OPT 462: Homework Set 1   Due on Wednesday 24, 2001

1 Integral form of Maxwell equations

1. 1. Derive the integral form of the macroscopic Maxwell equations by applying Gauss's and Stokes's theorems to the corresponding differential forms.

1. 2. In a sentence or two, write down the physical meaning of each equation.

2 One-dimensional Maxwell equations without sources

Use Maxwell's equations in differential form and assume that all fields depend only on the coordinate z and the time t. There are no currents and sources, and the medium is vacuum.

2. 1. Show that the field $E_x(z,t) = f(z - ct)$ is part of a solution of Maxwell's equations. Here, f is an arbitrarily differentiable function and c is a constant to be determined.

2. 2. Determine the remaining field components.
Hint: Set as many field components as possible equal to zero.

2. 3. Assume that the function f is a cosine function. Make a qualitative plot of the electromagnetic wave as it propagates along the z axis.

3 Laser pulse

A laser pulse is characterized by the function

$$f(s) = \begin{cases} \cos^2 s & -\pi/2 \leq s \leq \pi/2 \\ 0 & \text{else} \end{cases} , \tag{1}$$

and the electric field

$$E_x(\mathbf{r},t) = E_x(z,t) = E_o f(\omega[z/c - t]) \, . \tag{2}$$

The quantities ω, c, and E_o are given.

2. 1. What is the corresponding magnetic field. Assume that at $t=0$ the magnetic field is zero at large distances z.

2. 2. Describe in a few words the space and time for which the electromagnetic field is non zero.

2. 3. How and where does the energy propagate?