Fourth Midterm

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

(a) Show in detail how to calculate the magnetic field at point P using the Biot-Savart law and evaluate the answer. Consider the wire to be infinite at both ends.

(b) If the magnitude of the current in the wire is 5.50 A, calculate the magnitude of the field at P, if a = 2.63 cm

(c) What is the direction of the magnetic field at P (into or out of the paper)?

\[ \mathbf{dB} = \frac{\mu_0 I \, \mathbf{dl} \times \mathbf{r}}{4\pi r^2} \]

\[ \mathbf{I}_0 : \quad \mathbf{d}^2 \Rightarrow \mathbf{y}, \mathbf{r} \Rightarrow \mathbf{y} \quad \sin \theta = 0 \]

\[ \mathbf{I}_\theta : \quad \mathbf{d}^2 \Rightarrow \mathbf{z}, \mathbf{r} \]

\[ \mathbf{B} = \frac{\mu_0 I}{4\pi a} \int_0^\theta \sin \theta \, d\theta = \frac{\mu_0 I}{4\pi a} (1 - 0) = \frac{\mu_0 I}{4\pi a} \]

(b) \( I = 5.50 \text{ A}, \quad a = 2.63 \times 10^{-2} \text{ m} \) : \( \mu_0 = 4\pi \times 10^{-7} \text{ T m/A} \)

\[ \therefore \theta = \frac{\mu_0 I}{\mu_0 a} = 2.09 \times 10^{-9} \text{ T} \]

(c) Out of page direction (set \( \hat{z} \))

\[ \mathbf{B} = \frac{\mu_0 I}{\mu_0 a} \hat{z} \]