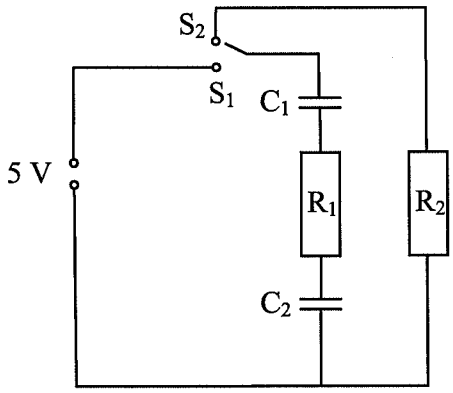
Exam MNW Physics of life, master phase, 4e yr January, 10 2007

Problem 1.
A switch has been a very long time in the position S_2. At a certain moment the switch is brought into the position S_1.



a. Derive the expression of the current through the capacitor C_1 as function of time

b. Derive the expression for the voltage across the capacitor C2 as function of time.

Problem 2.
An infinite long cylinder along the x-axis with radius R has a charge density, that is given by $\rho(r)= 2r$, where r is the distance to the x-axis.

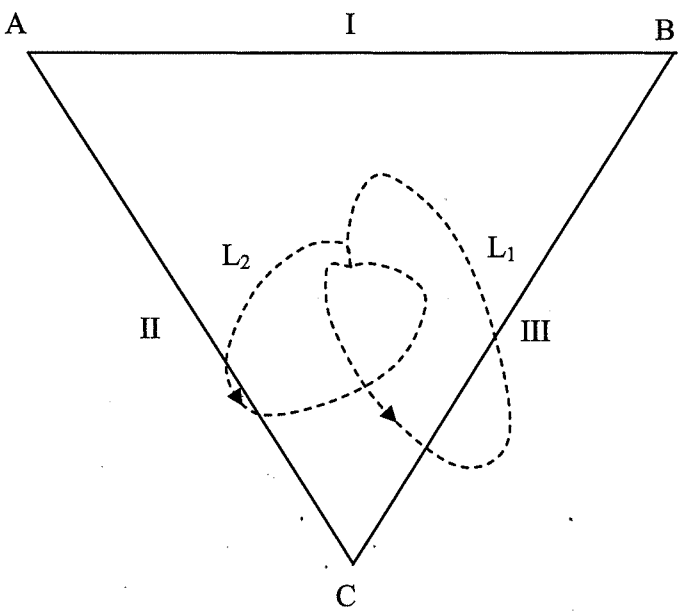
a. What is the electric field as function of r in the cylinder (use $\kappa\varepsilon_0 = 1$)?

b. What is the electric field as function of r outside the cylinder?

c. Make a drawing on the graph paper of the electric field as function of r.

Problem 3.
Suppose that the heart of a patient shows an aberrant electrical activation which is characterized by the fact that the depolarisation of the ventricles alternatively is described by the vector loops L_1 and L_2 (e.g. in the first beat L_1 is followed, the second beat L_2, the third L_1, the forth L_2 etc.). (The disease ventricular bigemeny looks like this example).

In the figure L_1 and L_2 are plotted during depolarisation of the ventricles. Also are plotted leads I, II and III. Suppose ABC is a triangle with three equal sides. Each dashed line segment indicates the same time interval.



a. Draw the ECG, measured in lead I during two cardiac cycles. (the depolarisation of the atria are omitted)

Motivate is all cases your answer.

Problem 4.
A pacemaker of a patient can deliver a stimulation pulse of which pulse duration and pulse strength can be adjusted externally after implantation. The chronaxy-rheobase curve of the patient is established experimentally and can be expressed as:

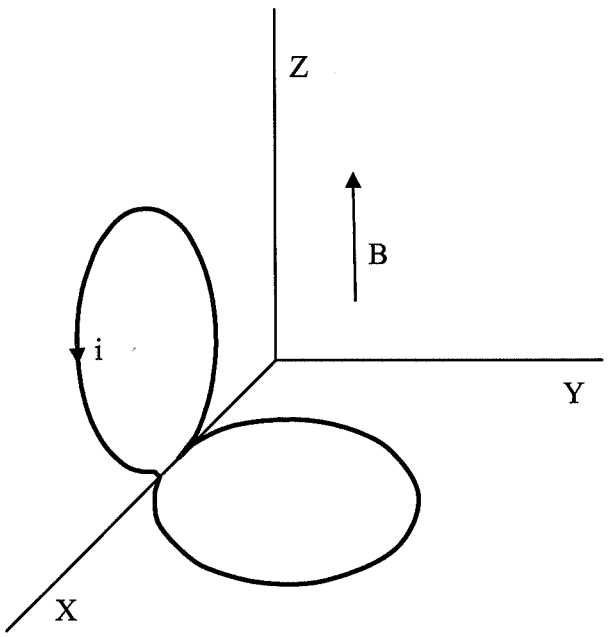
$i(t) = i_R (1 + t_c/t)$, with i_R: rheobase, t_c: chronaxy and t: the pulse duration

To stimulate the heart of the patient with a pulse of 0,5 ms, a current of 4,1 mA is minimally needed; to stimulate the heart with a pulse of 1 ms, a current of 2,1 mA is minimally needed.

a. What is the value of the rheobase?

b. What is the value of the chronaxy?

Problem 5.
An electronic circuit consists of two coils, fixed to each other (see figure). The left coil (in the XZ-plane) has a circular winding with radius r_1; the right coil (in the XY-plane) has a circular winding with radius r_2 ($>r_1$). Through the coils a current i is floating as indicated. At a certain moment a magnetic field **B** in the direction of the positive Z-axis is switched on. The circuit can only rotate about the x axis.



a. What are the magnetic moments of the left resp. the right coil (give sizes and directions)?

b. How will the circuit orient itself on the magnetic field in equilibrium?

Problem 6.
A piece of homogeneous tissue is magnetized by a magnetic field $B(t) = B_0 (1+\sin(2\pi t))$ along the positive Z-axis. The magnetization vector is **M**. At this field strength saturation is still not reached.

a. Make a drawing of the magnetization vector in space for 2 seconds.

Motivate in all situations your answer

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Naam: stud. nr.