Version 9/30/06

EECS 210 Applied Electromagnetic Theory

Fall 2006	**Office Hours**	**Prof. A. R. Neureuther,**
Tu, Th 12:30-2	**M, (W), 11AM**	**509 Cory Hall, 2-4590**
400 Cory	**Tu, Th, (F) 10AM**	**neureuth@eecs**

Homework # 4: Due 5 PM Friday Oct 6th

5.1) **Retarded Potential (time-domain)**: Consider the scalar potential produced by two time-varying sources., One source is at $x_1 = (0,0,0)$ and has charge $q_1(t)$, the other is at $x_2= (a,0,0)$ and has charge $q_2(t)$.
a) Using the scalar potential from a point charge write down a general expression for $\Phi(x,y,z,t)$.
b) Find the Electric field contributed by this potential E(x,y,z,t) far from the source in the z = 0 plane.
c) Now suppose $q_2(t) = q_1(t-\tau)$. Find the value of τ that for large positive distances on the x-axis will synchronize the contributions from the two sources regardless of the time-variation of $q_1(t)$.
d) Repeat part c) for a large distance in a direction n =($\cos\phi,\sin\phi$,0) i.e. ($R\cos\phi,R\sin\phi$,0) where R >> a.
e) Show how the delay can be described through using (x_2 dot n).
f) Find E(R,0,0,t) E(R,0,0,t) where R >> a, and show that it is given by $E_1E_1+ E_2E_2$ plus a cross term proportional to E_1E_2 and involving the delay between the sources.

5.2) **Retarded Potential (frequency-domain)**: Now reconsider the two point time-varying source in Problem 5.1).
a) Find an expression for $\Phi(x,y,z,\omega)$.
b) Find the Electric field contributed by this potential $E(x,y,z,\omega)$ far from the source in the z = 0 plane. Hint use n =($\cos\phi,\sin\phi$,0).
c) Using the curl E Maxwell equation find $H(x,y,z,\omega)$ far from the source in the z = 0 plane.
d) Show that $H(x,y,z,-\omega) = H^*(x,y,z,\omega)$
e) For the case of $q_2(t)= q_1(t-\tau)$, find $q_2(\omega)$ in terms of $q_1(\omega)$.
f) Find the product $E(R,0,0, \omega)$ $E(R,0,0, \omega)$ where R >> a, and show that it is given by $E_1E_1+ E_2E_2$ plus a cross term proportional to E_1E_2 and involving the phase between the sources and (x_2 dot n).

4.3) **Green's Function in Time-harmonic**: Consider the interior of a grounded box defined by the six planes, x = 0, y = 0, c = 0, x = a, y = b, and c = z. A time-varying charge source is given by $q(x,y,z,t) = \delta(x-d)\delta(y-e)\delta(z-f)\delta(t-\tau)$.
a) Convert this source to a Fourier representation using $q(x,y,z,\omega)$
b) Use the N-dimensional eigenfunctions and the scaler wave equation to find the solution for the potential inside the box.
c) Describe what happens to the potential when the time-harmonic frequency contribution $\omega^2\mu\varepsilon$ hits an eigenvalue.
c) Suppose instead you had used the N-1 eigenfunction expansion method what would happen when $\omega^2\mu\varepsilon$ hits an eigenvalue and then increases further?

Buzz Lighyear sez "To infinity and beyond."