ESE 271 Second Exam Name:

Fall, 2009 ID Number:

Do not place your answers on this front page.

Each problem is worth 25 points.

Prob. 1:

Prob. 2:

Prob. 3:

Prob. 4:

2nd exam

**Prob. 1:**

(a) (7 points) Find the single cosinusoid that equals

$$2\sin 2t + 4\cos(2t + 30^\circ)$$

(b) (8 points) Find the single cosinusoid whose phasor is equal to

$$2\sqrt{2}\angle 45^\circ - 4\angle -60^\circ$$

(Here, $\omega = 2$ again.)

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(a) $= 2\cos(2t - 90^\circ) + 4\cos(2t + 30^\circ)$

$\rightarrow 2\angle -90^\circ + 4\angle 30^\circ$

$= -j2 + 4\cos 30^\circ + j4\sin 30^\circ$

$= -j2 + 3.464 + j2$

$= 3.464$

$\rightarrow 3.464\cos 2t$

(b) $= 2 + j2 - 4\cos(-60^\circ) - 4j\sin(-60^\circ)$

$= 2 + j2 - 2 + 4j(.866)$

$= j2 + j3.464$

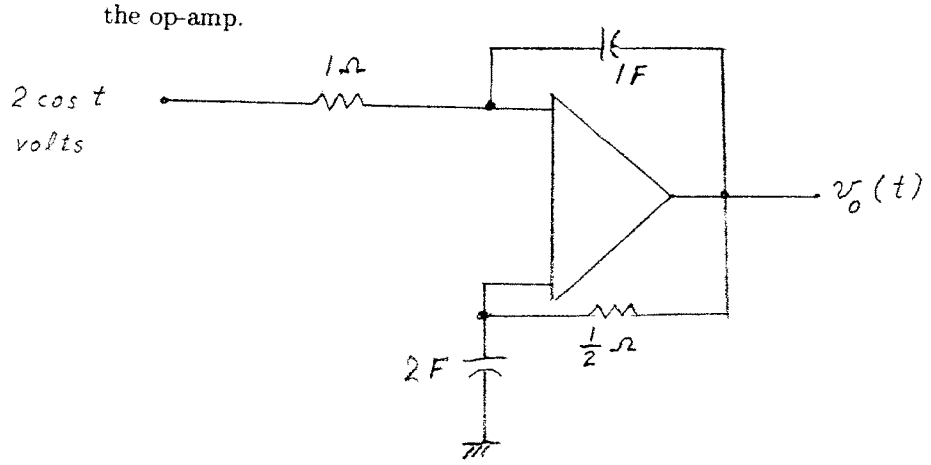
$= j5.464$

$\rightarrow 5.464\cos(2t + 90^\circ)$

2nd exam

**Prob. 2:**

Find $v_o(t)$ as a cosinusoidal function of time $t$. Use the virtual-short virtual-open model for the op-amp.

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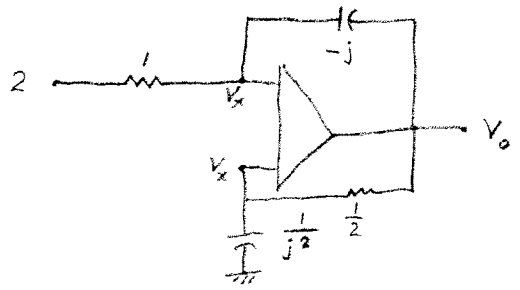



← The phasor circuit

At upper $V_x$ node: $\frac{2 - V_x}{1} + \frac{V_o - V_x}{-j} = 0$

$$-(1+j)V_x + jV_o = -2$$

At lower $V_x$ node:

$$V_x = V_o \frac{\frac{1}{j^2}}{\frac{1}{j^2} + \frac{1}{2}} = V_o \frac{1}{1+j}$$

Combine the equations:

$$-(1+j)\frac{V_o}{1+j} + jV_o = -2$$

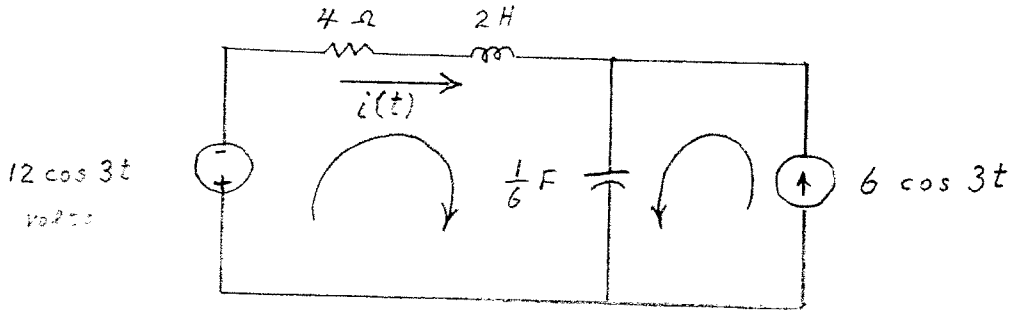
$$V_o = \frac{2}{1-j} = \frac{2}{\sqrt{2}\angle -45^\circ} = \sqrt{2}\angle 45^\circ$$

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

2nd exam

**Prob. 3:**

Using a mesh analysis, determine the current $i(t)$ as a cosinusoid. (Warning: Be careful of the polarity of the voltage source.)

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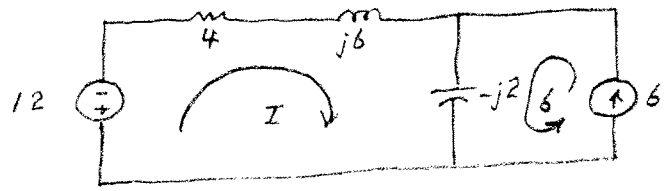
Phasor circuit:




KVL: $12 + (4 + j6)I - j2(I + 6) = 0$

$I(4 + j4) = -12 + j12$

$I\, 4\sqrt{2}\, \angle 45^\circ = 12\sqrt{2}\, \angle 135^\circ$

$I = 3 \angle 90^\circ$

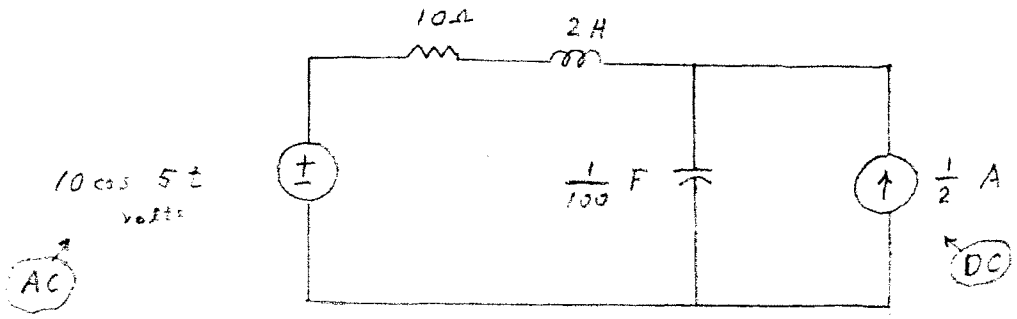
Therefore,

$i(t) = 3 \cos(3t + 90^\circ)$ (Also, $i(t) = -3 \sin 3t$)

2nd exam

**Prob. 4:**

What is the average power dissipated in the 10Ω resistor. The circuit is in a steady-state condition.

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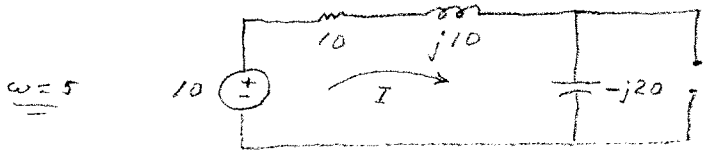
Use superposition:

AC source alone:

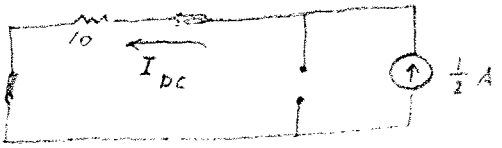



$$I = \frac{10}{10 - j10} = \frac{1}{\sqrt{2}\angle -45^\circ} = \frac{1}{\sqrt{2}}\angle 45^\circ$$

$$i(t) = \frac{1}{\sqrt{2}}\cos(5t + 45^\circ)$$

$$P_{av,AC} = \frac{I_m^2 R}{2} = 2.5\ W$$

DC source alone:




$$I_{DC} = \frac{1}{2}\ A$$

$$P_{av,DC} = I_{DC}^2 R = 2.5\ W$$

Both sources acting simultaneously:

$$P_{av,\,total} = 5\ W$$