Electromagnetism (PHYS 295): Week 11

Spring 2025 v1.0

Intro:
We'll study electromagnetic waves and LCR circuits.

Reading:

- PM Chapter 8 Sections 1 - 3 - maybe more or other material based on interest.
- PM Chapter 11 Sections 1 - 2 - Good stuff in Sections 4 - 6 too.

A look ahead:

- We'll be done!!

Problems: Due at the beginning of class on Friday May 9

(1) Wave solutions!
   (a) Verify that
   $$\mathbf{E}(t,z) = E_o \cos(kz - \omega t)\hat{\mathbf{x}} \text{ and } \mathbf{B}(t,z) = \frac{E_o}{c}\cos(kz - \omega t)\hat{\mathbf{y}}$$
   is in fact a valid electromagnetic plane wave. Hint: You'll need to check several things....
   (b) Where does $\hat{\mathbf{k}}$ point?
   (c) Sketch this wave.
   (d) What is the direction of polarization? (Just state the answer. No calculation!)

(2) 9.19

(3) After some thought it probably will not surprise you to learn that electromagnetic waves carry momentum. The momentum density is given by
   $$\mathcal{P} = \epsilon_o \mathbf{E} \times \mathbf{B}$$
   and so proportional to the Poynting vector.
   (a) What is the average momentum density carried by light with monochromatic plane waves?
   (b) Suppose you are aboard a small space cutter (of mass 2.2×10^3 kg) and decide to leave Earth's orbit. How large a sail area must it have to achieve an acceleration of 0.5 g?

(4) 9.24

(5) 8.8

(6) 8.20 One remarkable geometry