EE110 Winter 2006 MT#2

Name Solution | ________
LAST FIRST

Student I.D. ____________

DO NOT OPEN UNTIL INSTRUCTED TO DO SO.

- We will copy some graded exam papers for archival purposes!
- Put your name in the blank on EVERY page.
- Show your setup.
- Circle your answers.
- Add notes to help the graders determine your intentions.

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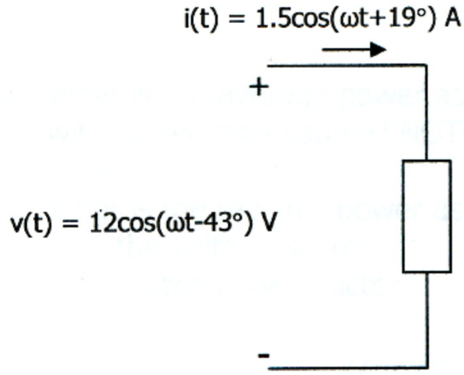
1. (15/100)



a. What is the instantaneous power associated with this circuit element?
b. Is the element absorbing or providing reactive power?

a. $p(t) = +v(t)i(t) = \frac{(12)(1.5)}{2}\cos(-43-19) + \frac{(12)(1.5)}{2}\cos(-43-19)\cos 2\omega t$

$- \frac{(12)(1.5)}{2}\sin(-43-19)\cos 2\omega t$

$= 9\cos(-62^\circ) + 9\cos(-62^\circ)\cos 2\omega t - 9\sin(-62^\circ)\sin 2\omega t$

$p(t) = 4.225 + 4.225\cos 2\omega t + 7.997\sin 2\omega t$

b. ~~Absorbing~~, because Q is −.
Providing

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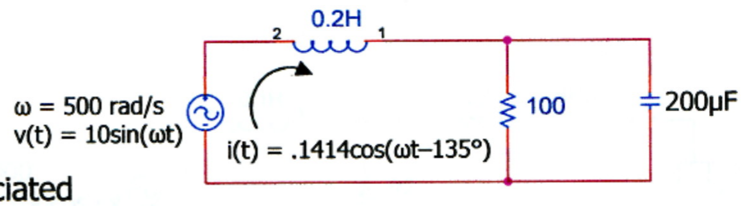
2. (20/100)



a. What is the average power associated with the voltage source? NOTE the sine!
b. What is the reactive power associated with the voltage source?
c. What is the Power Factor?

$v(t) = 10 \sin \omega t; \ \underline{V} = 10 \angle -90^\circ$

a. $P = -\frac{V_m I_m}{2} \cos(\phi_v - \phi_i) = -\frac{(10)(.1414)}{2} \cos(-90-(-135)) = -0.707 \cos 45^\circ$

$P = -0.5W$

b. $Q = -\frac{V_m I_m}{2} \sin(\phi_v - \phi_i) = 0.707 \sin 45^\circ = 0.5W$

c. $pf = \cos(\phi_v - \phi_i) = \cos 45^\circ = 0.707$

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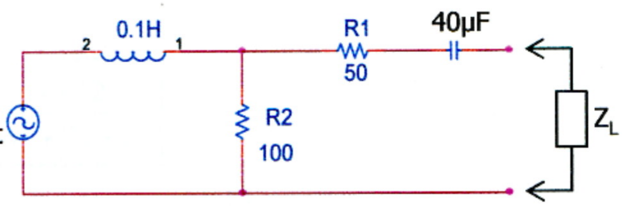
3. (40/100)

Assuming that Z_L can be set to any complex value, what is the maximum power that can be delivered to Z_L?

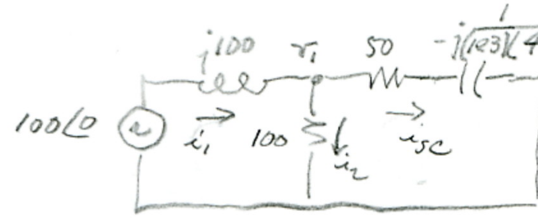
$\omega = 1000$
$v_s(t) = 100\cos \omega t$



Find Thev Eq

$$V_{th} = v_s(t) \frac{100}{j1000(.1)+100} = 100\angle 0\,(.5-j.5) = 50-j50 = 50\sqrt{2}\angle -45^\circ$$

$$-j\frac{1}{(1e3)(40e-6)} = -j25$$



$$\frac{100\angle 0 - v_1}{j100} = \frac{v_1}{100} + \frac{v_1}{50-j25}$$

$$i_{sc} = \frac{v_1}{50-j25}$$

$$\frac{100}{j100} = \frac{v_1}{j100} + \frac{v_1}{100} + \frac{v_1}{50-j25} = v_1(-j.01 + .01 + .016 + j.008) = v_1(.026 - j.002)$$

$$v_1 = \frac{-j1}{.026-j.002} = 2.941 - j38.235$$

$$i_{sc} = \frac{2.941 - j38.235}{50-j25} = 0.353 - j0.588$$

$$Z_{th} = \frac{V_{th}}{i_{sc}} = \frac{50-j50}{0.353-j0.588} = 100+j25$$

$$Z_{MPT} = 100 - j25$$

$$P_{max} = \frac{1}{8}\frac{V_{th\,max}^2}{R_L} = \frac{1}{8}\frac{(50\sqrt{2})^2}{100} = \frac{5000}{800} = 6.25W$$

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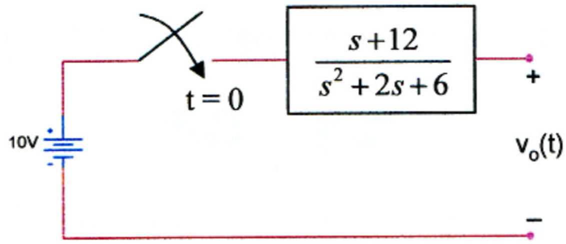
4. (10/100)



The output voltage in the s-domain $V_o(s)$ is described by the following expression: $$V_o(s)=\left(\frac{10}{s}\right)\left(\frac{s+12}{s^2+2s+6}\right)$$

Find the final value of $v_o(t)$.

$$FV=\lim_{s\to 0} sV_o(s)=\lim_{s\to 0} s\left(\frac{10}{s}\right)\left(\frac{s+12}{s^2+2s+6}\right)=20$$

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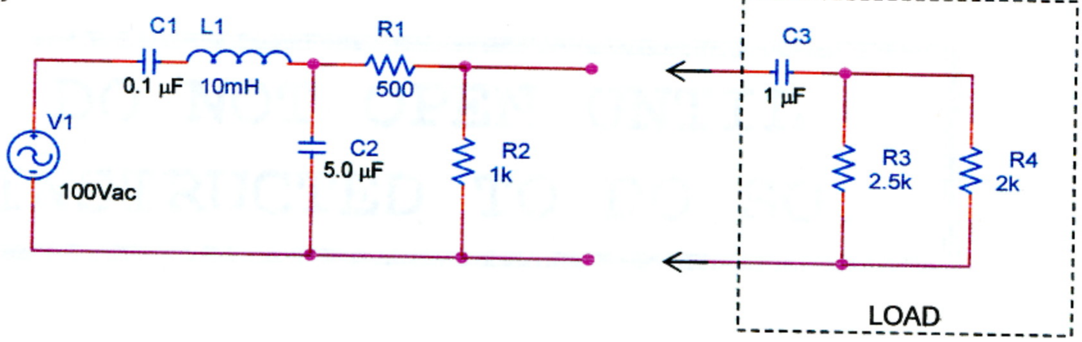
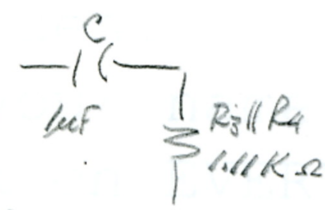
5. (15/100)



Assume that the designer wishes to manipulate the components in the load to maximize the power transfer to the load. Does the assumption in the text about the independence of R_L and X_L hold for this load? Explain how you arrived at your answer.

The assumption holds because the load can be represented by



, so $Z_L = (R_3 \| R_4) - j\frac{1}{\omega C}$.

If R_3 or R_4 changes, it does not affect the load reactance. If C changes, it does not affect the load resistance.