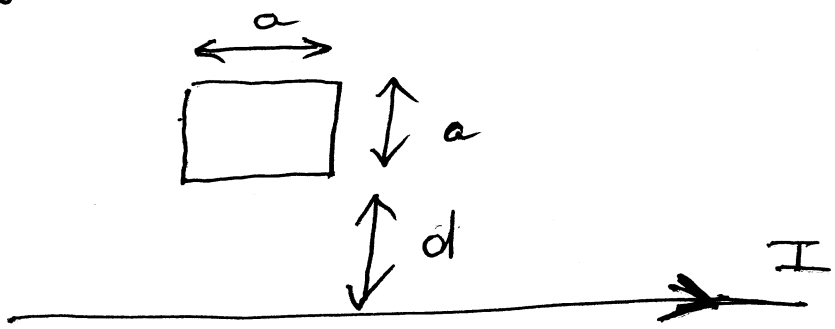
EM PROBLEM SET 5 - 2019

1. Consider a circular wire of radius R carrying a current I that is uniformly distributed through the wire. Using Ampere's law, compute the magnitude of the magnetic field as a function of r, the perpendicular distance from the centre of the wire for the case

(i) $r < R$ i.e. inside the wire

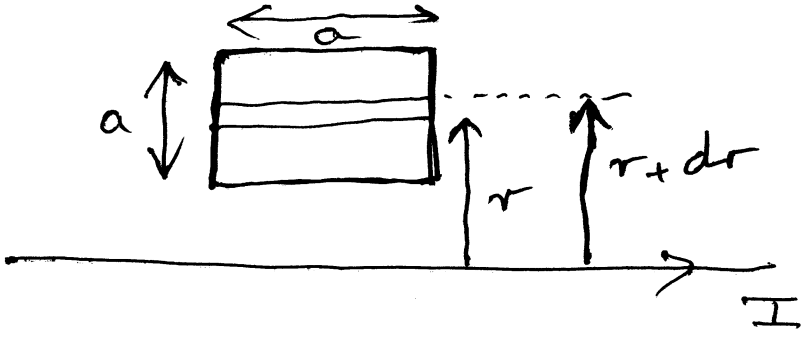
(ii) $r > R$ i.e outside the wire

2. A square loop of wire (with sides of length a) lies on a table at a distance d from a long straight wire carrying a current I:



(a) Use Ampere's law to determine the magnitude B(r) of the magnetic field at a perpendicular distance r from the wire

(b) Consider a strip between r and r+dr in the loop:



Determine the flux of the magnetic field through this strip.

(c) By integrating from $r = d$ to $r = d + a$, determine the flux of the magnetic field through the whole loop.

(d) If the wire loop is pulled away from the wire along the table, the distance d of the edge of the loop becomes a function of time, $d(t)$, and $\frac{d(d(t))}{dt}$ is the speed of the loop. What is the direction of the induced current in the loop (use Lenz's law).

(c) Deduce the magnitude of the induced EMF using

$$\mathcal{E} = \frac{d}{dt} (\text{flux through current loop}).$$