Name _____

ECE 201

Final Exam

August 5, 2009

By signing below, I certify that the work submitted on this examination is my own, and that I have adhered to fair standards of academic honesty. **This exam is void unless signed.**

_____

signature

Instructions

a) Write your name on the front page ONLY.

b) **Show all your work** for the following problems so that partial credit can be assigned. Cross out clearly any work which is to be disregarded. Be certain that the answer is distinguishable from the work. Unsupported answers will not be given credit unless otherwise indicated.

c) Extra paper is available if needed. Be sure to label the problem number for each page of your work.

d) Use units where required. **Answers without units are incomplete**, and cannot be assigned full credit.

e) Be sure that your work, and discussions and explanations when requested, are clear, concise, and organized.

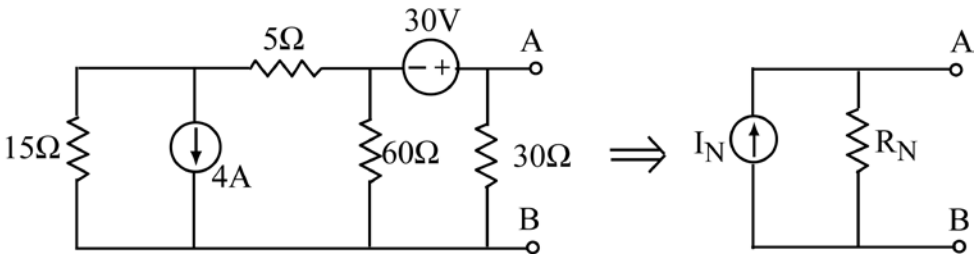
f) Potentially useful formulas are listed on the final page of this exam.

g) The point distribution on this exam is as follows:

		Score		
Prob. 1	20 Pts.		Sum 1-10	Outcome #1 (≥100 pts.?) ☐ Yes ☐ No
Prob. 2	20 Pts.		Sum 2, 6	Outcome #2 (≥20 pts.?) ☐ Yes ☐ No
Prob. 3	20 Pts.		Sum 1, 2	Outcome #3 (≥20 pts.?) ☐ Yes ☐ No
Prob. 4	20 Pts.		Prob. 4	Outcome #4 (≥10 pts.?) ☐ Yes ☐ No
Prob. 5	20 Pts.		Sum 6, 7	Outcome #5 (≥20 pts.?) ☐ Yes ☐ No
Prob. 6	20 Pts.		Sum 8, 9a	Outcome #6 (≥7 pts.?) ☐ Yes ☐ No
Prob. 7	20 Pts.		Prob. 9	Outcome #7 (≥15 pts.?) ☐ Yes ☐ No
Prob. 8	10 Pts.		Prob. 10	Outcome #8 (≥10 pts.?) ☐ Yes ☐ No
Prob. 9	30 Pts.		Prob. 5	Outcome #9 (≥10 pts.?) ☐ Yes ☐ No
Prob. 10	20 Pts.			
Total Score	200 Pts.			

(20 Pts.)

1. Reduce the circuit on the left to its Norton equivalent.

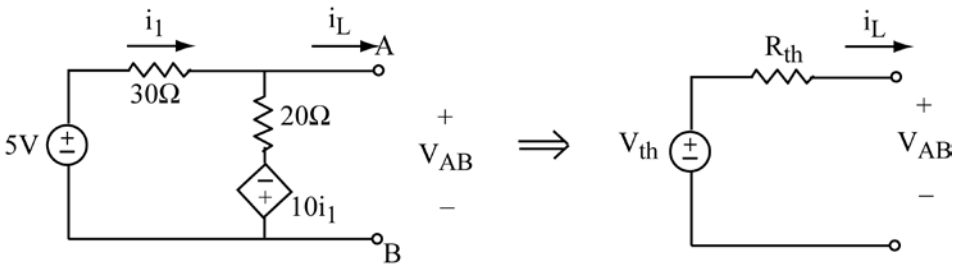


I_N =

R_N =

(20 Pts.)

2. Determine the Thévenin equivalent of the following network:

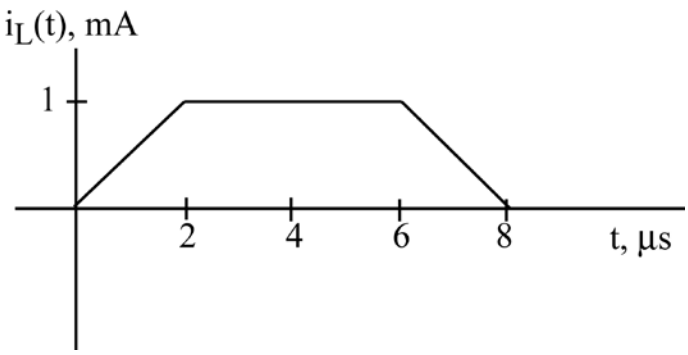


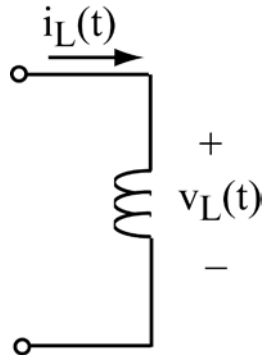
V_{th} =

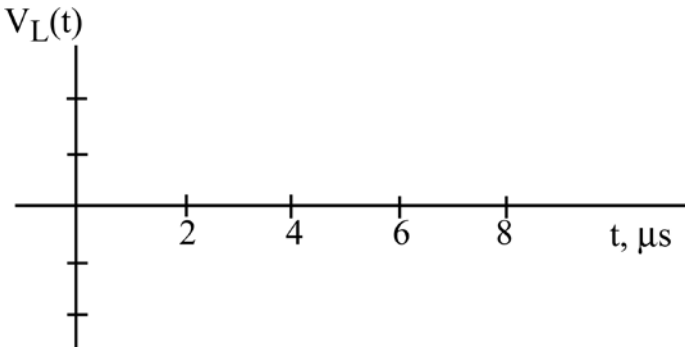
R_{th} =

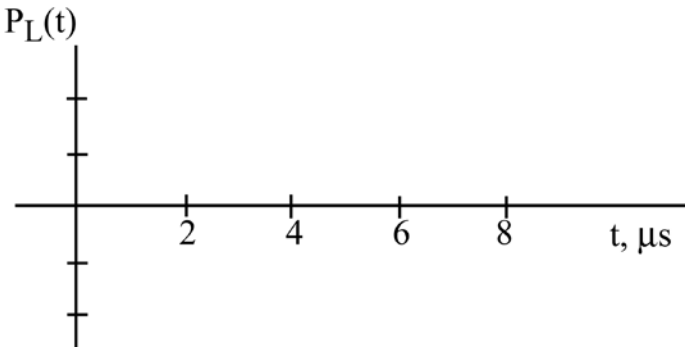
(20 Pts.)

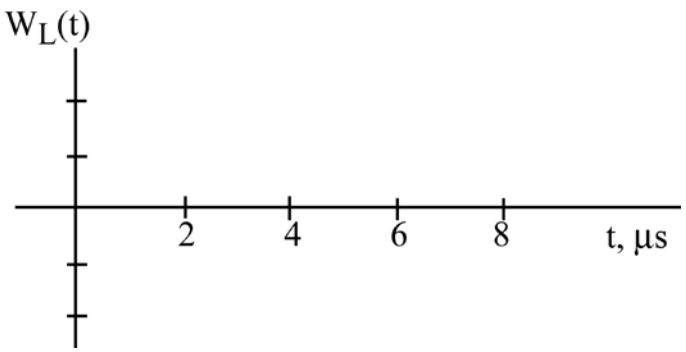
3. The current through a 4mH inductor is shown in the first plot. Determine and plot the voltage $V_L(t)$, the power absorbed by the inductor, $P_L(t)$, and the energy stored by the inductor, $W_L(t)$. Label the axes.







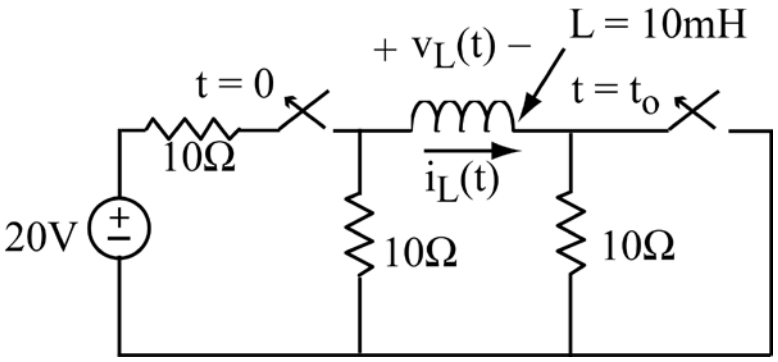




(20 Pts.)
4. In the following circuit, switches S_1 and S_2 have been closed for a long time. S_1 opens at t = 0, and switch S_2 opens at $t = t_o = 0.693$ms. Determine the voltage $V_L(t)$ for

(a) $0 < t < t_o$ and for

(b) $t > t_o$.

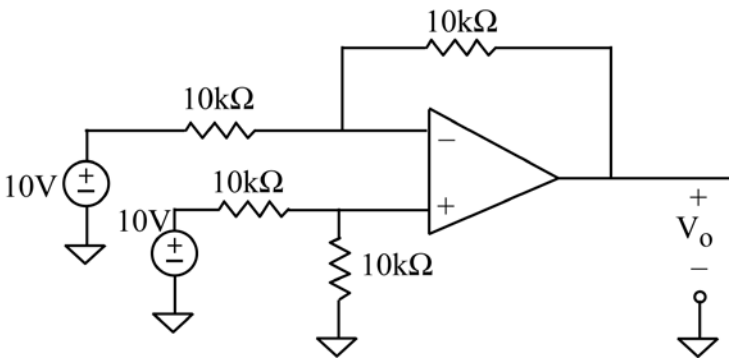


$V_L(t) =$	$0 < t < t_o$

$V_L(t) =$	$t > t_o$

(20 Pts.)

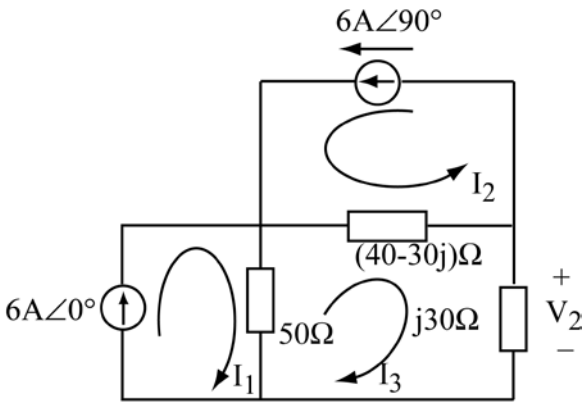
5. For the following ideal op amp circuit, determine the output voltage V_o.



V_o =

(20 Pts.)

6. a) In the following circuit, use mesh analysis to determine the mesh current $\mathbf{I}_3$.



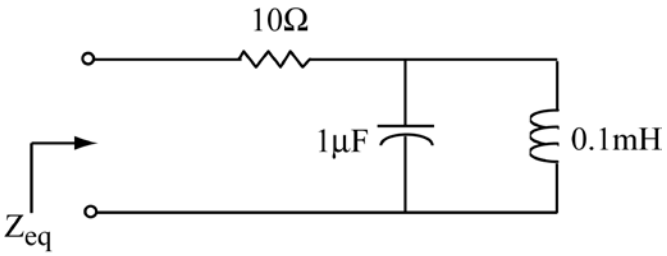
$\mathbf{I}_3$ =

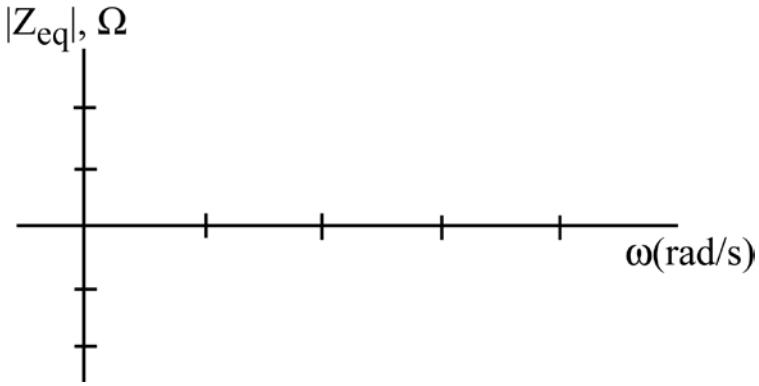
b) Find $\mathbf{V}_2$.

$\mathbf{V}_2$ =

(20 Pts.)

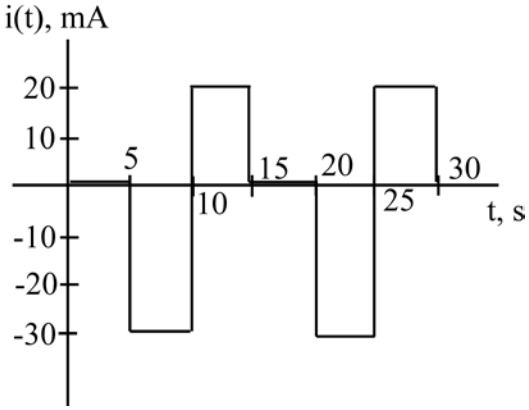
7. Determine $\left|Z_{eq}(\omega)\right|$ for the following network. Plot your result on the graph for $\omega > 10^3$. Label both axes.





(10 Pts.)

8. A periodic current through a resistor R = 10Ω is shown in the plot.



a) Determine the average current $\overline{i(t)}$.

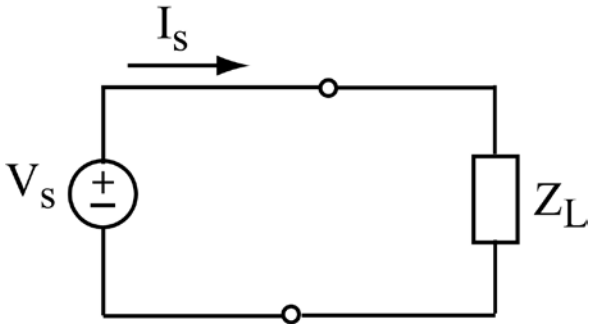
$\overline{i(t)}$ =

b) Determine the effective value of the current.

I_{eff} =

(30 Pts.)

9. A voltage $V_s = 100V_{rms}\angle 0°$ is applied to a load $Z_L = 100\Omega + j60\Omega$, as shown.



a) Determine $v_s(t)$.

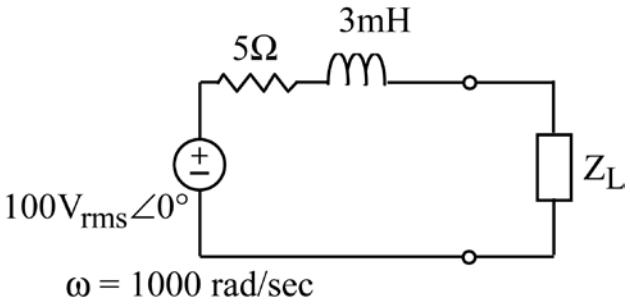
b) Determine the source current $\mathbf{I}_s$ (effective value). Express your answer in magnitude/phase form.

c) Determine the complex power delivered to the load.

d) Determine the power factor of the load.

e) Determine the impedance Z_{add} which, when connected in parallel with the load, will increase the power factor to 1.0.

(20 Pts.)
10.



a) Determine the load impedance Z_L that absorbs the maximum average power from the source.

Z_L =

b) What is the maximum average power delivered to the load?

P_{max} =

Useful formulas

$$x(t) = x(\infty) + \left[x(t_o^+) - x(\infty) \right] e^{-\left(t - t_o^+\right)/\tau}$$

$\tau = L/R$

$\tau = RC$

$$x(t) = x(\infty) + \left(A\cos\omega_d t + B\sin\omega_d t \right) e^{-\sigma t}$$

$$x(t) = x(\infty) + \left(A + Bt \right) e^{-\sigma t}$$

$$x(t) = x(\infty) + \left(Ae^{s_1 t} + Be^{s_2 t} \right)$$

$$\sigma = \begin{cases} R/2L & \text{(series)} \\ \dfrac{1}{2RC} & \text{(parallel)} \end{cases}$$

$$s_{1,2} = -\sigma \pm \sqrt{\sigma^2 - \omega_o^2}$$

$$s_1, s_2 = \frac{-b \pm \sqrt{b^2 - 4c}}{2} \text{ for } s^2 + bs + c = 0$$

$$\omega_d = \frac{\sqrt{4c - b^2}}{2} = \sqrt{\omega_o^2 - \sigma^2}$$

$$\omega_o = 1/\sqrt{LC}$$