Applications of electrodynamics, spring 2005

Exercise 6 (Thursday 3.3., return answers until 16:00 on Monday 28.2.)

1. Derive the plane wave formula of a uniform earth for the fields at the earth's surface:

$$E(t) = -\frac{1}{\sqrt{\pi\mu_0\sigma}} \int_0^\infty \frac{g(t-u)}{\sqrt{u}}\, du = -\frac{1}{\sqrt{\pi\mu_0\sigma}} \int_{-\infty}^t \frac{g(u)}{\sqrt{t-u}}\, du$$

   Start from the frequency domain relation between the fields ($E = E_y, g = dB_x/dt$). Omit the displacement current. Be careful with the phase conventions of the wave number when performing the inverse Fourier transform.

2. Assume that the magnetic field is a vertically downwards propagating plane wave arriving at the surface ($z = 0$) of a uniform earth. Ignore the displacement current.
   a) Calculate the magnetic field inside ($z > 0$) the earth assuming that the surface field $B(t)$ is known.
   b) Apply the result to the case $B(t) = B_0\theta(t)$ where $\theta(t)$ is the Heaviside step function. Illustrate graphically.

3. Apply the method of conformal mapping to a hemispherical anomaly of Sect. 5.4.4 when the primary field is a plane wave. Calculate the fields at the earth's surface, determine image currents and sketch the field lines.

Home exam: Problems will be given at the end of the lecture on Monday, 28 February. A paper copy will be available in the library just after the lecture, and on the WWW site about one hour later. Dead-line for returning answers: beginning of the last lecture on Friday, 4 March.