TUTORIAL

"Computational Electromagnetics"

to the lecture

"Numerical Methods in Electrical Engineering"

Tutorial 01 Thursday, March 18, 2010 (Time: 15:30 – 16:15; Room: T 212)

1 Introduction to Maxwell's Equations

01 Let us assume that E, D, H, B are sufficiently smooth solutions of the Maxwell field equations. Show that the magnetic flux density (magnetic induction) $B(x,t)$ is solenoidal for any time, i.e. $\mathrm{div}B(x,t) = 0$ for all $t > 0$, if the magnetic induction B is solenoidal at the initial time $t = 0$, i.e. $\mathrm{div}B(x,0) = 0$!

02 Let us assume that $B = \mu H$ in $\overline{V} = \overline{V}_1 \cup \overline{V}_2$, i.e. $M = 0$ in $\overline{V}$, and that $[\mu]_\Gamma = \mu_2 - \mu_1 \neq 0$ and $H^{(2)} \cdot n \neq 0$. Show that $[H \cdot n]_\Gamma = (H^{(2)} - H^{(1)}) \cdot n \neq 0$ across the interface Γ !

03 Show the interface condition

$$[E \times n]_\Gamma = 0 \text{ on } \Gamma \tag{1.1}$$

for the E-field !

Hint: Start from Faraday's law $(1)_F$ in integral form !

04 Show that for any continuously differentiable scalar function ψ the potentials $\tilde{A} = A + \nabla\psi$ and $\tilde{\varphi} = \varphi - \frac{\partial\psi}{\partial t}$ provide the same magnetic and electric fields, i.e. $B = \mathrm{curl}A = \mathrm{curl}\tilde{A}$ and $E = -\frac{\partial A}{\partial t} - \nabla\varphi = -\frac{\partial \tilde{A}}{\partial t} - \nabla\tilde{\varphi}$!