ELT-41736 Analysis of Electromagnetic Systems
Small Exam II 02.12.2013
Answer to all questions.
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1. (a) Describe the laws that govern magnetostatics in free space. Define also briefly the quantities used.

   (b) How are the laws changed if we consider domain that is not free space? (Aim to give detailed answer, i.e., complete set of conditions inherent in the case.)

   (c) In the electrostatic case we introduced so called electric scalar potential. Could we use in magnetostatics scalar potential? If yes/no, try to give a thorough reasoning.

   (6 p. in total)

2. (a) In electromagnetic motors, for instance, so called laminated structures are used (see the black board).

   i. Explain in which kind of cases such structures are needed. Reason why such structures are useful, use suitable EM laws to support your reasoning.

   ii. Reason also suitable direction of the lamination with respect to relevant EM quantities.

   (b) Show that if $\mathbf{F}(\mathbf{r}) = \mathbf{A}e^{j\boldsymbol{\kappa}\cdot\mathbf{r}}$ (where $\mathbf{A}$ is constant vector and $j^2 = -1$),

   $$\nabla \cdot \mathbf{F} = j\boldsymbol{\kappa} \cdot \mathbf{F} \text{ and } \nabla \times \mathbf{F} = j\boldsymbol{\kappa} \times \mathbf{F}.$$

   (5 p. in total)

3. (a) Consider solution to an electromagnetic wave problem. Let us suppose two candidates for electric flux density $\mathbf{D_1}$ and $\mathbf{D_2}$ for which holds that $\nabla \cdot (\mathbf{D_1} - \mathbf{D_2}) = 0$. Does this mean that $\mathbf{D_1} = \mathbf{D_2}$? If no, how are they related to each other?

   (b) In certain cases electric potential due to charges is given as

   $$\phi(\mathbf{r}, t) = \frac{1}{4\pi\epsilon} \int_{V'} \frac{\rho(\mathbf{r'}, t - \frac{|\mathbf{r}-\mathbf{r'}|}{c})}{|\mathbf{r}-\mathbf{r'}|} \, dV'.$$

   Explain what is special in this expression and how to interpret it. Consider also fundamental assumptions underlying in basic circuit analysis; how could you relate the intepretation to them.

   (4 p. in total)