Mathematical Foundations of Neuroscience - Sample Questions - Lecture 4 - 1d systems

Filip Piękniewski

November 2, 2009

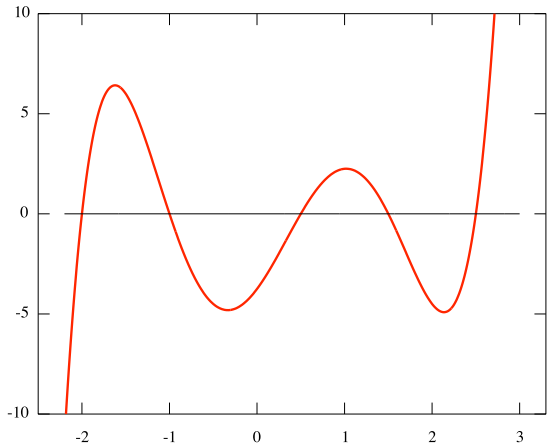
Questions marked with * are not obligatory.

1. Solve the equation:
$$\frac{dy(t)}{dt} = Ay(t) + B$$

2. Show that functions $e^{z_i x}$, where z_i are the roots of the characteristic polynomial are solutions to
$$\frac{d^n y(t)}{dt^n} + A_1 \frac{d^{n-1} y(t)}{dt^{n-1}} + \ldots + A_{n-1} \frac{dy(t)}{dt} + A_n y(t) = 0$$
what happens when some roots have multiplicity > 1?

3. Discuss the possible equilibrium (fixed) points of a 1d system. When are they (non) hyperbolic, (non) degenerate?

4. Given the picture of the right hand side function F of an autonomous 1d ODE mark stable, unstable equilibria and attraction domains.



5. What is a bifurcation? Describe the saddle node bifurcation in 2d.

6. What is the slow transition?

7. Formulate the quadratic integrate and fire neuron. Describe possible dynamical regimes depending on V_{reset} and I parameters.