# EE119 Discussion Section 1

**(01/25/10)**

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**Example Problems**

1. **Light as Wave – Hecht 3.1** consider the plane electromagnetic wave (in SI units) given by the expression $E_x = 0$, $E_y = 2\cos[2\pi \times 10^{14}(t - x/c) + \pi/2]$, and $E_z = 0$. What are the (a) frequency, angular frequency, (b) wavelength, wave-vector (propagation constant), (c) direction of motion, (d) phase velocity, initial phase angle, (e) amplitude and the polarization of the wave?

2. **Light as a Particle** – the room light in a classroom with average power of 5 μW hitting a detector that has an area of 1 $cm^2$. How many photons are hitting the detector per second if they are all red photons ($\lambda = 700$nm)? How many if they are all violet photons (($\lambda = 400$nm)?

3. **Reflection, Refraction and Total Internal Reflection** – Prof. Bokor throws you out of a helicopter into a sea of unknown liquid with only a protractor in hand. He then flies away to an angle of 49°, relative to the surface normal. You dive underwater and see that he is now at an angle of 32°.
   (a) Determine the index of refraction of the liquid.
   (b) You are still under water. Thinking you have drowned, Prof. Bokor flies away. Can you hold your breath until he appears to be at an angle of 47°?

4. **Polarization States** – describe the polarization of the following transverse, monochromatic waves.
   (a) $E = \mathbf{x}\sin(\omega t - kz) + \mathbf{y}\sin(\omega t - kz - \pi)$;
   (b) $E = \mathbf{x}\sin(\omega t - kz) + \mathbf{y}\sin(\omega t - kz - \pi/2)$;
   (c) $E = \mathbf{x}\,2\sin(\omega t - kz) + \mathbf{y}\sin(\omega t - kz - \pi/2)$.

5. **Polarizers and Malus's Law –**
   (a) You place a linear polarizer in front of unpolarized light. How much of the initial intensity is transmitted through the polarizer?
   (b) Now you have a second linear polarizer that is oriented at 90° to the first one. How much light is transmitted?
   (c) Now you partner bets that if he can make the light emerging from the second polarizer by using another polarizer. Are you in? If you try adding a third polarizer between the first and the second ones, with its transmission axis at 30° with that of the first one. What is the transmitted intensity you think you'll get? At what angle would you have to place the transmission axis to maximize the transmitted light?