ESE 271 Second Exam Name:

Fall, 2008 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:

Prob. 1:

Find the single cosinusoid $A_m \cos(3t + \phi)$ that is equal to

$$5\cos(3t + 30°) - 8\sin(3t + 135°)$$

That is, determine A_m and ϕ.

(You may work to four significant figures with your numbers.)

$5\cos(3t + 30°) + 8\cos(3t + 135° + 90°)$

$\downarrow$

$5\angle 30° + 8\angle 225°$

$= 5\cos 30° + j5\sin 30° + 8\cos 225° + j8\sin 225°$

$= 4.330 + j2.500 - 5.657 - j5.657$

$= -1.327 - j3.157$

$= 3.425\angle 247.2° = 3.425\angle -112.8$

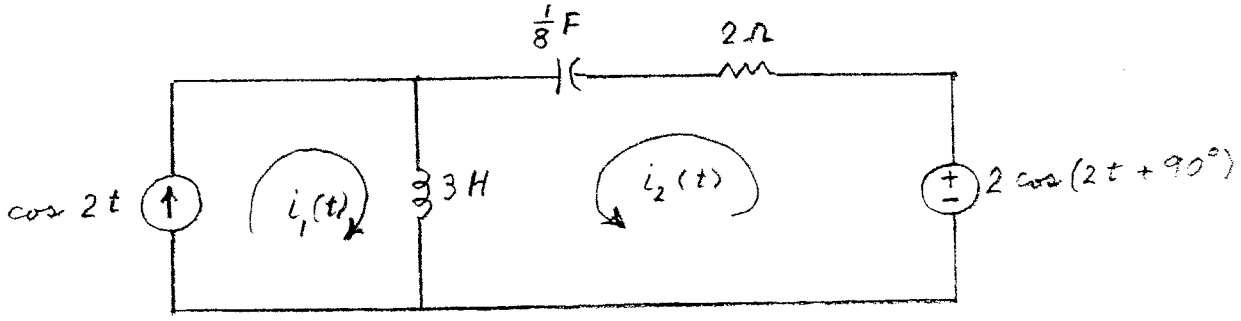
THUS,

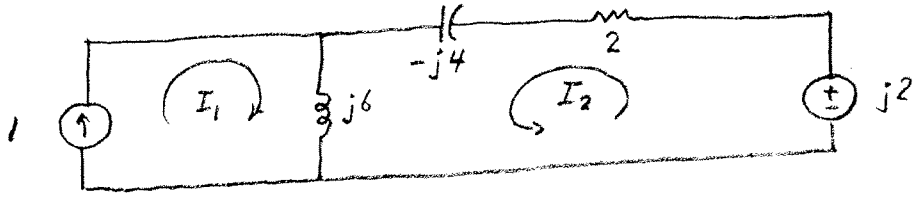
$A_m = 3.42$

$\varphi = 247.2°$ OR $\varphi = -112.8°$

Prob. 2:

Do a mesh analysis using the mesh currents shown to determine $i_2(t)$ as a cosinusoid.





$I_1 = 1$

KVL AROUND I_2 MESH:

$$-j2 + (2-j4)I_2 + (I_1 + I_2)j6 = 0$$

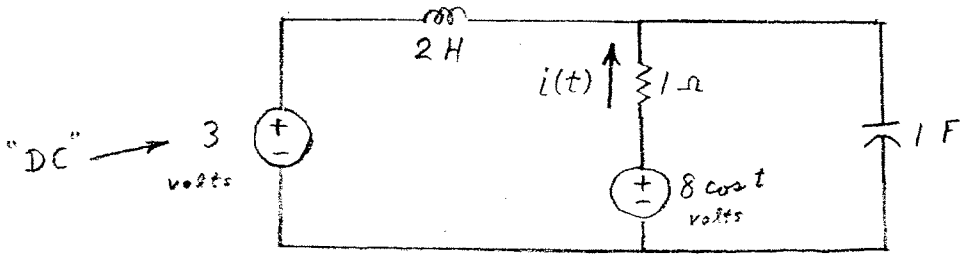
$$I_2 = \frac{-j2}{1+j} = \sqrt{2}\angle -135^\circ$$

So,

$$i_2(t) = \sqrt{2}\cos(3t - 135^\circ)$$

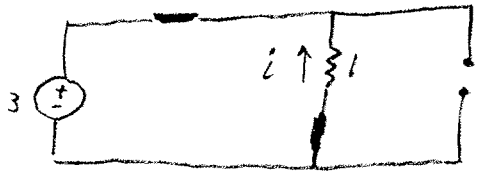
Prob. 3:

Find the effective value of the current $i(t)$ in the 1 Ω resistor.



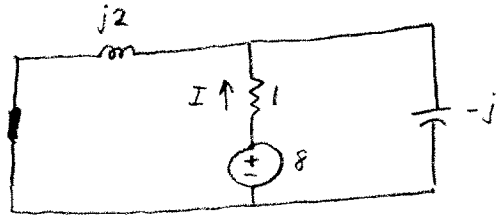
By SUPERPOSITION:

FOR THE 3 V SOURCE ALONE:



$i = -3$ A

FOR THE 8 cos t SOURCE ALONE



$$I = \frac{8}{1 + \frac{(j2)(-j)}{j^2 - j}} = \frac{8}{1 - j2} = \frac{8}{\sqrt{5}} \angle\theta$$

$\left(\theta = -\tan^{-1}\frac{-2}{1}\right)$

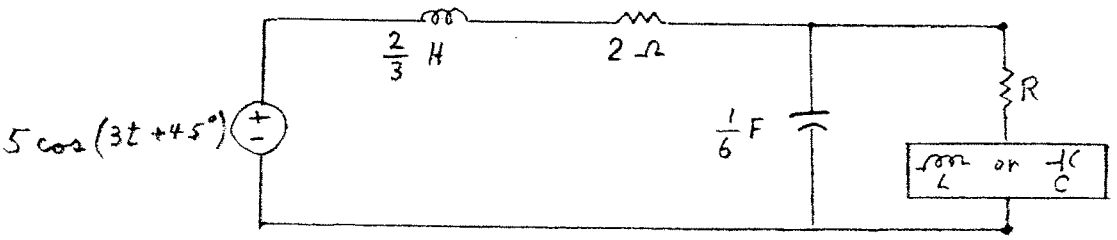
(WE DO NOT NEED θ)

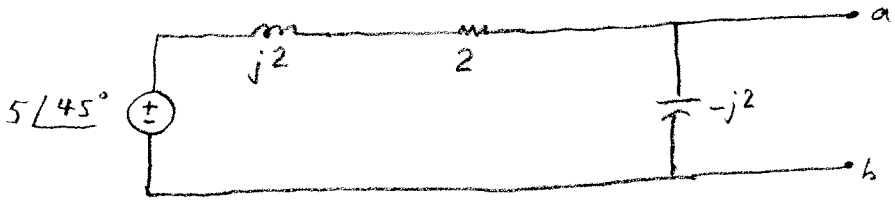
$$I_{eff} = \sqrt{(-3)^2 + \frac{(8/\sqrt{5})^2}{2}} = 3.924 \text{ A}$$

Prob. 4:

(a) Find R and either L or C to maximize the dissipated power P in R.

(b) What is that maximum power P_{max}?



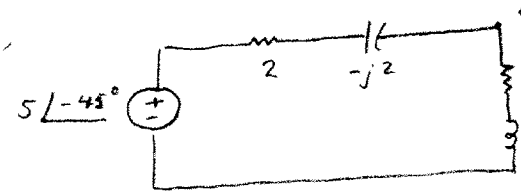


AS SEEN FROM TERMINALS a AND b:

$$V_{oc} = 5\angle 45° \frac{-j2}{j2+2-j2} = 5\angle -45°$$

$$Z_{TH} = \frac{(-j2)(2+j2)}{-j2+2+j2} = 2-j2$$

So,



WE MUST HAVE AN INDUCTOR HERE IN ORDER TO MAXIMIZE.

$$L = \frac{2}{3} H$$

FINALLY,

$$P_{MAX} = \frac{|V_{oc}|^2}{4R} = \frac{25}{8} W$$

$$= 3.125 W$$