# PHYSICS 4175: Assignment #12

**DUE: Thursday April 7, 2016**

## Problems:

1. **Problem 9.2 on page 385**

2. **Problem 9.7 on page 391**

3. **Problem 9.12 on page 400**

4. **Electromagnetic field in a linear material - worth 80**

   (a) Consider a homogeneous linear material with the constitutive equations: $\vec{D} = \epsilon\vec{E}$, $\vec{B} = \mu\vec{H}$ and $\vec{J} = \sigma\vec{E}$, where $\epsilon$, $\mu$ and $\sigma$ are real constants. Derive the wave equation for $\vec{E}$ that does not contain any other scalar fields or vector fields.
   Answer: $\bigtriangledown \times \bigtriangledown \times \vec{E} = -\sigma\mu\frac{\partial\vec{E}}{\partial t} - \epsilon\mu\frac{\partial^2\vec{E}}{\partial t^2}$

   Consider circular cylindrical symmetry and using separation of variables, solve the equations in part (a) when:

   (b) $\vec{E} = \hat{e}_z E_z(t)$
   (c) $\vec{E} = \hat{e}_z E_z(r)$
   (d) $\vec{E} = \hat{e}_z E_z(\theta)$
   (e) $\vec{E} = \hat{e}_z E_z(z)$
   (f) $\vec{E} = \hat{e}_z E_z(t, r)$
   (g) $\vec{E} = \hat{e}_z E_z(t, \theta)$
   (h) $\vec{E} = \hat{e}_z E_z(t, z)$
   (i) $\vec{E} = \hat{e}_z E_z(r, \theta)$
   (j) $\vec{E} = \hat{e}_z E_z(r, z)$
   (k) $\vec{E} = \hat{e}_z E_z(\theta, z)$
   (l) $\vec{E} = \hat{e}_z E_z(t, r, \theta)$
   (m) $\vec{E} = \hat{e}_z E_z(t, r, z)$
   (n) $\vec{E} = \hat{e}_z E_z(t, \theta, z)$
   (o) $\vec{E} = \hat{e}_z E_z(r, \theta, z)$
   (p) $\vec{E} = \hat{e}_z E_z(t, r, \theta, z)$

   Do not assume anything about the solutions except $\vec{E}$ must be singled-valued.