ENG M20
Quiz # 1
Spring 18
Moorpark College

Student Name: Jared Fowler

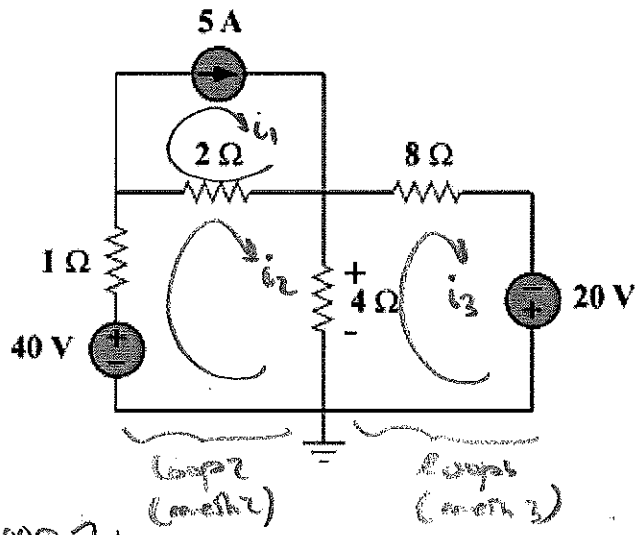
Grade: 24/25

There are FIVE problems in Quiz 1. Write complete solutions to all problems and show all your work. Do not just write the answers. If you need more space insert additional sheets. Be neat and use pencil or workout the problems on separate sheets and transfer your work neatly to exam papers.

Problems # 1 – 5 **5 points each**

Problem 1. HW PROBLEM Set3, Prob4. ✓

Apply mesh analysis to find v_o across 4Ω in the circuit below:



KVL @ loop 2:

$-40V + 1(i_2) + 2(i_2 - i_1) + 4(i_2 - i_3) = 0$

$-40V + 1i_2 + 2i_2 - 2i_1 + 4i_2 - 4i_3 = 0$

$-40V + 7i_2 - 2\cancel{i_1}^{5} - 4i_3 = 0$ Note: $i_1 = 5A$

$-50V + 7i_2 - 4i_3 = 0$ (1)

KVL @ loop 3:

$-20V + 4(i_3 - i_2) + 8i_3 = 0$

$-20V + 4i_3 - 4i_2 + 8i_3 = 0$

$-20V + 12i_3 - 4i_2 = 0$

$-5V + 3i_3 - i_2 = 0$ (2)

$\hookrightarrow i_2 = 3i_3 - 5V$

$(1,2) \rightarrow 50V + 7(3i_3 - 5V) - 4i_3 = 0$

$-50V + 21i_3 - 35V - 4i_3 = 0$

$85 = 17i_3$

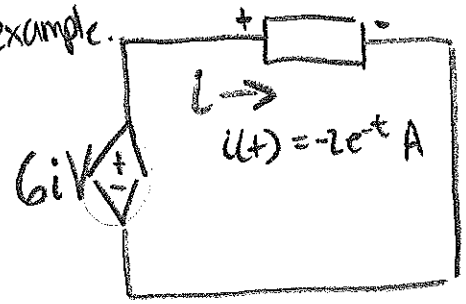
$i_3 = 5A \rightarrow (2) \rightarrow i_2 = 3\cancel{i_3}^{5} - 5 = 10A$

$V_o = iR = (i_2 - i_3)4 = (10 - 5)(4) = \boxed{20V}$ ✓

Problem2. The current entering the positive terminal of an element is $i(t) = -2e^{-t}$ A. ✓
If the voltage across the element is $6i$ Volts.

A) Find the power as function time.
B) Determine the energy delivered to the element between 0 and 1s.

...example.



Energy delivered = $w = \int_{t_0}^{t} P\,dt$

A) $P = Vi$

$P = 6i^2$

$P(t) = 6(-2e^{-t})^2$

$\boxed{P(t) = 24e^{-2t}}$

B) Energy $w = \int_0^1 24e^{-2t}\,dt$

$= \left[-12e^{-2t} + C\right]_0^1$

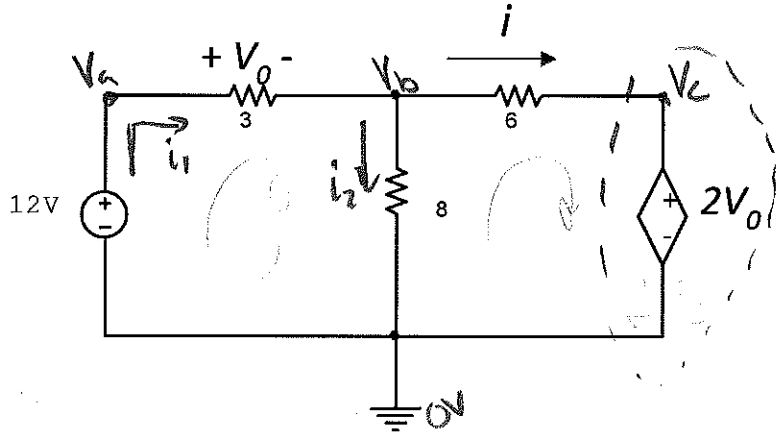
$= -12e^{-2(1)} - (-12e^{-2(0)})$

$= -12e^{-2} + 12(1)$

$= \boxed{10.38 \text{ Joules}}$

5/5

Problem3. Use Nodal analysis to find V_o and i in the following circuit.



3(11)

Note: $V_a = 12V$ and Note: $V_c = 2V_o$ (2) and Note: $V_o = V_a - V_b$ (3)

KCL @ V_b:

$i_1 = i_2 + i$

$$\frac{V_a - V_b}{3} = \frac{V_b - 0}{8} + \frac{V_b - V_c}{6}$$

$$\frac{V_a}{3} - \frac{V_b}{3} = \frac{V_b}{8} + \frac{V_b}{6} - \frac{V_c}{6}$$

$$\frac{8V_a}{24} - \frac{8V_b}{24} = \frac{3V_b}{24} + \frac{4V_b}{24} - \frac{4V_c}{24}$$

$$8V_a - 8V_b = 3V_b + 4V_b - 4V_c$$

$$8V_a - 15V_b = -4V_c \quad (1)$$

$$96 = 15V_b - 4V_c \quad (1)$$

$$96 = 15V_b - 4(2V_b)$$

$$96 = 15V_b - 8V_b$$

$$96 = 15V_b - 8(V_a - V_b)$$

$$96 = 15V_b - 8(12 - V_b)$$

$$96 = 15V_b - 96 + 8V_b$$

$$192 = 23V_b \rightarrow V_b = 192/23$$

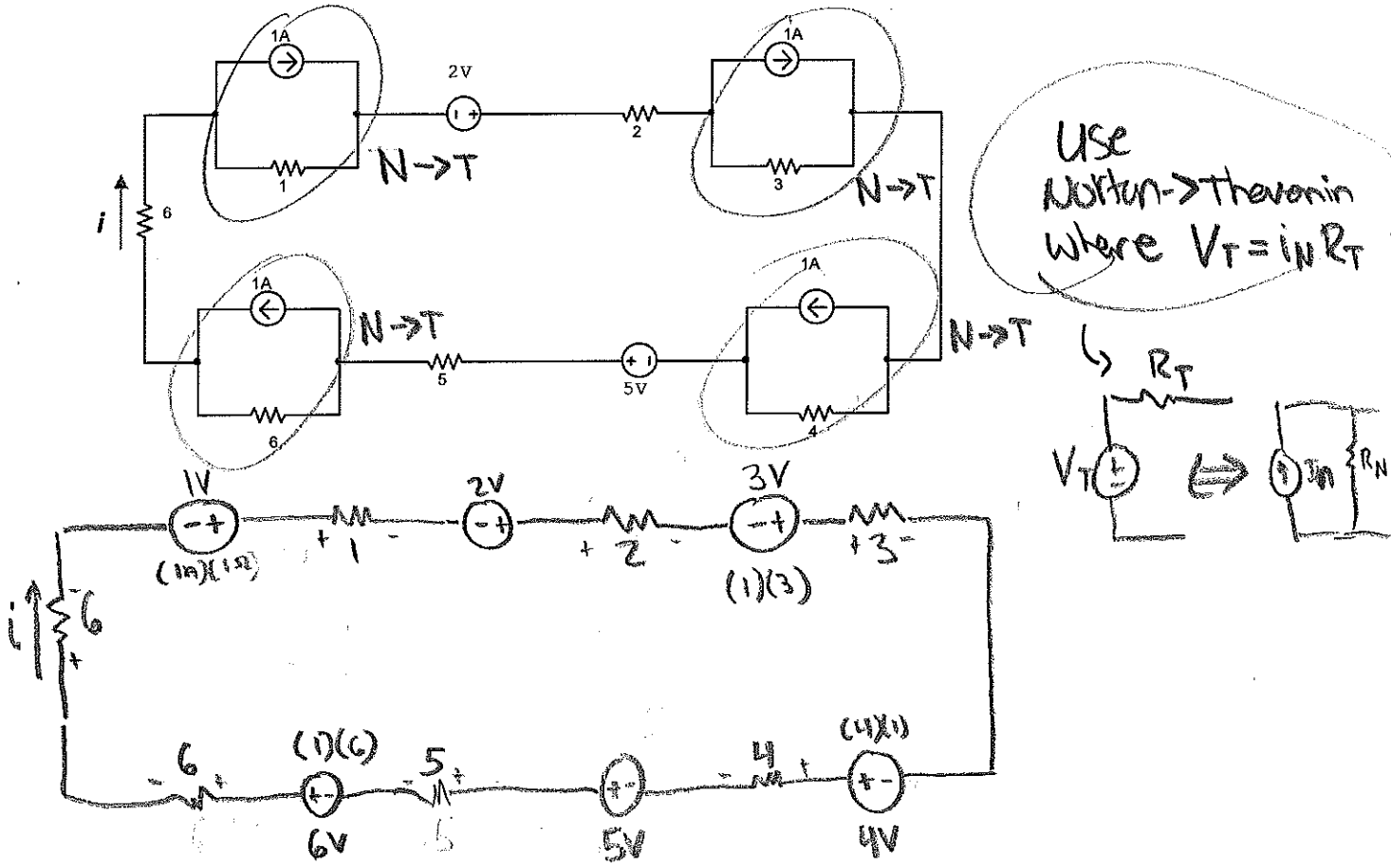
$$V_b = 8.34V$$

(3): $V_o = 12 - 8.34 = \boxed{3.66V}$

$$i = \frac{V_b - V_c}{6} = \frac{8.34V - 2(3.66V)}{6}$$

$$= \boxed{0.17A}$$

Problem4. Use source transformation to determine i in the 6 Ω resistor.



Now use KVL:

$$6i - 1V + i - 2V + 2i - 3V + 3i - 4V + 4i - 5V + 5i - 6V + 6i = 0$$

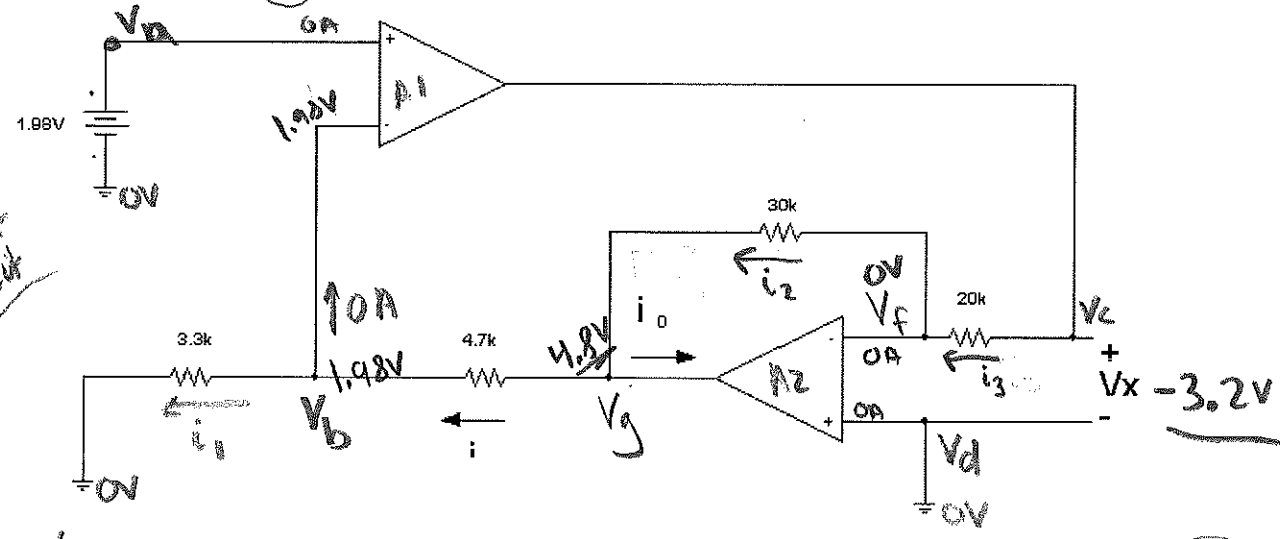
$$27i - 21V = 0$$

$$27i = 21V$$

$$i = \frac{21}{27} = \boxed{\frac{7}{9}A}$$

5/5

Problem5. Find V_x, **i,** and i_0 , in the following circuit.



to zero in OA → principle of open circuit

KCL @ V_b (-) input A1)

$i = i_1 + 0A$

$\frac{V_g - V_b}{4.7k} = \frac{V_b - 0}{3.3k}$

$\frac{V_g}{4.7k} - \frac{V_b}{4.7k} = \frac{V_b}{3.3k}$

Note: $V_a = 1.98V$

by principle of short,

$V_b = 1.98V$

$V_g = \left(\frac{1.98}{3.3k} + \frac{1.98}{4.7k}\right)(4.7k)$

$V_g = 4.8V$

KCL @ V_g

$i_2 = i_0 + i$

$\frac{V_f - V_g}{30k} = i_0 + \frac{V_g - V_b}{4.7k}$

Note: $V_f = 0V$, b/c $V_d = 0V$, and principle of short

$\frac{0 - 4.8}{30k} = i_0 + \frac{4.8}{4.7k} - \frac{1.98}{4.7k}$

$-.16mA = i_0 + 1.021mA - .421mA$

$i_0 = -0.76mA$

KCL @ V_f (-) input A2)

$i_3 = i_2 + 0A$

$\frac{V_c - 0}{20k} = \frac{0 - 4.8V}{30k}$

$\frac{V_c}{20k} = \frac{-4.8V}{30k}$

$V_c = V_x = -3.2V$

? = ?

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Soln 2. A). $P(t) = i(t)\,v(t) = (-2e^{-t})(6(-2e^{-t}))$

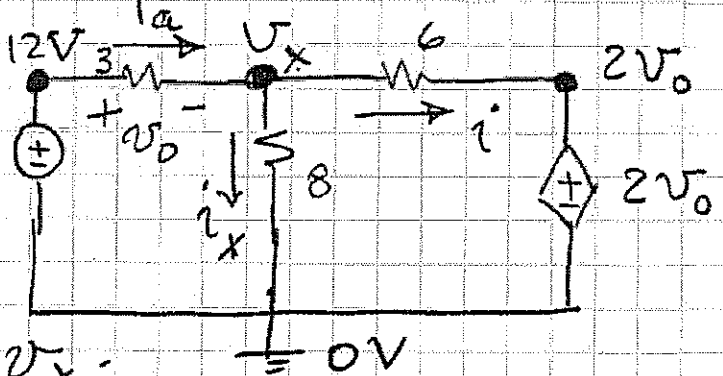
$$P(t) = \boxed{24e^{-2t}} \text{ W}$$

B). $$W = \int_0^1 P(t)\,dt = \int_0^1 24e^{-2t}\,dt$$

$$= \frac{24}{-2} e^{-2t}\Big|_0^1 = -12\left(e^{-2} - e^{0}\right) = 12(1 - e^{-2})$$

$$W = \boxed{10.4\text{ J}}$$

Soln 3.



KCL @ v_x:

KCL @ $i_a = i_x + i$ $\quad \dfrac{12 - v_x}{3} = \dfrac{v_x - 0}{8} + \dfrac{v_x - 2}{6}$ EQ1

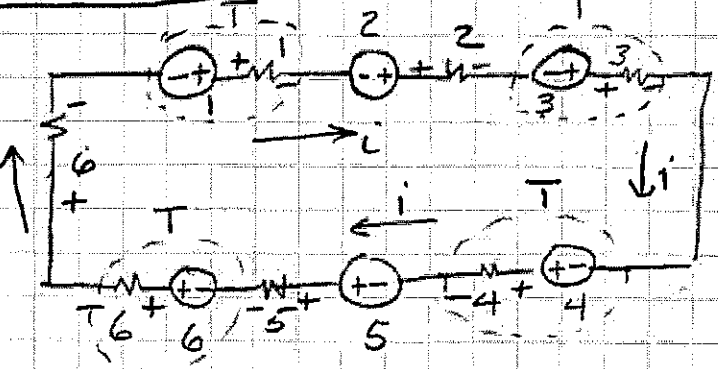
Also: $12 - v_x = v_o$ EQ2

EQ1: $96 = 15v_x - 8v_o$

EQ2: $12 = v_x + v_o$ $\Big\} \Rightarrow$ $v_x = 8.35$, $\boxed{v_o = 3.65}$

$$i = \frac{v_x - 2v_o}{6} = \frac{8.35 - (3.65)2}{6} = \boxed{0.175\text{ A}}$$

Soln 4.

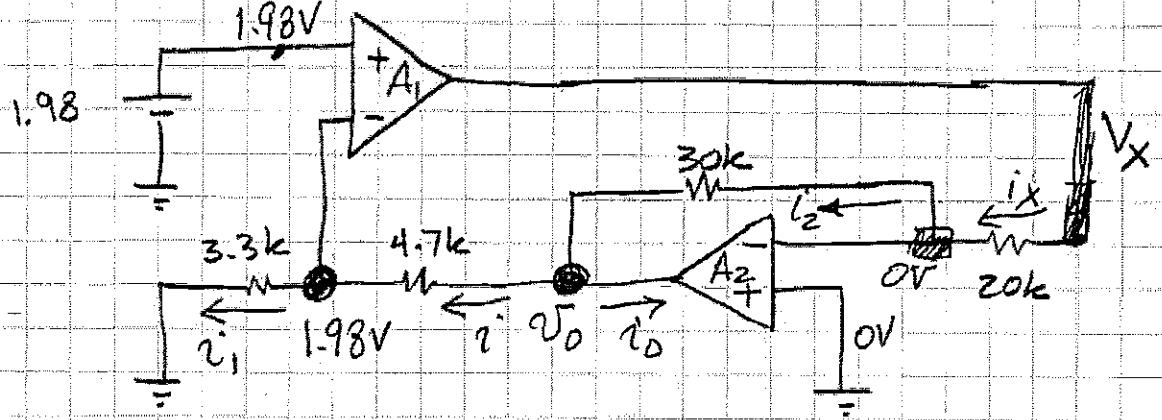


KVL around the loop:

$+6i - 1 + i - 2 + 2i - 3 + 3i - 4 + 4i - 5 + 5i - 6 + 6i = 0$

$27i - 21 = 0 \quad i = \frac{21}{27} = \frac{7}{9} = \boxed{0.78\,A}$

Soln 5.



$i_1 = \frac{1.98 - 0}{3.3k} = 0.6\,mA$ KCL @ − input of A_1, $i = i_1$

$i = \boxed{0.6\,mA}$ by inspection: $i = \frac{v_0 - 1.98}{4.7k}$,

Since $i = 0.6mA$ $(0.6m)(4.7k) = v_0 - 1.98 \rightarrow v_0 = 4.8$

$i_2 = \frac{0 - v_0}{30k} = \frac{0 - 4.8}{30k} = -0.16\,mA$

KCL @ v_0 node: $i_2 = i + i_0$, $i_0 = i_2 - i$

$i_0 = -0.16mA - 0.6mA = \boxed{-0.76\,mA}$

KCL @ − input of $A_2 \rightarrow \frac{v_x - 0}{20k} = \frac{0 - v_0}{30k}$

$\frac{v_x}{20k} = -0.16\,mA$, $v_x = \boxed{-3.2V}$

ENG M20
Quiz # 2
Spring 18
Moorpark College

Student Name: Jared Fowler

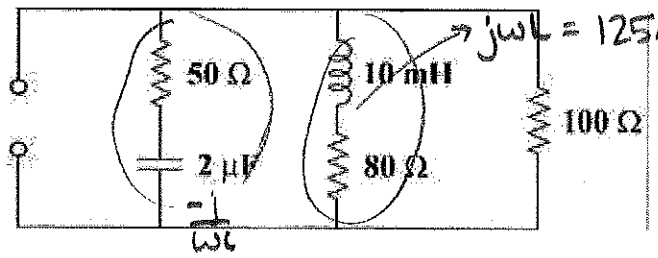
Grade: 18.5 + 1.8 / 25 20.3 / 25

There are FIVE problems in Quiz 2. Write complete solutions to all problems and show all your work. Do not just write the answers. If you need more space insert additional sheets. Be neat and use pencil or workout the problems on separate sheets and transfer your work neatly to exam papers.

Problems 1-5 **5 points each**

Problem#1. Homework problem from Chapter 10

Problem1. The network below is part of the schematic describing an industrial electronic sensing device. What is the total impedance of the circuit at 2 kHz?



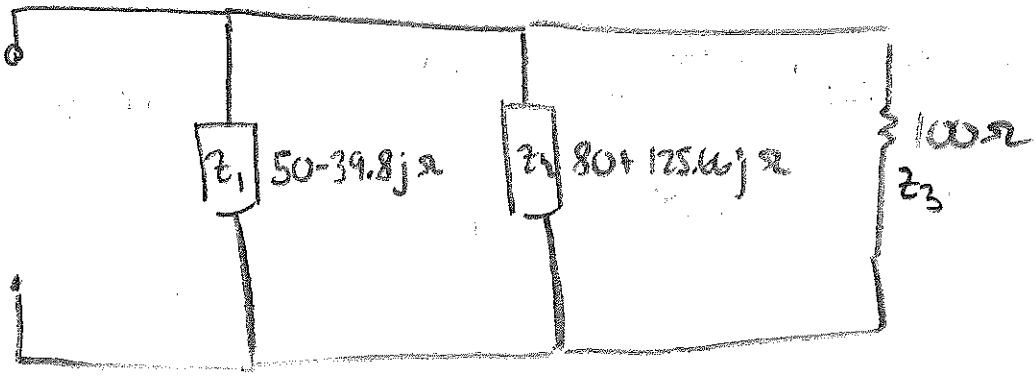
Note: $\omega = 2\pi f$, $f = \frac{1}{t}$

$2000\,Hz = f$

$\Rightarrow \omega = 2\pi(2k)$

$= 12566.4 \frac{rad}{s}$

$\frac{-j}{(12566.4)(2\times10^{-6})} = -39.8j\ \Omega$



$\frac{1}{Z} = \frac{1}{100} + \frac{1}{50-j39.79} + \frac{1}{80+j125.66}$

$\frac{1}{Z} = 10^{-3}(10+12.24+j9.745+3.605-j5.663)$

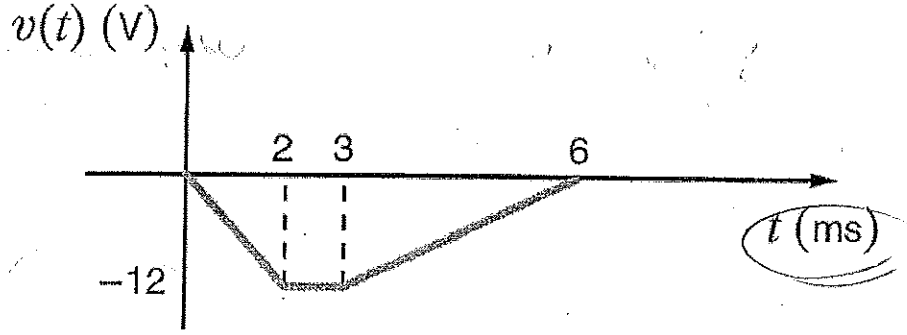
$= (25.85+j4.082)\times10^{-3}$

$= 26.17\times10^{-3}\ \angle 8.97°$

$Z = 38.21\ \angle -8.97°\ \Omega$

5/5

Problem2. The voltage across a 2uF capacitor is given by the waveform below. Compute the current waveform and sketch this waveform.



$i = C\frac{dv}{dt}$ → Slope

$0 \le t < 2,\ C\frac{dv}{dt} = C\frac{-12}{.002} = (-6000)(.000002) = -0.012\ A$

$2 < t < 3,\ C\frac{dv}{dt} = C(0) = 0\ A$

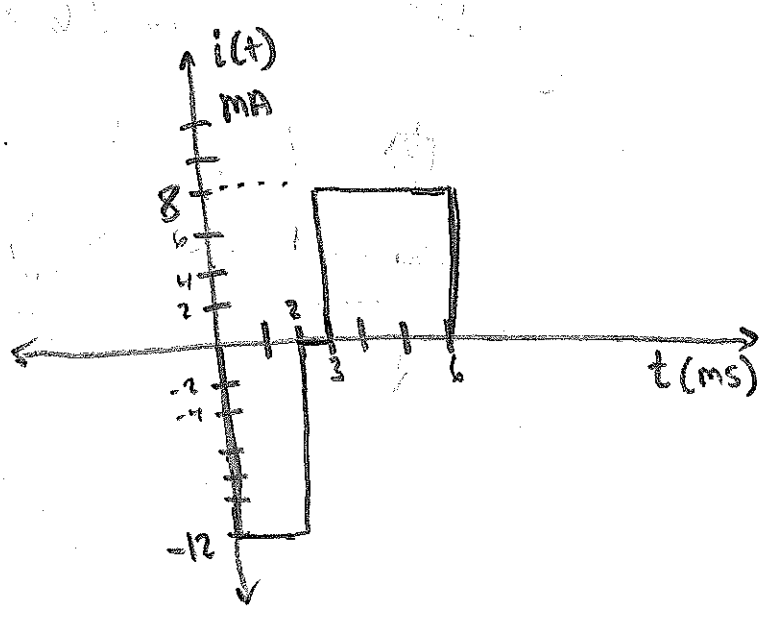
$3 < t \le 6,\ C\frac{dv}{dt} = C\left(\frac{0 - -12}{.003}\right) = 4000(.000002) = 0.008A$

$0 \le t < 2ms\ \ i(t) = -12\ mA$

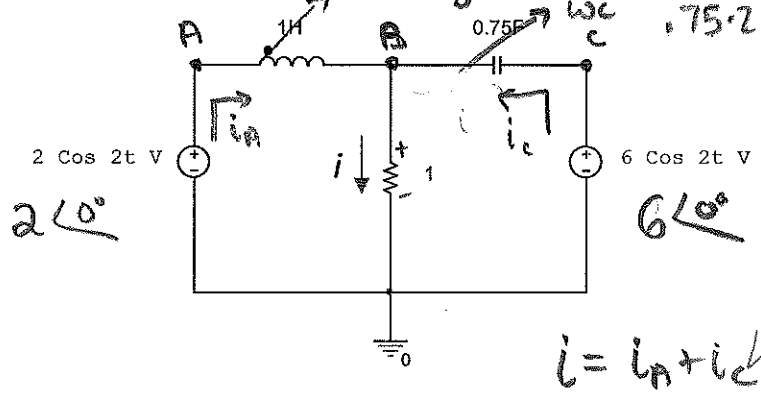
$2ms < t < 3ms,\ i(t) = 0A$

$3ms < t \le 6ms,\ i(t) = 8\ mA$

5/5



Problem3. Find the A.C. steady state current i using nodal analysis.



→ is easier

$j\omega L = 2j$ $\quad \frac{-1}{\omega C} = \frac{-j}{.75 \cdot 2} = -.667j$

Note: $\omega = 2$

$2\angle 0°$ $\quad 6\angle 0°$

$i = i_A + i_c$

T→N

KVL: V_B

$(2\angle 0°)$ $\quad 2j$ $\quad 1$ $\quad -.667j$ $\quad (6\angle 0°)$ $\quad -.667j$

$(2\angle 90°)(2\angle 0°)$ $\quad (2j)(1)$ $\quad .667\angle -90°$ $\quad (6\angle 0°)(.667\angle -90°)$

$1\angle 90°$ $\quad 2j+1$ $\quad 9\angle 90° \rightarrow 9$

$\frac{(2\angle 90°)(1\angle 0°)}{2.24\angle 63.43°} = .894\angle 26.57° = Z_1$

$.8 + .4j = Z_1$

10A $\quad 9$ $\quad Z_1$ $\quad -.667j$

$\frac{(.894\angle 26.57)(.667\angle -90)}{.8 + .4j - .667j} = .71\angle -44.98$?

$.8 - .267j$

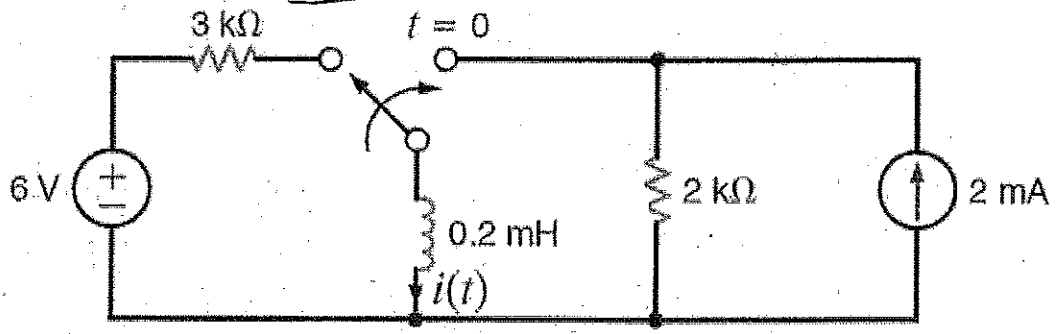
$.84\angle -18.45°$

10A $\quad Z_1$ $\quad .71\angle 44.98$ $\quad .71\angle 44.98$

T→N

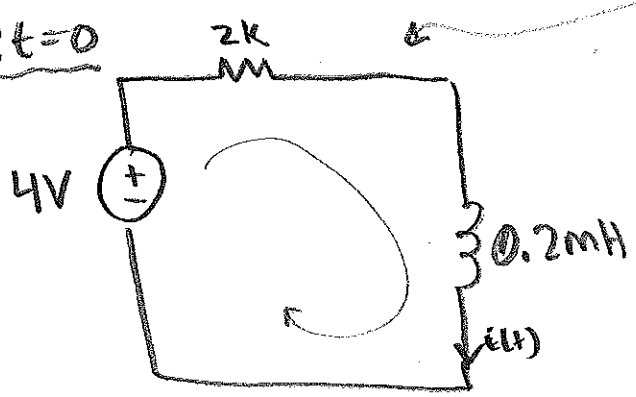
$\rightarrow \boxed{i = 10A}$

Problem4. Determine $i(t)$ for $t > 0$ in the circuit below:



N→T

@ t=0



KVL: $-4 + 2ki + L\frac{di}{dt} = 0$

$L\frac{di}{dt} + 2ki = 4$

$\frac{di}{dt} + 1000000i = 20000$

$x(t) = x_f + x_n$

$x_f = K \rightarrow 1000000k = 20000$

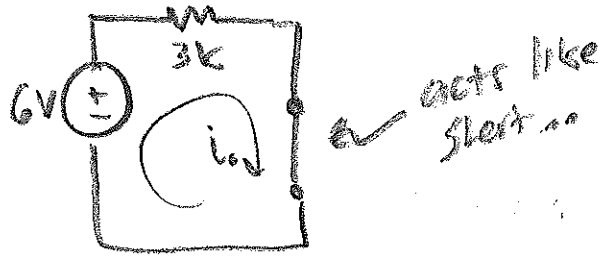
$\rightarrow k = .002$

$x_n \rightarrow ke^{st}$, $s = -1000000$

$\rightarrow s + 1000000 = 0$

$\rightarrow i(t) = .002 + k_1 e^{-1000000t}$

Note: @ t(0⁻),



KVL: $-6 + 3ki = 0$

$i = \frac{6}{3k} = 2mA$

$\therefore i(0) = 2mA$

(I.C.)

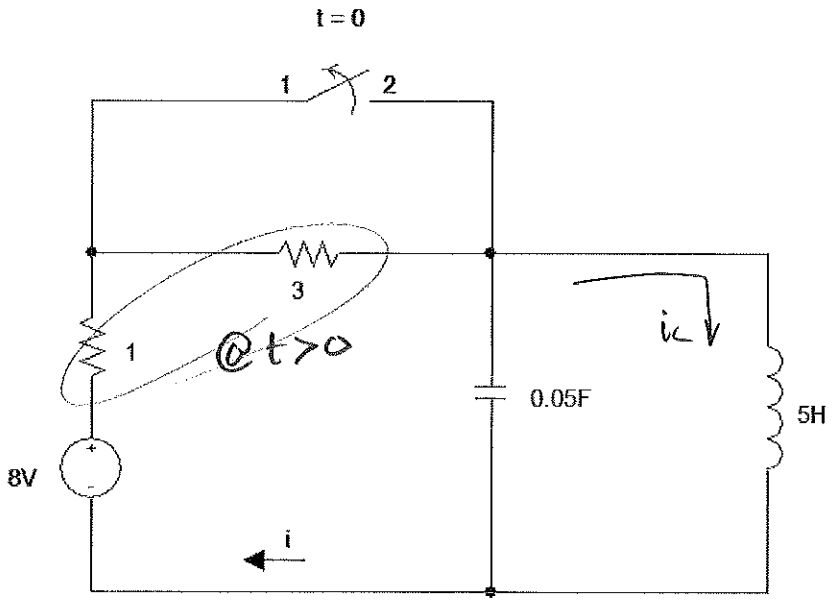
$i(0) = .002 = .002 + k_1 e^{-1000000(0)}$

$\rightarrow k_1 = 0$ ...

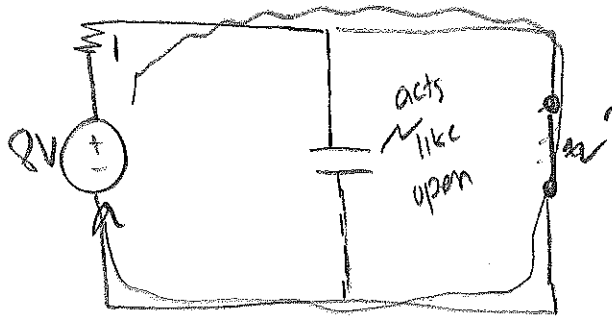
$\therefore \boxed{i(t) = 2mA} \quad @ t > 0$

... guess this makes sense. Inductor continues to act like short as same current flows through it.

Problem5. Find *i(t)* for *t > 0* if the circuit is in DC steady state at $t = 0^-$.



Note: @ $t = 0^-$

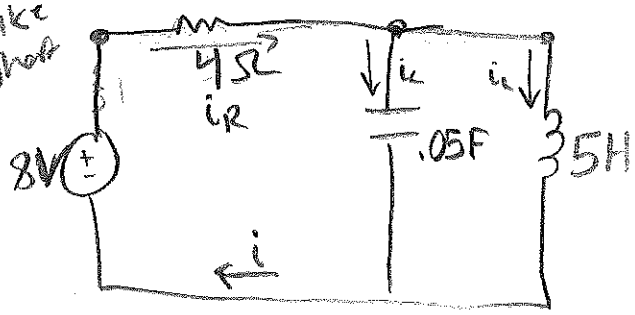


KVL: $-8 + 1i = 0$

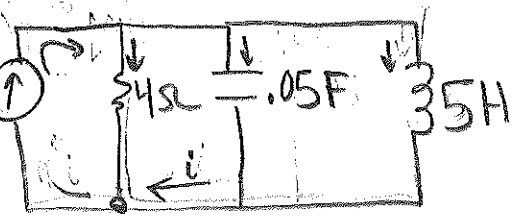
$i(0^-) = 8A$ (I.C.)

$V_C(0) = 0$

@ $t > 0$,



T→N $\quad i = i_C + i_L$



$$\left[\frac{1}{C}\int v\,dt + i(0) = L\frac{di_L}{dt}\right]\frac{d}{dt}$$

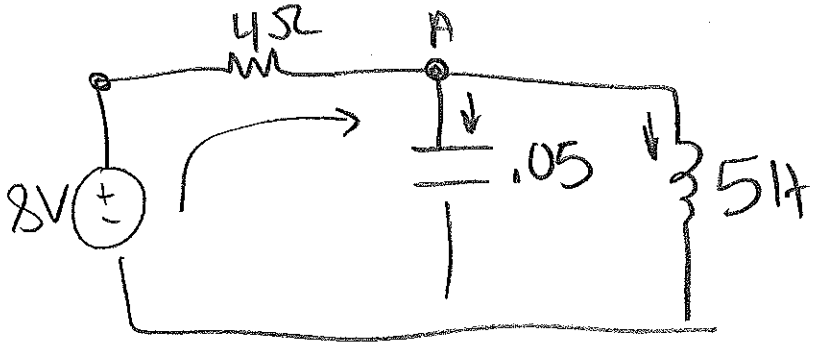
$$i_C = C\frac{dv}{dt}$$

$$i_L = \frac{1}{L}\int i\,dt + Y_L(0)$$

$$i_C = L\frac{d^2i_L}{dt^2}$$

25

see attachment



KCL@A

$$\frac{8-V_A}{4} = C\frac{dV}{dt} + \frac{1}{L}\int V\,dt + i(0) \qquad \text{Let } V_A = V_L$$

$$2 - V_A = C\frac{dV}{dt} + \frac{1}{L}\int V\,dt \qquad \frac{d}{dt}$$

$$C\frac{d^2V}{dt^2} + \frac{dV}{dt} + \frac{1}{L}V = 0$$

$$\frac{d^2V}{dt^2} + \frac{1}{.05}\frac{dV}{dt} + \frac{1}{(5)(0.05)}V = 0$$

$$\frac{d^2V}{dt^2} + 20\frac{dV}{dt} + 4V = 0 \quad (Eq1)$$

Note: $\omega^2 = 4 \Rightarrow \omega = 2$, $2\zeta = 20 \Rightarrow \zeta = 5$, $\zeta > 1 \Rightarrow$ over-damped

$$s^2 + 20s + 4 = 0$$

$$s_1, s_2 = \frac{-20 \pm \sqrt{400-16}}{2}$$

$$-10 + \frac{19.6}{2} = -0.2$$

$$-10 - \frac{19.6}{2} = -19.8$$

$$\rightarrow V(t) = k_1 e^{-0.2t} + k_2 e^{-19.8t}$$

$$V_c(0) = 0 = k_1 + k_2 \Rightarrow k_1 = -k_2$$

$$V(t) = k_1 e^{-.2t} - k_1 e^{-19.8t}$$

~~$i = C\frac{dv}{dt} = C\left(k_1(-29.6)e^{-29.6(0)} = k_1 9.6 e^{0}\right)$~~

~~$i(0) = 8$~~

$$i(0) = 8 = C\frac{dv}{dt} = C(-.20k_1 + 19.8k_1)$$

$$160 = 19.58\,k_1$$

$$k_1 = \underline{8.17}$$

$$k_2 = \underline{-8.17}$$

$$\therefore \underline{V(t) = 8.17e^{-.2t} - 8.17e^{-19.8t}}$$

Now...

$$i = i_C + i_L$$

$$= C\frac{dv}{dt} + \frac{1}{L}\int v\,dt + i(0)^{8}$$

So...

$$i(t) = .05\left((8.17)(-.2)e^{-.2t} + (8.17)(19.8)e^{-19.8t}\right) + \frac{1}{5}\left(-\frac{8.17}{.2}e^{-.2t} + \frac{8.17}{19.8}e^{-19.8t}\right) + 8$$

... very difficult problem...

... doing 2nd order is easy... getting it setup is the puzzle.

Soln 2. $i_c = C\frac{dv}{dt}$

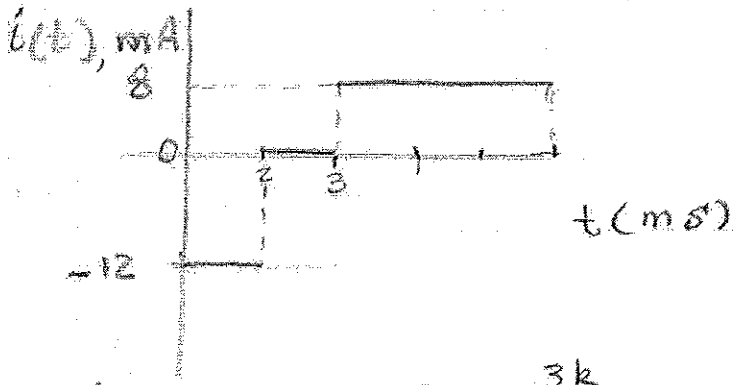
$t < 0 \quad v = 0 \quad i_c = 0$

$0 < t < 2ms, \; v = -6000t, \; i_c = 2\times10^{-6}(-6000) = -12mA$

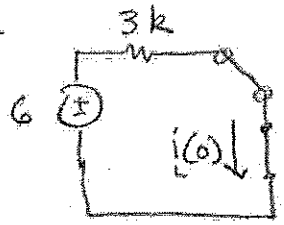
$2ms < t < 3ms, \; v = -12, \; i_c = 0$

$3ms < t < 6ms, \; v = -24 + 4000t, \; i_c = 2\times10^{-6}(4000) = 8mA$

$t > 6ms, \; v = 0, \; i_c = 0$

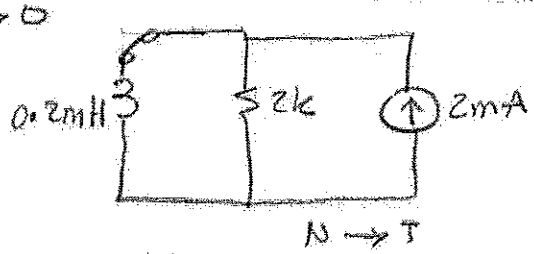


Soln 4. For $t = 0^-$

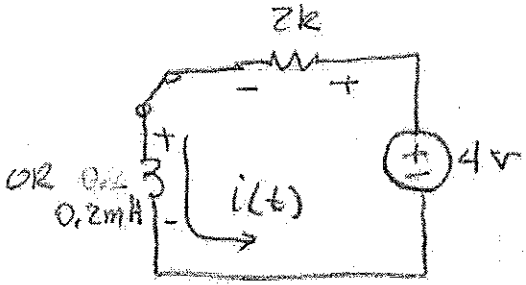


$i_L(0^-) = i_L(0) = \frac{6}{3k} = 2mA$

For $t > 0$



N → T



ckT L

KVL for ckT L :

$$-4 + 2k\,i + 2\times10^{-4}\frac{di}{dt} = 0$$

$$\frac{di}{dt} + 10^{+7}\,i = 2\times10^{4}, \quad i_f = K_1$$

$$0 + 10^{7}K_1 = 2\times10^{4}, \quad K_1 = 2\times10^{-3}A = 2mA$$

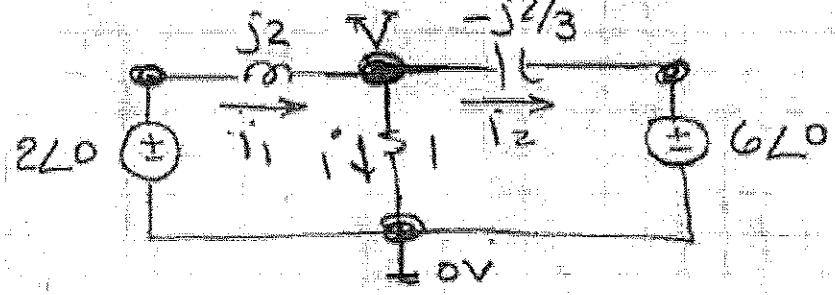
$$i_n = K_2 e^{-10^7 t}, \quad i(t) = i_n + i_f = K_2 e^{-10^7 t} + 2mA$$

$$i(0) = 2mA = K_2(1) + 2mA \Rightarrow K_2 = 0$$

$$i(t) = 2mA.$$

Soln 3 Test 2. MC SP 2=18

$\omega = 2$ rad/s then $\omega L = 2\,\Omega$ $\frac{1}{\omega C} = \frac{2}{3}\,\Omega$



$i_1 = i + i_2$ $\quad \frac{2-V}{j2} = \frac{V}{1} + \frac{V-6}{-j2/3}$

$\frac{2-V}{j2} = V + \frac{3(V-6)}{-j2}$ $\quad 2-V = j2V - 3V + 18$

$-16 = V + j2V - 3V = j2V - 2V = (-2+j2)V$

$-8 = (-1+j)V$

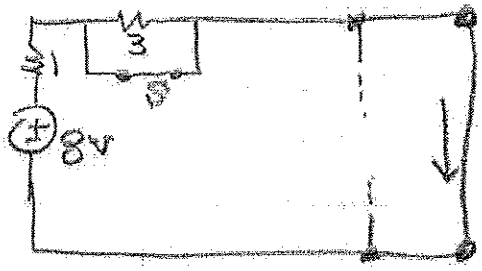
$-j8 = (-j + j^2)V$

$-j8 = (-j-1)V$ $\quad j8 = (j+1)V$

$V = \frac{j8}{1+j} = \frac{8\angle 90}{1.4\angle 45} = 5.7\angle 45^\circ$ V

$i = \frac{V}{1\,\Omega} = 5.7\angle 45^\circ$ A $\quad i(t) = 5.7\cos(2t+45)$

Soln 5. @ $t=0^-$



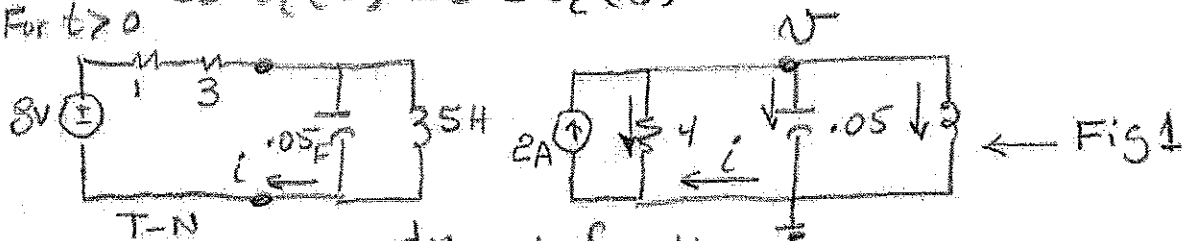
$i_L = \frac{8}{1} = 8A$

3Ω is short by the S!

Short across C;

So $v_c(0^-) = 0 = v_c(0)$

For $t>0$



← Fig 1

$$2 = \frac{v}{4} + .05\frac{dv}{dt} + \frac{1}{5}\int v\,dt + i_L(0) = 0 \quad \text{EQ 1}$$

$$\Rightarrow \frac{d^2v}{dt^2} + 5\frac{dv}{dt} + 4v = 0 \Rightarrow s^2+5s+4=0,\ s_1=-1,\ s_2=-4$$

$$v = K_1e^{-t} + K_2e^{-4t} \qquad v_c(0)=0=K_1+K_2,\ K_1=-K_2$$

Evaluate EQ @ $t=0$ $\quad 2 = \frac{v_c(0)}{4} + .05\left.\frac{dv}{dt}\right|_{t=0} + 0 + 8$

$$\left.\frac{dv}{dt}\right|_{t=0} = -120$$

$$\frac{dv}{dt} = -K_1e^{-t} - 4K_2e^{-4t}$$

$$\left.\frac{dv}{dt}\right|_{t=0} = -120 = -K_1 - 4K_2,\ K_1 + 4K_2 = 120$$

From Fig 1 $\quad i + \frac{v}{4} = 2A$

$K_1 = -40,\ K_2 = 40$

$$i = 2 + 10e^{-t} - 10e^{-4t}$$