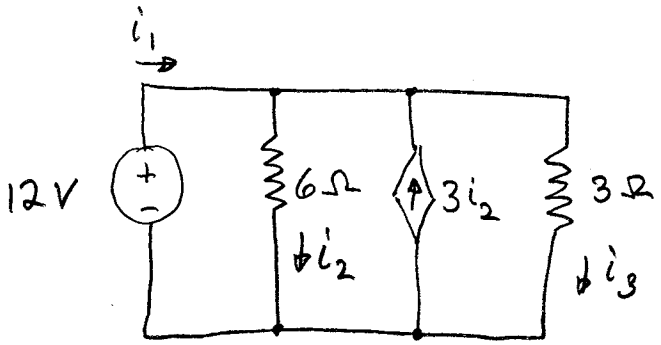
Physics 116A Fall 2003: Exam 1

10/28/2003

Closed book and notes except for one 8.5 in x 11 in sheet of paper. Show reasoning for full credit. Complex quantities are in **boldface**, *e.g.*, $\mathbf{H}(s)$. Many problems ask for numerical answers. There are 4 problems and 100 points. Be sure to put your name on all pages submitted.



(approx. points)

10 1. Find i_1 in the circuit above. (*Hint:* you should be able to find i_2 and i_3 pretty quickly.)

40 2. (a) Find the Thévenin equivalent of the circuit below.

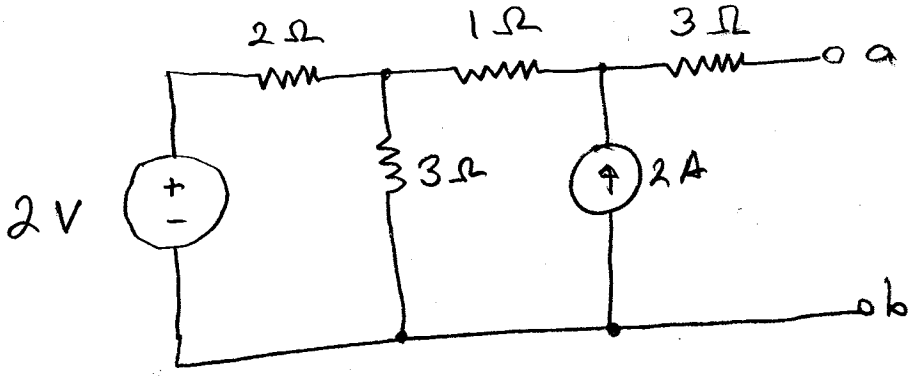
i. Find the open circuit voltage, V_{ab} (open circuit) $\equiv V_{oc}$.

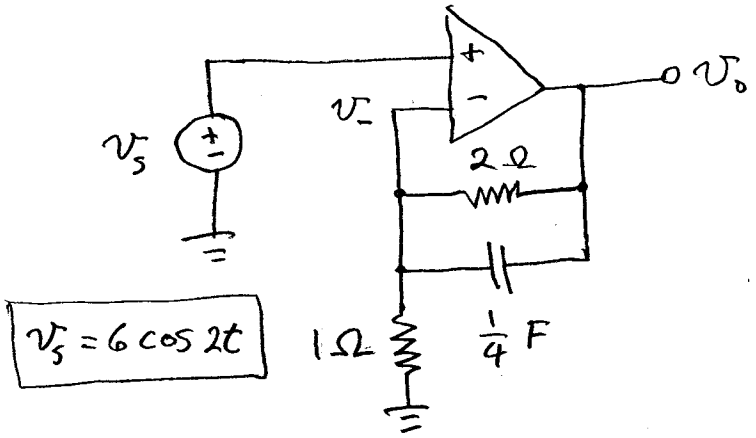
ii. Find the resistance between a and b with the independent sources set to zero, $\equiv R_0$.

iii. Draw the Thévenin equivalent circuit.

(b) For what value of resistance, R_L, connected between a and b will the power dissipated in R_L be maximum?

(c) Find the maximum power delivered.





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3. For the circuit above, $v_s = 6\cos 2t$ V. Use the rules for ideal op-amps to find the following quantities *(at the given frequency)*.

   (a) Find the combined **Z** for the 2 Ω resistor in parallel with the capacitor.

   (b) Find a phasor expression for $\mathbf{V}_-$ in terms of $\mathbf{V_o}$.

   (c) Find $\mathbf{H} = \mathbf{V_o}/\mathbf{V_s}$.

   (d) Find $\mathbf{V_o}$ and $v_o(t)$.

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4. Consider the LRC circuit below with output taken across the capacitor.

   (a) Find an expression for $\mathbf{H}(j\omega) \equiv \mathbf{V_o}/\mathbf{V_s}$.

   (b) Eliminate L, R and C in your expression by expressing your result in terms of $\omega_r \equiv 1/\sqrt{\mathrm{LC}}$ and $Q \equiv \frac{1}{\mathrm{R}}\sqrt{\frac{\mathrm{L}}{\mathrm{C}}} = \frac{\omega_r \mathrm{L}}{\mathrm{R}} = \frac{1}{\omega_r \mathrm{RC}}$.

   (c) For the remainder, let $Q = 1/\sqrt{2}$. This is some sort of filter.

      i. Find an approximate expression for $|\mathbf{H}|$ when $\omega << \omega_r$.

      ii. Find an approximate expression for for $|\mathbf{H}|$ when $\omega \gg \omega_r$.

      iii. Find $|\mathbf{H}|$ when $\omega = \omega_r$.

      iv. What kind of filter is this (*e.g.*, high pass, low pass, band pass...)?

   (d) This is called a *two pole filter.* Explain briefly what this means. *E.g.*, what function of which variable has these poles and why are there two of them, given your expression for **H**?