Name: ______________________________ (please print)

Signature: ____________________________

ECE 2201 – Quiz #1
June 11, 2021
Online

1. This quiz is open book, open notes. You may not work with another person or try to obtain the answer to the quiz online.
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 30 minutes to work on this quiz.

_________________/25

Room for extra work

The voltage $v_D(t)$ for device D is plotted in the graph below. The current $i_D(t)$ is given by

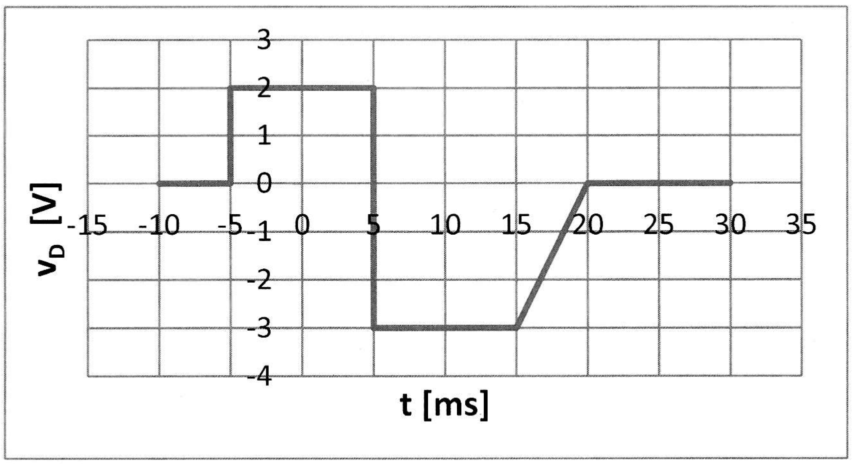
$$i_D(t) = 15\ [\text{mA}]\ e^{-0.02\ [1/\text{ms}]t}.$$

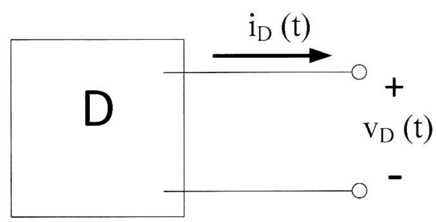
a) Find the power delivered to device D at t = 2 [ms].

b) Find the energy delivered to device D in the time interval -10 [ms] to 12 [ms].

c) Assuming the charge carrier are electrons, state in which direction they are moving through device D at t = 0 [ms]. Express this any way you like, as long as you are clear.

d) State whether the electrons are gaining or losing energy at t = 0 [ms].





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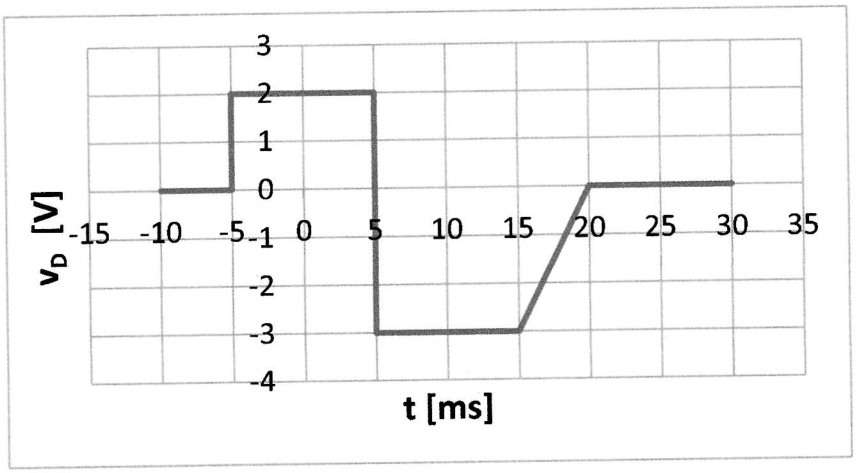

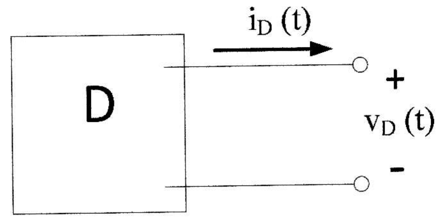

"delivered to" = "absorbed by"

a) $P_{del\ to\ D}(t) = P_{abs\ by\ D}(t) = -v_D(t)\, i_D(t)$

sign +2

calc +2

$$P_{abs\ by\ D}\Big|_{t=2[ms]} = -v_D(2[ms])\, i_D(2[ms]) = -2 \cdot 0.015\, e^{-0.02\cdot 2}$$

$$= -28.82\ [mW]$$

b)

$$W_{abs\ by\ D} = -\int_{-5[ms]}^{5[ms]} (2)(0.015\, e^{-0.02t})\, dt - \int_{5[ms]}^{12[ms]} (-3)(0.015\, e^{-0.02t})\, dt$$

integral +8

units +2

time +2

$$= -\left(-\frac{1}{0.02}\right)(2)(0.015\, e^{-0.02t})\Big|_{-5}^{5} - \left(-\frac{1}{0.02}\right)(-3)(0.015\, e^{-0.02t})\Big|_{5}^{12}$$

$$= -0.3005 + 0.26597 = -3.45\times10^{-2}\ [mJ]$$

+ 3

Room for extra work

Units: we used [V], [A], and [msec] in the integration, so the units in the resulting calculation will be [mJ].

We can also do this in [V], [A] [s]:

$$0.02\left[\frac{1}{ms}\right] = 20\left[\frac{1}{s}\right]$$

$$W_{abs\,by\,D} = -\int_{-5\times10^{-3}[s]}^{5\times10^{-3}[s]} (2)(0.015\,e^{-20t})dt - \int_{+5\times10^{-3}}^{12\times10^{-3}[s]} (-3)(0.015\,e^{-20t})dt$$

The result will of course be numerically equivalent, but the units of the integration above are [J].

If you used [V], [mA], [ms] then units will be [μJ].

c) At $t=0$, $i_D>0$, so electrons are moving opposite the reference current since reference current direction = actual current direction. So electrons are moving into D at the upper terminal.

d) At $t=0$, $P_{abs\,by\,D} < 0 \Rightarrow$ D is delivering power. That means any charge carrier, positive or negative, is gaining energy.