Name: _____ (please print)

Signature: _____

ECE 2201 – Midterm Exam
June 18, 2019

Keep this exam closed and face up until you are told to begin.

1. This exam is closed book, closed notes. You may use one 8.5" x 11" crib sheet, or its equivalent.
2. Show all work on these pages. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit.
3. Show all units in solutions, intermediate results, and figures. Units in the quiz will be included between square brackets.
4. If the grader has difficulty following your work because it is messy or disorganized, you will lose credit.
5. Do not use red ink. Do not use red pencil.
6. You will have 90 minutes to work on this exam.

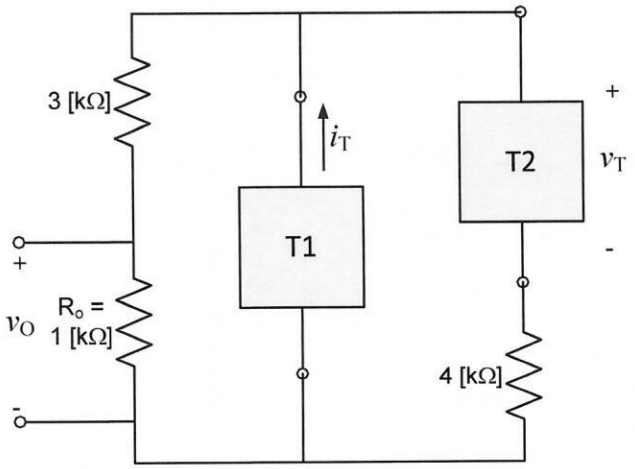
1. _____/35
2. _____/40
3. _____/25

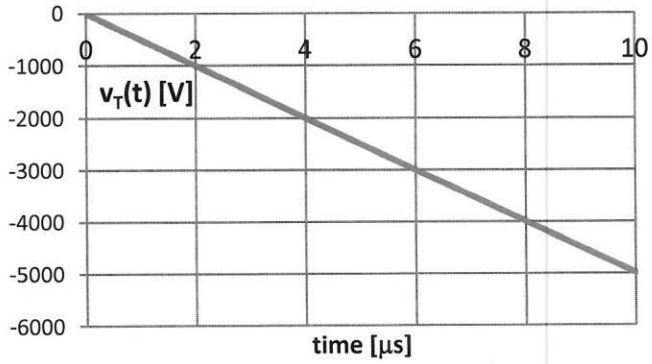
Total = 100

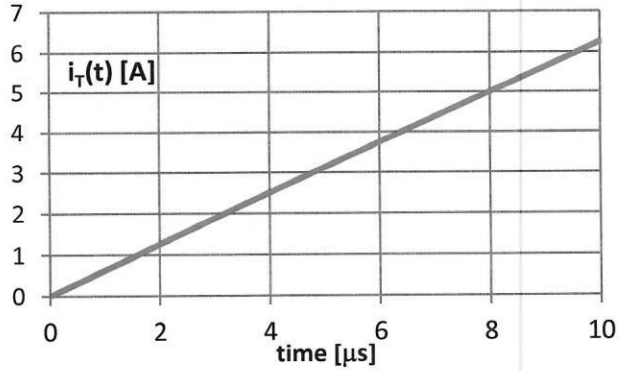
Room for extra work

1. (35 points) Two units of the revolutionary new Trombetterator have been installed in the circuit below. The Trombetterator is capable of operating as a current source or as a voltage source. The current $i_T(t)$ generated by Trombetterator T1 and the voltage $v_T(t)$ generated by Trombetterator T2 are shown in the graphs and labeled on the circuit diagram.

Find the energy delivered to the output resistor R_o over the time period $0 < t < 8$ [μs].

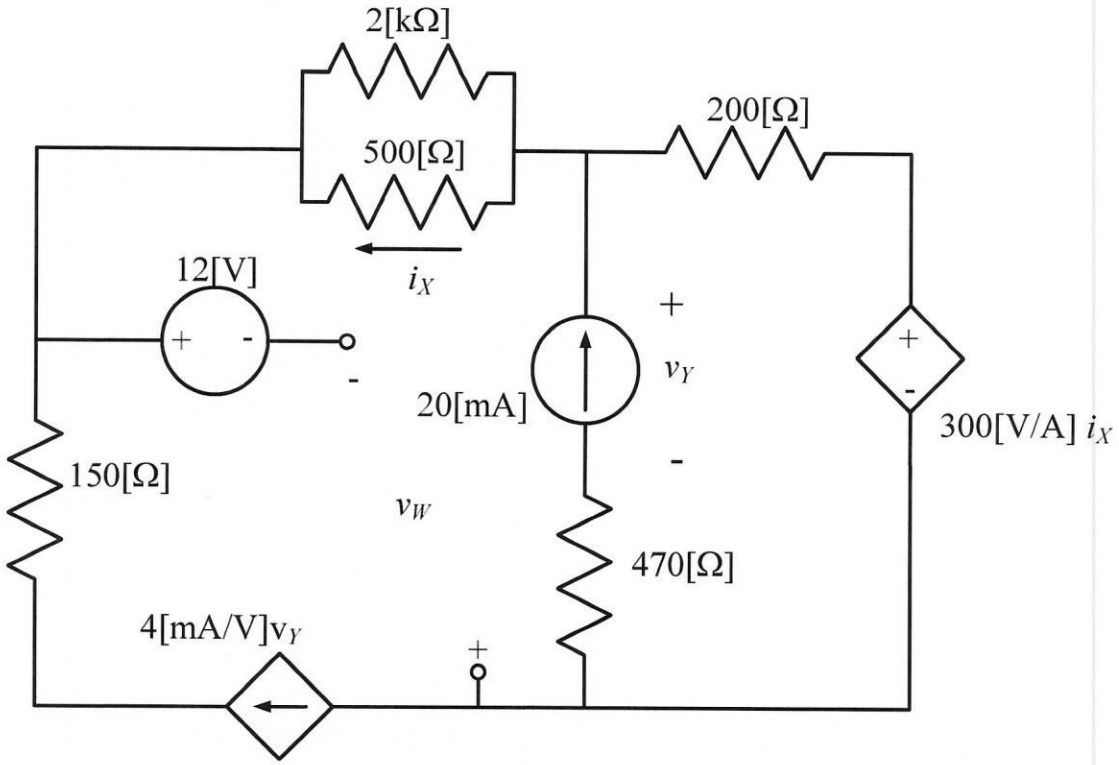






Room for extra work

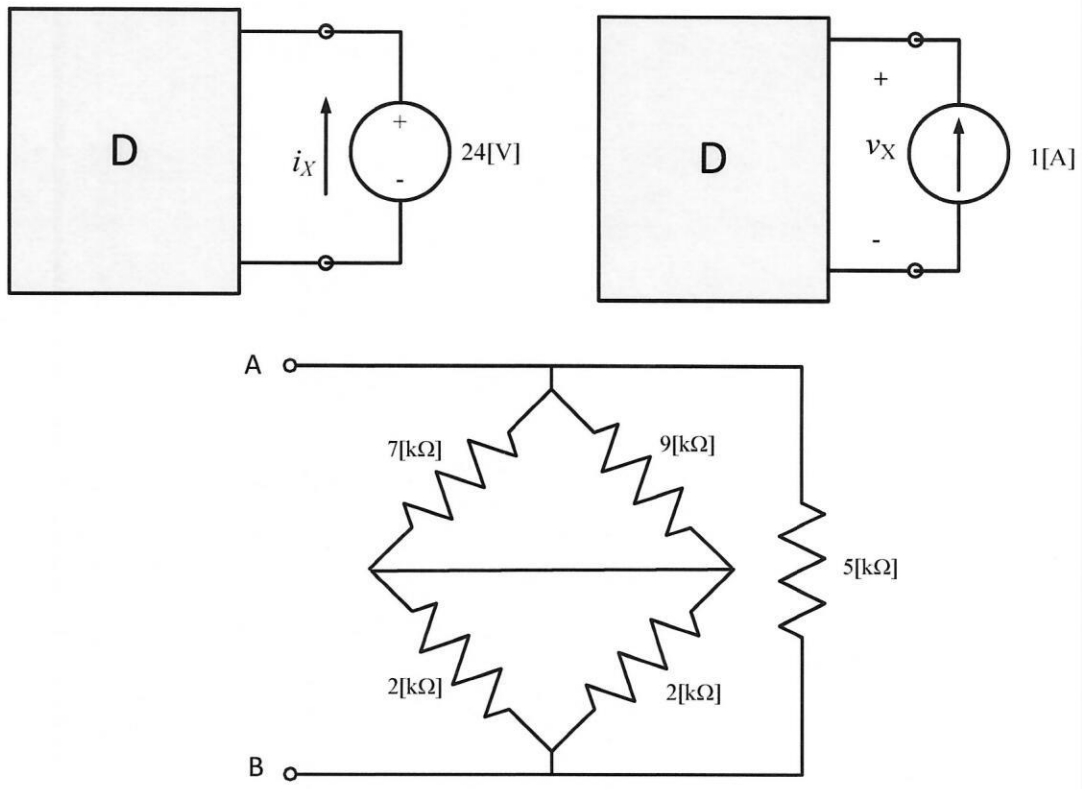
2. (40 points) For this circuit, find v_W.



Room for extra work

3. (25 points) The device D shown below can be modeled by a voltage source in series with a resistor. When the device is connected to a 24 [V] source, the current i_x is found to be 40 [mA]. When the device is connected to a 1 [A] current source, the voltage v_x is found to be - 24 [V].

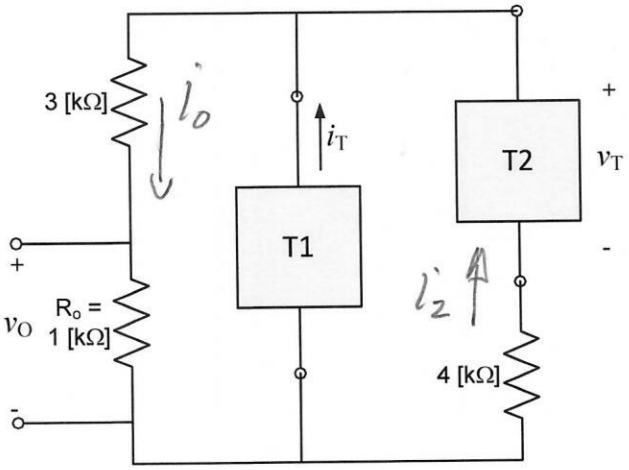
If the terminals A, B of the network of resistors shown are connected to the device terminals, find the power delivered to the network.

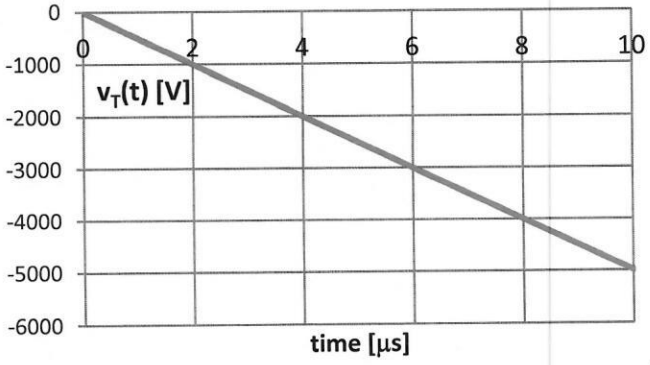


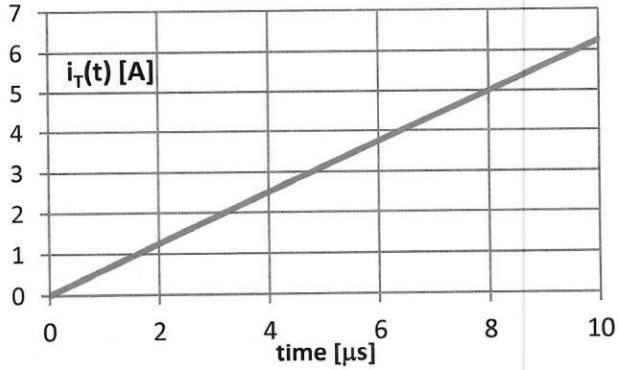
Room for extra work

1. (35 points) Two units of the revolutionary new Trombetterator have been installed in the circuit below. The Trombetterator is capable of operating as a current source or as a voltage source. The current $i_T(t)$ generated by Trombetterator T1 and the voltage $v_T(t)$ generated by Trombetterator T2 are shown in the graphs and labeled on the circuit diagram.

Find the energy delivered to the output resistor R_o over the time period $0 < t < 8$ [μs].







$v_T(t) = -500\left[\frac{V}{\mu s}\right] t \quad t \text{ in } [\mu s]$

$= -5 \times 10^8 t \ [V] \quad t \text{ in } [s]$

$i_T(t) = \frac{5}{8}\left[\frac{A}{\mu s}\right] t \quad t \text{ in } [\mu s]$

$= 6.25 \times 10^5 t \ [A] \quad t \text{ in } [s]$

$-v_T + (i_T + i_2)\,4000 + 4000\, i_2 = 0$

$i_2 = \frac{v_T - 4000 i_T}{8000} = \frac{-5\times10^8 t - 2.5\times10^9 t}{8000}$

Room for extra work

$$i_2'(t) = -6.25\times10^4 t - 3.125\times10^5 t = -3.75\times10^5 t \text{ [A]}$$
$$t \text{ in [s]}$$

$$i_0' = i_1' + i_2' = 2.5\times10^5 t \text{ [A]}$$

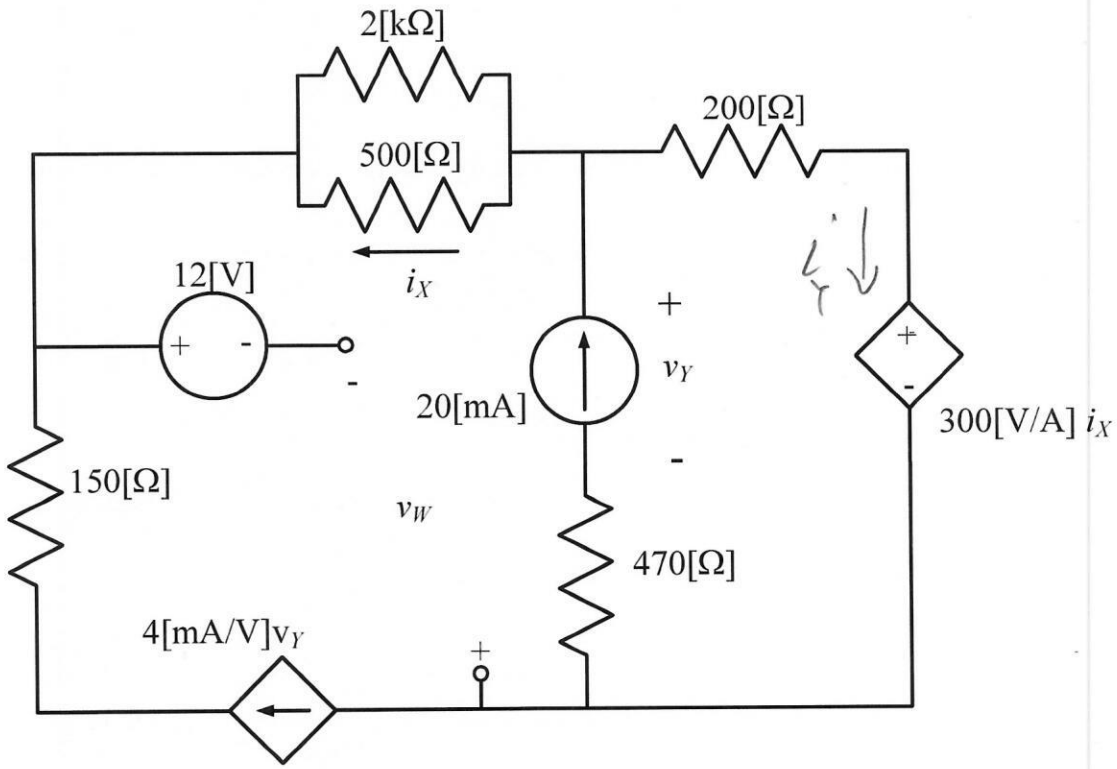
$$\therefore P_{del\ to\ R_0} = i_0'^2 R_0 = 6.25\times10^{13} t^2 \text{ [W]} \quad t \text{ in [s]}$$

$$W_{del\ to\ R_0} = \int_0^{8\times10^{-6}\text{ [s]}} 6.25\times10^{13} t^2\, dt$$

$$= 2.083\times10^{13} t^3 \Big|_0^{8\times10^{-6}}$$

$$\boxed{W_{del\ to\ R_0} = 10.67 \text{ [mJ]}}$$

2. (40 points) For this circuit, find v_W.



CDR: $i_x' = -0.004\, v_Y \cdot \frac{2000}{2000+500} = -3.2\times10^{-3}\, v_Y$ [A]

KVL: $-v_Y + 200 i_Y' + 300 i_x' + 0.02(470) = 0$

$\Rightarrow$ $v_Y = 200 i_Y' + 300(-3.2\times10^{-3}) v_Y + 9.4$

$1.969\, v_Y = 200 i_Y' + 9.4$

$v_Y = 11.46$ [V]

$i_Y = 65.85$ [mA]

KCL $0.004\, v_Y + 0.02 = i_Y'$

Room for extra work

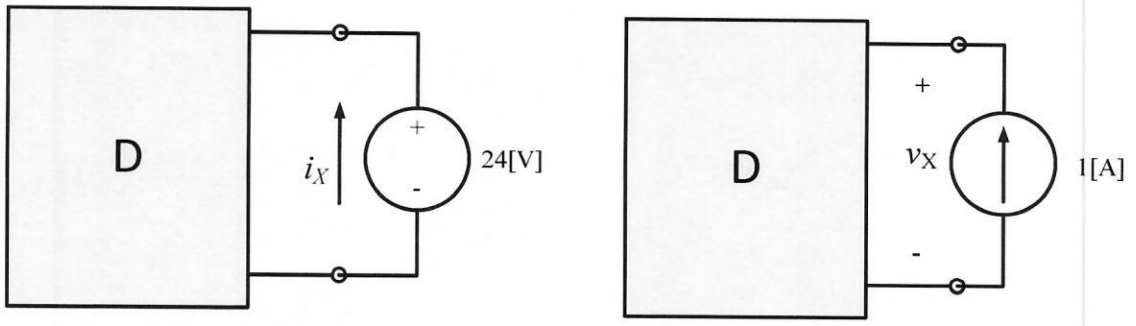
$$\therefore \; i_x = -3.2 \times 10^{-3} V_T = -36.67 \; [mA]$$

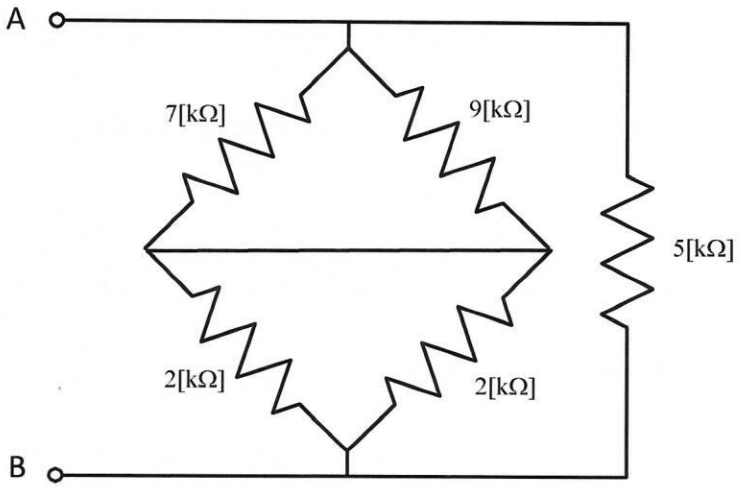
KVL: $$V_w - 12 - 500 i_x + V_T - 470(0.02) = 0$$

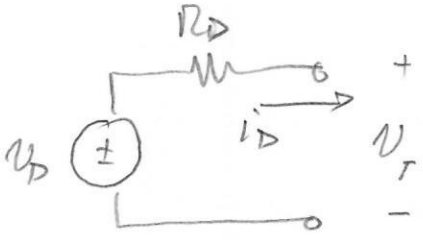
$$\boxed{V_w = -8.395 \; [V]}$$

3. (25 points) The device D shown below can be modeled by a voltage source in series with a resistor. When the device is connected to a 24 [V] source, the current i_x is found to be 40 [mA]. When the device is connected to a 1 [A] current source, the voltage v_x is found to be - 24 [V].

If the terminals A, B of the network of resistors shown are connected to the device terminals, find the power delivered to the network.







$$v_D - v_T - i_D R_D = 0$$

$$v_T = 24\,[V] \Rightarrow i_D = -0.04\,[A]$$

$$v_T = -24\,[V] \Rightarrow i_D = -1\,[A]$$

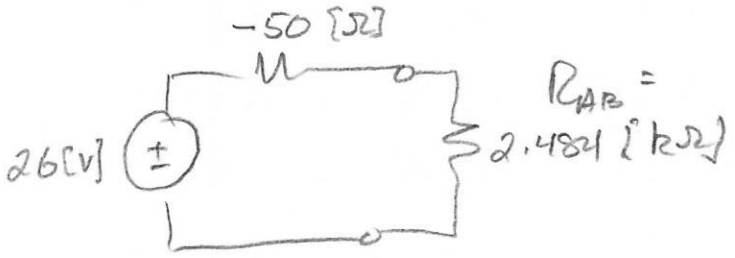
$$\therefore \quad v_D - 24 - (-0.04) R_D = 0 \qquad v_D = 26\,[V]$$

$$v_D + 24 + 1 \cdot R_D = 0 \qquad R_D = -50\,[\Omega]$$

Room for extra work

$R_{AB} = (7 \| 9 + 2 \| 2) \| 5$ R in [kΩ]

$R_{AB} = 4.9375 \| 5 = 2.484$ [kΩ]



$P_{del\ to\ R_{AB}} = \left(\frac{26}{2484-50}\right)^2 \cdot 2484 = 283.44$ [mW]