Third Midterm

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Discussion Section # 1

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

(a) If all capacitors have the same value, $C$, calculate the effective capacitance between a and b.

\[
C = \frac{2C \cdot C}{2C + C} + \frac{C \cdot C}{C + C} = \frac{2}{3}C + \frac{C}{2} = \frac{7}{6}C
\]

(b) Silicon has an atomic mass of 28.0 and a density of $2.33 \text{ g/cm}^3$. If impurities are added so there is $1.00 \times 10^5$ charge carriers per atom, calculate the number of charge carriers per cm$^3$.

\[
\nu = \frac{6.02 \times 10^{23}}{28.0} \cdot \frac{2.33}{10^{-5}} = 5.01 \times 10^{17} \frac{1}{\text{cm}^3}
\]

(c) A copper wire carries a current of 157 A. If the diameter of the wire is 2.00 mm, what is the current density?

\[
j = \frac{I}{\pi r^2} = \frac{157}{\pi \cdot (1.0 \times 10^{-3})^2} = 5.00 \times 10^4 \frac{\text{A}}{\text{m}^2}
\]

(d) If the current in (c) is carried by electrons and the drift velocity is $1.00 \times 10^4 \text{ m/s}$, what is the density of charge carriers?

\[
\nu = \frac{i}{(e \nu)} = \frac{5.10^4}{1.6 \times 10^{-19} \cdot 10^{-4}} = 3.12 \times 10^{30} \frac{1}{\text{m}^3}
\]

(e) If 60 volts is applied between A and B, calculate the charge on the 15 pF capacitor.

\[
Q = V \cdot \frac{C_1 \cdot C_2}{C_1 + C_2} = 60 \cdot \frac{10 \cdot 15}{25} \pm \sqrt{\frac{360}{C}} = 3.6 \times 10^{-10} \text{C}
\]