Third Midterm

Name (Print) __________ Name (Signed) __________

Discussion Instructor (Circle One): Bertolina Hari Jaw Krantz
Discussion Section #: Lakner McDonald Pollard

Report all numbers to three significant figures.
Use the conversion constants and data given on the front page.

(a) If each resistor is 2.00 ohms, calculate the effective resistance between (a) and (b).

$$R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{2.00} + \frac{1}{2.00}} = 1.00 \, \Omega$$

(b) Calculate the charge on the capacitor 2.00 time constants after the switch is closed.

$$Q = CV = (2.00 \times 10^{-6} \, \text{F}) (1.75 \, \text{V}) = 3.50 \times 10^{-5} \, \text{C}$$

(c) A 33.0 \, \mu F capacitor is charged to 1500 volts. It is left on the lecture table and 20.0 minutes later it is found to have a potential of 75.0 v. Find the leakage resistance.

$$R = \frac{V}{Q} = \frac{75.0 \, \text{V}}{3.50 \times 10^{-5} \, \text{C}} = 2.14 \times 10^{7} \, \Omega$$

(d) A heavy copper wire carries a current of 12500 Amps. The wire is square with each side 0.500 cm. If copper has $8.48 \times 10^{28}$ electrons/m$^3$ free to move, calculate the drift velocity in this wire.

$$v = \frac{q}{n} = \frac{1.6 \times 10^{-19} \, \text{C}}{8.48 \times 10^{28} \, \text{m}^{-3}} = 1.88 \times 10^{-10} \, \text{m/s}$$

(e) A 12,500 ohm resistor is dissipating 0.752 watt of power. Find the current in this resistor.

$$I = \frac{P}{R} = \frac{0.752 \, \text{W}}{12,500 \, \Omega} = 0.0000602 \, \text{A} = 7.76 \, \text{mA}$$
(a) \[ V_d = \frac{I}{N q A} = \frac{12,500 \text{ A}}{(8.48 \times 10^{28} \text{ electrons/m}^3)(160 \times 10^{-12} \text{ cm})} \times (5 \times 10^{-2} \text{ m})^2 = 3.68 \times 10^2 \text{ m/s} \]

(b) \[ \theta(t) = Q_{\text{max}} (1 - e^{-t/T}) \quad ; \quad Q(2\mu) = Q_{\text{max}} (1 - e^{-2}) \quad ; \quad Q_{\text{max}} = CV \]

\[ Q(2\mu) = (2.00 \times 10^{-6} C)(1.75V)(1-e^{-2}) = 3.63 \times 10^{-6} \text{ C} \]

(c) Discharging capacitor \[ Q = Q_i e^{-t/T} \]

\[ CV = Q_i e^{-75/1500} \quad 75V = 1500Ve^{-75/1500} \]

\[ r = -\frac{75}{1500} = \frac{-1}{1000} = \frac{1}{75} \quad \therefore \quad \gamma = \frac{1}{1500} \quad \therefore \quad \tau = \frac{1}{75} \quad \therefore \quad \tau = \frac{1}{75} \quad \therefore \quad \tau = \frac{1}{75} \quad \therefore \quad RC = \frac{20 \times 60}{1500} = 1.214 \times 10^{-2} \Omega \]

\[ R = \frac{20 \times 60}{\ln\left(\frac{1500}{75}\right)} \]

\[ = 1.214 \times 10^{-2} \Omega \]

(d) \[ p = I^2 R \quad I = (\frac{P}{R})^{1/2} = \left(\frac{0.75 \text{ W}}{12500 \text{ A}}\right)^{1/2} = 7.76 \times 10^{-3} \text{ A} \]