Engr M20 - HW set 1 for Ch. 1 and Ch. 2

Jared Fowler
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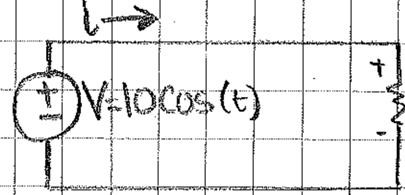
1) A resistor absorbs an instantaneous power of $20\cos^2(t)$ mW when connected across $V = 10\cos(t)$ V, voltage source. Find i and R.



$$P = Vi$$

$$20\cos^2(t)\,\text{mW} = 10\cos(t)\,\text{V} \cdot i$$

$$i = \frac{0.02\cos^2(t)}{10\cos(t)}$$

$$i = 0.002\cos(t)\ \text{A} = \boxed{2\cos(t)\ \text{mA}}$$

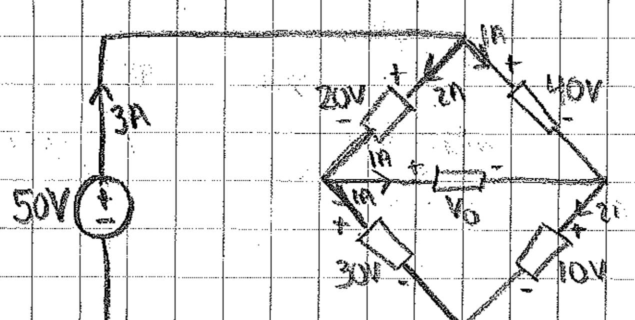
$$V = iR$$

$$10\cos(t)\,\text{V} = 0.002\cos(t)\,R$$

$$R = \frac{10\cos(t)}{0.002\cos(t)}$$

$$R = 5000\,\Omega = \boxed{5\,\text{k}\Omega}$$

2) Find V_o for the circuit below:



Use KVL : $\sum_{m=1}^{M} V_m = 0$ (for any closed loop)

...so... $-50V + 20V + V_o + 10V = 0$

$$V_o = \boxed{20V}$$

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3) If the current flowing through an element is given by:

$$i(t) = \begin{cases} 3t\,A, & 0 < t < 6s \\ 18\,A, & 6 < t < 10s \\ -12\,A, & 10 < t < 15s \\ 0, & t > 15s \end{cases} \qquad \text{Given: } q(0) = 0$$

Plot the charge stored in the element over $0 < t < 20s$.

Note:

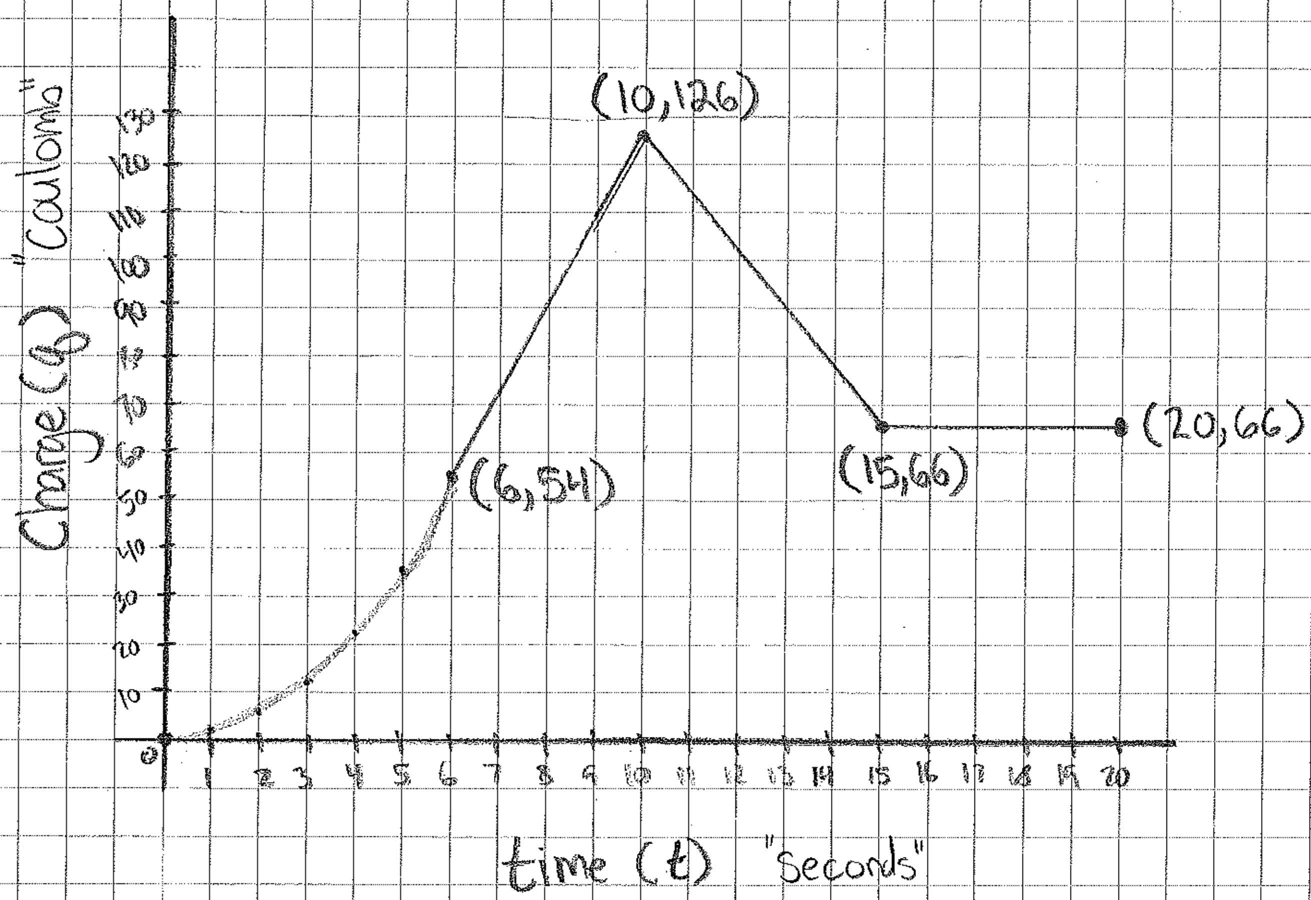
$q(t) = i\,dt$,

$Q = \int_{t_1}^{t_2} i\,dt$ $\Longrightarrow$

$\int_0^6 3t\,A\,dt = \frac{3}{2}t^2\Big]_0^6 \longrightarrow$ @ $t=6$, $q=54$

$\int_6^{10} 18\,A\,dt = 18t\Big]_6^{10} \longrightarrow$ @ $t=10$, $q = 54+72 = 126$

$\int_{10}^{15} -12\,A\,dt = -12t\Big]_{10}^{15} \longrightarrow$ @ $t=15$, $q = 126-60 = 66$



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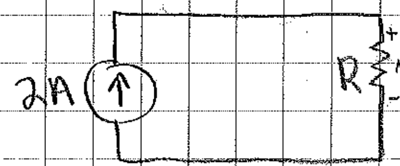
4) Specify the resistance R in Figure below so that both of the following Conditions are satisfied.

1. $V > 10V$
2. The power absorbed by the resistor is less than $25W$.



Use the resistor table to just choose resistor(s) nominal values that satisfy the design.

Note:

$$\left.\begin{array}{l} V = iR \\ V = 2R \ , \ V > 10 \rightarrow R > 5\Omega \\ \\ P = Vi = i^2R, \ P < 25W \\ \\ 25 > (2^2)R \rightarrow R < 6.25\Omega \end{array}\right\} \quad 5 < R < 6.25$$

... So, we can use one of the following: $\boxed{5.1\Omega, 5.6\Omega, 6.2\Omega}$

5) In a household, a 120-W PC is run for 4 hours/day, while a 60-W bulb burns for 8 hours/day. If the utility company charges \$0.12/KWh, Calculate how much the household pays per year on the PC and the bulb.

Note:

$\star$ 1 year = 365 days = 8760 hours = 525600 min = 31536000 s

$$120W \cdot (60 \cdot 60 \cdot 4 \cdot 365)s = 630720000 \ W \cdot s$$

$$60W \cdot (60 \cdot 60 \cdot 8 \cdot 365)s = 630720000 \ W\text{-}S$$

$$\frac{\$0.12}{KW\text{-}H} \cdot 2(630720 \ KW\text{-}S) \cdot \frac{1 \ KW\text{-}H}{(60 \cdot 60) KW\text{-}S} = \boxed{\$42.05}$$

... and on leap year: \$42.16