THIRD MIDTERM

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Discussion Section:

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

(a) Calculate the effective resistance between A and B if all resistors have the value of 3.00 Ω.

\[ R_{eq} = \frac{14}{5} \, \Omega \]

(b) Calculate the effective value of the capacitance between A and B if all capacitors have the value 30.0 pF.

\[ C_{eq} = \left[ \frac{1}{50pF} + \frac{1}{25pF} \right]^{-1} = 125.6 \, pF \]

(c) If ε = 75.0 V, what is the power being dissipated in the 25 Ω resistor?

\[ R_{eq} = 100 \, \Omega + 18.75 \, \Omega = 118.75 \, \Omega \]
\[ V_{total} = I_{total} R_{eq} \Rightarrow I_{total} = \frac{V_{eq}}{R_{eq}} = \frac{75 \, V}{118.75 \, \Omega} = 0.632 \, A \]
\[ I_1 + I_2 = I_{total} \quad V_1 = V_2 \Rightarrow V_1 = I_1 R_1 = I_2 R_2 \]
\[ V = V_2 = I_{total} R_2 \]
\[ P = V_2 I_1 = (11.85 \, V) \left( 4.17 \, A \right) = 56.2 \, W \]

(d) Calculate the drift velocity (in m/s) in a silver wire with current = 4.20 A that has a circular cross section with \( r = 1.20 \times 10^{-3} \, m \). Silver has \( 5.90 \times 10^{22} \) electrons/cm³ (3.0 m) are mobile.

\[ I = neq \, V \Rightarrow u = \frac{I}{neq A} = \left( \frac{4.20 \, A}{5.90 \times 10^{22} \, \text{cm}^3} \right) \times \left( 1.20 \times 10^{-3} \, m \right) \]
\[ = 9.82 \times 10^{-5} \, m/s \]

(e) A parallel plate capacitor is constrained using a material whose dielectric constant is 4.27. If it is necessary to have the plate separator at 1.27 mm, what is the area needed to give \( C = 17.0 \, pF \)?

\[ C = K \varepsilon_0 \frac{A}{d} \Rightarrow A = \frac{Cd}{K\varepsilon_0} = \frac{17.0 \, pF \times 1.27 \times 10^{-3} \, m}{(4.27)(8.85 \times 10^{-12} \, C^2 / N \cdot m^2)} = 5.71 \times 10^{-4} \, m^2 \]