Midterm #2

Closed Book; You may have 2 8.5x11" "cheat-sheets" (Four sides). Show all work.

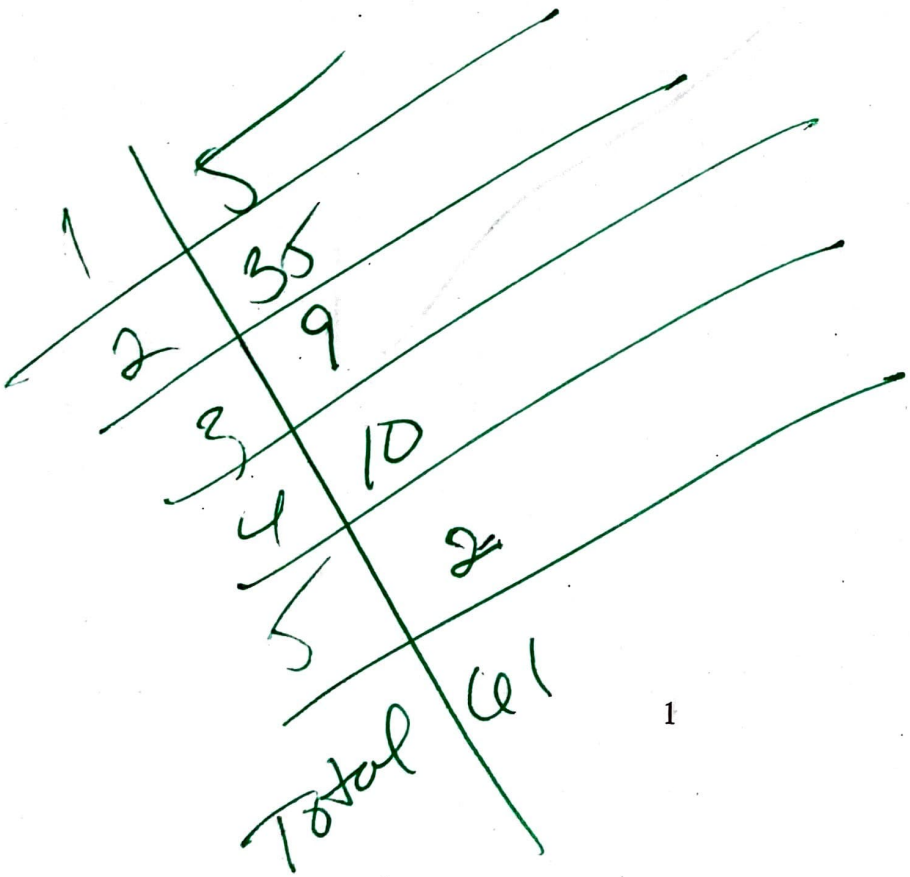
Honor Code

"All Students taking courses in the School of Engineering agree, individually and collectively that they will not give or receive unpermitted aid in examinations or other course work that is to be used by the instructor as the basis of grading" – From the 2005-2007 Undergraduate Bulletin

I have read, understood and agree to abide by the Honor Code of the School of Electrical Engineering.

Signature: Muliawidjaja

Show all work. If you don't understand the question, state what you think I'm asking and answer that. Please circle your answers.



47%

$V_{2\Omega} = iR$

$= (2)(1) = 2V$

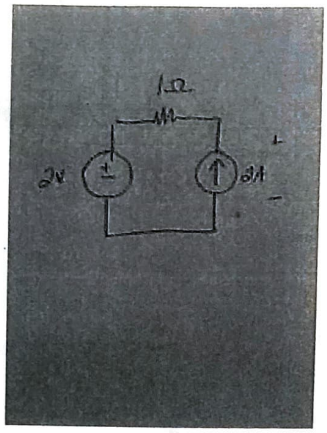


Figure 1: Circuit for Problem 1

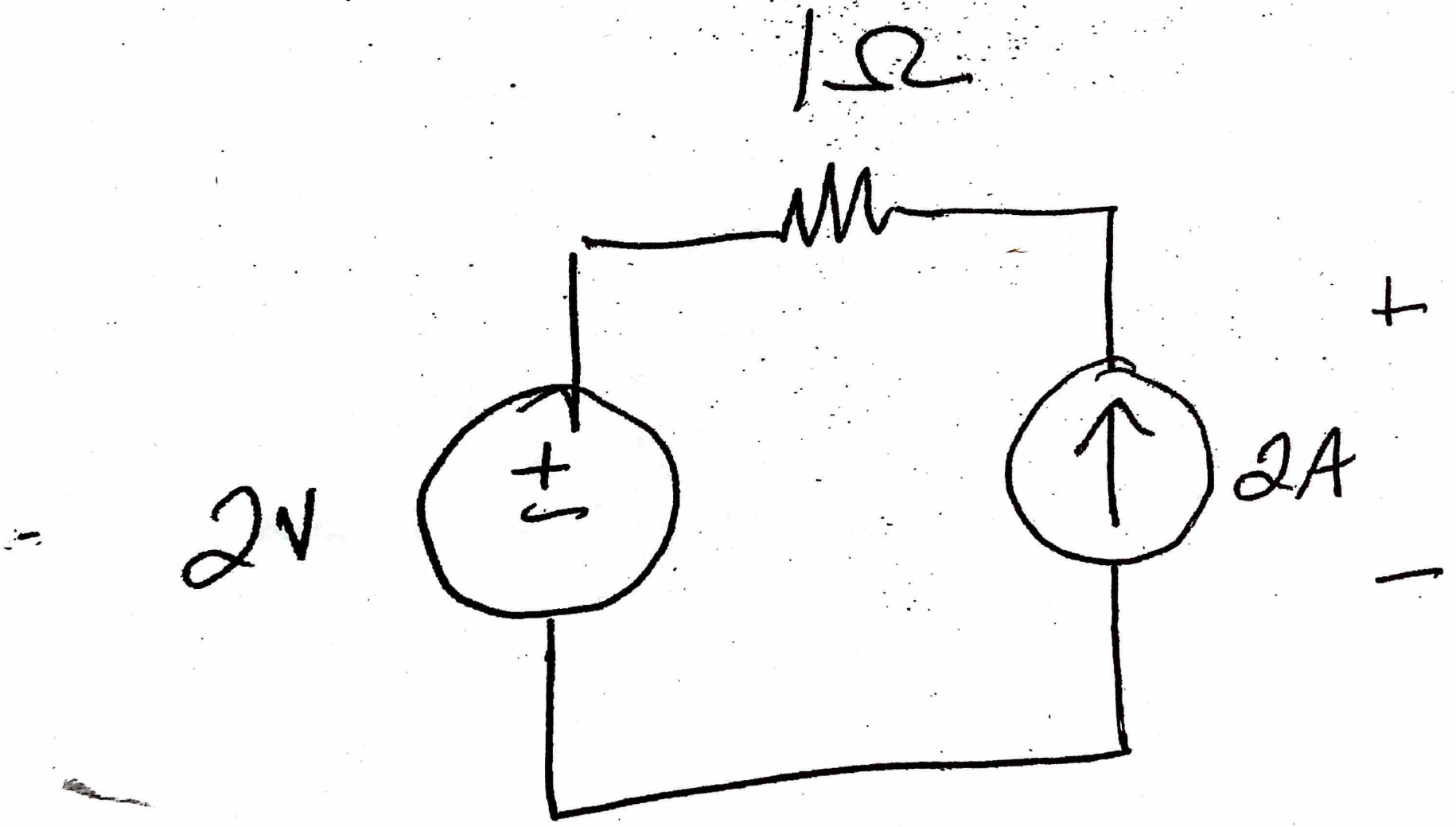
1. Consider the circuit shown in Fig. 1. (10 points)

   Find the power in the voltage source, resistor and current source. (10 points)

Element	I(A)	R(Ω) (if applicable)	V	P(W)
2V source	2		2	$P = IV = (2)(2) = 4W$
1Ω Resistor	2	1	−2	$P = IV = (2)(-2) = -4W$
2A source	2		0	$P = (2)(0) = 0$

-5

See solutions


1Ω
2V
2A
+
−

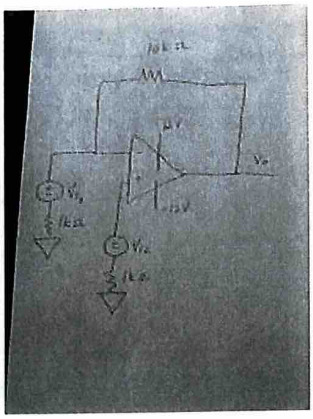


Figure 2: Op-amp circuit for Problem 2

2. Operational Amplifiers (Op-Amps) Consider the circuit in Fig. 2.

   (a) Find V_0 as a function of V_{s1} the voltage source on the left and V_{s2} the voltage source on the right. (10 points)

   (b) Now set $V_{s2} = 2$ and $V_{s1} = 3$ Volts. What is V_0? (10 points)

   (c) Now set $V_{s2} = 2$ and $V_{s1} = 1/2$ Volts. What is V_0? (10 points)

   (d) Let $V_{s2} = 0$ and $V_{s1}(t) = \cos(1000t + \pi/4)$ Volts. What is $V_0(t)$? (10 points)

$V_n = V_p \quad \| \quad @ \; \frac{V_n - V_{S1}}{1000} + \frac{V_n - V_o}{10000} = 0$

$V_p = V_{S2} \leftarrow \quad \frac{V_p - V_{S2}}{1000} = 0$

$V_p = V_{S2} = V_n$

$\frac{V_{S2} - V_{S1}}{1000} + \frac{V_{S2} - V_o}{10000} = 0 \qquad (-10000)$

$-10V_{S2} + 10V_{S1} - V_{S2} + V_o = 0$

$V_o = 11V_{S2} - 10V_{S1}$

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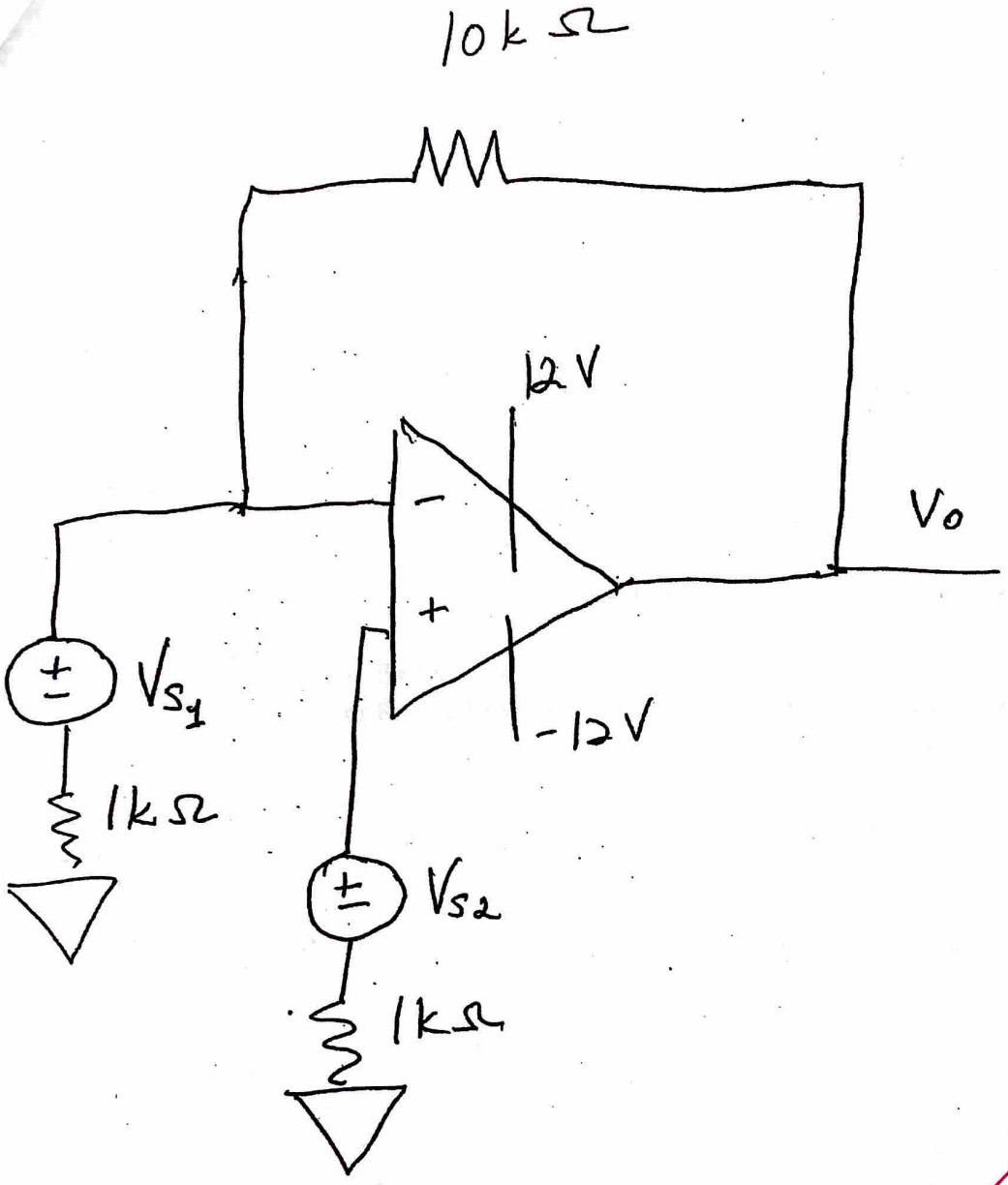


(b.) $V_o = 11(2) - 10(3) = 22 - 30 = -8$ V

(c.) $V_o = 11(2) - 10(0.5) = 22 - 5 = 17$ V

(d.) $V_o = 11(0) - 10\left[\cos\left(1000t + \frac{\pi}{4}\right)\right]$

$= -10\cos\left(1000t + \frac{\pi}{4}\right)$

-5

12 Volts

-12 Volts

Figure for 1 Prob. 2

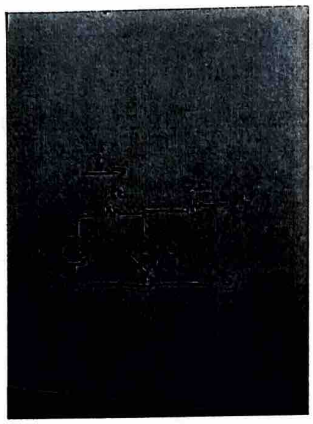
3. 

Figure 3: Circuit for 3, part b

(a) Find the Thevenin voltage for the circuit shown in Fig. 3. (10 points)

(b) Find the Thevenin resistance for the circuit shown in Fig. 3. (10 points)

(a.)

$$-10 + 2i + 3i = 0$$

$$-10 + 5i = 0$$

$$5i = 10$$

$$i = 2\ A$$

$V_{TH} = 3V$

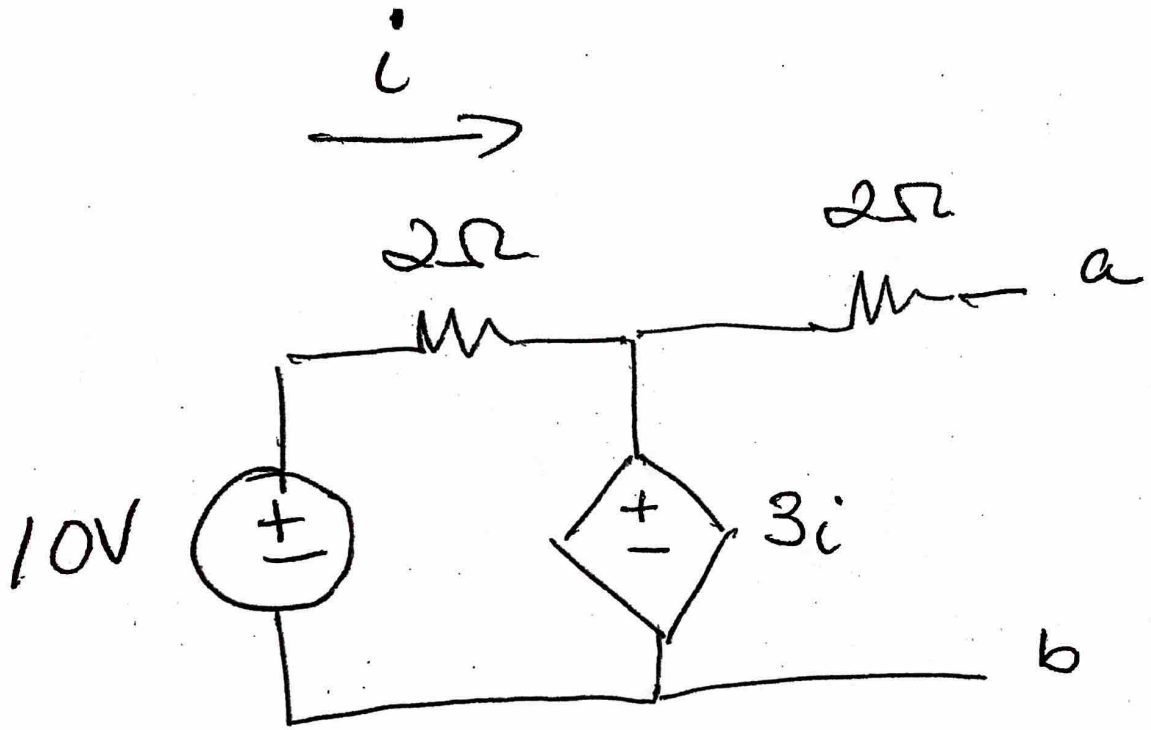
$$V_{TH} = R_{TH} \cdot i_{TH}$$

$$= 2 \| 2 \cdot 2 = 1 \cdot 2 = 2\ V$$

(b.)

$$R_{TH} = 2 \| 2 = 1\ \Omega$$

Part 3b)



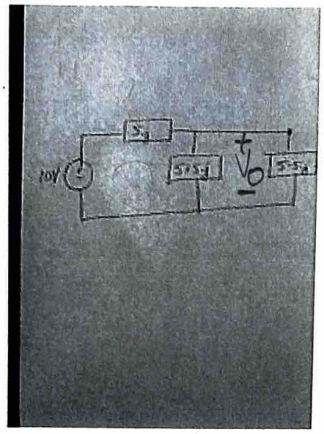


Figure 4: First circuit for Problem 4. The impedance to the right is 5-5j while the impedance in parallel with it 5+5j

4. Impedance and phasors

(a) Consider the phasor circuit in Fig. 4
Find the phasor voltage across the 5+5j impedance. (10 points)

(b) Now consider the AC circuit shown in Figure 5.

i. Draw the phasor/impedance equivalent of the circuit. (10 points) → Answer below Figure 5

ii. Find the steady-state phasor voltage of the capacitor. (10 points)

(c) Convert $3+4j$ to a cosine with frequency $\omega = 100$ r/s. (10 points)

Part c?

4 a.

$$V_o = V_{5+5j} = \frac{(10)\left[(5+5j)\,||\,(5-5j)\right]}{5j+\left[(5+5j)\,||\,(5-5j)\right]}$$

Almost

$$= \frac{(10)(50)}{5j+50} = 9.90 - 0.99j \text{ V}$$

$$= 9.9504 \angle 5.71^\circ$$

Complex math issue.

$$10e^{-j\pi/4}$$

Prob 4

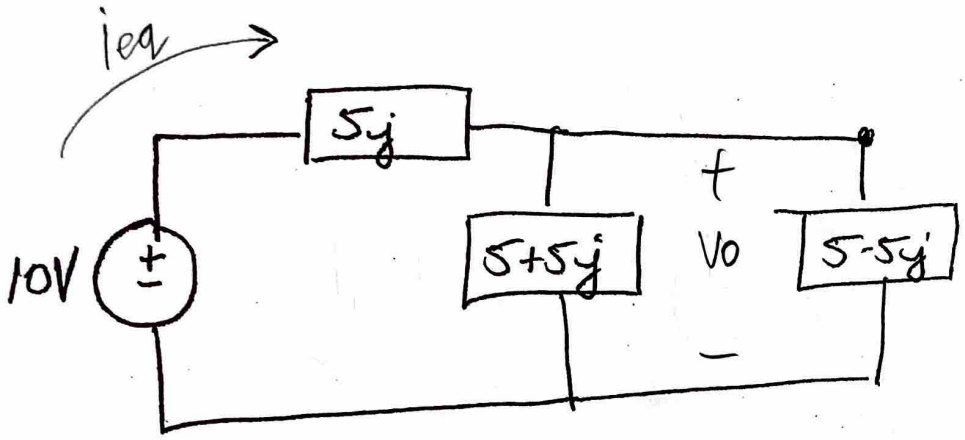


Figure 4 for Problem 5

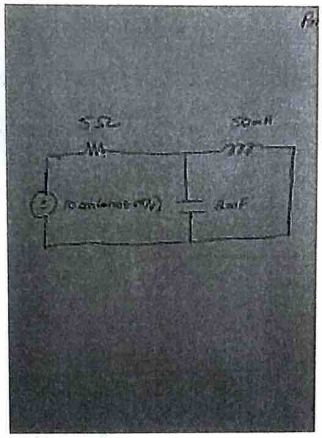
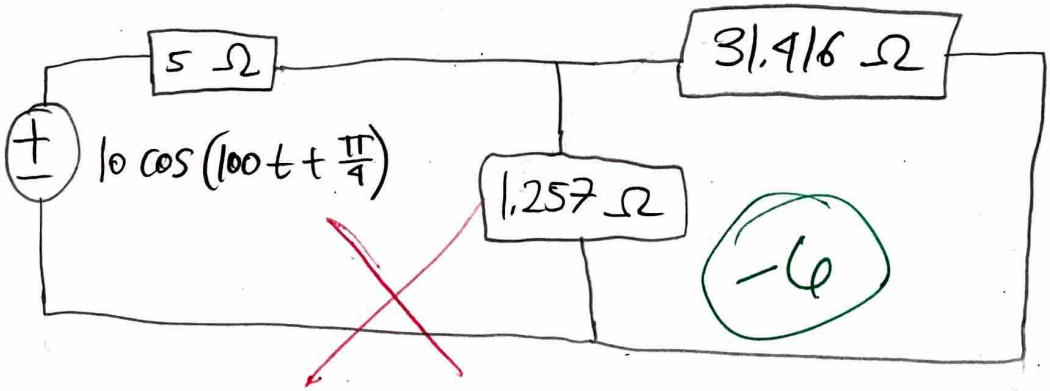


Figure 5: Second circuit for Problem 4

b. i. $Z_{50mH} = jWL = j(2\pi \cdot 100)(50 \cdot 10^{-3}) = 10\pi = 31.416\,\Omega$

$Z_{2mF} = jWC = j(2\pi \cdot 100)(2 \cdot 10^{-3}) = 0.4\pi = 1.257\,\Omega$

$Z_{5\Omega} = 5\,\Omega$



ii.

-10

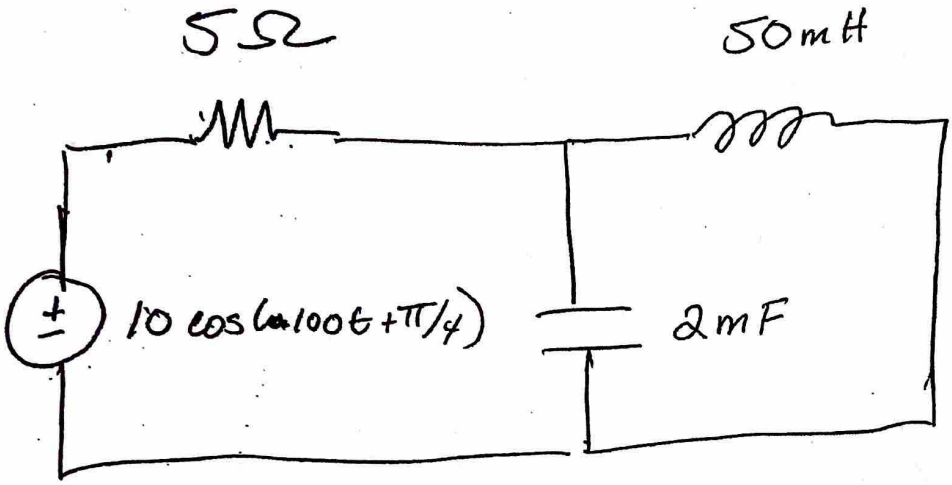


Fig 5 for Prob 4.

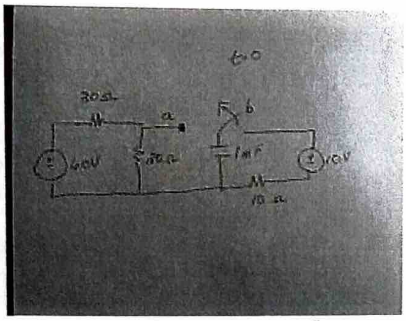


Figure 6: Circuit for Prob 5

5. DC transients

   (a) In this DC circuit, the switch has been turned to the right for a long time. Find the steady-state voltage in the capacitor v_c. (10 points)

   (b) Now the switch is turned to the left. Find $v(t)$ for $t \geq 0$. (10 points)

(a.) $i_{1mF} = \frac{10}{10} = 1$

$V_{1mF} = -\frac{j I_{1mF}}{\omega C}$

$= -\frac{j(1)}{\omega(0.001)}$

-8

(b.)

-10

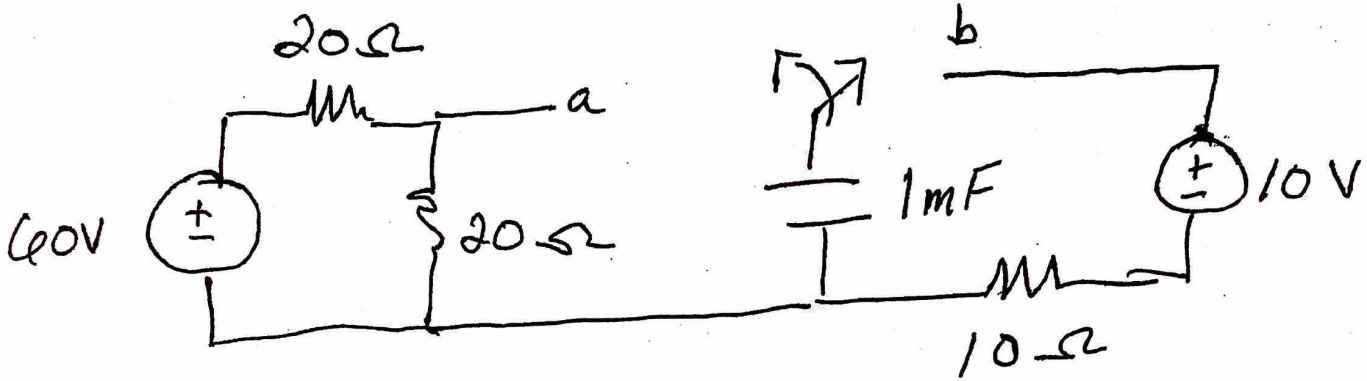


Figure 6 For Problem 5