PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2015**

College of Sciences

Section 1 **Quiz 7** **16 April 2015**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

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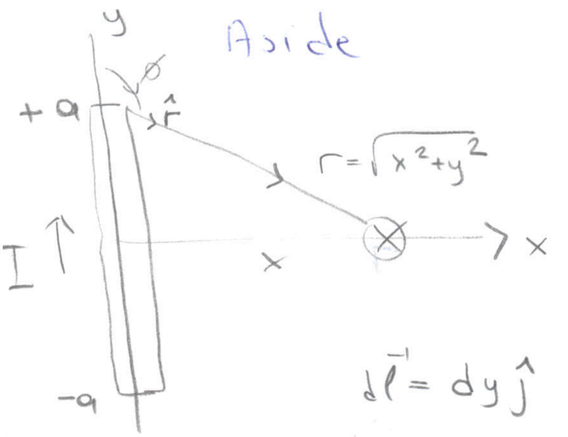
Name: Ongun ARISEV **Student ID:** **Signature:**

Two long straight wires as shown in the sketch carry current of I = 100 A in the indicated directions. What is the magnetic field at point P midway between the wires if they are

d = 0.1 m apart. $\mu_0 = 4\pi \times 10^{-7}\ N/A^2$

Aside



$d\vec{l} = dy\,\hat{j}$

$d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\,d\vec{l}\times\hat{r}}{r^2}$

$\sin\phi = \sin(\pi-\phi) = x/\sqrt{x^2+y^2}$

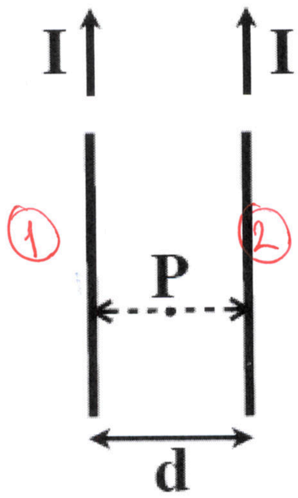
$d\vec{l}\times\hat{r} = dy\,\sin\phi$

$$B = \frac{\mu_0}{4\pi}\int_{-a}^{a}\frac{x\,dy}{(x^2+y^2)^{3/2}} = \frac{\mu_0 I}{4\pi}\frac{2a}{x\sqrt{x^2+a^2}}$$

$y = x\tan\theta$

$$\lim_{a\to\infty} B = \frac{\mu_0 I}{2\pi x}\frac{a}{a\sqrt{1+x^2/a^2}} = \frac{\mu_0 I}{2\pi x}$$

The magnetic field strength of a very long wire



$\vec{B}_{1P} = \frac{-\mu_0 I}{2\pi\frac{d}{2}}\hat{k}$ (wire 1)

$\vec{B}_{2P} = \frac{\mu_0 I}{2\pi\frac{d}{2}}\hat{k}$ (wire 2)

$\vec{B}_{total} = \vec{B}_{1P} + \vec{B}_{2P} = \vec{0}$

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Section 2 **Quiz 7** **16 April 2015**

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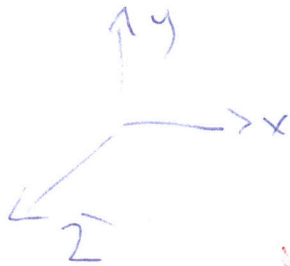
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

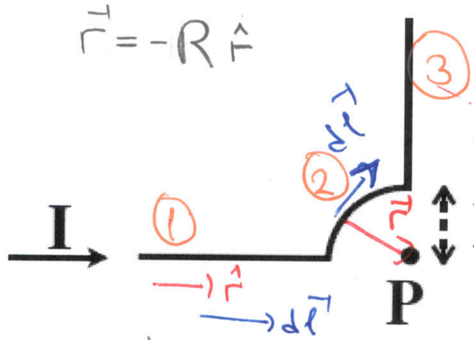
Using the Biot-Savart law, calculate the magnetic field at point P due to the segments of the current carrying conductors as shown in the sketch. Take the current as I = 4 A and radius of the circle as R = 0.3 m. You may take $\pi = 3$.

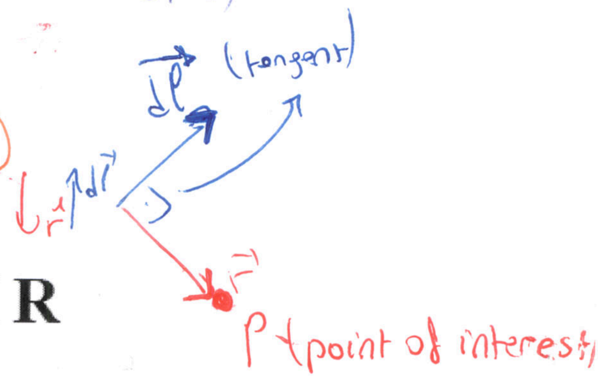
Cylindrical coordinates (r, θ, z)



$d\vec{l} = -R\,d\theta\,\hat{\theta}$

$\vec{r} = -R\,\hat{r}$





Biot Savart

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\,d\vec{l}\times\hat{r}}{r^2}$$

$|\vec{r}| = R = 0.3\,m$

$d\vec{l}\times\hat{r} = -\sin(90^\circ)R\,d\theta\,\hat{z} = -R\,d\theta\,\hat{z}$

No contribution from parts ① and ② since $\hat{r}$ and $d\vec{l}$ are parallel and anti-parallel, respectively.

$$\vec{B} = -\frac{\mu_0}{4\pi}\int_{\pi/2}^{\pi}\frac{I R\,d\theta}{R^2}\hat{k} = -\frac{\mu_0 I}{4\pi R}\frac{\pi}{2}\hat{k} = \frac{-\mu_0 I}{8R}\hat{k}$$

$$\vec{B} = -\frac{(4\pi\times10^{-7}\,N/A^2)(4\,A)}{8\;0.3\,m} = (-2\times10^{-6}\,T)\hat{k}$$

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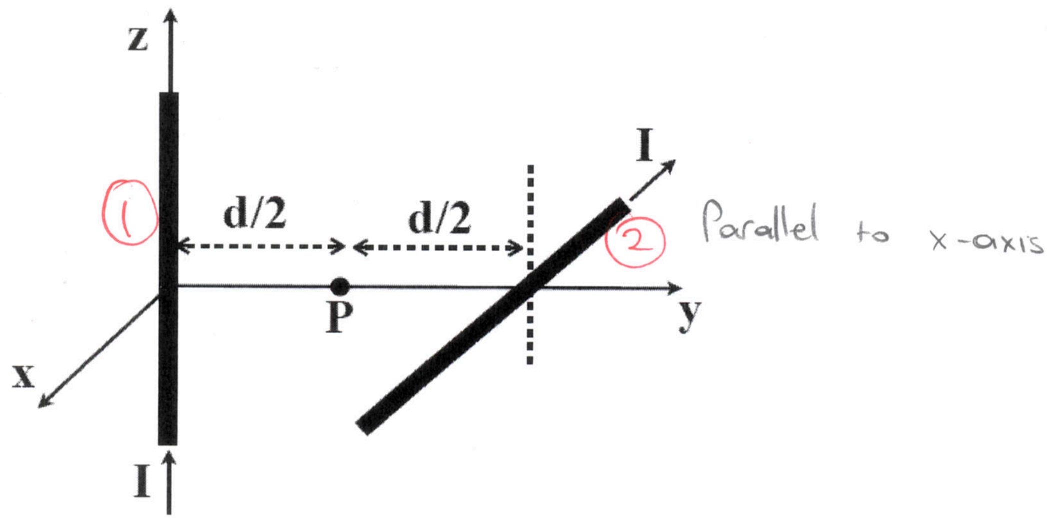
Section 3 Quiz 7 16 April 2015

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Two long straight wires as shown in the sketch carry current of I = 100 A in the indicated directions. One wire is along the z axis while the other is in the xy plane. What is the magnetic field at point P midway between the wires if they are d = 0.1 m apart.



$$\vec{B}_{1P} = \frac{-\mu_0 I}{2\pi \frac{d}{2}} \hat{i} \qquad \vec{B}_{2P} = \frac{\mu_0 I}{2\pi \frac{d}{2}} \hat{k}$$

$$\vec{B}_{total} = \frac{\mu_0 I}{\pi d}(-\hat{i}+\hat{k}) = \frac{(4\pi \times 10^{-7} N/A^2)(100 A)(-\hat{i}+\hat{k})}{\pi (0.1 m)}$$

$$\vec{B}_{total} = (4 \times 10^{-4} T)(-\hat{i}+\hat{k})$$

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Section 4 **Quiz 7** **16 April 2015**

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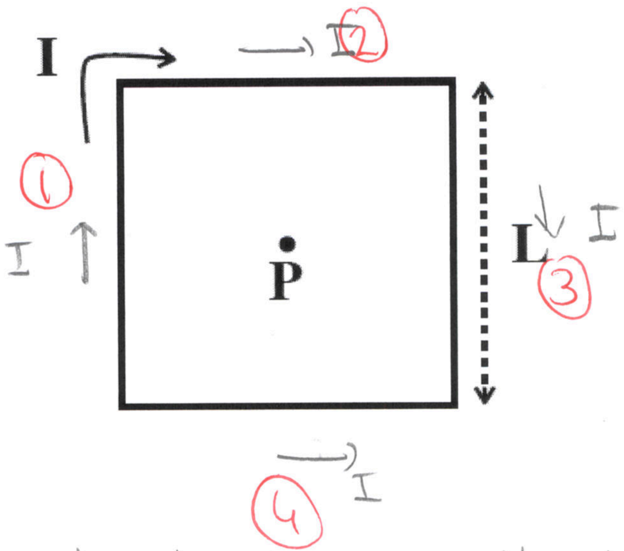
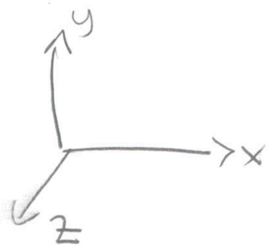
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Calculate the magnetic field at the center (P) of a current (I = 2 A) carrying square coil made from four wire segments of size L = 0.3 m as shown in the sketch. You may assume the segments are infinitely long wires.





According to right hand rule all the wires will have the contribution in the same direction (minus-z direction). Therefore

$$\vec{B}_{total} = -4 \cdot \frac{\mu_0 I \hat{k}}{2\pi \frac{L}{2}} = \frac{(4\pi \times 10^{-7} N/A^2)(2A)}{\pi \; 0.3\, m} \; -4\hat{k}$$

$$B_{total} = \left(-\frac{32}{3} \times 10^{-6} \; T\right)\hat{k}$$

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Section 5 **Quiz 7** **16 April 2015**

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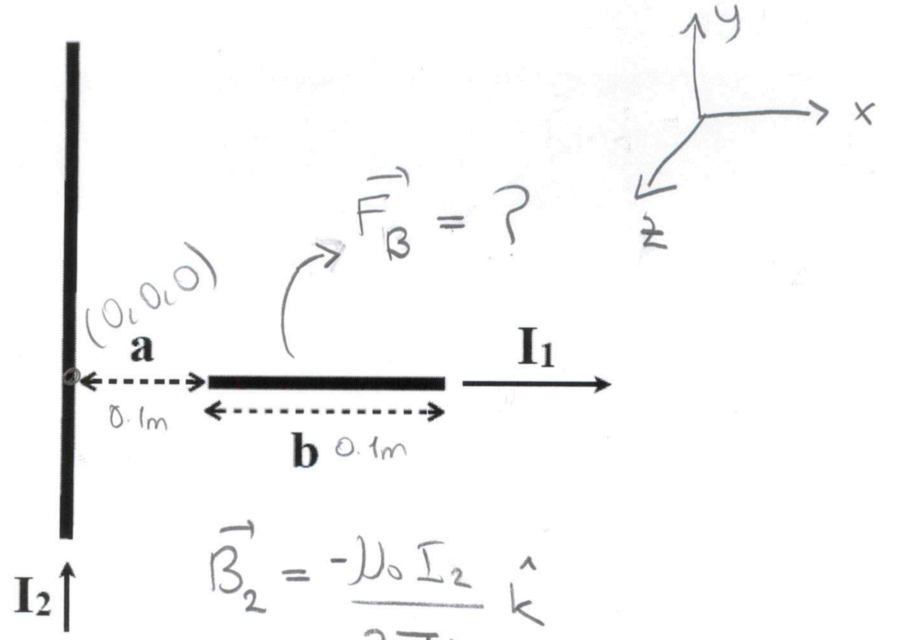
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Calculate the magnetic force on a wire segment of size b = 0.1 m, carrying current

I_1 = 2A, due to the magnetic field generated by an infinitely long straight wire carrying current I_2 = 1A. The segment is placed at a distance a = 0.1 m from the long wire as shown in the sketch.



$$\vec{B}_2 = \frac{-\mu_0 I_2}{2\pi x}\hat{k}$$

→ Non-uniform mag-field
we need to integrate

$$d\vec{F}_B = I_1 d\vec{l} \times \vec{B}_2 \qquad d\vec{l} = dx\,\hat{i}$$

$$\vec{F}_B = \hat{j}\,\frac{I_1 I_2 \mu_0}{}\int^{a+b} \frac{dx}{x} = \frac{\mu_0 I_1 I_2}{}\ln\left(\frac{a+b}{a}\right) = \hat{j}\,4\times10^{-7}\times\ln(2)\ \text{N}$$