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SMG-8146 RF-electronics preparatory II

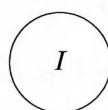
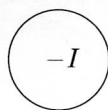
Small Exam II 05.12.2011

Answer to three of the four questions.

Each question gives maximum of five points

Jari Kangas

1. Consider a pair of parallel wires in air, in which a DC current I and $-I$ flows, respectively. See the picture below for a cross-section of the case. Explain how to obtain field lines of the related magnetic field and also draw enough field lines to sketch the field.



2. Correct or incorrect? *To get points, support your answer by an argument or an example.*
 - (a) Retarded potentials are related to finite velocity of information. (1 p)
 - (b) In insulators the Faraday's induction law does not apply, because no current can get induced in an insulator. (1 p)
 - (c) It is possible even in a general time dependent case to express the electric field using scalar potentials. (1 p.)
 - (d) The magnetic dipole is formed to two poles, North and South poles. (1 p)
 - (e) The magnetic susceptibility relates \mathbf{B} and \mathbf{M} . (1 p)
3. (a) Uniform plane wave that propagates in an insulator ($\mu_r = 1$, $\sigma = 0$) has following \mathbf{E} -field

$$\mathbf{E}(\mathbf{r}, t) = \mathbf{u}_x \cos(10^8 t - \frac{z}{\sqrt{3}}).$$

- i. Find the frequency and wavelength of the wave.
 - ii. What is the dielectric constant of the medium?
 - iii. Find the corresponding \mathbf{H} -field.
- (b) Describe upon which factors do the velocity of light depend. Give examples of what kind of values it can assume and consider also possible consequences if we are to use EM waves to transmit information.
4. (a) Define *polarization of a wave*, give also examples of it.
 - (b) Describe what is so called *skin depth* and explain briefly its physical background.