# Control and Systems Theory Methods in Neurostimulation

**Eduardo Cerpa**, Pontificia Universidad Católica de Chile

Contact: eduardo.cerpa@uc.cl

Electrical stimulation therapies are used to treat the symptoms of a variety of nervous system disorders. Recently, the use of high frequency signals has received increased attention due to its varied effects on tissues and cells. In this talk, we will see how some mathematical methods can be useful to address relevant questions in this framework when the FitzHugh-Nagumo model of a neuron is considered. Here, the stimulation is through the source term of an ODE and the level of neuron activation is associated with the existence of action potentials which are solutions with a particular profile. A first question concerns the effectiveness of a recent technique called interferential currents, which combines two signals of similar kilohertz frequencies intended to activate deeply positioned cells [CCE$^+$23, EC23]. The second question is about how to avoid the onset of undesirable action potentials originated when signals that produce conduction block are turned on [ECon]. We will show theoretical and computational results based on methods such as averaging, Lyapunov analysis, quasi-static steering, and others.

[CCC$^+$on] Eduardo Cerpa, Nathaly Corrales, Matías Courdurier, Leonel Medina, and Esteban Paduro. The impact of high frequency-based stability on the onset of action potentials in neuron models. in preparation.

[CCH$^+$23a] Eduardo Cerpa, Matías Courdurier, Esteban Hernández, Leonel Medina, and Esteban Paduro. A partially averaged system to model neuron responses to interferential current stimulation. *J. Math. Biology*, 2023.

[CCH$^+$23b] Eduardo Cerpa, Matías Courdurier, Esteban Hernández, Leonel Medina, and Esteban Paduro. Approximation and stability results for the parabolic fitzhugh-nagumo system with combined rapidly oscillating sources. arXiv:2305.00123v2, 2023.