TAMPERE UNIVERSITY OF TECHNOLOGY
Ragnar Granit Institute

71210 Bioelektroniikka - Bioelectromagnetism
Laskuharjoitus 8 – Exercise 8, 17.11.2004

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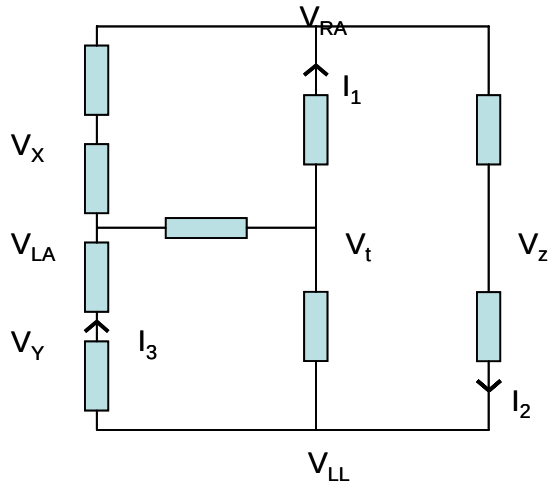
1. Three electrodes (a, b and c) are on the surface of a volume conductor. The lead vectors for a dipole defined at the three locations are:

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

Last week you defined the ratio of the voltages measured between the electrodes a and b to a and c for a dipole oriented in x direction. This time, what is the lead vector for a measurement taken from the electrodes A&B to C?

2. In the Wilson network shown below, all resistors are 2 kΩ. At the time of the R-peak. the voltages at LA=67 mV, RA=62 mV and LL=65 mV.
a) Compute the voltages at X, Y, Z and T.
b) What are the current values I_1, I_2 and I_3?



3. During a QRS-complex at some time instant t the following potentials were measured:

III-lead	+1,1 mV
aVR-lead	-3,4 mV
V1 -lead	-3,5 mV

Approximate the potentials in the leads I, II, aVL, aVF, V6 and V4.

4. In Figure 1 an ECG-lead system measuring dipoles parallel to X-axis is depicted.
a) Determine the value of the resistor X when the resistance 5R at the point E is not connected.
b) If the 5R is connected, what is the value of the resistor X?

5. Using his model Ernest Frank measured 4.3 mV, 2.8 mV and 5.0 mV readings between the points C and D, P and G, and P and D on the 6th level in his model. Determine the potentials between the points E and A
a) on the same level,
b) on level 4.

Image space measured by Frank; see Bioelectromagnetism Chpt 11 - Figures 14, 15, 16 and 17.

6. Figure 2 a) represents a normal QRS-complex measured from the limb lead I. Calculate (actually, just approximate) the altered QRS-complex if hypertrophy (shown in Fig. 2 b) of the left ventricle generates an additional dipolar moment starting 45 ms after the beginning of the QRS and lasts 35 ms. The dipole moment strength is 15 mAm and it is linearly decreasing to zero during the last 15 ms. When the activation spreads in the hypertrophic section, the direction of this dipole on the frontal plane will change from 70 (caudal on the sinister side) to 90, i.e., to cranial. Use the Einthoven triangle when approximating the lead sensitivity.

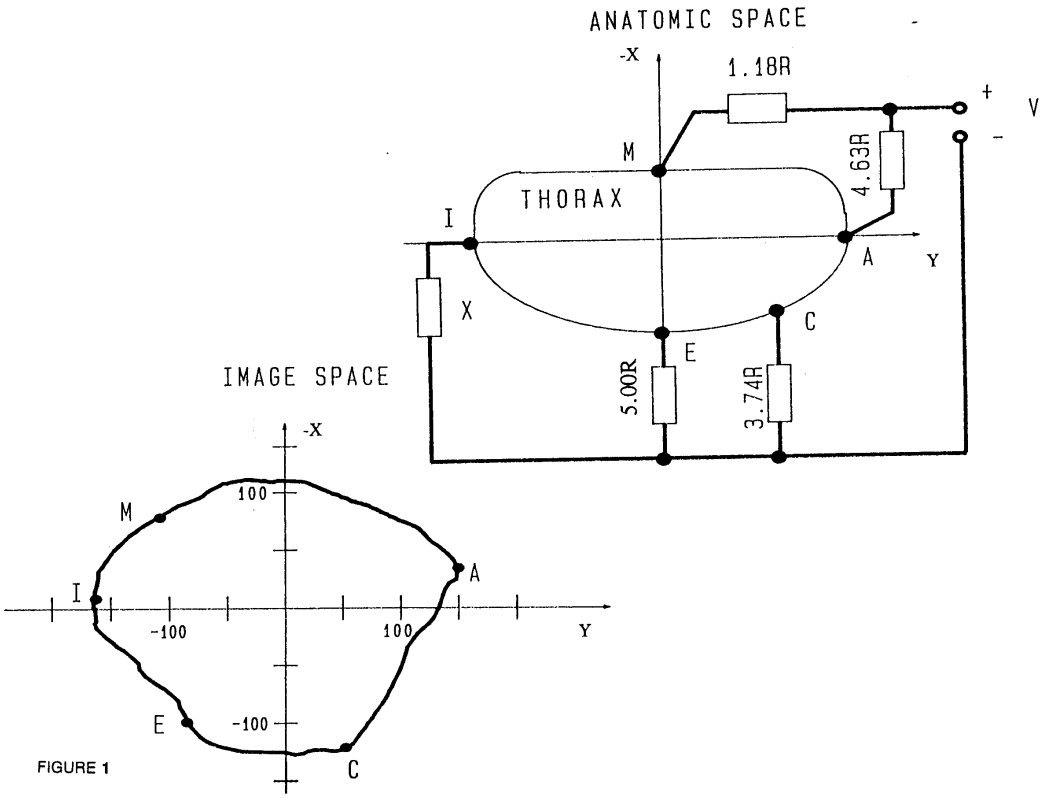


FIGURE 1

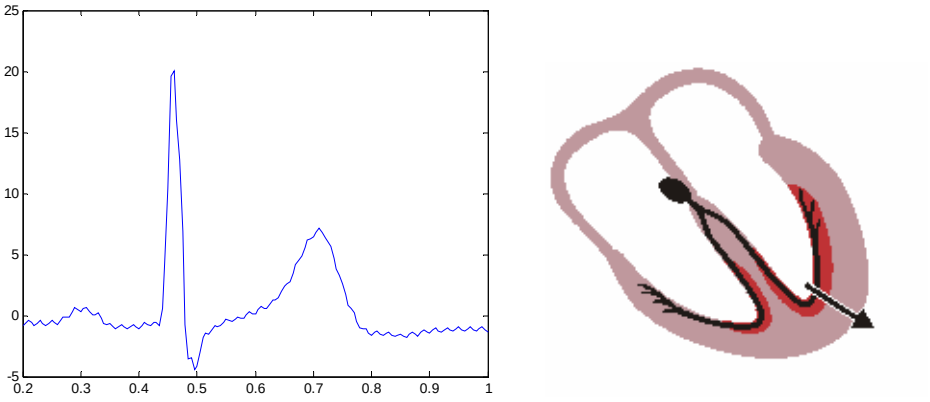


Figure 2. a) QRS-complex. b) Hypertrophy of the left ventricle