NYU Physics 2 — Problem Set 9

Due by Friday 2002 April 5 at 1pm at Irene Port’s office in Meyer 424.

Problem 1
Imagine that 120 V AC electricity is generated with a single loop of area 1 m\(^2\) rotating at 60 rps in a magnetic field. What is the required strength of the magnetic field? State your assumptions and show your work. How does your answer change if the loop has 1000 windings?

Problem 2
A toroidal solenoid of inner radius \(a\), outer radius \(b\), and height \(h\) has \(N\) equally spaced turns of wire around it. If this solenoid carries current \(I\), what is the magnetic field everywhere inside the solenoid? Use Ampere’s law and assume cylindrical symmetry (not a terrible assumption, it turns out). Now imagine that this solenoid is pierced though its center, along the axis of symmetry, by a very long, straight wire. What is the mutual inductance between the wire and the solenoid? Draw diagrams to explain your reasoning and your answer. Pay attention in lecture for some hints on this problem.

Problem 3
A square loop of side length \(a\), mass \(m\), and total resistance \(R\), aligned with the \(x-z\) plane, falls vertically in the negative \(z\) direction under the influence of gravity \(\vec{g} = -g \hat{k}\). Space is filled with a \(y\)-direction magnetic field \(\vec{B} = B_y \hat{j}\) the magnitude of which varies with height as

\[
B_y = B_0 + \alpha z .
\]  

What is the terminal velocity \(v_z\) of the loop?