

## **Introduction to Theoretical Neuroscience**

**Larry Abbott, Ken Miller, Stefano Fusi**

**Meetings** – Tuesday, Thursday 2:00-3:30

**Location** - JLG, 5th floor, conference room L5-084 (3227 Broadway, NY, NY 10027)

**TAs** – Ramin Khajeh, Jacob Portes, Sean Bittner

**Text** - Theoretical Neuroscience by P. Dayan and L.F. Abbott (MIT Press)

**Webpage** - <https://ctn.zuckermaninstitute.columbia.edu/courses>

### **January**

- 16 Math session
- 18 Matlab session
- 23 Matlab session
- 25 Electrical Properties of Neurons, Integrate-and-Fire Models (Larry)
- 30 Synapses, Short-Term Plasticity, Release Probability (Stefano)

### **February**

- 1 Long-term plasticity (Stefano)
- 6 Hodgkin-Huxley (Larry)
- 8 Adaptation, Izhikevich Model, Phase-Planes, Stability Analysis (Larry)
- 13 Poisson spiking (Larry)
- 15 White Noise and Its Effect on I&F model (Larry)
- 20 Spike-Triggered Averages, Reverse Correlation, Visual Receptive Fields (Ken)
- 22 GLMs, Maximum Likelihood and Generative Models (Ken)
- 27 Population Encoding and Decoding (Ken)

### **March**

- 1 Noise and Correlation Analyses (Ken)
- 6 Cosyne
- 8 PCA, Dimensional Reduction (Larry)
- 13 SPRING BREAK
- 15 SPRING BREAK
- 20 Readouts, Perceptrons (Stefano)
- 22 Spiking and Rate Networks (transition from spiking to rate) (Stefano)
- 27 Network math (Ken)
- 29 Balanced Spiking Networks, E/I balance, stabilization and amplification (Ken)

### **April**

- 3 Fixed Points, Lyapunov Fctn; Ring Model; Decision-making networks? (Ken)
- 5 Cortical Map Formation (Ken)
- 10 Perceptrons, 2-layer networks (Stefano)
- 12 Deep Networks, backprop, convolutional nets (Stefano)
- 17 Recurrent Networks (Hopfield, Capacity) (Stefano)
- 19 Chaotic Networks (Larry)
- 24 Recurrent Networks (learning) (Larry)
- 26 Reinforcement Learning (Stefano)