Desk Copy

ECE 300
Spring Semester, 2007
Test #2

wlg Test B **Name** wlg
Print (last, first)

Work the exam on your own engineering paper. Work on one side of your paper only. Attach your work to the back of this exam sheet and staple in the top left hand corner. . Each problem percentage credit is indicated out beside the problem.

(1) You are given the circuit of Figure 1.

25%

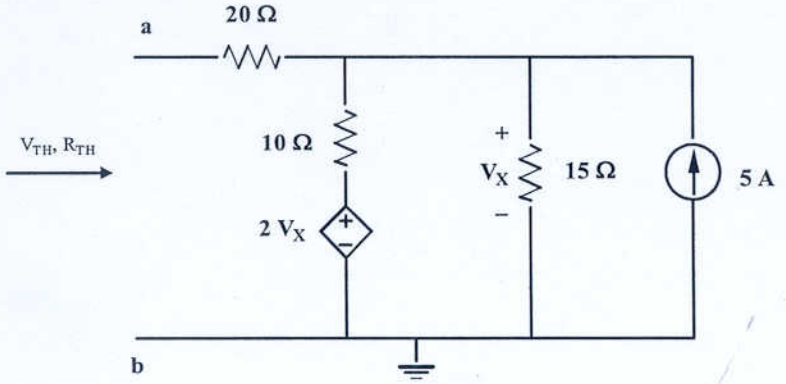


Figure 1: Circuit for problem 1.

(a) Determine the short-circuit current, that is, the current flowing through a wire with zero ohms connected between a-b. Assume the positive direction of the current to be a to b.
(b) Determine the open-circuit voltage, that is, the voltage, V_{ab}, between terminals a-b with the short removed.
(c) Determine V_{TH} (Thevenin's voltage) and R_{TH} (Thevenin's resistance) looking into a-b.
(d) Draw the Thevenin circuit.

(2) You are given the circuit of Figure 2.
(a) Find the Norton equivalent circuit with respect to terminals a-b. You are required to find I_{NORTON} by actually finding the short circuit current.
(b) Draw your Norton equivalent circuit showing the I_{NORTON}, R_{TH} and terminals a-b.

20%

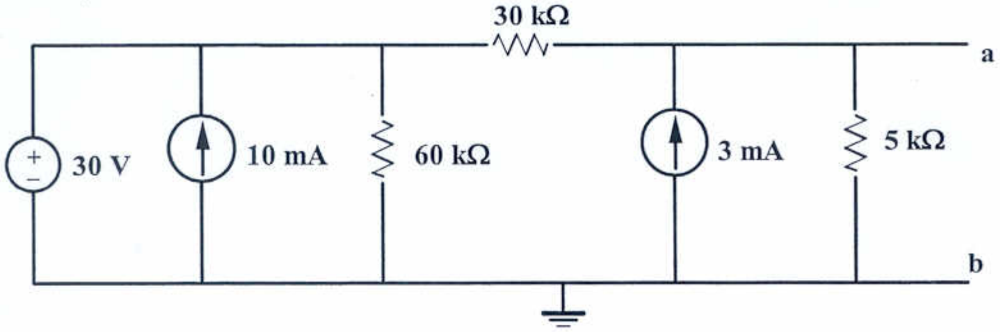


Figure 2: Circuit for problem 2.

(3) Determine the value of V_S in the op amp circuit of Figure 3 so that $V_O = -2$ V.

15%

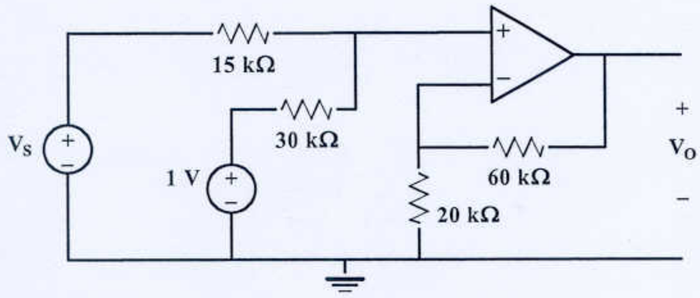


Figure 3 Circuit for problem 3.

(4) You are given the circuit of Figure 4.

(a) Find the Thevenin equivalent circuit to the right of A-B. Draw the circuit.

(b) Find the value of R_L for maximum power transfer to R_L.

(c) What is the value of the power delivered to R_L when it has the value found in (b)?

20%

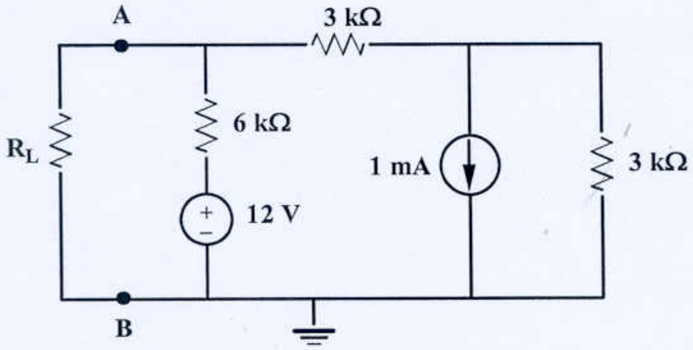


Figure 4: Circuit for problem 4.

(5) Consider the circuit shown in Figure 5. The switch is closed at t = 0 and has been closed long enough for the circuit to reach steady state; that is, all currents and voltages in the circuit have reached constant values. C_2 and R_3 and L_2 are unknown. Under these conditions

(a) find the energy stored in the 0.1 H inductor (give units),

(b) the capacitor voltage V_{C1},

(c) the capacitor voltage V_{C2}.

20%

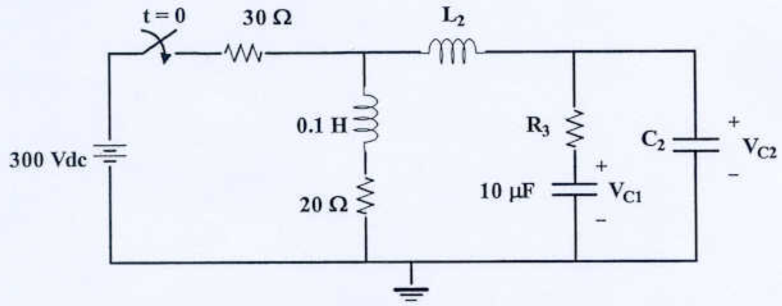


Figure 5: Circuit for problem 5.

Test 2B

(1)

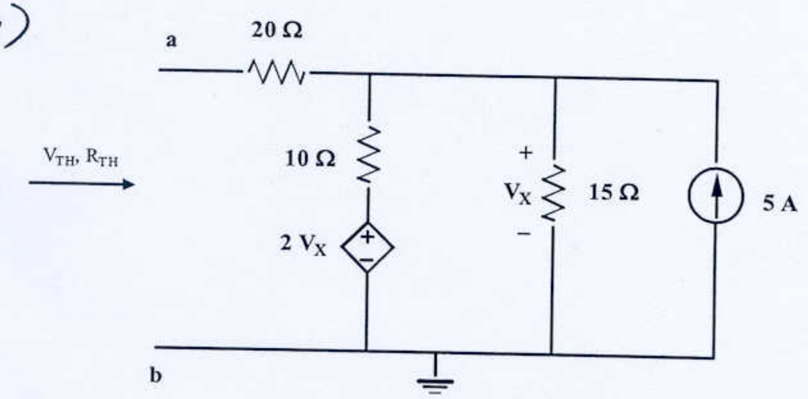
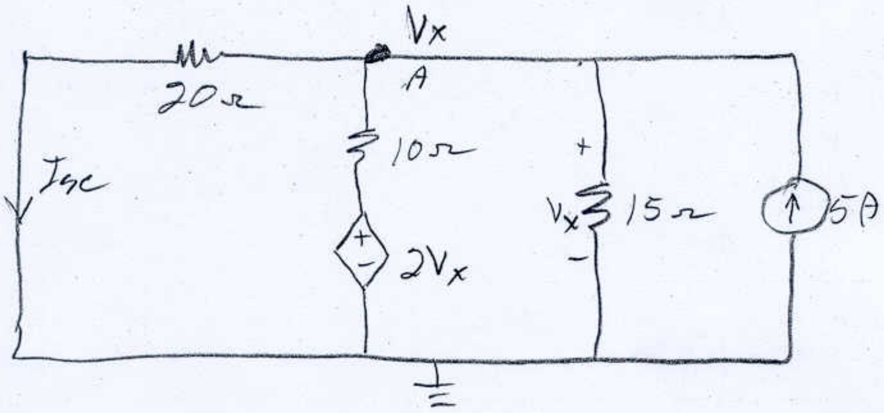


Figure 1: Circuit for problem 1.

(a) Determine the short-circuit current, that is, the current flowing through a wire with zero ohms connected between a-b. Assume the positive direction of the current to be a to b.
(b) Determine the open-circuit voltage, that is, the voltage, V_{ab}, between terminals a-b with the short removed.
(c) Determine V_{TH} (Thevenin's voltage) and R_{TH} (Thevenin's resistance) looking into a-b.
(d) Draw the Thevenin circuit.

(a) Draw with the short ckt,
Let the node voltage at A be
V_x (we can do this because
this is true)



At A

$$60\left(\frac{V_x}{20} + \frac{V_x - 2V_x}{10} + \frac{V_x}{15} = 5\right)$$

$$3V_x - 6V_x + 4V_x = 300$$

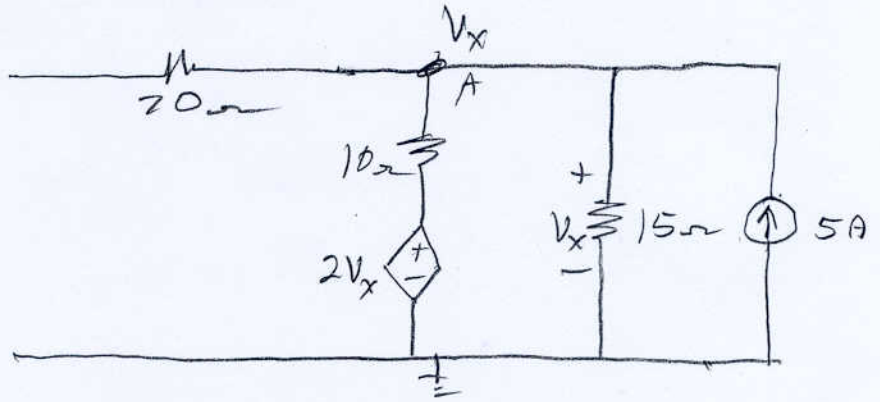
$$V_x = 300\ V$$

(1) cont

$$I_{sc} = \frac{V_x}{20} = \frac{300}{20} = 15A$$

$$I_{sc} = I_N = 15A$$

(b) To determine the open circuit voltage



At A:

$$30\left(\frac{V_x - 2V_x}{10} + \frac{V_x}{15} = 5\right)$$

$$-3V_x + 2V_x = 150$$

$$V_x = -150V$$

$$V_{TH} = V_x = -150V$$

$$\underline{R_{TH}} = \frac{V_{TH}}{I_{sc}} = \frac{-150}{15} = \underline{-10\Omega}$$

(d)

(2) You are given the circuit of Figure 2.

(a) Find the Norton equivalent circuit with respect to terminals a-b. You are required to find I_{NORTON} by actually finding the short circuit current.

(b) Draw your Norton equivalent circuit showing the I_{NORTON}, R_{TH} and terminals a-b.

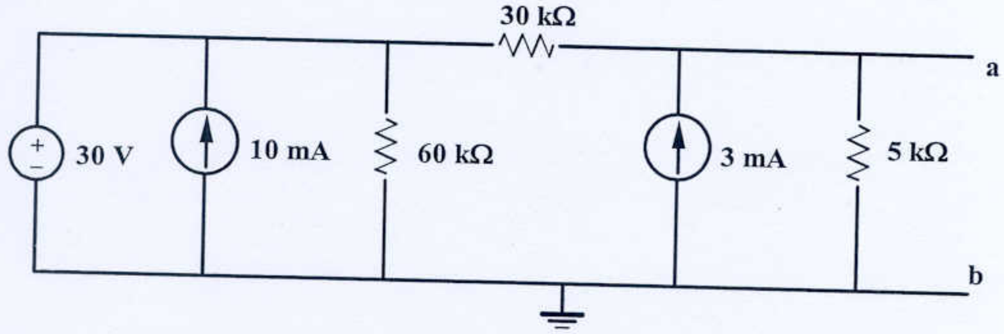
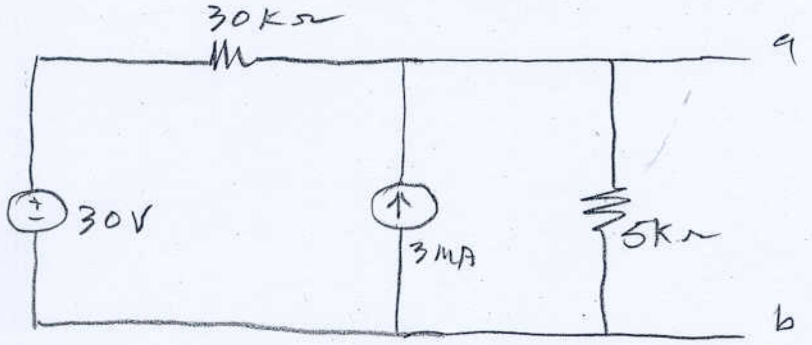
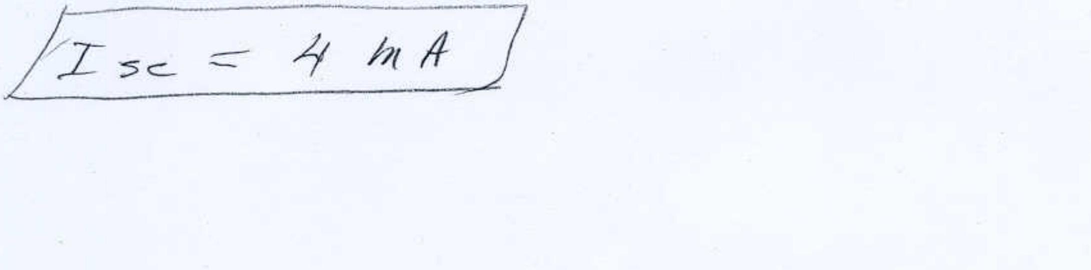


Figure 2: Circuit for problem 2.

(a) The circuit reduces to the following



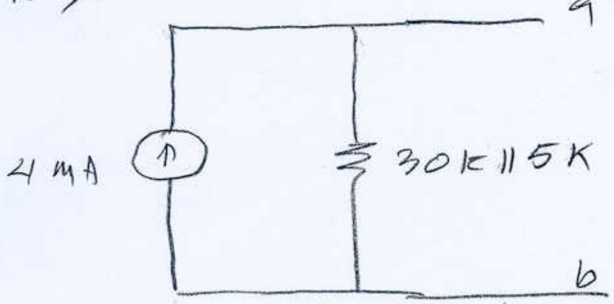
Using source transformation gives;



$I_{sc} = 4\ mA$

(2) cont.

The last circuit can be drawn as



$R_q = \frac{30 \times 5}{35} K = 4.2857\ k\Omega$

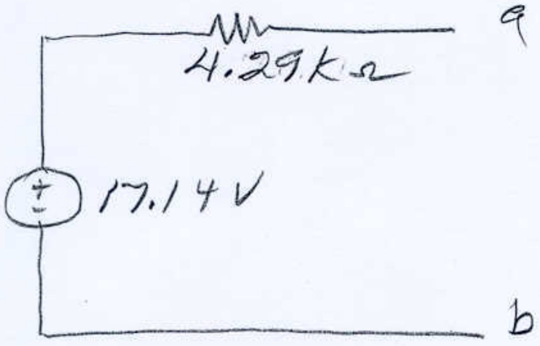
$V_{ab} = V_{oc} = V_{TH} = (4\ mA)(4.2857k)$

$\underline{V_{TH} = 17.14\ V}$

$R_{TH} = \frac{V_{TH}}{I_{sc}} = \frac{17.14}{4\ mA}$

$\boxed{R_{TH} = 4285\ \Omega}$

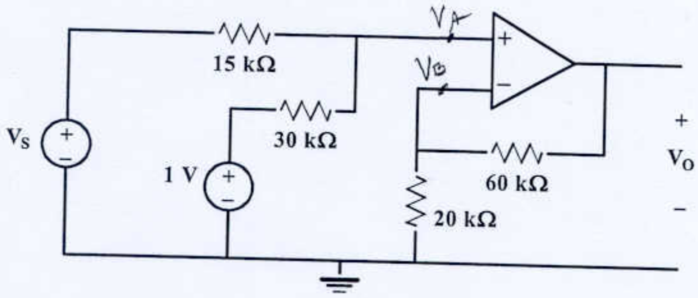
1(d)



Thevenin ckt

Test 2B

(3) Determine the value of V_S in the op amp circuit of Figure 3 so that $V_O = -2$ V.



At V_A:

$$\frac{V_A - V_s}{15K} + \frac{V_A - 1}{30K} = 0$$

$$2V_A - 2V_s + V_A - 1 = 0$$

$$3V_A = 2V_s + 1$$

$$V_A = \frac{2V_s + 1}{3}$$

At V_B

$$V_B = \frac{V_o \times 20K}{60K + 20K} = 0.25\,V_o$$

$V_A = V_B$

$$\frac{2V_s + 1}{3} = .25\,V_o = -0.5$$

$V_o = -2$

$$2V_s + 1 = -1.5$$

$$2V_s = -2.5$$

$$\boxed{V_s = -1.25\text{ V}}$$

2B

$$\frac{V_A}{20k} + \frac{V_A - V_S}{60k} = 0$$

$$3V_A + V_A - V_S = 0$$

$$V_A = \frac{V_S}{4} = \frac{2V_S + 1}{3}$$

$$3V_S = 8V_S + 4$$

$$5V_S = -4$$

$$V_S = -$$

$$\frac{V_A - V_S}{15k} + \frac{V_A - 1}{30k} = 0$$

$$2V_A - 2V_S + V_A - 1 = 0$$

$$3V_A = 2V_S + 1$$

$$V_A = \frac{2V_S + 1}{3}$$

$$-0.5 = \frac{2V_S + 1}{3}$$

$$-1.5 = 2V_S + 1$$

$$2V_S = -2.5$$

$$V_S = -1.25$$

$$\frac{V_A}{20k} + \frac{V_A - V_O}{60k} = 0$$

$$3V_A + V_A - V_O = 0$$

$$4V_A = V_O$$

$$V_A = \frac{V_O}{4} = -0.5$$

2B

(4) You are given the circuit of Figure 4.

(a) Find the Thevenin equivalent circuit to the right of A-B. Draw the circuit.

(b) Find the value of R_L for maximum power transfer to R_L.

(c) What is the value of the power delivered to R_L when it has the value found in (b)?

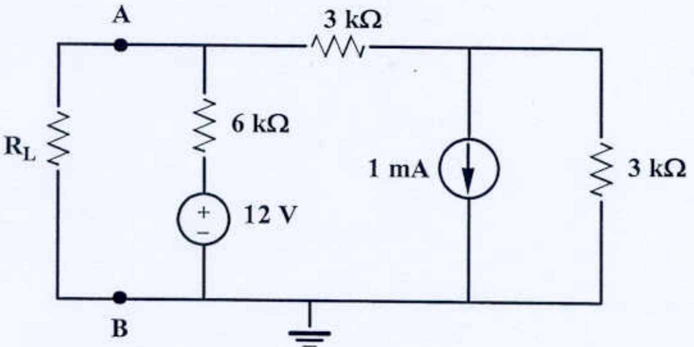
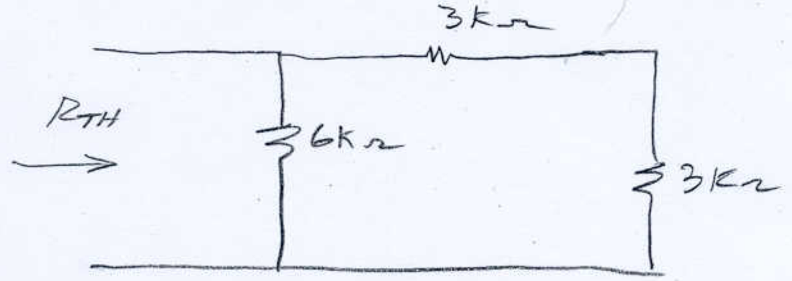


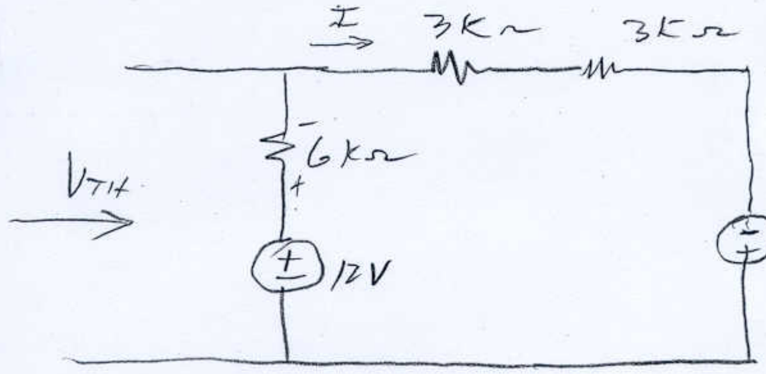
Figure 4: Circuit for problem 4.

(a) Look into A-B with R_L removed and independent sources de-energized



$R_{TH} = 3k\Omega$

With A-B open and using source x-formation:



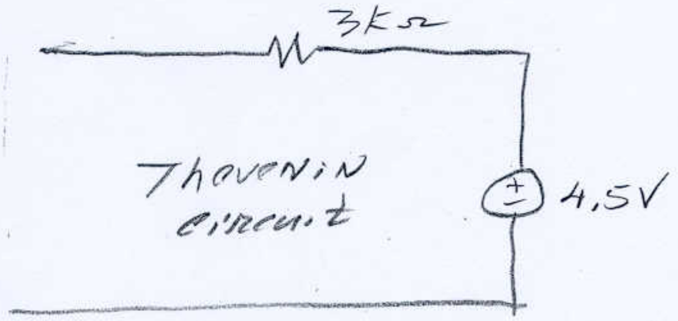
(4) cont

$$I = \frac{15}{12k}$$

$$V_{TH} = 12 - 6k \times \frac{15}{12K} = 4.5V$$

(I)

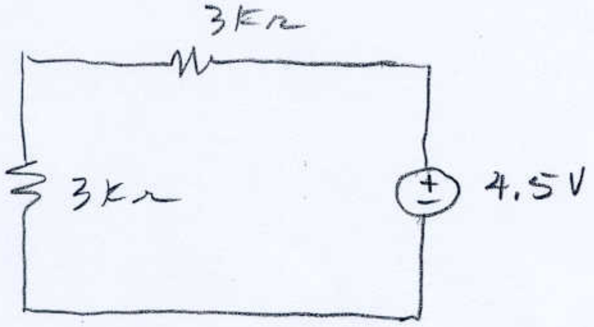
$V_{TH} = 4.5V$



1b) R_L for max pwr x-fer is

$$R_L = R_{TH} = 3k\Omega$$

1c)



$$P_L = \left(\frac{4.5}{6k}\right)^2 \times 3K = 1.688\ mW$$

$P_L = 1.688\ mW$

(5) Consider the circuit shown in Figure 5. The switch is closed at t = 0 and has been closed long enough for the circuit to reach steady state; that is, all currents and voltages in the circuit have reached constant values. C_2 and R_3 and L_2 are unknown. Under these conditions

(a) find the energy stored in the 0.1 H inductor (give units),
(b) the capacitor voltage V_{C1},
(c) the capacitor voltage V_{C2}.

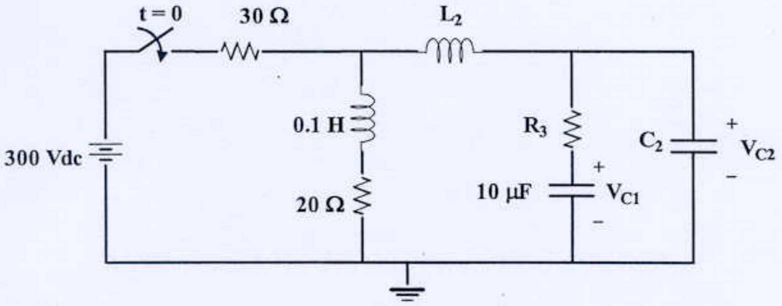
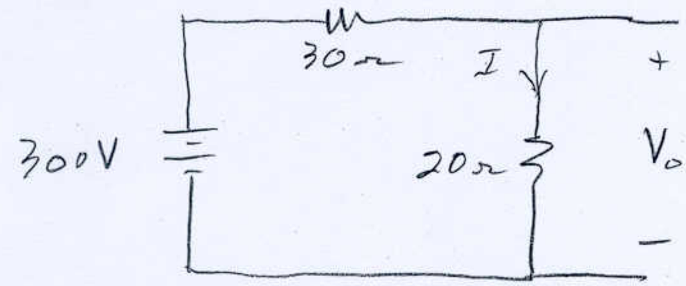


Figure 5: Circuit for problem 5.

(a) In steady state the circuit is as follows (capacitors open, inductors shorted)



$$I = \frac{300}{50} = 6A$$

$$W_L = \frac{1}{2} L I^2 = \frac{1}{2} \times 0.1 \times 6^2 = 1.8 \text{ Joules}$$

$$\boxed{W_L = 1.8 \text{ Joules}}$$

23

(5) cont

(b)

The capacitor voltage V_{c_1} is the same as V_0:

$$V_0 = \frac{300 \times 20}{20 + 30} = 120\,V$$

$V_0 = 120\,V$

$V_{c_1} = 120\,V$

(c) No current thru R so

$V_{c_2} = V_{c_1} = 120\,V$