Capacitor Breakout/Review Problems- DC Lecture **2171**

Team Name: ____________________ **Section:** ______________

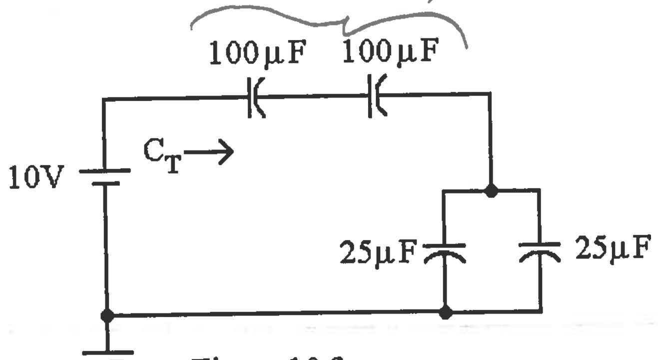
Members Present (full names printed):

1) ____________________
2) ____________________
3) ____________________
4) ____________________

* Solutions *

Capacitor Breakout/Review Problems- DC Lecture 2171

50µF

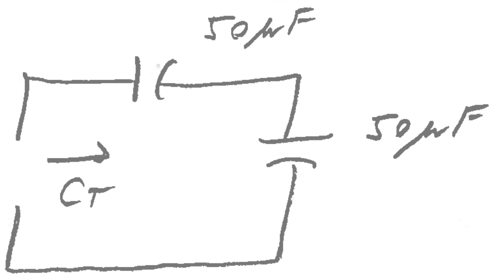


25µF + 25µF

Figure 10.3

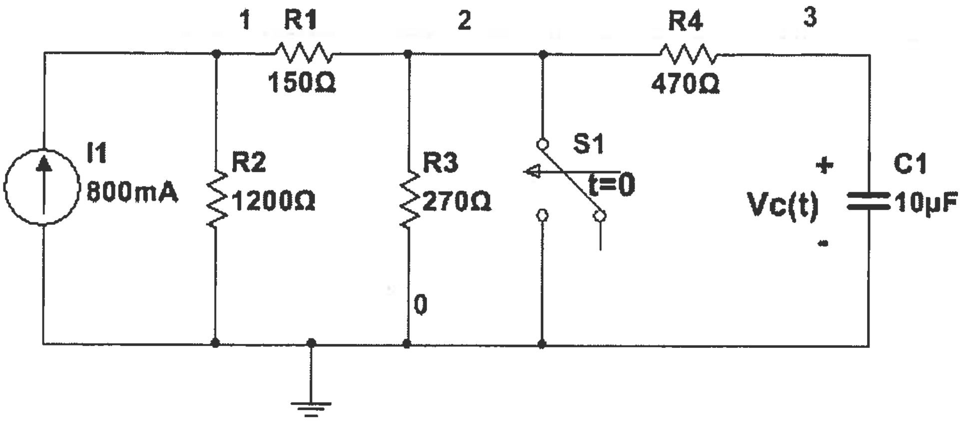
Find:

1) CT, the total capacitance seen by the source



$$\frac{1}{\frac{1}{50\mu F} + \frac{1}{50\mu F}}$$

$$\boxed{C_T = 25\mu F}$$



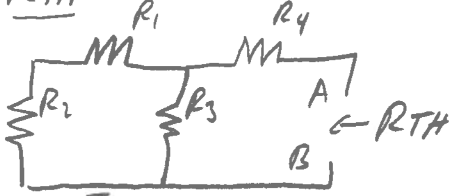
Given that switch S1 has been open for a long time BEFORE t=0

Find:

1) Vc(t) at t=0
2) The maximum current through R4 AFTER t=0
3) The time constant of the charging circuit (t < 0)
4) The time constant of the discharge circuit (t > 0)
5) Vc(t) for t > 0
6) The charge on the capacitor (C1) at t = 10msec

(FIND THEVENIN EQUIV FOR CHARGE PHASE)

R_{TH}



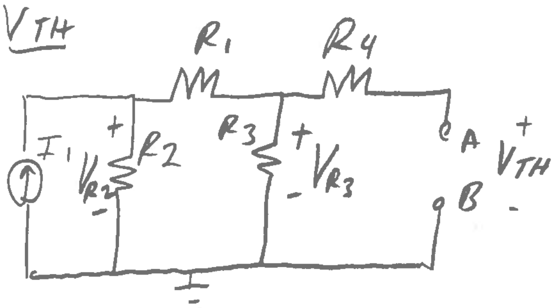
$R_{TH} = [(R_1 + R_2)//R_3] + R_4$

$= (1350\Omega // 270\Omega) + 470\Omega$

$= 225\Omega + 470\Omega$

$R_{TH} = 695\Omega$

V_{TH}



$V_{R2} = (I_1)([R_1 + R_3]//R_2)$

$= (0.8A)(420\Omega // 1200\Omega)$

$= (0.8A)(311.1\Omega)$

$V_{R2} = 248.9V$

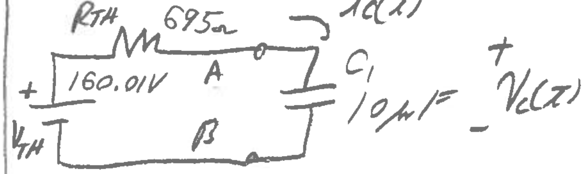
$\therefore V_{R3} = V_{R2}\left(\frac{R_3}{R_3 + R_1}\right)$

$V_{R3} = 160.01V$

HENCE

$V_{TH} = 160.01V$

HENCE, FOR $t < 0$



$V_c(t)$ FOR $t \geq 5\tau = V_{TH}$

OR $\boxed{160.01V}$ (1)

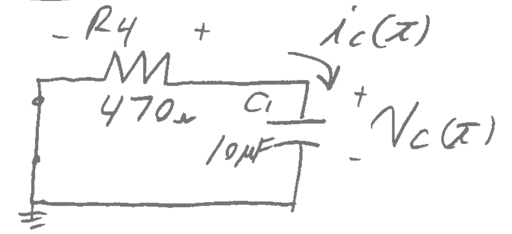
$\tau_{CH} = (R_{TH})(C_1)$

$= \boxed{6.95\,ms}$ (3)

@ $t = 0$

$V_c = V_{TH} = 160.01V$

DISCHARGE CIRCUIT $(t > 0)$



$V_c(0) = 160.01V$, INITIAL VALUE

$V_c(t) = 160.01\, e^{-t/\tau_{DIS}}$

$\tau_{DIS} = (R_4)(C_1) = \boxed{4.7\,ms}$ (4)

$\therefore$ For $t > 0$,

$\boxed{V_c(t) = 160.01V\, e^{-\frac{t}{4.7ms}}}$ (5)

$i_c(t) = -\dfrac{V_c(t)}{R_4} = -340.4mA\, e^{-\frac{t}{4.7ms}}$

$\therefore i_{c\,MAX}\big|_{t>0} = \boxed{-340.4\,mA}$ (2)

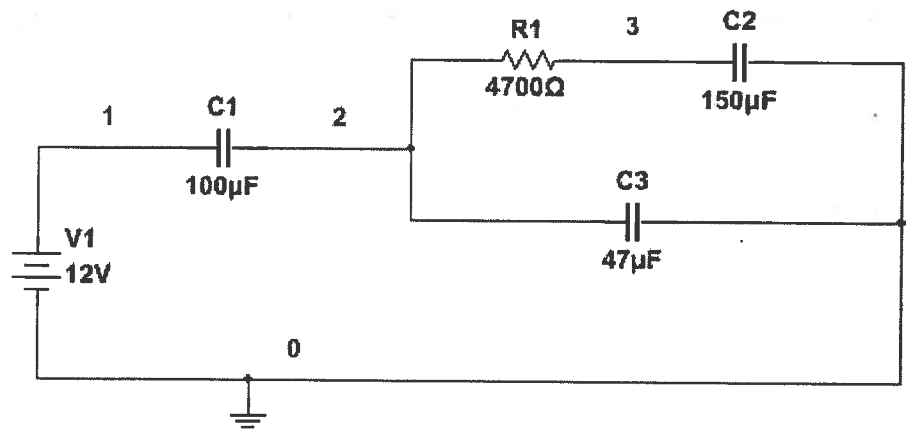
$V_c(t = 10ms) = 160.01V\, e^{-\frac{10E-3\,sec}{4.7E-3\,sec}}$

$= \underline{\underline{19.06V}}$

BUT $Q = CV$

$\therefore Q = (10\mu F)(19.09V)$

$\boxed{Q = 190.9\mu C}$ (6)



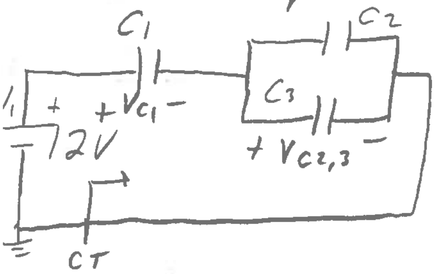
$Q = C \cdot V$

Find:

1) The voltage across and the charge on each capacitor (steady-state)

REDRAWN IN S.S.

- NO CURRENT THROUGH R_1,
∴ NO V_{DROP} ACROSS IT



$C_T = C_2 // C_3$ COMBINED IN SERIES W/ C

$C_2//C_3 = C_2 + C_3 = 197\mu F$

$\therefore C_T = \dfrac{1}{\frac{1}{197\mu F} + \frac{1}{100\mu F}} = \underline{66.33\mu F}$

HENCE $Q_T = C_T \cdot V = (66.33\mu F)(12V)$
$= \underline{795.96\mu C}$

$Q_{C1} = Q_T = 795.96\mu C$ (SERIES CIRCUIT)

$\therefore Q_{C1} = \boxed{796\mu C}$

& $V_{C1} = \dfrac{Q_{C1}}{C_1} = \boxed{7.96V}$

$\therefore V_{C2,3} = V_1 - V_{C1} = 4.04V$, KVL

$\boxed{V_{C2} = 4.04V}$

$\boxed{V_{C3} = 4.04V}$

$Q_{C2} = C_2 \cdot V_{C2} = \boxed{606\mu C}$

$Q_{C3} = C_3 \cdot V_{C3} = \boxed{189.9\mu F}$

CHECK:

$Q_{CT} = Q_{C1} = Q_{C2} + Q_{C3}$

$796\mu C = 795.9\mu C$

✓ (SMALL ROUNDING ERROR)