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Sample exam for neuronal networks B, SS08

<http://www.igi.tugraz.at/lehre/NNB/SS08>

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Please provide short and precise answers. You can answer in German.

1. **(5 points):** Describe the gross function of the following regions in the central nervous system: cerebellum (Kleinhirn), thalamus, hippocampus, cortex, spinal cord (Rückenmark), brain stem (Hirnstamm).
- 2a. **(10 Punkte):** Given is a leaky integrate-and-fire (LIF) neuron. The voltage for a time varying input current is given by

$$u(t) = u_r e^{-\frac{t-t-\Delta_{abs}}{\tau_m}} + \frac{1}{C_m} \int_0^{t-t-\Delta_{abs}} e^{-\frac{s}{\tau_m}} I(t-s) ds.$$

The parameters are $u_r = 0V$, $R_m = 1M\Omega$, $C_m = 20nF$ and $\Delta_{abs} = 1msec$. During the whole time the neuron does not fire. The input current is a Dirac-delta pulse at time $t = t_I = 1sec$:

$$I(t) = I_0 \delta(t - t_I),$$

with small I_0 such that the threshold is not reached. Compute the membrane voltage $u(t)$.

- 2b. **(5 points):** Why is it impossible to model a LIF neuron with a spike-response-model (SRM₀)? (Hint: one can see it in the formula above).
3. **(10 points):** Another theory question.
4. **(10 points):** Describe Hebb's postulate and the Hebb rule. Write down the mathematical formulation of the Hebb rule in a rate model. Which problems can occur and how can one get rid of these problems?