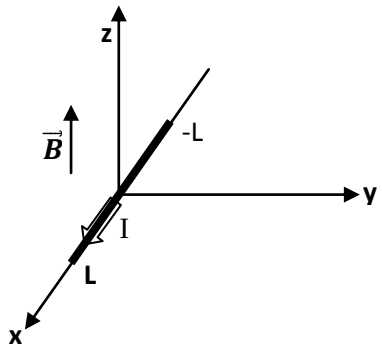
Final Exam Phy2323, Summer 2010

Time: 3 hours, Open book, Prof: Reza Khanbabaie

- Please write your name and student number in both question booklet and answer booklet.
- Scientific calculator is allowed.
- Please *solve 6 problems out of 7* and write all steps in your answer booklet. Solving all 7 problems has extra credit.

1. A wire of length *2L* lies on the x-axis and carries a current *I* (as shown below). If the magnetic flux density in the region is $\vec{B} = B\hat{z}$, determine the magnetic force acting on the wire. If the length of the wire is *20 cm*, *B = 0.5 T* and *I = 2 A*, find the force on the wire.



2. A very long (∞) hollow cylindrical conductor of inner radius *2 cm* and outer radius of *4 cm* is located along the *z*-axis and carries a current of *2 A* in the *z*-direction. If the current distribution is uniform, determine the magnetic field intensity ($\vec{H}$) at any point in the space ($r < 2\ cm$, $2\ cm \leq r \leq 4\ cm$, $r > 4\ cm$).

3. The inner radius of a toroid (with a rectangular cross section) is *10 cm*, the outer radius is *15 cm* and the height is *5 cm*. This uniformly wound coil carries a current of *0.5 A*. If the magnetic field intensity at the *mean radius* is *80 A/m*, a) Determine the number of turns in the coil. b) Calculate the energy stored in the magnetic field if the *relative* permeability of the core is *500*.

4. Consider region *1* as free space, region *2* has a relative permeability of *100*. The magnetic flux density in the region *1*, z > 0, is $\vec{B} = 1.5\,\hat{x} + 0.8\,\hat{y} + 0.6\,\hat{z}$ mT (mili Tesla). If *z = 0* marks the boundary between two regions, determine the magnetic flux density in region *2*.

5. A rectangular loop of dimensions *20 cm* × *10 cm* is made of aluminum wire of radius *1.2 mm*. The loop is placed in a magnetic field that is increasing at the rate of *40 T/s* (Tesla per second). What is the induced current in the loop? Draw a sketch and show the direction of the induced current. (the conductivity of Aluminum is 3.57×10^{7} S/m and $R = l/\sigma A$ for a wire).

6. An inductive coil has a resistance of *0.5 Ω* and an inductance of *2 H*. It is required to store a magnetic energy of *6.4 kJ* at all times. How much power is required to maintain such energy storage?

7. If the magnetic field intensity in a source-free, dielectric medium (ϵ) is given as $\vec{H} = 2H_0 \cos(\alpha x) \cos(\omega t)\, \hat{z}$ [A/m], determine the electric field intensity using Maxwell's equation from Ampere's law.