8. Determine the energy absorbed by a 5 H inductor between 4 time constants and infinity if the current through the inductor is given by

$$i = 2 + 5e^{-3t} \text{ A}$$

Start from the integral definition for the energy. Evaluate all integrals. Provide the units for the energy expression.

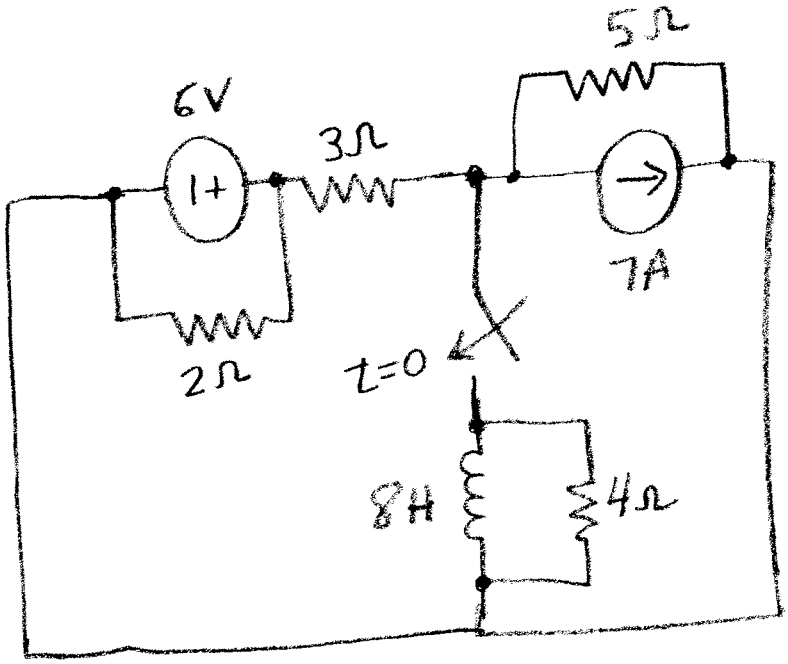
$v = 5(-15e^{-3t})$ $\quad \tau = 1/3$ sec

$$E = \int_{4\tau}^{\infty} 5(-15)(2e^{-3t} + 5e^{-6t})\,dt$$

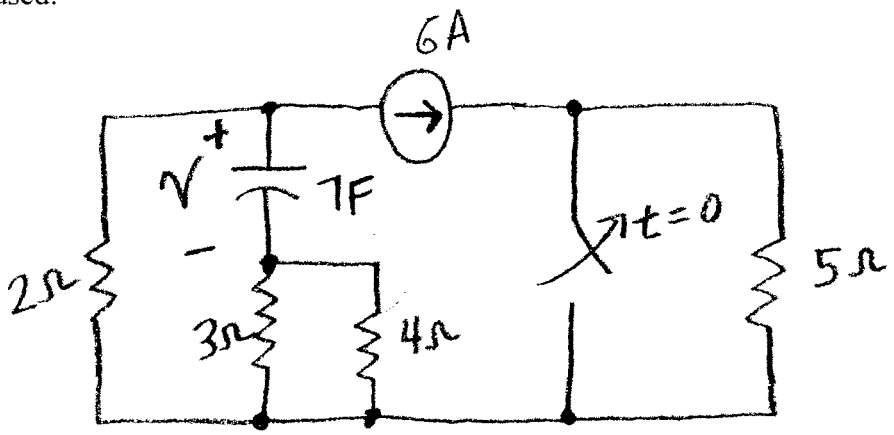
$$= 5(-15)\left[\frac{2e^{-3t}}{-3} + \frac{5e^{-6t}}{-6}\right]_{4/3}^{\infty}$$

$$= -5(15)\left[\frac{2e^{-4}}{3} + \frac{5e^{-8}}{6}\right] \text{ J or W-s}$$

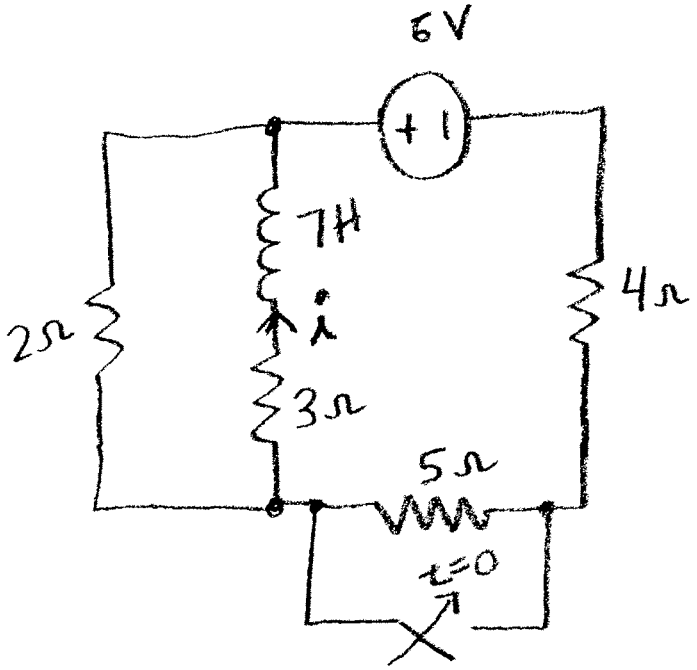
9. The switch has been open for a long time before closing at $t = 0$. Find the time constant for $t > 0$. Provide the units for the time constant. (The symbol used for elements in parallel, e.g., $7\|13$, may be left in the expression.)



10. The switch has been closed for a long time. At $t = 0$, the switch is opened. Find
a) the initial voltage for $v(t)$
b) the final voltage for $v(t)$
c) the time constant for $v(t)$ $t > 0$
d) the complete expression for $v(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



11. The switch has been open for a long time. At $t = 0$, the switch is closed. Find
a) the initial current for $i(t)$
b) the final current for $i(t)$
c) the time constant for $i(t)$ $t > 0$
d) the complete expression for $i(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



Printed Name: SOLN

Signature: _____

21 pts + 2 pts = 23 pts total
↑ units

Answer Sheet (Provide Units)

1 1. ceramic

1 2. boom!

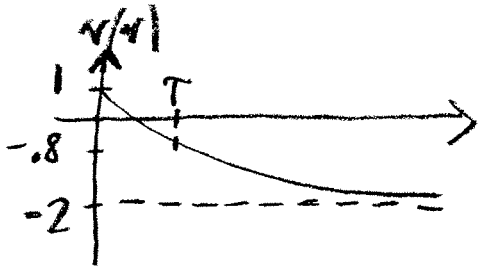
1 3. $\frac{4 \cdot 5}{4+5} + 2 + 3$ F

1 4. $[(5 \| 6) + 4 + 3] \| 2$ H

1 5. $-8(4e^{-4t})$ A

1 6. $9\left(-\frac{2}{7}e^{-4/7}\right)$ V

2 7.



2 8. $-5(15)\left[\frac{2e^{-4}}{3} + \frac{5e^{-8}}{6}\right]$ J or W-s

1 9. $8 / (3 \| 4 \| 5)$ sec

1 10(a). $-6(2)$ V

1 10(b). $-6(2)$ V

1 10(c). $[(3 \,//\, 4) + 2]\,7$ sec

1 10(d). $-6(2)$ V

3 11(a). $-6 \times \frac{2 \,//\, 3}{(2 \,//\, 3) + 4 + 5} \frac{1}{3}$ A OR $\frac{-6}{(2 \,//\, 3 + 4 + 5} \times \frac{2}{2+3}$ A

1 11(b). $-6 \times \frac{2 \,//\, 3}{(2 \,//\, 3) + 4} \frac{1}{3}$ A OR $\frac{-6}{(2 \,//\, 3) + 4} \times \frac{2}{2+3}$ A

1 11(c). $7 \,/\, [(2 \,//\, 4) + 3]$ sec

1 11(d). $-6 \times \frac{2 \,//\, 3}{6 \,//\, 3 + 4} \frac{1}{3} + \left(-6 \times \frac{2 \,//\, 3}{2 \,//\, 3 + 4 + 5} \frac{1}{3} + 6 \frac{2 \,//\, 3}{(2 \,//\, 3 + 4} \frac{1}{3}\right) e^{-4}$ A

8. Determine the energy absorbed by a 5 H inductor between 4 time constants and infinity if the current through the inductor is given by

$$i = -2 + 3e^{-5t} \text{ A}$$

Start from the integral definition for the energy. Evaluate all integrals. Provide the units for the energy expression.

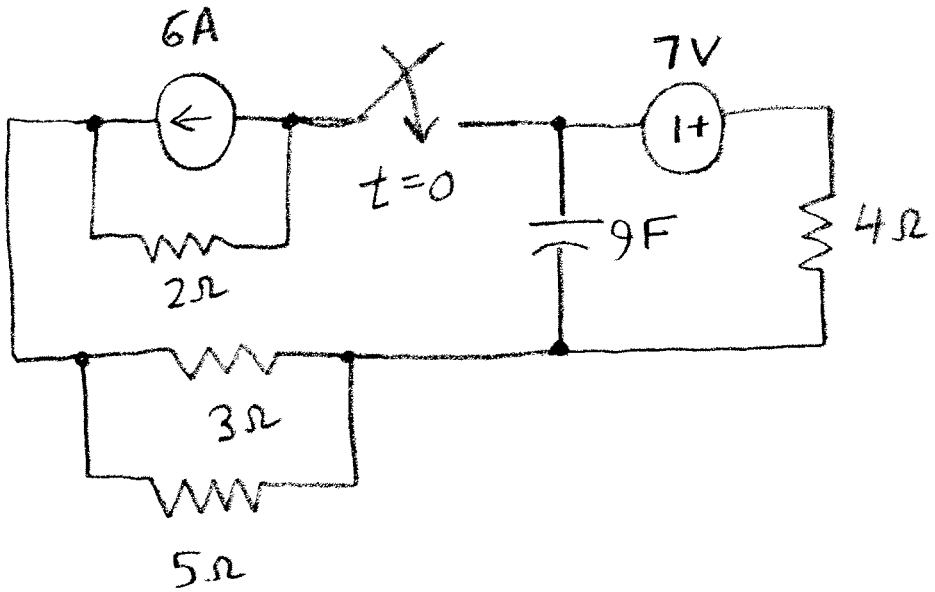
$$v = 5(-15e^{-5t})$$

$$E = \int_{4\tau}^{\infty} 5(-15e^{-5t})(-2+3e^{-5t})\,dt$$

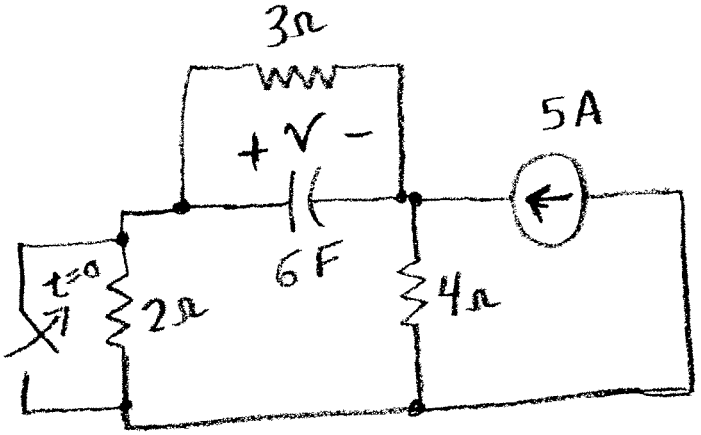
$$= 5(-15)\int_{4\tau}^{\infty} (-2e^{-5t} + 3e^{-10t})\,dt \qquad e^{-\infty} = 0$$

$$= 5(-15)\left[\frac{-2e^{-5t}}{-5} + \frac{3e^{-10t}}{-10}\right]_{4(\frac{1}{5})}^{\infty} = -5(15)\left[\frac{2e^{-4}}{5} + \frac{3e^{-8}}{10}\right]$$

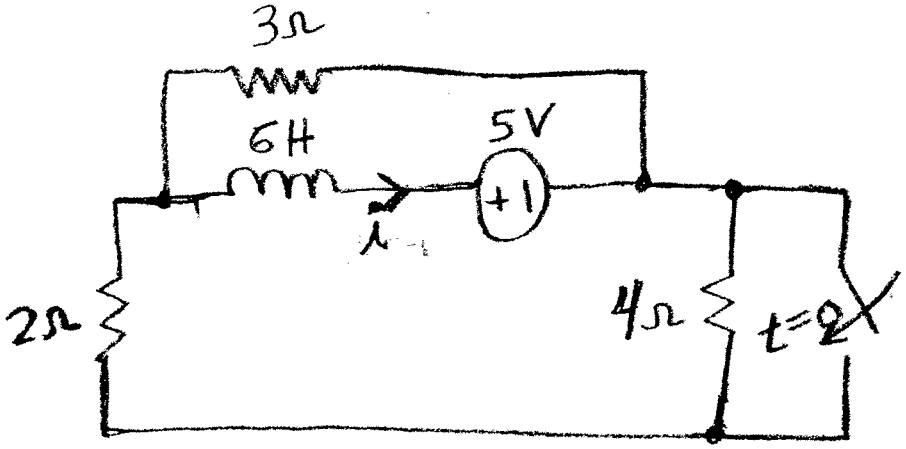
9. The switch has been open for a long time before closing at $t = 0$. Find the time constant for $t > 0$. Provide the units for the time constant. (The symbol used for elements in parallel, e.g., $7\|13$, may be left in the expression.)



10. The switch has been closed for a long time. At $t = 0$, the switch is opened. Find
a) the initial voltage for $v(t)$
b) the final voltage for $v(t)$
c) the time constant for $v(t)$ $t > 0$
d) the complete expression for $v(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



11. The switch has been open for a long time. At $t = 0$, the switch is closed. Find
a) the initial current for $i(t)$
b) the final current for $i(t)$
c) the time constant for $i(t)$ $t > 0$
d) the complete expression for $i(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



Printed Name: SOLN

Signature:

19 pts + 2 pts = 21 pts total

Answer Sheet (Provide Units)

1 1. glass

1 2. boom!

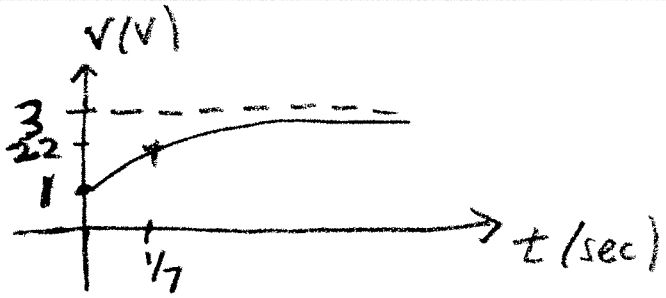
1 3. $\frac{(2+3)(4+5)}{2+3+4+5}$ F

1 4. $\{[(3\|5)+4]\|2\}+6$ H

1 5. $-8\left(\frac{2}{3}e^{-t/3}\right)$ A

1 6. $3(-7e^{-7t})$ V

2 7.



2 8. $-5(15)\left[\frac{2e^{-4}}{5}+\frac{3e^{-8}}{10}\right]$ J or W-s

1 9. $\{[(3\|5)+2]\|4\}$ 9 sec

1 10(a). $-5 \times \frac{4}{4+3+0} \times 3$ V OR $-5 \times [(0+3) \| 4] \times \frac{3}{0+3}$

1 10(b). $-5 \times \frac{4}{4+3+2} \times 3$ V OR $-5 \times [(2+3) \| 4] \times \frac{3}{2+3}$

1 10(c). $[(2+4) \| 3]\ 6$ sec

1 10(d). $-5 \times \frac{4}{4+3+2} \times 3 + \left[-5 \times \frac{4}{4+3} \times 3 + 5 \frac{4}{4+3+2} \times 3\right] e^{-t/\tau}$ V

1 11(a). $-5 / [(2+4) \| 3]$ A

1 11(b). $-5 / (2 \| 3)$ A

1 11(c). $6 / (2 \| 3)$ sec

1 11(d). $-5 / (2 \| 3) + \left(-5 / (2+4) \| 3 + 5 / (2 \| 3)\right) e^{-t/\tau}$

8. Determine the energy absorbed by a 3 H inductor between 3 seconds and infinity if the current through the inductor is given by

$$i = 7e^{-13t} \text{ A}$$

Start from the integral definition for the energy. Evaluate all integrals. Provide the units for the energy expression.

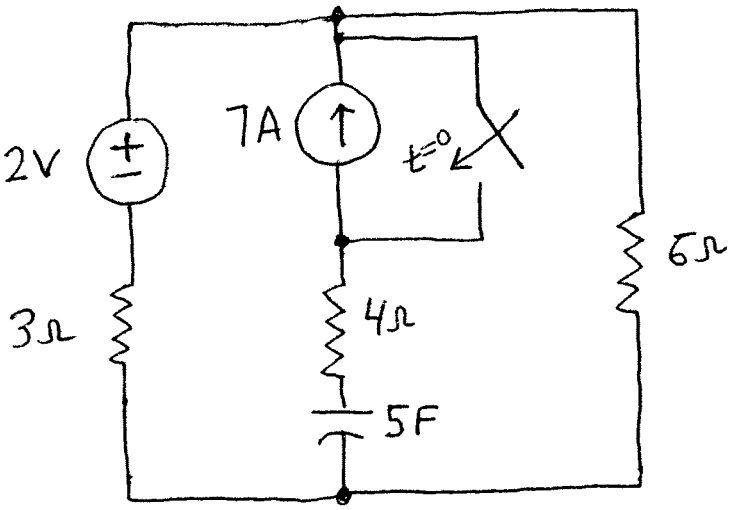
$$E = \int p\,dt = \int_3^\infty v i\,dt = \int_3^\infty L\frac{di}{dt} i\,dt$$

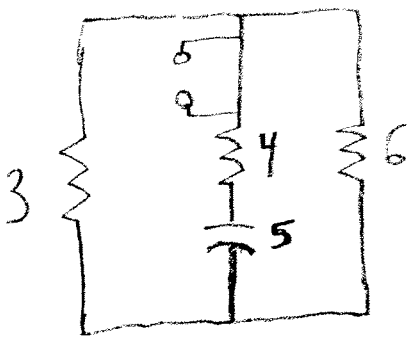
$$= \int_3^\infty 3(7)(-13)e^{-13t}\cdot 7e^{-13t}\,dt = 3\cdot 7^2(-13)\int_3^\infty e^{-26t}\,dt$$

$$= -3\cdot 7^2(-13)\left[\frac{e^{-26t}}{-26}\right]_3^\infty = \frac{3\cdot 7^2(13)}{26}\left[0 - e^{-26(3)}\right]$$

J, W-S

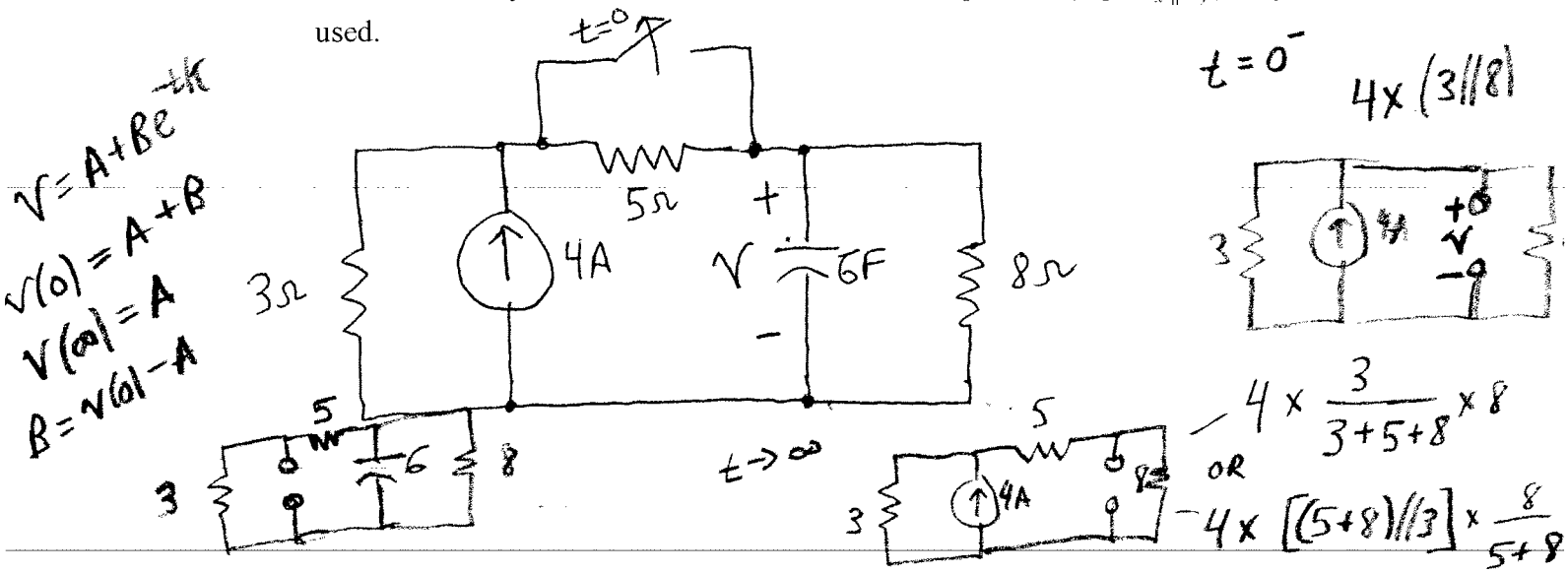
9. The switch has been open for a long time before closing at $t = 0$. Find the time constant for $t > 0$. Provide the units for the time constant. (The symbol used for elements in parallel, e.g., $7\|13$, may be left in the expression.)



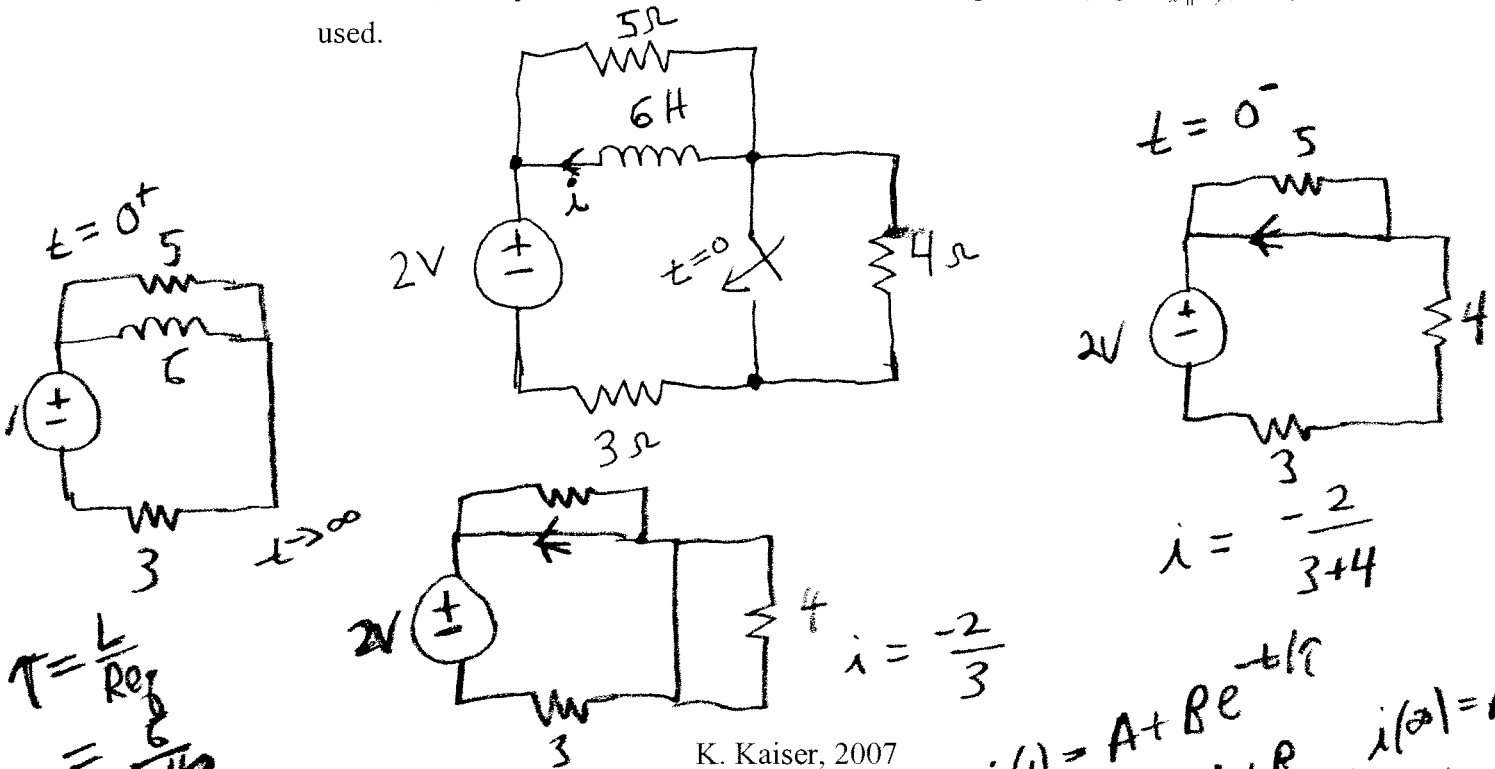


$\tau = R_{eq}C$

10. The switch has been closed for a long time. At $t = 0$, the switch is opened. Find
a) the initial voltage for $v(t)$
b) the final voltage for $v(t)$
c) the time constant for $v(t)$ $t > 0$
d) the complete expression for $v(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



11. The switch has been open for a long time. At $t = 0$, the switch is closed. Find
a) the initial current for $i(t)$
b) the final current for $i(t)$
c) the time constant for $i(t)$ $t > 0$
d) the complete expression for $i(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



Printed Name: SOLUTION

Signature: _____

Answer Sheet (Provide Units)

1 1. teflon, polyester, polypropylene, mylar, ceramic

1 2. one battery could charge the other - explosion?

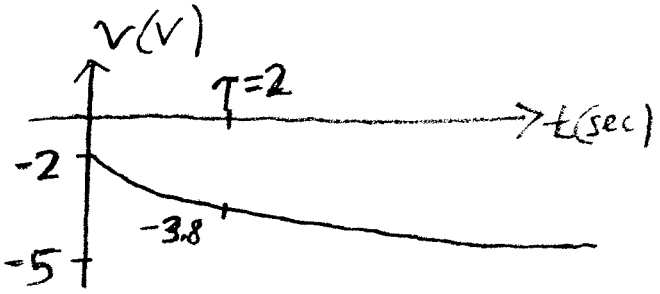
1 3. $\frac{(3+4)5}{3+4+5} + 2$ F

1 4. $[(5+6)//4//3] + 2$ H

1 5. $7 \times 36e^{-12t}$ A

1 6. $4 \times \frac{3}{8}e^{-4t}$ V

2 7.



2 8. $-\frac{3.7^2(13)}{26}e^{-26(3)}$ J or W-s

1 9. $[(3//6)+4]5$ sec

1 10(a). $4 \times \frac{3}{3+8} \times 8$ V or $4 \times (3 \| 8)$ V

1 10(b). $4 \times \frac{3}{3+5+8} \times 8$ V

1 10(c). $\tau = 6 \times [(3+5) \| 8]$ sec

1 10(d). $v(\infty) = 4 \times \frac{3}{3+5+8} \times 8$ $+ \{ 4 \times \frac{3}{3+8} \times 8 - 4 \times \frac{3}{3+5+8} \times 8 \} e^{-t/\tau}$ V
$v(0) - v(\infty)$

1 11(a). $-2 / (3+4)$ A

1 11(b). $-2/3$ A

1 11(c). $\tau = 6 / (3 \| 5)$ sec.

1 11(d). $i(\infty) = -\frac{2}{3} + \left(-\frac{2}{3+4} + \frac{2}{3} \right) e^{-t/\tau}$ A
$i(0) - i(\infty)$

Ken Kaiser
Winter 2007

EE212 Final

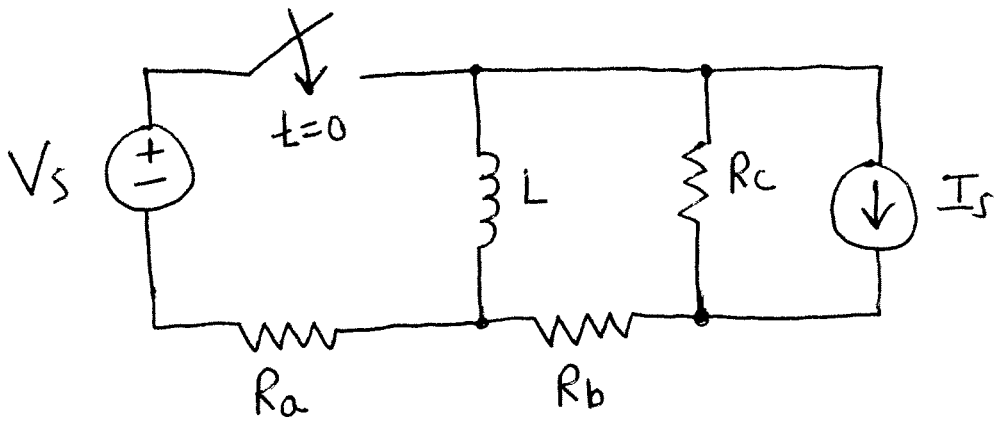
The weighting of each problem is not necessarily the same.

Test Instructions:

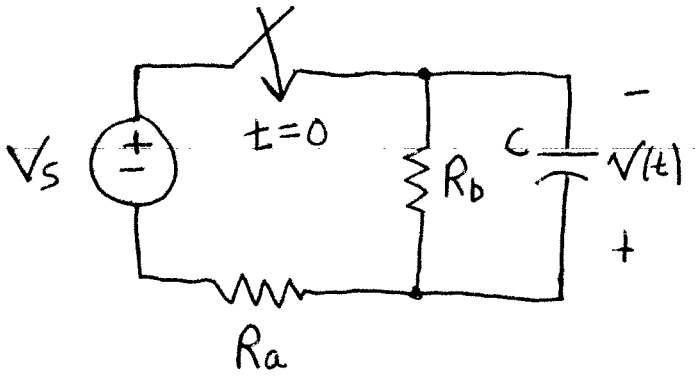
1. This is a closed book, closed notes examination. No additional tables, including integral tables, may be used.
2. Calculators, computers, and other electronic computational devices are not permitted.
3. You may work in the test booklet.
4. Provide only your final solutions on the test answer sheet.
5. Provide units on all answers.
6. The length of the examination is 1 hour.
7. For the final grade, only the answers on the answer sheet will be graded.
8. These problems are graded right or wrong. (In most cases, there is no partial credit.) If multiple solutions or intermediate work are provided, the solution is considered incorrect. Use parenthesis when needed.

---

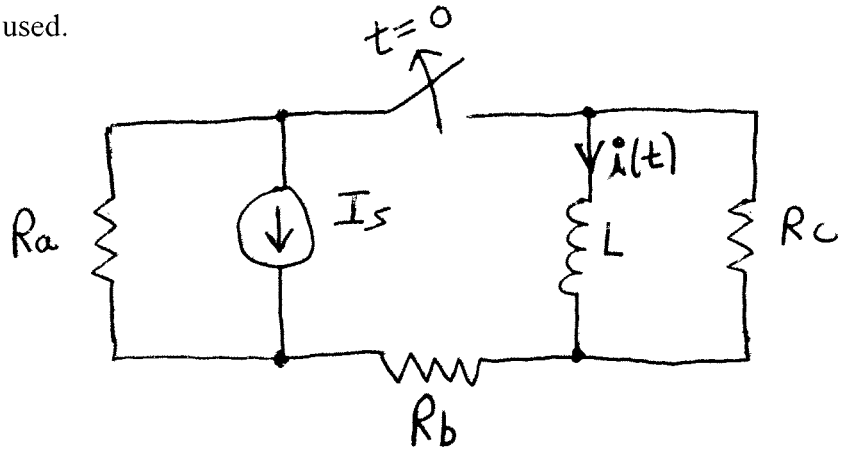
1. The switch has been open for a long time before closing at $t = 0$. Find the time constant for $t > 0$. Provide the units for the time constant. (The symbol used for elements in parallel, e.g., $7\|13$, may be left in the expression.)



2. The switch has been open for a long time. At $t = 0$, the switch is closed. Find
a) the initial voltage for $v(t)$
b) the final voltage for $v(t)$
c) the time constant for $v(t)$ $t > 0$
d) the complete expression for $v(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



3. The switch has been closed for a long time. At $t = 0$, the switch is opened. Find
a) the initial current for $i(t)$
b) the final current for $i(t)$
c) the time constant for $i(t)$ $t > 0$
d) the complete expression for $i(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



Printed Name: SOLUTION

Signature:

34 total

Answer Sheet (Provide Units)

1 1. $L / [(R_b + R_c) // R_a]$ sec.

1 2(a) 0 V

1 2(b) $-V_s \times R_b/(R_a + R_b)$ V

1 2(c) $\tau = (R_b // R_a)C$ sec

1 2(d) $-V_s \frac{R_b}{R_a + R_b}(1 - e^{-t/\tau})$ V

1 3(a) $-I_s \times \frac{R_a}{R_a + R_b}$ A

1 3(b) 0 A

1 3(c) $\tau = \frac{L}{R_c}$ sec

1 3(d) $-I_s \frac{R_a}{R_a + R_b} e^{-t/\tau}$ A

3 4. $v(t) = \frac{A\omega L R_b}{\sqrt{(R_a R_b)^2 + (\omega L R_a + \omega L R_b)^2}} \cos(\omega t + \theta + 90^\circ - \tan^{-1}\frac{\omega L(R_a + R_b)}{R_a R_b}$

2 5. $-A \times \frac{\frac{1}{j\omega C_b}}{\frac{1}{j\omega C_b} + R + j\omega L + \frac{1}{j\omega C_x}} \times \frac{1}{j\omega C_x}$

1 6. $\left(\frac{1}{j\omega C} + j\omega L\right) // R$

8. Determine the energy absorbed by a 7 F capacitor between 0 seconds and 4 time constants if the voltage across the capacitor is given by

$$v = -1 + 3e^{-4t} \text{ V}$$

Start from the integral definition for the energy. Evaluate all integrals. Provide the units for the energy expression.

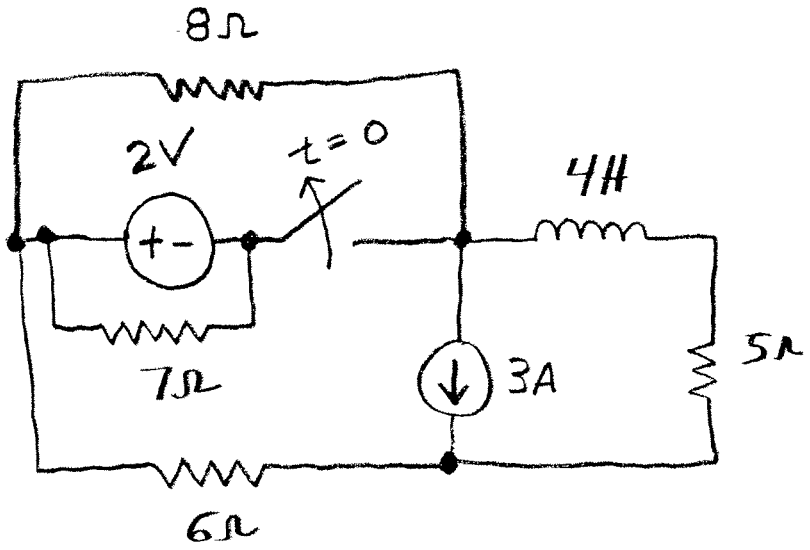
$$E = \int p\,dt = \int_0^{4\tau} (-1+3e^{-4t})\,7(-12e^{-4t})\,dt \qquad i = C\frac{dv}{dt} = 7(-12e^{-4t})$$

$$= 7(-12)\int_0^{4\tau} (-e^{-4t} + 3e^{-8t})\,dt \qquad \tau = 1/4$$

$$= 7(-12)\left[\frac{e^{-4t}}{4} - \frac{3e^{-8t}}{8}\right]_0^{4\tau} \qquad @\ t = 4\tau = 1$$

$$= 7(-12)\left[\frac{e^{-4}}{4} - \frac{3e^{-8}}{8} - \frac{1}{4} + \frac{3}{8}\right]$$

9. The switch has been closed for a long time before opening at $t = 0$. Find the time constant for $t > 0$. Provide the units for the time constant. (The symbol used for elements in parallel, e.g., $7\|13$, may be left in the expression.)



$$\tau = \frac{L}{R_{eq}}$$

10. The switch has been open for a long time. At $t = 0$, the switch is closed. Find
a) the initial voltage for $v(t)$
b) the final voltage for $v(t)$
c) the time constant for $v(t)$ $t > 0$
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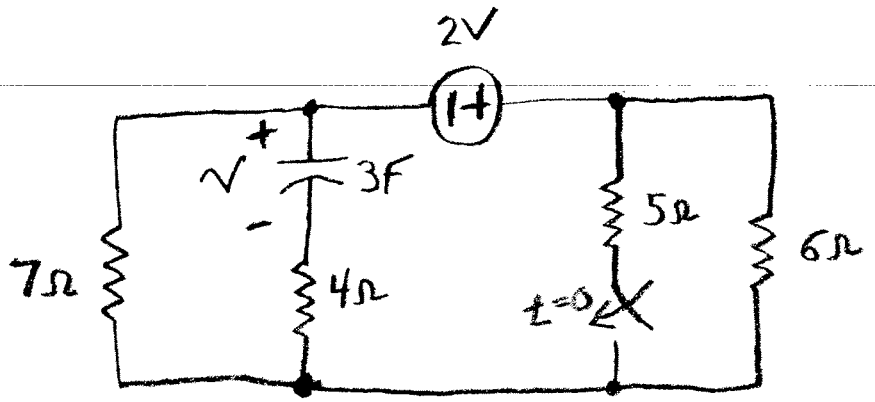
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



11. The switch has been closed for a long time. At $t = 0$, the switch is opened. Find
a) the initial current for $i(t)$
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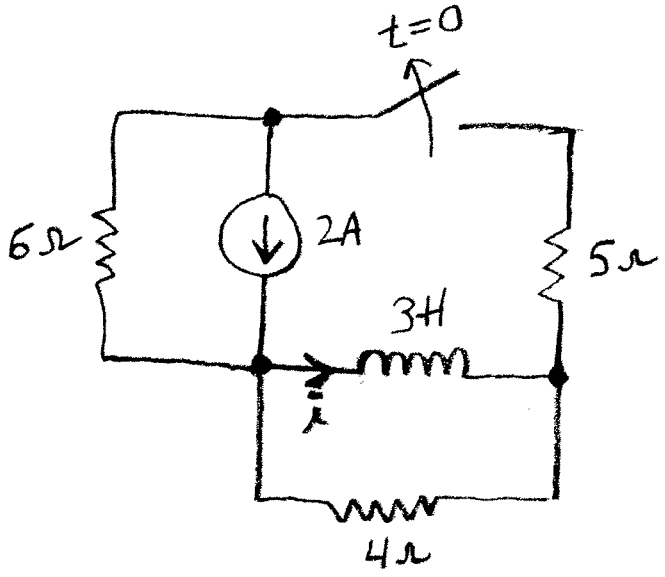


Winter 2009

Printed Name: SOLUTION

Signature:

Answer Sheet (Provide Units)

19 pts + 2 pts (units) = 21 pts total

1 1. glass

1 2. explosion!

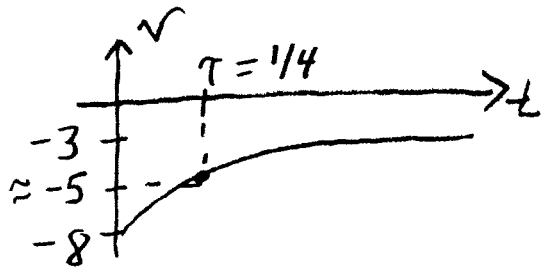
1 3. $\frac{(4+5)3}{4+5+3} + 2$ F

1 4. $(2+3+4)\|5\|6$ H

1 5. $-\frac{30}{4}e^{-4t}$ A

1 6. $-24e^{-3t}$ V

2 7.



2 8. $7(-12)\left[\frac{e^{-4}}{4} - \frac{3e^{-8}}{8} - \overbrace{\frac{1}{4} + \frac{3}{8}}^{1/8}\right]$ J, W-s

1 9. $4/(5+6+8)$ sec

1 10(a). $-2\,\frac{7}{6+7}$ V

1 10(b). $-2\,\frac{7}{(6\|5)+7}$ V

1 10(c). $[(5\|6\|7)+4]3$ sec

1 10(d). $-2\,\frac{7}{(6\|5)+7} + \left(-2\,\frac{7}{6+7} + 2\,\frac{7}{(6\|5)+7}\right)e^{-t/\tau}$ V

1 11(a). $2\,\frac{6}{6+5}$ A

1 11(b). 0 A

1 11(c). 3/4 sec

1 11(d). $2\,\frac{6}{6+5}e^{-t/\tau}$ A

Ken Kaiser
Winter 2009

EE212 Final

The weighting of each problem is not necessarily the same.

Test Instructions:

1. This is a closed book, closed notes examination. No additional tables, including integral tables, may be used.
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3. You may work in the test booklet.
4. Provide only your final solutions on the test answer sheet.
5. Provide units on all answers.
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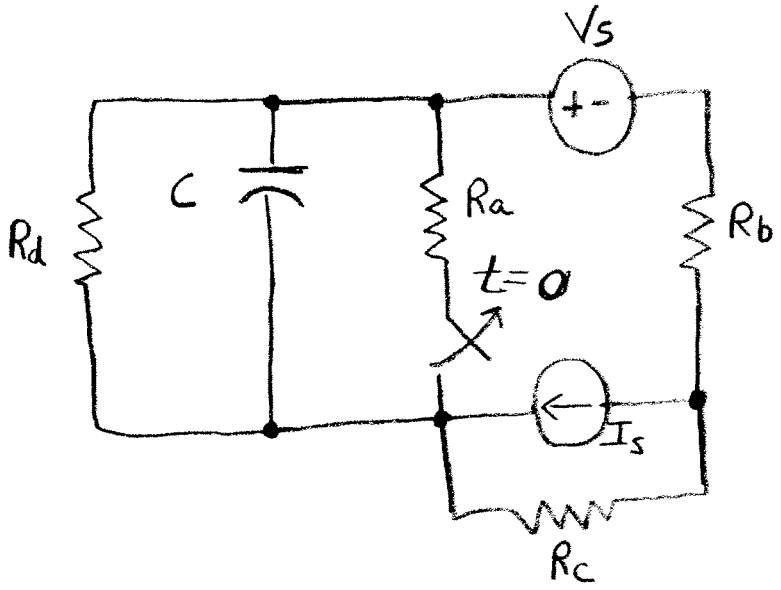
---

1. The switch has been closed for a long time before opening at $t = 0$. Find the time constant for $t > 0$. Provide the units for the time constant. (The symbol used for elements in parallel, e.g., $7\|13$, may be left in the expression.)



2. The switch has been open for a long time. At $t = 0$, the switch is closed. Find
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b) the final voltage for $v(t)$
c) the time constant for $v(t)$ $t > 0$
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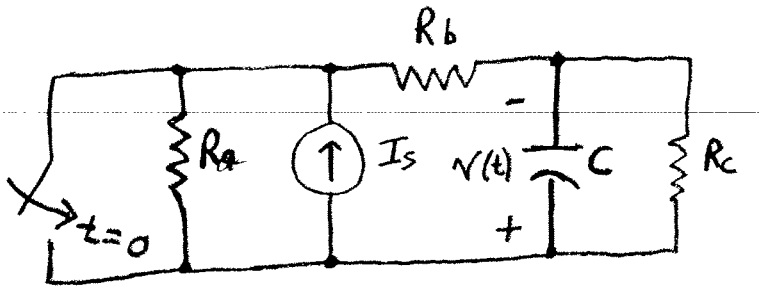
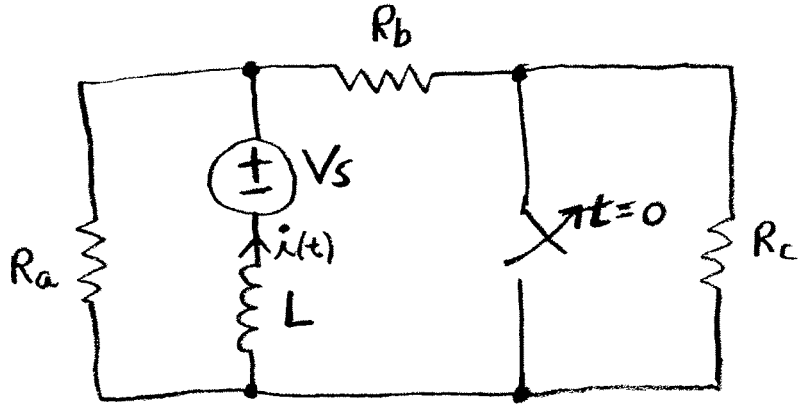
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



3. The switch has been closed for a long time. At $t = 0$, the switch is opened. Find
a) the initial current for $i(t)$
b) the final current for $i(t)$
c) the time constant for $i(t)$ $t > 0$
d) the complete expression for $i(t)$ $t > 0$
If needed, the symbol for two resistive elements in parallel (e.g., $R_x \| R_y$) may be used.



50 pts total

Printed Name: SOLUTION

Signature: _____

Answer Sheet (Provide Units)

1 1. $C((R_b+R_c)\,//\,R_d)$ sec.

1 2(a) $-I_s \frac{R_a}{R_a+R_b+R_c} R_c$ V

1 2(b) 0 V

1 2(c) $C(R_b\,//\,R_c)$ sec

1 2(d) $-I_s \frac{R_a}{R_a+R_b+R_c} R_c e^{-t/\tau}$ V

1 3(a) $\frac{V_s}{R_a\,//\,R_b}$ A

1 3(b) $V_s / ((R_b+R_c)\,//\,R_a)$

1 3(c) $L/(R_b+R_c)\,//\,R_a$ sec

1 3(d) $\frac{V_s}{(R_b+R_c)\,//\,R_a} + \left(\frac{V_s}{R_a\,//\,R_b} - \frac{V_s}{(R_b+R_c)\,//\,R_a}\right) e^{-t/\tau}$

4 4. $\frac{-12}{\sqrt{8}}\cos(2t+100-45^\circ)$, $\frac{12}{\sqrt{8}}\cos(2t+55^\circ+180^\circ)$ V

($\sqrt{8}=2\sqrt{2}$; 55° and 235°)

2 5. $A\angle 0^\circ \times \frac{1/j\omega C}{1/j\omega C + R}$ V

2 6. $\left[(R_b+R_a)\,//\,\frac{1}{j\omega C}\right] + j\omega L$