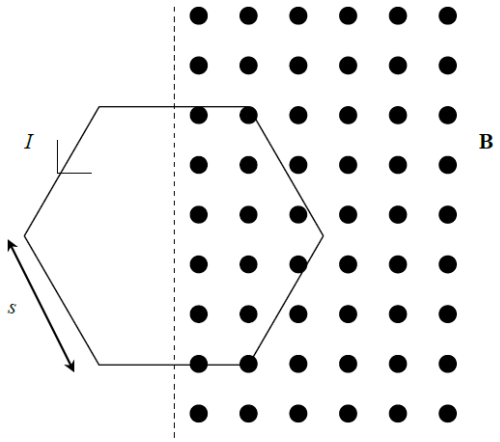
PHYS 3033/3053 Assignment 8

Due: 27 Nov 2015 at begin of lecture at 3:00 pm

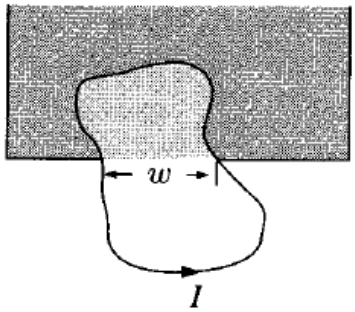
Problem 1.
A wire of the shape of a regular hexagon with side length *s* and carrying uniform current *I* flowing in the counterclockwise direction has its right half inside a uniform magnetic field **B** pointing outwards, as shown in the figure below:



(a) Find the force experienced by the loop.

(b) The current loop has its own magnetic field. Find the magnitude and direction of this field when observed at a point *P* at a large distance *d* (*d* >> *s*) **on the plane of the loop**. The distance is so large that one can use the multipole expansion and keep only the dipole term.

Problem 2.
A plane wire loop of irregular shape is situated so that part of it is in a uniform magnetic field **B** (in Fig. 4 the field occupies that shaded region, and points perpendicular to the plane of the loop). The loop carries a current I. Show that the net magnetic force on the loop is $F = IBw$, where w is the chord subtended. Generalize this result to the case where the magnetic field region itself has an irregular shape. What is the direction of the force?



Problem 3.

For a configuration of charges and currents confined within a volume $\mathcal{V}$, show that

$$\int_{\mathcal{V}} \mathbf{J} d\tau = d\mathbf{p} / dt,$$

Where $\mathbf{p}$ is the total dipole moment. [*Hint:* evaluate $\int_{\mathcal{V}} \nabla \cdot (x\mathbf{J}) d\tau$.]