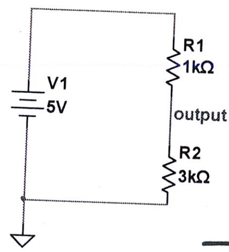
ECET 337
Exam 1A
Spring 2025

Solutions
Name

Show *all* off your work. No work => no credit.
Include units properly in all calculations and answers. No units => no credit.

1.

a. [6%] Calculate the voltage at the output with respect to common.



$V_{output} =$ 3.75V

$$\frac{5V * 3k\Omega}{1k\Omega + 3k} = 3.75V$$

1 2 1 2

or

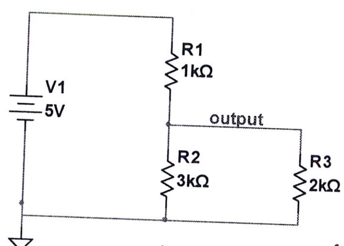
$$I = 5V/(1k\Omega + 3k\Omega) = 1.25mA$$

1 2 1

$$V = 1.25mA * 3k\Omega = 3.75V$$

2

b. [9%] Calculate the voltage at the output with respect to common.



1.2kΩ

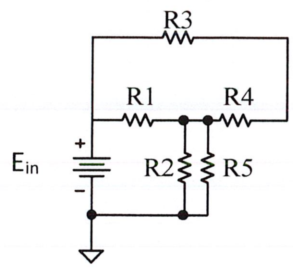
$V_{output} =$ 2.73V

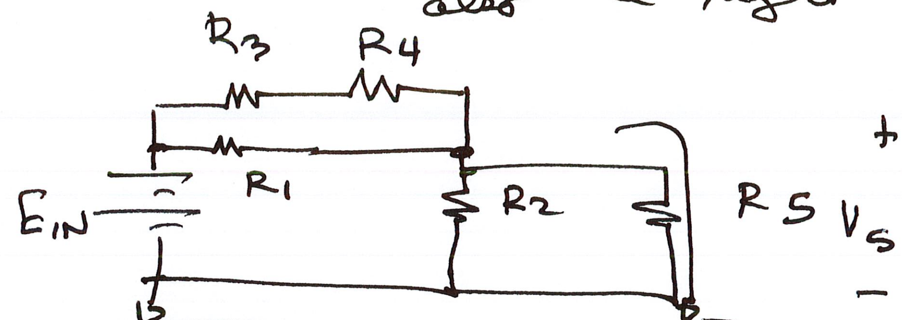
$$R_{23} = \left((3k\Omega)^{-1} + (2k\Omega)^{-1}\right)^{-1} = 1.2k\Omega$$ 3

$$V_{OUT} = \frac{5V * 1.2k\Omega}{\underbrace{1k\Omega + 1.2k\Omega}_{2}} = 2.73V$$ 1

Answers below are an EXAMPLE of a correct solution. Other solutions may also be right

2. Impedance Combination





[25%] Complete a *plan* to calculate the current through R5. Place the equations in the right order, using the nomenclature developed for solving a circuit using impedance combination. Enter your equations, in the *correct order*, in the numbered cells below.

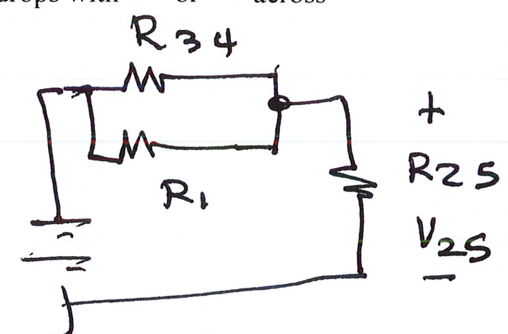
Indicate the correct equations. Do *not* say $R_{ab} = R_a//R_b$ if R_a is in parallel with R_b. Instead, provide the correct equation to actually calculate R_{ab} given the values of R_a and R_b.

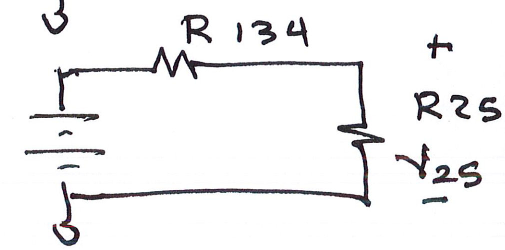
Redraw the schematic as often as necessary to clearly explain your plan.

Be sure to indicate current directions on the schematic, and voltage drops with + - or - + across the affected component.

-3 each error

1 $R_{25} = (R_2^{-1} + R_5^{-1})^{-1}$	14
2 $R_{34} = R_3 + R_4$	15
3 $R_{134} = (R_{34}^{-1} + R_1^{-1})^{-1}$	16
4 $V_{25} = \dfrac{E_{IN} \; R_{25}}{R_{134} + R_{25}}$	17
5 $V_5 = V_{25}$	18
6 $I_{R5} = V_5 / R_5$	19
7	20
8	21
9	22
10	23
11	24
12	25
13	26





$i = C \frac{dv}{dt}$ $v = \frac{1}{C}\int_0^t i\, dt$ CAP

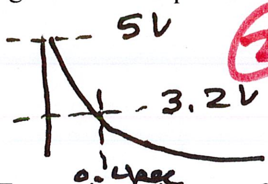
$i = \frac{1}{L}\int_0^t v\, dt$ $v = L\, di/dt$ INDUCTOR

Put your calculator in the *Exact* mode under Document Settings

3. Capacitors and Inductors in the Time Domain

a. [5%] Write the equation for decaying exponential voltage with an amplitude of 5 V and a time constant, $\tau = 400$ millisec.

$v_C(t) = 5e^{-t/\tau}$ 1 1 1 2



b. [10%] Write the equation for the current through a 2 μF capacitor with waveform from question 3.a. applied across it.

Begin by recording below the differential or integral relationship of i_C and v_C in terms of i_C, C, and v_C.

$\boxed{i = C\, dv/dt} = 2\mu \frac{d}{dt}\left(5e^{-t/400ms}\right)$ 5

Solve this equation. $i_C = -\frac{e^{-\frac{5t}{2}}}{4000}$ 2

Write this equation in *standard* form. $i_C = -2\cancel{5}\mu\, e^{-t/0.4}$ 3

c. [5%] Write the equation for a voltage *ramp* that begins at 0 V and rises 5 V in 0.6 seconds.

$v(t) = 8.33t$ $\frac{5}{0.6}t = 8.33t$ 2 3

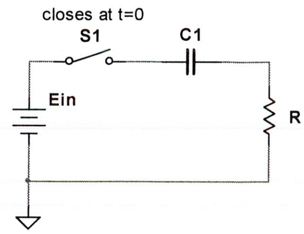
d. [10%] Write the equation for the current through a 300 mH inductor which has the voltage ramp from step c driven into it.

Begin by recording below the differential or integral relationship of i_L and v_L in terms of i_L, L, and v_L.

$\boxed{i = \frac{1}{300m}\int_0^t 8.33t}\, dt = \frac{833}{60}t^2$ 5

Solve this equation. $i_L = 13.88\, t^2$ 2 3

4. RC Circuit solution with Differential Equations



a. [5%] Use Kirchhoff's voltage law to write an equation that sums the voltages around the loop.

$$E_{IN} = v_c + v_R$$

b. [7%] Use Ohm's law and the relationship of voltage and current for a capacitor to convert that voltage equation to a first order differential equation with current, (and its derivative) as the independent variable.

Put your final answer in the form needed to use **deSolve** on the calculator. 2 2

$$E_{IN} = \frac{1}{C}\int_0^t i\,dt + iR$$

Derivative

$$0 = \frac{1}{C} i + i' R$$

1 1 1

$$i' = -\frac{1}{RC} i$$

c. [6%] What are:

$i(\infty) =$ 0 2 $i(0^+) =$ $\frac{E_{IN}}{R}$ 2 $\tau =$ RC 2

d. [12%] Solve the differential equation. Write the exact entry into your calculator, the solution for $i(t)$ given by the calculator. Then put this equation in *standard* form. 4

Calculator entry $deSolve\left(i' = \frac{-1}{r*c} * i \text{ and } i(0) = \frac{e}{r}, t, i\right)$

Calculator answer $\frac{E \quad e^{-t/(c*r)}}{r}$ 2

Standard form $i(t) =$ $\frac{E_{IN}}{R} e^{-t/RC}$ 3

$v_R(t) =$ $E_{IN}\, e^{-\frac{t}{RC}}$ 3

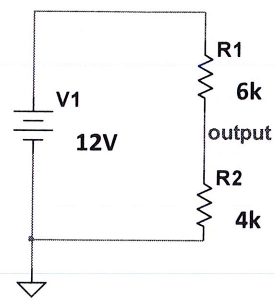
ECET 337
Exam 1B
Spring 2025

Solution
Name

Show *all* off your work. No work => no credit.
Include units properly in all calculations and answers. No units => no credit.

1.

a. [6%] Calculate the voltage at the output with respect to common.



$$V_{out} = \frac{12V * 4k\Omega}{6k\Omega + 4k\Omega} = 4.8V$$

1 2 2 1

OR

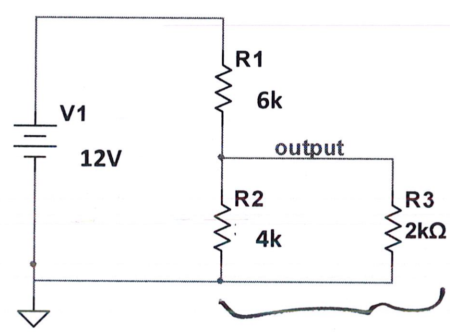
$$I = 12V / (4k\Omega + 6k\Omega)$$

$$I = 1.2mA$$

$$V = 1.2mA * 4k\Omega = 4.8V$$

V_{output} = 4.8V

b. [9%] Calculate the voltage at the output with respect to common.



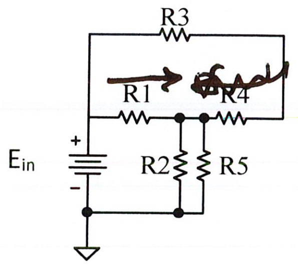
$$R_{23} = \left((4k\Omega)^{-1} + (2k\Omega)^{-1}\right)^{-1} = 1.33k\Omega$$ 3

V_{output} = 2.177V

$$V_{out} = \frac{12V * 1.33k\Omega}{6k\Omega + 1.33k\Omega}$$ 2

$$= 2.177V$$ 1

2. Impedance Combination



I_{R1}

[25%] Complete a *plan* to calculate the **current through** ~~R4~~ R1. Place the equations in the right order, using the nomenclature developed for solving a circuit using impedance combination. Enter your equations, in the *correct order*, in the numbered cells below.

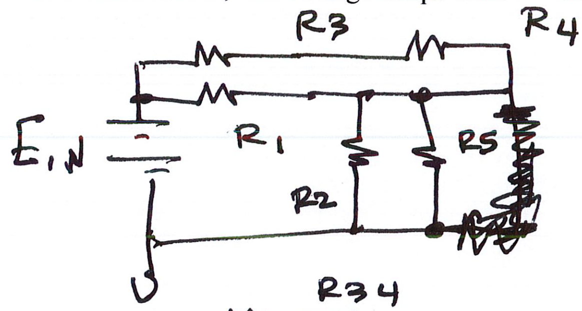
Indicate the correct equations. Do *not* say $R_{ab} = R_a//R_b$ if R_a is in parallel with R_b. Instead, provide the correct equation to actually calculate R_{ab} given the values of R_a and R_b.

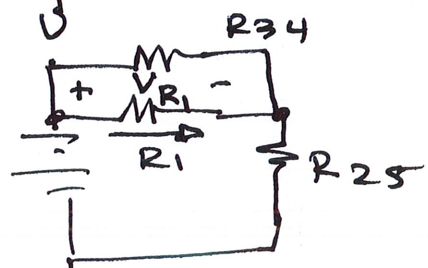
Redraw the schematic as often as necessary to clearly explain your plan.

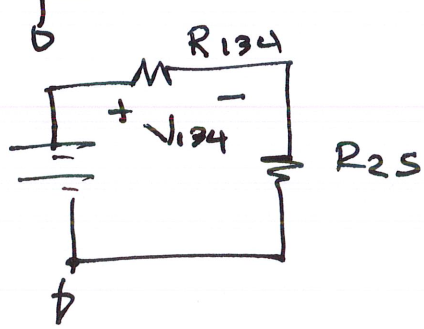
Be sure to indicate current directions on the schematic, and voltage drops with + - or - + across the affected component.

-3 pt per step missed

1	$R_{34} = R_3 + R_4$
2	$R_{25} = R_2^{-1} + R_5^{-1}$
3	~~[illegible]~~
4	$R_{134} = (R_1^{-1} + R_{34}^{-1})^{-1}$
5	$V_{134} = E_{IN}\, R_{134} / (R_{134} + R_{25})$
6	$V_{R1} = V_{134}$
7	$I_{R1} = V_{R1} / R_1$
8	
9	
10	
11	
12	
13	







$i = c\, dv/dt$

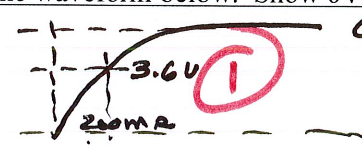
Put your calculator in the *Exact* mode under Document Settings

3. Capacitors and Inductors in the Time Domain

a. [5%] Write the equation *rising* exponential voltage with an amplitude of 6 V and a time constant, τ = 200 millisec. 1

$v_C(t) = 6(1 - e^{-t/\tau})$ 1 1 τ 200ms

Sketch the waveform below. Show 6V and 200 ms 1



1

b. [10%] Write the equation for the current through a 5 μF capacitor with waveform from question 3.a. applied across it.

Begin by recording below the differential or integral relationship of i_C and v_C in terms of i_C, C, and v_C.

$i = c\, dv/dt = 5\mu \frac{d}{dt} \, 6V (1 - e^{-t/0.2})$ 5

Solve this equation. $i_C = \dfrac{6\, e^{-5t}}{40\,000}$

Write this equation in *standard* form. $i_C = \cancel{25}\,150\mu\, e^{-t/0.2}$ 5

c. [5%] Write the equation for a voltage *ramp* that begins at 0 V and rises 12 V in 2 seconds.

$v(t) = 6t$ $\qquad \dfrac{12V}{2sec} t = 6t$ 2 3

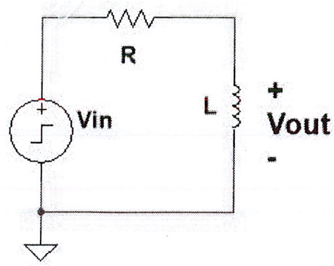
d. [10%] Write the equation for the current through a 700 mH inductor which has the voltage ramp from step c driven into it.

Begin by recording below the differential or integral relationship of i_L and v_L in terms of i_L, L, and v_L.

$i = \frac{1}{L}\int_0^t v\,dt = \frac{1}{0.7}\int_0^t 6t\, dt$ 5

Solve this equation. $i_L = \frac{30}{7} t^2 = 4.29\, t^2$ 2 3

4. RL Circuit solution with Differential Equations



a. [5%] Use Kirchhoff's voltage law to write an equation that sums the voltages around the loop.

$$v_{IN} = v_R + v_L$$

b. [7%] Use Ohm's law and the relationship of voltage and current for an inductor to convert that voltage equation to a first order differential equation with current, (and its derivative) as the independent variable.

Put your final answer in the form needed to use **deSolve** on the calculator.

$$v_{IN} = iR + L\,di/dt \quad 2 \quad 2$$

$$\frac{v_{IN}}{L} - i\frac{R}{L} = i' \qquad i' = -\frac{R}{L} * i + \frac{v_{IN}}{L} \quad 1 \quad 1 \quad 1$$

c. [6%] What are:

$i(\infty) = \dfrac{v_{IN}}{R}$ 2 $i(0^+) = 0$ 2 $\tau = \dfrac{L}{R}$ 2

d. [12%] Solve the differential equation. Write the exact entry into your calculator, the solution for $i(t)$ given by the calculator. Then put this equation in *standard* form.

Calculator entry $\text{deSolve}\left(i' = -\frac{R}{L} + \frac{V}{L} \text{ and } i(0)=0, t, i\right)$ 4

Calculator answer $\dfrac{V}{R} - \dfrac{e^{\frac{-r \cdot t}{L}} \times v}{R}$ 2

Standard form $i(t) = \dfrac{V}{R}\left(1 - e^{-t/\tau}\right) \quad \tau = L/R$ 3

$v_R(t) = V_{IN}\left(1 - e^{-t/\tau}\right) \quad \tau = L/R$ 3