Level 2 EM Q6 2002/3

A circular parallel plate air-filled capacitor of radius *R* has a small plate separation, *d*, and large plate area such that edge effects may be neglected.

a) In terms of the electric field, *E*, how much energy is stored within the capacitor?

b) If *E* changes with time at what rate does the energy in **a)** change with time?

c) By integrating Maxwell's 4th equation, $\nabla \times \underline{B} = \mu_o \underline{J} + \mu_o \varepsilon_o \frac{\partial \underline{E}}{\partial t}$ over a circular surface between and parallel to the plates demonstrate that $H\left(=\frac{B}{\mu_o}\right)=\left(\frac{\varepsilon_o R}{2}\right)\frac{\partial E}{\partial t}$ tangential to the circle at the edge of the plates.

d) Make a rough sketch showing the relative directions of *E* and *H* if *E* is increasing with time and also indicate the direction of the Poynting vector, *S*. By performing the integration $\int \underline{S} \cdot d\underline{a}$ over a closed "pill box" shaped area just enclosing the capacitor show that the energy/time flowing into the region between the capacitor plates is exactly equal to your answer in **a)**.