**TAMPERE UNIVERSITY OF TECHNOLOGY**
*Ragnar Granit Institute*

**71210 Bioelektroniikka - Bioelectromagnetism**
**Laskuharjoitus 10 – Exercise 10, 1.12.2004**

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1. In the centric dipole model for a spherical homogeneous torso, why is the image surface corresponding to the surface of the torso also a sphere? How about when the dipole is not located in the center?

2. Calculate the field strength in the center of a coil measuring magnetic field if the source ***m*** (magnetic dipole, normal parallel to the normal of the coil) situates on a plane 15 cm from the coil? Another coil is introduced to the system (10 cm from the original coil) and these two identical coils are used as a gradiometer. What is the level of the signal in this new system compared to the single coil arrangement if the source is 15 cm apart under the measuring coil and the normal of the source is parallel to the normal of the coils?

3. Show the most efficient EEG measurement setup for current dipole oriented a) radially b) tangentially to the skull (i.e. so that the signal has largest amplitude). What kind of setup would you use to determine if the source dipole is oriented radially or tangentially - is there such a single measurement?

4. Figure 1 represents a potential data distribution at a model of a (half) head generated by a reciprocal current of 1.0 μA applied to electrodes C and D. Calculate the potential between electrodes C and D generated by current dipoles A and B (|P| = 4 μAcm).

5. In impedance cardiography (ICG) an electric current is injected to the body and the corresponding voltage is measured. The ratio of the voltage and current gives the impedance, Z. Z can be obtained using the concept of lead field as follows

$$Z = \int_v \frac{1}{\sigma} \bar{J}_{LE} \bullet \bar{J}_{LI} dv$$

where $\sigma$ = conductivity
$\mathbf{J}_{LE}$ = lead field of the voltage measurement
$\mathbf{J}_{LI}$ = lead field of the current feeding electrodes
v = volume.

Sketch the lead fields for a system shown in Fig 2. What kind of sensitivity is obtained for impedance changes in different regions?

6. Applying the impedance measurement to the whole body electrode setting shown in Fig. 3, how would you measure segmental data related *only* to

a) right arm
b) trunk?

*Hint - think about the sensitivity equation, dot product in it…*

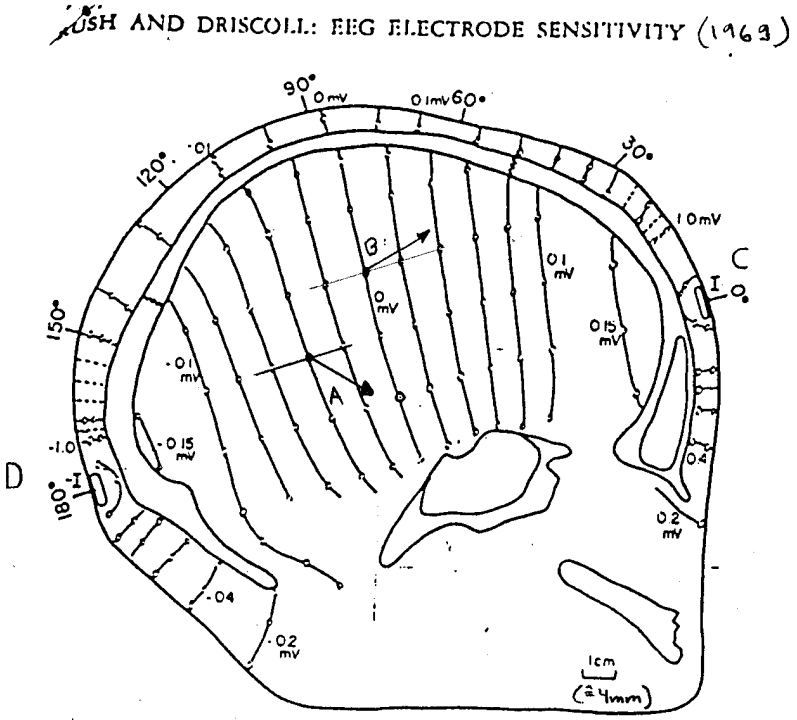


Fig. 1. Potential data at surface of electrolytic tank (midsagittal plane). Lines between 0.1-mV curves are spaced at equal potential differences (0.02 mV) apart. Electrodes at 0° and 180° are near centers of frontal and occipital bones, respectively. $I = 1.0$ μA in the half-head model; fluid resistivity is 2220 Ω·cm.

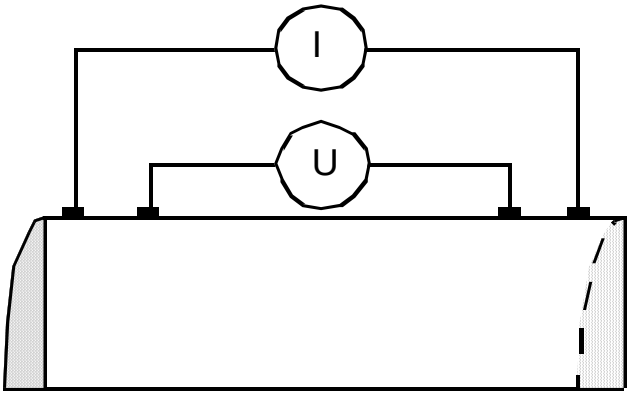


Figure 2. Impedance measurement system

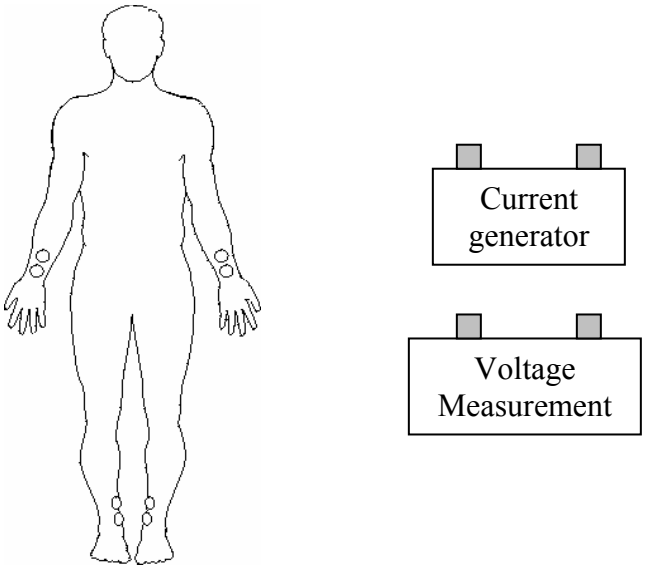


Fig. 3. Electrode locations for the whole-body impedance cardiography