EM FALL 01 A

An infinitely thin, perfectly conducting sheet lies in the plane $z = 0$ of an otherwise empty space.

a) A current is introduced into the conductor so that the z-component of the B field is

$$B_z = B_{z0}\cos(kx)$$

just above and below the sheet; here $k > 0$. Find **B** at all points outside the sheet; you may assume that $B \to 0$ as $z \to \infty$. Hint: recall that a vector field **v** satisfying $\nabla \times \mathbf{v} = 0$ may be rewritten in terms of a "potential" $\psi\,(\mathbf{v} = \nabla\psi)$ satisfying $\nabla^2\psi = 0$.

b) Sketch the field lines in the *x-z* plane, making sure you indicate their direction.

If you were unable to solve part a), in the following write the formulae in terms of the unknown function $B(x,y,z)$.

c) How much work, per unit area in the *x-y* plane, was required to produce this electromagnetic field?

d) Find the surface current density in the sheet.

e) Now suppose that the conducting sheet is embedded in a medium with constant relative magnetic permeability μ/μ_0, and that currents in the sheet produce a field

$$B_z = B_{z0}\cos(kx)$$

Just above and below the sheet. What is the new surface current density in the sheet?