

FOURTH MIDTERM

3

Name: Yansheng Wu

Discussion Instructor (circle): Billeter Diwekar Kennedy Murray Whitaker

Discussion Section # _____

Student ID #: _____

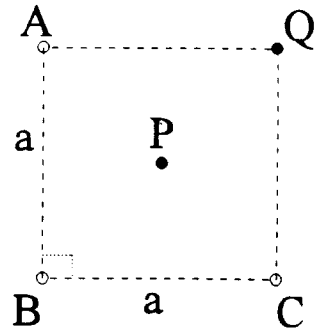
SHOW ALL WORK!!!!

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

Three long, straight wires are perpendicular to the plane of the paper. Wire A has current into the paper. Wires B and C have current out of the paper. Each wire has a current of magnitude 1.50 A. [a = 5.65 cm]

- (a) Find the magnetic field, magnitude and direction, at point P which is in the center of the square of which A, B and C are corners.
 (b) Calculate the force per unit length, magnitude and direction, on a fourth wire at Q, the remaining corner of the square. The current in Q is 1.50 A out of the paper. The wire Q is parallel to A, B and C.



$$(a) \quad |\vec{B}_A| = |\vec{B}_B| = |\vec{B}_C| = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0 I}{2\pi(\frac{a}{\sqrt{2}})}$$

$$\vec{B}_P = |\vec{B}_A| \left[\frac{-\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}} \right] + |\vec{B}_B| \left[\frac{-\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}} \right] + |\vec{B}_C| \left[\frac{-\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}} \right]$$

$$= \frac{\mu_0 I}{2\pi(\frac{a}{\sqrt{2}})} \left[\frac{3\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}} \right] = \mu_0 \left[1.593 \times 10^{-5} \hat{i} + 0.531 \times 10^{-5} \hat{j} \right] \text{ T}$$

$$(b) \quad |\vec{F}_A| = |\vec{F}_C| = \frac{\mu_0 I^2}{2\pi a} \quad |\vec{F}_B| = \frac{\mu_0 I^2}{2\pi\sqrt{2}a}$$

$$\vec{F}_Q = |\vec{F}_A| (\hat{i}) + |\vec{F}_B| \left(\frac{-\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}} \right) + |\vec{F}_C| (\hat{j})$$

$$= \frac{\mu_0 I^2}{2\pi a} \left(\hat{i} + \frac{-3\hat{j}}{2} \right) = \left[0.398 \times 10^{-5} \hat{i} - 1.195 \times 10^{-5} \hat{j} \right] \text{ N}$$