FINAL EXAM

Name (print) ____________________________ Name (signed) ____________________________

Discussion Instructor (circle): Brown Chakhbashian Condella Portnoi Zhukov

Discussion Section #

SHOW ALL WORK!!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

For the circuit shown the switch is open for a long time and then closed for exactly 2.00 time constants, and then opened.

\[ S \quad R_1 \quad W \quad \Xi R_2 \quad \Xi R_3 \]

(a) Calculate the charge on the capacitor the instant the switch is opened.

(b) Find the magnitude of the current in \( R_3 \) 6.00 \( \times 10^3 \) seconds after the switch is opened.

(c) As discussed in class, show in detail how to obtain the time constant for charging the capacitor and obtain a numerical value for that time constant.

\[ C = 2.40 \times 10^{-6} \text{ F} \]
\[ \varepsilon = 225 \text{ V} \]
\[ R_1 = 1.50 \times 10^3 \text{ ohms} \]
\[ R_2 = 0.700 \times 10^3 \text{ ohms} \]
\[ R_3 = 1.10 \times 10^3 \text{ ohms} \]

\[ Q(t) = Q_0 e^{-t/\tau} \]
\[ \tau = C \left( \frac{R_2 + R_3}{R_1 + R_3} \right) \]

For discharging
\[ Q_0 = Q_{\infty} \left( 1 - e^{-2} \right) \]
\[ Q_{\infty} = \frac{C \varepsilon R_3}{R_1 + R_3} \]

\[ Q_0 = \frac{2.40 \times 10^{-6} \times 225 \times 4.1 \times 10^3}{1.5 \times 10^3 + 1.1 \times 10^3} \left( 1 - e^{-2} \right) = \]
\[ = 2.28 \times 10^{-6} \left( 1 - 0.1353 \right) = 1.975 \times 10^{-6} \text{ C} \]

\[ \tau = 4.32 \times 10^{-3} \text{ s} \]

\[ I(t) = I_0 e^{-t/\tau} = \frac{Q_0}{\tau} e^{-t/\tau} \]

\[ t = 6.00 \times 10^{-3} \text{ s} \]
\[ I = \frac{1.98 \times 10^4}{4.32 \times 10^{-3}} e^{-1.39} = 1.14 \times 10^{-2} \text{ A} \]
\[
\tau' = C \left( R_2 + \frac{R_1 R_3}{R_1 + R_3} \right) = 2.4 \times 10^{-4} \left( 0.7 \times 10^{-3} + 0.63 \times 10^{-3} \right)
\]
\[
\tau' = 3.2 \times 10^{-3} \text{ s}
\]