EAS 110b: The Technological World

Description:
Using electromagnetic (EM) waves as the connecting scientific thread, this course describes how a wide variety of common technologies work. The experimental observations of Coulomb, Faraday, Ampere, etc. (including equations) will be used to derive the properties of EM waves, their propagation and information transmission; elementary principles of quantum mechanics describe the interaction of EM waves with matter. Those properties will then be applied to show how EM waves are used in communications, graphics display, position location, medical diagnostics, data storage, etc. Both basic science and device design will be covered. The course is intended for students who like to take things apart to see how they work.

Expected Quantitative Preparation:
Students are expected to have taken algebra and trigonometry before taking this course; calculus is neither required nor used. A Yale publication, "The Quantitative Approach", will be distributed to all students; it reviews all of the math that is required in the course and should be an adequate reference. Typical problems from the course are:

1. In Coulomb's law, $$F = \frac{K_e Q_1 Q_2}{r^2}$$

$K_e = 9.0 \times 10^9\ N \cdot m^2/C^2$ in SI units , where C is a Coulomb of charge. The magnitude of the charge on an electron or a proton is $Q = 1.6 \times 10^{-19}$ C. What is the force between an electron and a proton a distance of 10 nm apart?

2. A light wave in air strikes the surface of a lake at 37° to the surface normal. If the index of refraction of the lake water is 1.33, use Snell's law

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

to find the direction in which the light wave propagates under the water.

3. In back projecting x-ray absorption data to determine the image in a CAT scan, the following values are obtained:
A + B = 6, C + D = 9, A + C = 7, and A + D =10.
Find A, B, C and D.