$$\frac{\partial}{\partial t}\underline{\boldsymbol{B}} = -\nabla \times \underline{\boldsymbol{E}}$$
$$\frac{\partial}{\partial t}\underline{\boldsymbol{D}} = \nabla \times \underline{\boldsymbol{H}}$$

GhK
TET

$$\frac{\partial}{\partial t}\underline{\boldsymbol{p}} = \nabla \cdot \underline{\underline{\boldsymbol{T}}}$$
$$\frac{\partial}{\partial t}\underline{\underline{\boldsymbol{S}}} = \mathrm{sym}\{\nabla \underline{\boldsymbol{v}}\}$$

Universität Gesamthochschule Kassel
Dr.–Ing. R. Marklein
Dipl.–Ing. R. Hannemann
Fachbereich Elektrotechnik
Fachgebiet Theoretische Elektrotechnik

Kassel, den 13.09.00
Zeit: 14.00 - 16.00

EFT I - Exam

Electromagnetic Field Theory I

Last Name:............................ Immatrikulations-Nr.:...........................

First Name:.............................. Middle Name:..............................

Signature: ____________________

Problem	1	2	3	$\sum_{i=1}^{3}$	
Points:					

Problem	4	5		$\sum_{i=4}^{5}$	$\sum_{i=1}^{5}$
Points:					

Mark: _____

Problem 1 [8 Points]

Given is a spherical capacitor with

$$K := \{(R, \vartheta, \varphi) \,|\, R \in (1, 2),\ \vartheta \in [0, \pi],\ \varphi \in [0, 2\pi)\}.$$

(a) Determine the electric potential $\Phi = \Phi(R)$ with

$$\Delta\Phi = 0 \quad \text{in} \quad K \quad , \quad \Phi(1) = 0 \quad \text{and} \quad \Phi(2) = 1.$$

(b) Determine the electric field $\underline{\mathbf{E}}$ in K.

(c) Determine the electric voltage U between $R = 2$ and $R = 1$.

Problem 2 [9 Points]

Given is an electric point charge with the total charge Q at $\underline{\mathbf{R}}_1 = \underline{\mathbf{e}}_z$. The space $z \leq 0$ is perfectly conducting and grounded ($Phi = 0$).

(a) Sketch the situation and the field lines of the electric field.

(b) Determine the potential Φ by using the method of images.

(c) Determine the electric fieldstrength $\underline{\mathbf{E}}$.

(d) Show that the electric fieldstrength $\underline{\mathbf{E}}$ has only a normal component at the boundary $z = 0$.

Problem 3 [14 points]

Given is the electric current density

$$\underline{\mathbf{J}}(r) = \begin{cases} \frac{I_0}{\pi r_0^2}\,\underline{\mathbf{e}}_z & , \quad 0 \leq r \leq r_0 \\ \underline{\mathbf{0}} & , \quad \text{else} \end{cases} .$$

(a) Determine the electric current I through the xy–plane.

(b) Determine the magnetic fieldstrength $\underline{\mathbf{H}}(\underline{\mathbf{R}})$ for $0 \leq r < \infty$.

(b) Sketch $\underline{\mathbf{H}}(\underline{\mathbf{R}})$ for $0 \leq r \leq 2r_0$.

Problem 4 [7 points]

Given is an electric point charge with the total charge Q at the origin of the coordinate system.

(a) Determine the electric charge distribution $\varrho(\underline{\mathbf{R}})$ and the electric flux density $\underline{\mathbf{D}}(\underline{\mathbf{R}})$.

(b) Let S be the surface of a ball with radius R_0 centered at the origin. Determine the closed surface integral

$$\oiint_S \underline{\mathbf{D}} \cdot \mathrm{d}\underline{\mathbf{S}}$$

directly and by using Gauß' theorem.

Problem 5 [10 points]

Determine the total electric charge Q for the electric charge distribution

$$\varrho(R) = \begin{cases} \varrho_0 \left(\frac{R_0}{R}\right)^2 \sin\left(\pi \frac{R-R_1}{R_2-R_1}\right) & , \quad R_1 \leq R \leq R_2 \\ 0 & , \quad \text{else} \end{cases} .$$