ECSE-200 Quiz #10 (XVI Nov 2018)

NAME_____ McGill ID#_____

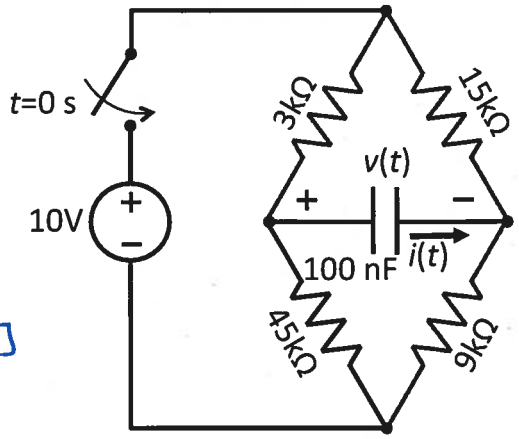
READ each question carefully. Do your work independently. SHOW ALL YOUR WORK. Give units on your answers (where appropriate).

Consider the circuit below. The circuit is in dc steady state for $t < 0$, and the switch closes instantaneously at $t = 0$ s.

1) What is $v(t)$ for $t > 0$? [4pts]

2) What is $i(t)$ for $t > 0$? [2pts]

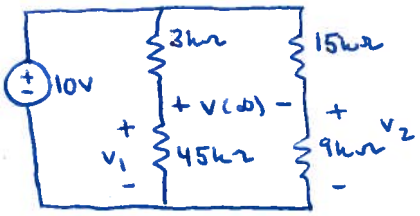
3) What is the maximum power absorbed by the capacitor? [1pt]



1) $t < 0$

$v(0+) = v(0-) = 0V$ [+1/2]

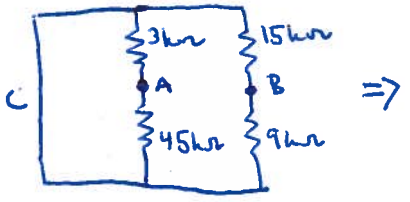
$t \to \infty$

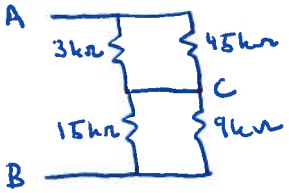


$v_1 = 10V \cdot \frac{45k\Omega}{3k\Omega + 45k\Omega} = 9.375V$

$v_2 = 10V \cdot \frac{9k\Omega}{9k\Omega + 15k\Omega} = 3.75V$

$v(\infty) = v_1 - v_2 = 5.625\,V$ [+1/2]





$R_T = 3k\Omega \,||\, 45k\Omega + 15k\Omega \,||\, 9k\Omega$

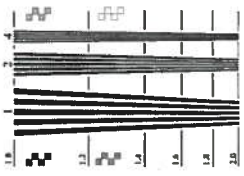
$= 8.4375\,k\Omega$

$\tau = R_T C$ [+1]

$= 843.75\,\mu s$ [+1]

$v_x(t) = v_x(\infty) + [v_x(0+) - v_x(\infty)] \exp(-t/\tau)$

$= 5.625V - 5.625V \exp(-t/843.75\,\mu s) \quad t > 0$ [+1]



2) $i = C \frac{dv}{dt}$ [+1]

$= 100nF \cdot \frac{d}{dt}\left[5.625V - 5.625V \exp(-t/843.75\mu s)\right]$

$= 100nF \cdot (-5.625V) \cdot \left(\frac{-1}{843.75\mu s}\right) \cdot \exp(-t/843.75\mu s)$

$= \frac{2}{3} mA \exp(-t/843.75\mu s) \quad t>0$ [+1]

3) $p_{abs} = i \cdot v$

$= \frac{2}{3} mA \cdot 5.625V \cdot \exp(-t/\tau)[1 - \exp(-t/\tau)]$

$= 3.75mW \exp(-t/\tau)[1 - \exp(-t/\tau)]$

$\max(p_{abs}) = 3.75mW \max(\exp(-t/\tau)[1 - \exp(-t/\tau)]) \quad t>0$

$= 3.75mW \max(x(1-x)) \quad 0 \le x \le 1$

$= 3.75mW \cdot \frac{1}{4} = 937.5\,\mu W$ [+1]