University of Washington **Spring Quarter 2020**
Physics 515 **May 1-4, 2020**
Graduate Electrodynamics III

Mid-Term Exam

- The exam is due via email Monday, May 4, at 11 am PDT. Points will be deducted for a late submission.

- Use a separate sheet of paper for each problem solution; you will therefore have a minimum of 3 pages in your submitted PDF file. Assemble pages in problem-order (1, 2, 3).

- This is an open-book exam; you may refer to the Jackson textbook and lecture notes.

- Show your work in enough detail so the grader can follow your reasoning and your method of solution.

- The exam should take about an hour and 20 minutes to complete.

- Feel free to contact me with questions.

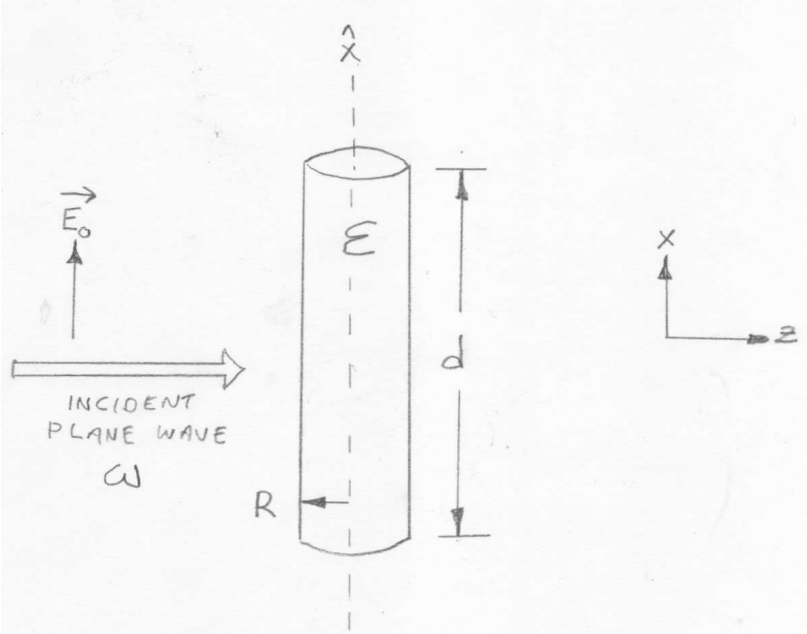
- Email-submission instructions:
  1. Scan your solutions as a single PDF file
  2. Name your file `midterm-`*lastname*`.pdf`
  3. Attach your file to an email
  4. ... with subject line `midterm-`*lastname*
  5. And send your email to `ljrosenberg@phys.washington.edu`

I. (40 points) Scattering.
As shown, a plane wave of angular frequency ω, polarized in the *x*-direction and propagating in the *z*-direction encounters a cylindrical dielectric rod with axis along the *x*-direction, length *d*, radius *R* and real permittivity ε.

a. Using the Poynting formalism in the long-wavelength limit, find the scattering cross section.

b. Using the Optical-Theorem formalism in the long-wavelength limit, find the total cross section.

c. Argue and explain why (a) or (b) is more likely to be correct.



II. (30 points) Antennae.
We discussed in lecture (April 3) the geometric parameters of antennae, including directivity, effective aperture and radiation resistance.

a. For the infinitesimal electric dipole, compare the directivity D_0 for the two cases where the current along the antenna is constant versus the current having the triangle distribution of Jackson eqn. 9.25.

b. For the infinitesimal electric dipole, compare the effective aperture A_{eff} for the two cases where the current along the antenna is constant versus the current having the triangle distribution of Jackson eqn. 9.25.

c. For the infinitesimal electric dipole, compare the radiation resistance R for the two cases where the current along the antenna is constant versus the current having the triangle distribution of Jackson eqn. 9.25.

III. (30 points) Relativity.

The figure shows the view to an observer in an inertial frame of two rockets on an anti-parallel trajectory, each with speed ½ *c*. The observer then sees, when the rockets are closest to each other, rocket-1 sending a missile with speed ¾ *c* aimed to hit rocket-2. To an observer at rest in rocket 1, what angle is the missile aimed so as to hit rocket 2 (where the angle along the rocket-1 velocity is zero).