1 Magnetism and Electromagnetism

1. The figure below shows half the $B - H$ graph for a ferrite material. Make a rough estimate of the power lost in the full magnetization cycle due to hysteresis, given:
ferrite- diameter 18 mm, length 22 mm; coil- 150 turns, current 0.1 A, frequency 4 kHz.

![Graph of B versus H](image)

Figure 1: $B - H$ graph for a MnZn ferrite material, as used in Physics 2 Experimental Physics.

2. The figure below shows schematic diagrams for $M$, $B$ and $H$ for a uniformly magnetized cylindrical permanent magnet.

(a) Why do the lines of $B$ and $H$ look so similar outside the magnet?

(b) Why do they differ inside the magnet?

(c) Comment on the equation $B = \mu_r \mu_0 H$ in both regions.

1
Figure 2: Schematic of the fields inside a cylindrical magnet.

(d) Comment on the equation $B = \mu_0(H + M)$ in the magnet. In particular, show the directions of these three vectors at a point near the top right hand corner of the magnet.

3. A long solenoid is wrapped around a cylinder of aluminium. The current is $i = 0.5A$, and the number of turns per unit length is $10^4$. Calculate the $H$ field, the $B$ field and the relative permeability.
4. A rectangular loop of width $l$ is being pulled out of a region of constant field $B$, into a region where $B = 0$, at constant speed $v$ by a force $F$, as in the diagram below. Find an expression for the current $i$ in the loop, and hence calculate the force required to pull it out.

![Diagram of a current loop being pulled out of a region of constant $B$.]

Figure 3: A current loop being pulled out of a region of constant $B$.

5. We now consider a generator, a current loop rotating in a magnetic field, as in the diagram below. Show that the induced emf in the loop is $e = \omega BA \sin \omega t$. If the load resistance is $R$, calculate the force $F$ required to keep the loop rotating, its torque, and the mechanical power $P$. Show that $P$ also equals the electrical power dissipated in the circuit.
Figure 4: A single loop armature, of area $A$, rotating in a region where the field is $B$. The loop rotates with constant angular velocity $\omega$, under the influence of a force $F$.

6. The diagram below shows a simple transformer arrangement, with the secondary coil located outside the cylindrical primary coil. A naïve view is that this transformer would not work, since the cylindrical primary coil forms a solenoid, and a solenoid concentrates all its field inside it. Explain why this view is incorrect, and why the transformer can indeed function.

Figure 5: A transformer, with a secondary coil outside the primary coil.

7. You are 3 m away from a 150 W electric light globe. Estimate the electric field of
the light where you are. What simplifying assumptions did you make?