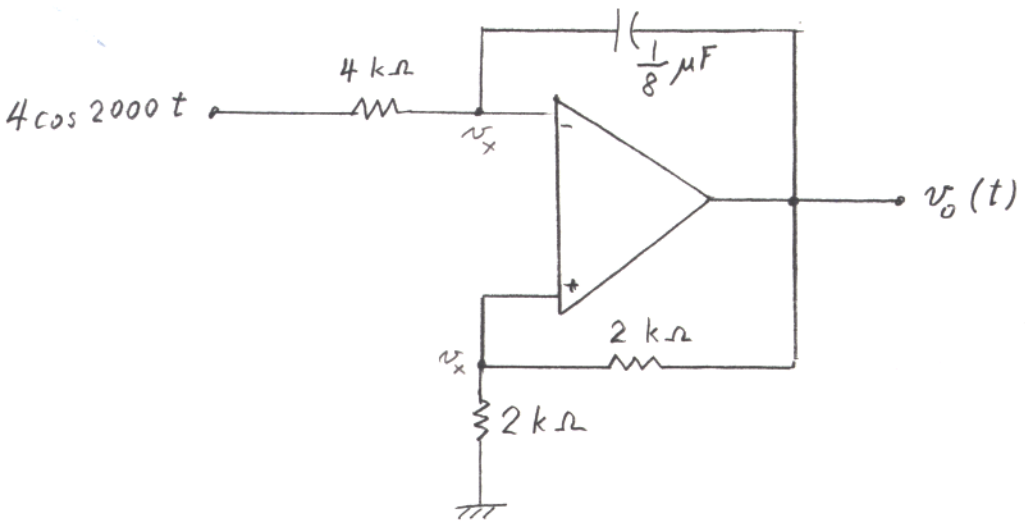
$$\frac{W-V}{2} + \frac{W}{-j4} = 5 \quad \Rightarrow \quad W = \frac{-j2V}{1-j2}$$

$$(2+j2)V - j2\,\frac{-j2V}{1-j2} = 0$$

$$V = 3.75 - j1.25 = 3.95\angle -18.4^\circ \quad \checkmark$$

Prob. 3 (25 points):

Find the output voltage $v_0(t)$ as a cosinusoid.



$$\frac{1}{j\omega C} = -j\frac{1}{2000\times\frac{1}{8}\times 10^{-6}} = -j4\ k\Omega$$

$$V_x = \frac{V_o}{2}$$

$$\frac{V_x - 4}{4} + \frac{V_x - V_o}{-j4} = 0$$

$$V_x - 4 + jV_x - jV_o = 0$$

$$\frac{V_o}{2} + j\frac{V_o}{2} - jV_o = 4$$

$$V_o(1-j) = 8$$

$$V_o = 4\sqrt{2}\angle 45^\circ$$

$$v_o(t) = 4\sqrt{2}\cos(2000t + 45^\circ)$$

$$= 5.66\cos(2000t + 45^\circ)$$

Prob. 4 (10 points):

Find the effective value I_{rms} for $i(t)$.

$$i(t) = 2 + 3\cos(2t + 30°) + 4\cos(5t - 45°)$$

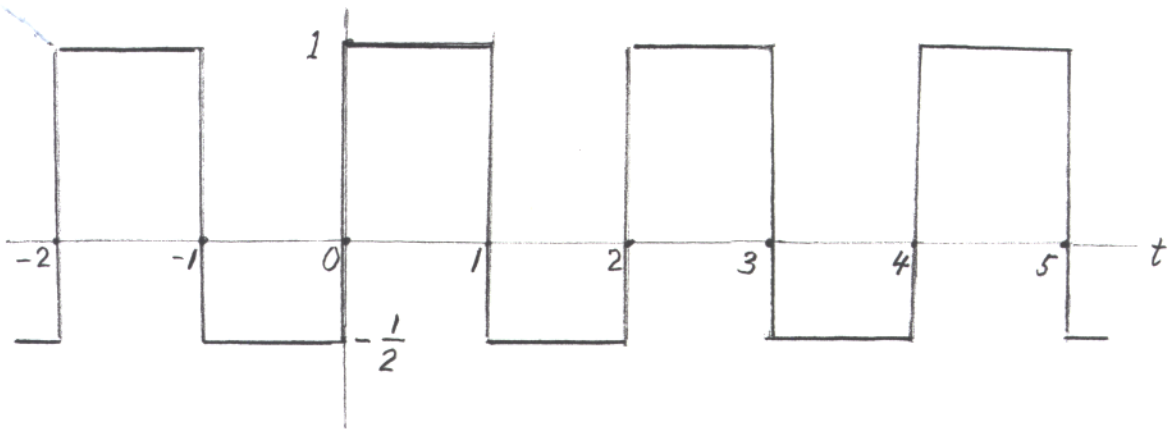
$$I_{rms} = \sqrt{2^2 + \frac{3^2}{2} + \frac{4^2}{2}}$$

$$= \sqrt{16.5}$$

$$= 4.06$$

Prob. 5 (10 points):

Find the effective value I_{rms} for the following periodic wave.



$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i(t)^2\,dt}$$

$$= \sqrt{\frac{1}{2}\left(\int_0^1 1^2\,dt + \int_1^2 \left(-\tfrac{1}{2}\right)^2 dt\right.}$$

$$= \sqrt{\frac{1}{2}\left(1+\frac{1}{4}\right)}$$

$$= .7906$$