Neuroniin synapsoi joukko samanlaisia synapseja, joiden neuronin solukalvoon tuottama yhteenlaskettu maksimikonduktanssi (kun kaikki synapsien postsynaptiset ionikanavat ovat auki) on $g_S = 10 \ \mu S$ ja käänteispotentiaali $E_S = 0 \ mV$. Lepotilassa kaikki synapsikanavat ovat kiinni. Na/K-pumpun vaikutusta ei huomioida.

a) Mikä on neuronin lepokalvojännite?

b) Mikä on maksimaalinen kalvojännitemuutos, jonka synapsit pystyisivät tuottamaan, jos jännitemuutos ei aiheuttaisi muutoksia g_K-, g_{Na}- eikä g_{Cl}-arvoihin? (kalvojänniteen erotus, kun kaikki synapsikanavat joko auki tai kiinni; edellyttää siis kaikkiin synapseihin yhtaikaisen stimulaation)

Aputietoja:

$e = 1{,}602 \cdot 10^{-19} \ C$

$R = 8{,}31 \ J / (K \ mol) = 1{,}99 \ cal / (K \ mol)$

mM = millimoolia/litra

$N = 6{,}022 \cdot 10^{23} \ 1/mol$

$k = 1{,}381 \cdot 10^{-23} \ J/K$

$F = 96 \ 487 \ C / mol = 23061 \ cal / (V \ mol)$

$0 \ °C = 273{,}15 \ K$

$\varepsilon_0 = 8{,}854 \cdot 10^{-12} \ C \ V^{-1} \ m^{-1}$

Kuva tehtävään 3.
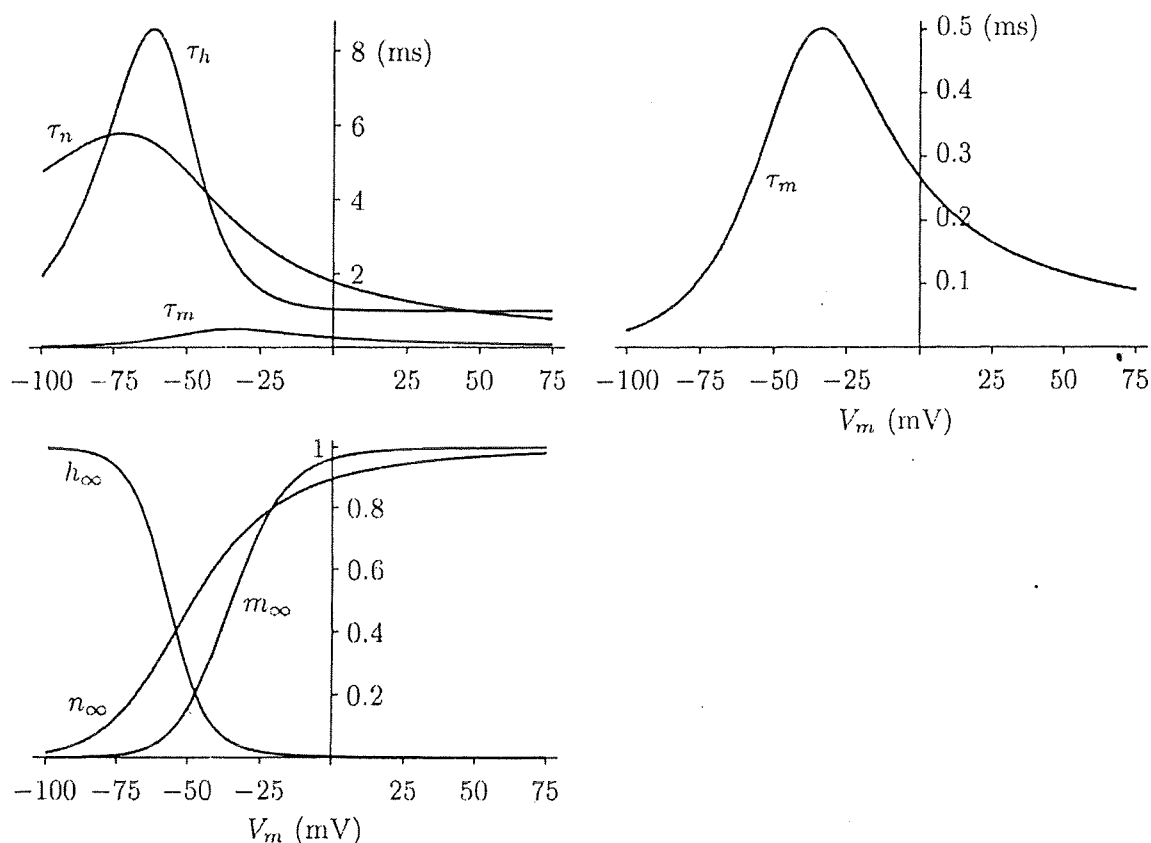
Tfy-99.4280 Medical Imaging Methods

Problems for examination on January 14, 2009

1. List all the medical imaging methods available for standard clinical use you have learned about during this course. In connection of each one name at least one inherent strength of the method based on the physical working principle or a technical solution.

2. The pressure field of a flat circular ultrasonic transducer as a function of distance from its surface can be characterized consisting of two domains: near field and far field. Describe qualitatively the difference of pressure wave patterns between them and calculate the distance of their boundary from the transducer as a function of wavelength and transducer diameter.

3. There are two modern imaging modalities which do not require using any contrast agent to simultaneously generate anatomical images of blood vessels and measure the local blood flows inside? Name the methods and describe the physical working principles they are based on.

4. Sketch the Radon transform $f(x,y) \rightarrow p(r,\phi)$ for ϕ from $0°$ to $360°$ for an object consisting of 4 thin lead rods in air arranged parallelly to z-axis and located in corners of a square. Assume the transform is registered on a film in a tradional X-ray transmission set-up.

5. Estimate the spin-lattice and spin-spin relaxation times of cerebrospinal fluid, white matter and grey matter of the brain based on the information in the attached pieces of MRI lecture material.

   - **The attached selected lecture material is at your disposal**

   - **You may answer in English, Finnish or Swedish**