Exercise 11

[1] (30pts) In the class we have obtained a single loop current of radius $R$ with a current $I$ give rise to the $x$ component of the field

$$B_x = \frac{2\pi I}{R} \sin^3(\theta)$$

where $\theta$ is the angle in the figure (see blow).

Making use of this result, find the magnetic field along the axis of a solenoid having $N$ turns per centimeter with each carrying a current $I$. Find the magnetic pressure (energy density of magnetic field $B^2/8\pi$) exerted on the inside of the solenoid at its midpoint (the last part From Schwartz 4-5).

[2] (35pts) From Schwartz 4-3: A circular toroid with rectangular cross section, as shown, is wound on a core having permeability $\mu$. $N$ turns of wire are used, and a steady current $I$ is put through the wire. 
(a) Find the fields $H$, $B$, and $M$ at radius $r$ within the toroid. (b) Find the vector potential $A$ at the center of the toroid.

[3] (35pts) From Schwartz 4-4: An electromagnetic crane is constructed of a U-shaped steel yoke with 1000 turns of wire carrying current $I$, as shown. The permeability of the steel is 1000. We would like to use it to lift a steel block of dimension $30 \text{ cm} \times 30 \text{ cm} \times 120 \text{ cm}$ and having the same permeability.

Estimate the magnitude of $I$ in order that we just be able to lift the block as shown (the density of steel can be taken as 8).