EE6506 Computational Electromagnetics: Jan - May 2019, Uday Khankhoje

Assignment 1, 25.01.2018, due 04.02.2018 (12p in ESB323)

Clearly state the CONCEPT involved in solving each problem. Do NOT write lengthy answers. Make reasonable assumptions and STATE them. You are free to discuss with your classmates and look at reference books. But, you must write your solutions yourself and mention who you collaborated with for your solution. Looking for solutions online is not allowed.

1. For a volume V with a surface S and scalar functions ψ, ϕ, prove:
   (a) $\oint_S \phi \frac{\partial \psi}{\partial n} ds = \int_V (\phi \nabla^2 \psi) dv + \int_V (\nabla \phi \cdot \nabla \psi) dv$: Green's first identity
   (b) $\oint_S (\phi \frac{\partial \psi}{\partial n} - \psi \frac{\partial \phi}{\partial n}) ds = \int_V (\phi \nabla^2 \psi - \psi \nabla^2 \phi) dv$: Green's second identity
2. Given that the instantaneous electric field inside a source-free, homogeneous, isotropic, and linear medium is given by $\mathcal{E} = [\alpha(x+y)\hat{x} + \beta(x-y)\hat{y}] \sin(\omega t)$, find a relation between α, β.
3. An electric line source of infinite length and constant current along the z axis radiates in free space, and at large distances from the source the expression for the magnetic field is as follows: $\mathbf{H} = \hat{\phi} H_0 \exp(-j\beta_0 \rho)/\sqrt{\rho}$, ($H_0$ is a constant). Find the corresponding electric field.
4. Give a short proof of the uniqueness theorem, being sure to point out why the medium needs to be lossy.
5. Derive a continuity relation for the normal components of $\mathbf{D}$ at an interface between two media in the presence of a surface charge.
6. Derive (but do not solve) the form of the differential equation obeyed by a time-harmonic wave travelling along the z axis of a waveguide at a point away from the exciting current. The cross-section of the waveguide is not a function of the z co-ordinate, but an arbitrary $\epsilon(x, y)$. Hint: What is the logical and simplest form of the z-dependence of the field? Make simplifying assumptions like the choice of polarization, etc., and state them.

At the start of your submission, please hand write the following text:

I, _____(name), state that the submitted work is my original work. I have discussed with these people: _____, and referred to these books: _____.
_____(sign and date).