Name: _____ (please print)

Signature: _____

ECE 2201 – Quiz #3 (version a)
October 9, 2018

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

1. This quiz 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 35 minutes to work on this quiz.

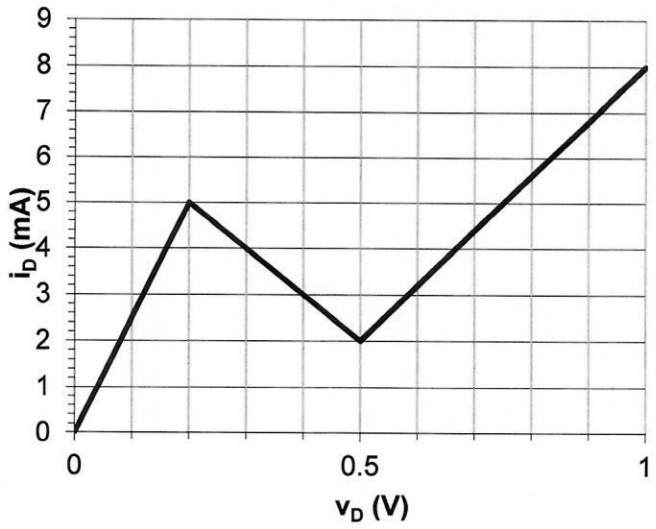
_____/25

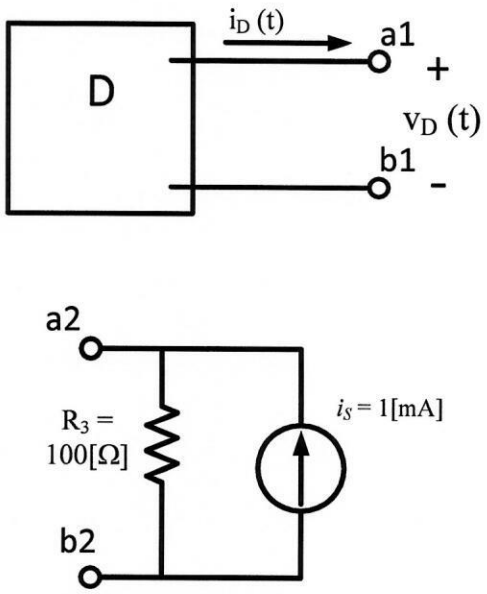
Room for extra work

The device D shown in the upper figure on the right can be modeled by a voltage source in series with a resistor.

i) Find the value of the voltage source and resistor used to model the device for the voltage range 0.2 to 0.5 V. Draw a circuit diagram showing these components, and label the terminals a and b.

ii) Suppose now that device D is connected to the circuit shown in the lower figure on the right, connecting terminals a1 to a2, and b1 to b2. Find the power delivered by the current source i_s.





Room for extra work

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ECE 2201 – Quiz #3 (version b)
October 9, 2018

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Room for extra work

The device D shown in the upper figure on the right can be modeled by a current source in parallel with a resistor.

i) Find the value of the current source and resistor used to model the device for the voltage range 0.2 to 0.5 V. Draw a circuit diagram showing these components, and label the terminals a and b.

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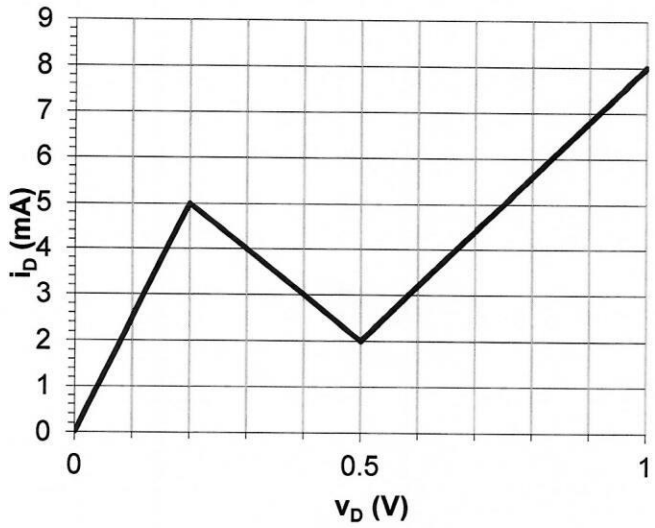

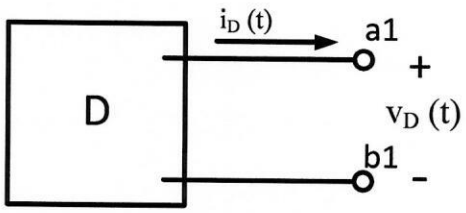

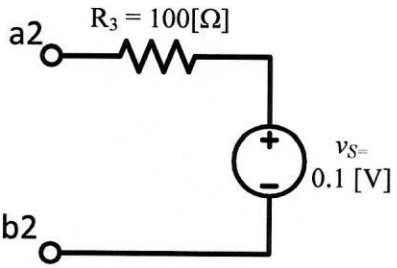

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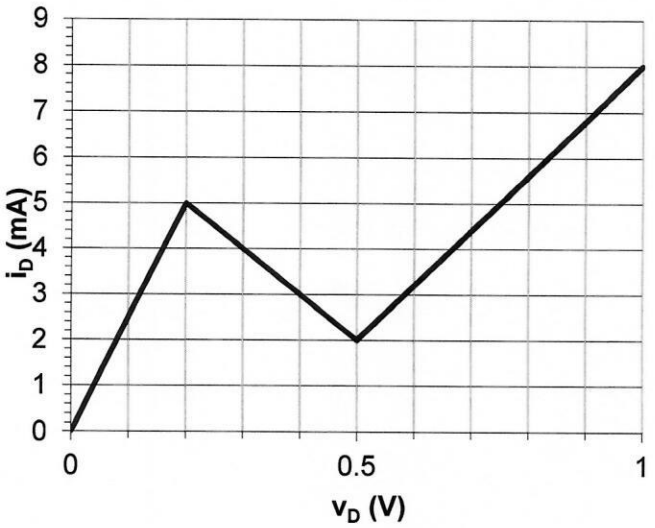
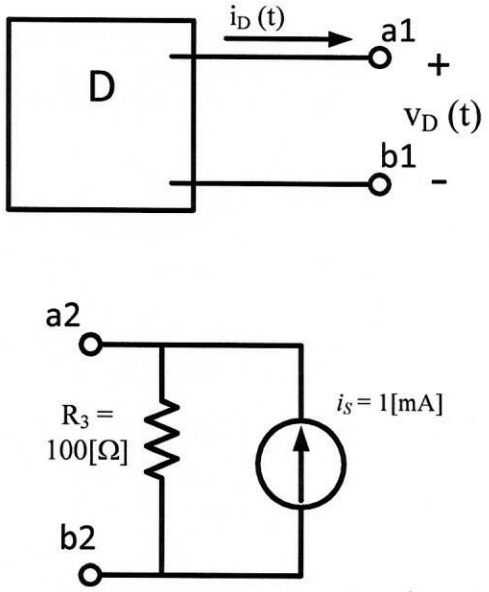
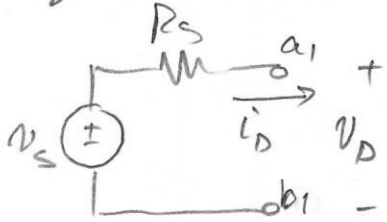
i) Find the value of the voltage source and resistor used to model the device for the voltage range 0.2 to 0.5 V. Draw a circuit diagram showing these components, and label the terminals a and b.

ii) Suppose now that device D is connected to the circuit shown in the lower figure on the right, connecting terminals a1 to a2, and b1 to b2. Find the power delivered by the current source i_s.





i) We'll draw the device model first, then generate an equation relating i_D', v_D to the model parameters:



$$-v_s + i_D' R_s + v_D = 0 \quad \text{KVL}$$

$$i_D' = \frac{v_s}{R_s} - \frac{v_D}{R_s}$$

From the graph, we have

$$0.005 = \frac{v_s}{R_s} - \frac{0.2}{R_s} \qquad 0.002 = \frac{v_s}{R_s} - \frac{0.5}{R_s}$$

$$\Rightarrow \quad v_s = 0.7\,[V] \qquad R_s = 100\,[\Omega]$$

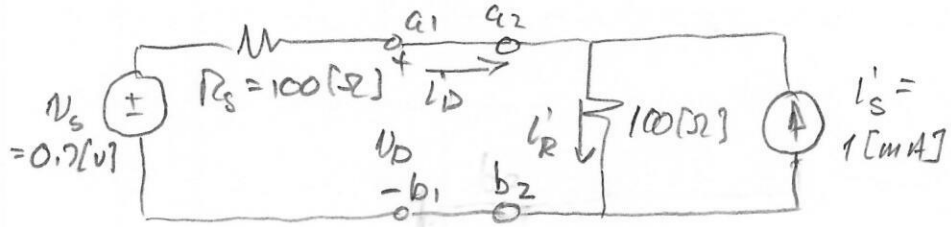
Room for extra work

We could also have found the equation for i_D vs v_D from the graph:

$$i_D = m v_D + b = -0.01 v_D + 0.007$$

Comparison with our KVL shows $R_s = -\frac{1}{-0.01} = 100\,[\Omega]$, and $v_s = 0.007 \cdot R_s = 0.7\,[V]$.

ii) We draw the device model along with the attached circuit:



KCL: $-i_D + i_R - 0.001 = 0$ KVL: $-v_s + i_D R_s + 100 i_R = 0$

$\Rightarrow -0.7 + 100 i_D + 100 i_R = 0$

$\Rightarrow i_D = 0.003\,[A]$ $i_R = 0.004\,[A]$ $v_D = 100 i_R = 0.4\,[V]$

$P_{del\ by\ i_s} = i_s \cdot v_D = (0.001)(0.4) = 0.4\,[mW]$

Note that $i_D = 3\,[mA]$ and $v_D = 0.4\,[V]$ is a point on the graph between $v_D = 0.2\,[V]$ and $v_D = 0.5\,[V]$. If the circuit in part ii) had different parameters - say $i_s = 100\,[mA]$, for example - we would have found that $i_D = -46.5\,[mA]$ and $v_D = 5.35\,[V]$. This point is not on the graph, and we would conclude that our model is not valid.

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ECE 2201 – Quiz #3 (version b)
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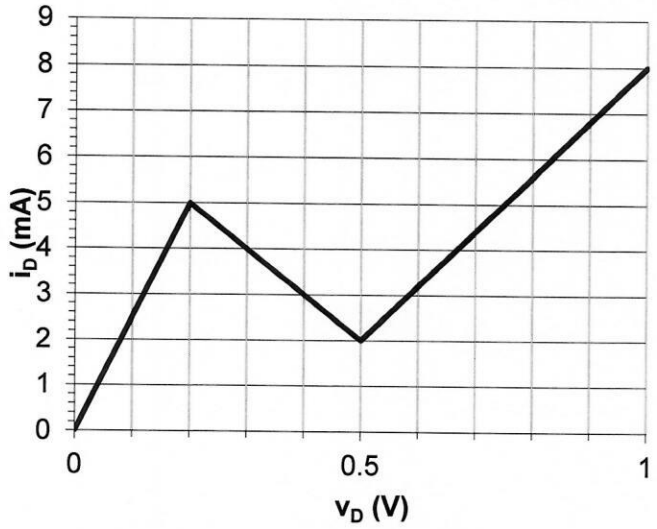
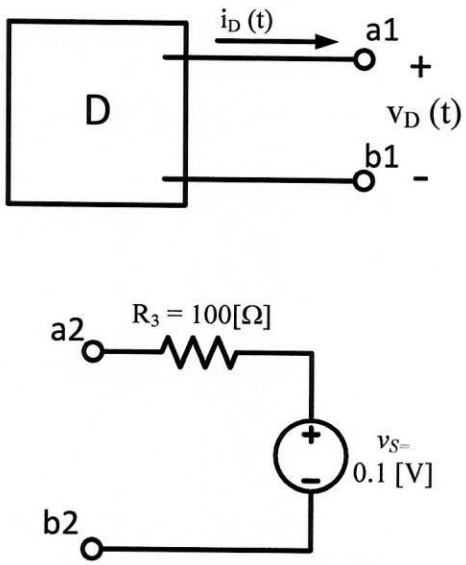
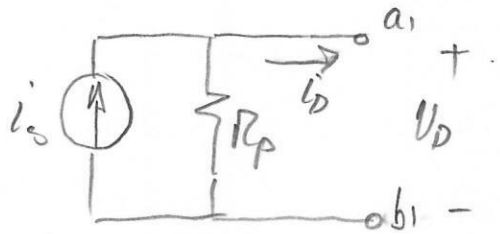




i) We'll draw the device model first, then generate an equation relating v_D, i_D to the model parameters:



$$i_D = i_s - \frac{v_D}{R_p} \qquad \text{(KCL)}$$

From the graph, we have

$$\left.\begin{aligned} 0.005 &= i_s - \frac{0.2}{R_p} \\ 0.002 &= i_s - \frac{0.5}{R_p} \end{aligned}\right\} \Rightarrow \begin{aligned} i_s &= 0.007\ [A] \\ R_p &= 100\ [\Omega] \end{aligned}$$

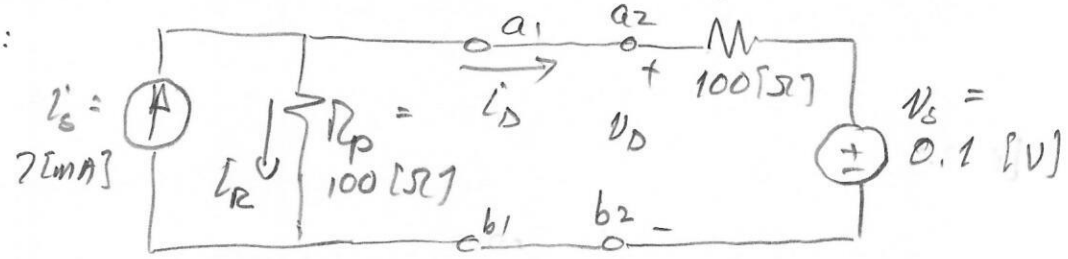
Room for extra work

We could also have found the equation for i_D vs. v_D from the graph:

$$i_D = m v_D + b = -0.01\, v_D + 0.007 \quad [A]$$

Comparison with our KCL shows $i_S = b = 0.007$ [A], $R_p = -\frac{1}{m} = 100$ [Ω].

ii) we draw the device model along with the attached circuit:



KCL

$$-i_S + i_D + i_R = 0$$

$$-0.007 + i_D + i_R = 0$$

KVL

$$-i_R R_p + 100 i_D + 0.1 = 0$$

$$-100 i_R + 100 i_D + 0.1 = 0$$

$$\Rightarrow \quad i_D = 0.003 \text{ [A]} \qquad i_R = 0.004 \text{ [A]}$$

$$P_{\text{del by } v_S} = -i_D (0.1) = -0.3 \text{ [mW]}$$

Note that $i_D = 3$ [mA] & $v_D = i_R R_p = 0.4$ [V] is a point on the graph between $v_D = 0.2$ [V] and $v_D = 0.5$ [V]. If the circuit in part ii) had different parameters - say $v_S = 1$ [V], for example - we would have found that $i_D = -0.015$ [A], $v_D = 0.85$ [V]. This point is not on the graph, so we would conclude that our model is not valid.