Electromagnetism. Lecture 6

Topics:
-Wave propagation in good conductors.
-Penetration depth.
-Surface impedance.
-Current displacement (skin effect).
-Current fields in wires.
-Shielding.

Reading:
GMF pages 83-105

Exercise 16.1
Around the preamplifier for the CD input in a radio there is a screen of a general metal sheet of thickness 0.5 mm (Medium constants are given at the end of the document).
a. Calculate the attenuation due to the absorption of radiated noise fields with frequencies 20 – 20 kHz, expressed in dB.
b. Calculate the attenuation due to reflection across the electric field, expressed in dB. The calculation is carried out for 20 kHz and is calculated from the surface impedance. Both surfaces are included, absorption is not included.
c. Calculate the phase shift a 20 kHz signal undergoes from front to back. Express the result in degrees.

Exercise 16.2
How far do radio waves penetrate into the sea?
Assume that seawater is a conductor and ϵ_r= 80, μ_r= 1, σ= 5 S/m.
Calculate the ocean depth where a radio wave is attenuated to 1% of the incident amplitude due to absorption.
a. For a 10 kHz signal (Submarine frequencies).
b. For a 100 MHz signal (FM radio).

Exercise 16.3
Before Olsen watches TV (the antenna works fine now), he wants to put a Saturday chicken in the microwave. Olsen has been told in the grill bar that the chicken is a distinct type of leader once it is thawed, and that μ_r= 1 , σ = 5 S/m for the chicken he bought.
In this task, only absorption is considered.
a. How deeply do the fields penetrate the chicken when Olsen's micro works at 2.45 GHz?
b. To preserve the juices and flavor, Olsen has wrapped the chicken in aluminum foil with thickness of 11 μm. How many dB has the power density attenuated in the chicken now?
The power density $E \cdot H$ is measured in W/m^2.

c. When there is a μ -metal screen in the glass door approx. 1 mm thick, and the oven has an E field on it of approx. 1 kV/m, what will the field strength be just outside the door?
Media constants, which need to be used in the exercises:

	μ_r	σ_r
μ-metal	80.000	0,03
aluminium	1	0,61
metal sheet	1000	0,17

$\sigma_{Cu} = 58 \times 10^6\ S/m$. Conductances are given relative to σ_{Cu}.

Solutions:

Exercise 16.1	3,83 dB	121,18 dB	90,4 dB 799,3°
Exercise 16.2	10,37 m	10,37 cm	
Exercise 16.3	4,547 mm	55,89 dB	-318,7e3 dB 1 kV/m