TAMPERE UNIVERSITY OF TECHNOLOGY
Ragnar Granit Institute

71210 Bioelektroniikka - Bioelectromagnetism
Laskuharjoitus 7 – Exercise 7, 10.11.2004

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1. A cube (0.6*0.6*0.6 m) forms a volume conductor (ρ=10 Ωcm). Two opposite sides of the cube have been covered by a conducting medium forming two electrodes. Inside the cube is a current dipole (strength 50 mA, source and sink 10 cm apart) perpendicular to the electrode surfaces. Derive the equation for potential difference between the electrodes.

2. A current dipole (dipole moment 10^{-7} Am) is in an infinite homogeneous volume conductor ($\sigma=3*10^{-3}$ S/m). It generates potential D(P) at the point P far away from the dipole location. The dipole is replaced by a double layer (area 4 cm^2) generating the same potential D(P). What is the double layer potential? (*Answer: 83 mV*)

3. Derive the lead vectors of the limb leads I, II, and III, leads VR, VF, VL, and the Goldberger leads aVR, aVL ja aVF in a spherical homogeneous volume conductor.

4. Three electrodes (a, b and c) are on the surface of a volume conductor. Inside the conductor is a dipole source. The lead vectors of this dipole defined at the three locations (a, b and c) are:

$$\overline{c_a} = \bar{i} + 2\bar{j} + \bar{k}$$
$$\overline{c_b} = 3\bar{i} + 7\bar{j} + 2\bar{k}$$
$$\overline{c_c} = 7\bar{i} + 5\bar{j} + 4\bar{k}$$

   The dipole is parallel to the unit vector i. What is the ratio of the voltages measured between electrodes a and b to a and c? (*Answer: 1/3*)

5. Figure 1 represents an image surface of a volume conductor. Construct new X and Y-leads that would measure dipole sources parallel to X and Y-axis, respective. Use the electrode locations A, B, and C.

6. On the outer rim of a two dimensional volume conductor on points P_i, i = 1,...,6 the potentials generated by a unit dipole oriented parallel to X or Y axes at point P_o are as follows:

Electrode	Potentials generated by X and Y dipoles	
P_i	V_X	V_Y
1	4	5
2	6	-1
3	1	-4
4	-4	-2
5	-4	2
6	-1	5

Using these measurements is it possible to

a) Derive the image surface of this source dipole location?
b) Calculate the lead vector of a lead between the points 3 and 6?
c) Derive the potential at the point 4 generated by a unit dipole at a point P_z?
d) Derive the lead field of the volume conductor?
e) Construct a VECG lead system (X and Y-leads) that would measure the X and Y components of the dipole at the point P_o with similar sensitivity?

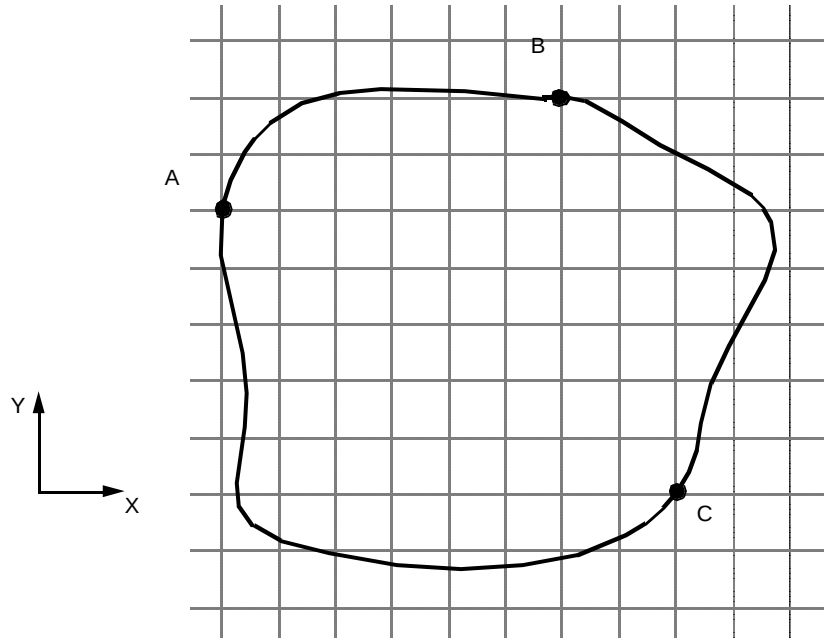

Figure 1. Image surface of a volume conductor. A, B and C refer to the electrode locations.