Fall 2023

# BIOL 432-101: Introduction to Computational Neuroscience

Horacio Rotstein

# Fall 2023 Course Syllabus
# Biol432

| | |
|---|---|
| **Course Title:** | Introduction to Computational Neuroscience |
| **Textbook:** | "An Introductory Course in Computational Neuroscience" by P. Miller – MIT Press (2018), 1st edition, ISBN: 978-0262038256 |
| **Recommended Books:** | "Mathematical Foundations of Neuroscience" by G. B. Ermentrout & D. H. Terman – Springer (2010), 1st edition - ISBN: 978-0-387-87707-5.<br><br>"Foundations of Cellular Neurophysiology" by D. Johnston & S. Wu – The MIT Press (1995) - ISBN: 0-262-100053-3.<br><br>"Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting" by E. M. Izhikevich – The MIT Press (2007), 1st edition – ISBN: 0-262-09043-8.<br><br>"Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems" by P. Dayan & L. Abbott – The MIT Press (2001) , 1st edition– ISBN: 0-262-04199-5.<br><br>"Biophysics of Computation: Information Processing in Single Neurons" by C. Koch – Oxford University Press (1999) – ISBN: 0-19-510491-9 |
| **Prerequisites:** | NJIT Catalog or Permission by instructor |
| **Website:** | http://web.njit.edu/~horacio/IntroCompNeuro/IntroCompNeuroF23.html |

| Week | Topic | Assignment |
|---|---|---|
| 1 | Introduction to Mathematical and Computational Neuroscience<br>Passive membrane properties – The passive membrane equation | See course website |
| 2 | Ordinary differential equations (ODEs): Review of analytical methods<br>Ordinary differential equations (ODEs): Review of numerical methods (MATLAB, Python) | " |
| 3 | Dynamics of the passive membrane<br>The passive membrane equation | " |
| 4 | Integrate-and-fire models.<br>The Hodgkin-Huxley model | " |
| 5 | Hodgkin-Huxley type models with additional ionic currents<br>The cable equation | " |

| | | |
|---|---|---|
| **6** | Reduced models and reduction of dimensions | “ |
| **7** | Introduction to dynamical system methods for neural models | “ |
| **8** | One-dimensional neural models: Phase-space analysis I | “ |
| **9** | Two-dimensional neural models: Phase-space analysis II | “ |
| **10** | Sub-threshold oscillations: Two- and Three-dimensional models<br>Bursting | “ |
| **11** | Synaptic dynamics & short-term plasticity | |
| **12** | Overview of network dynamics: small networks | “ |
| **13** | Overview of network dynamics: large networks | “ |
| **14** | Student Presentations | “ |
| **15** | Student Presentations | |

| **IMPORTANT DATES** | |
|---|---|
| FIRST DAY OF SEMESTER | Sep 5, 2023 |
| LAST DAY TO ADD/DROP | Sep 11, 2023 |
| THANKSGIVING RECESS | Nov 23-24, 2023 |
| LAST DAY TO WITHDRAW | Nov 13, 2023 |
| LAST DAY OF CLASSES | December 13, 2023 |
| FINAL EXAM PERIOD | December 17-23, 2023 |

**Grading Policy (tentative)**

| **Assignment Weighting** | |
|---|---|
| | |
| Homework, Quizzes, Mini Projects & Class Participation | 40 |
| Midterm Exam / Project | 30 |
| Final Project / Presentation | 30 |
| | |

| **Tentative Grading Scale** | |
|---|---|
| A | 90 -- 100 |
| B+ | 85 – 89 |
| B | 80 – 84 |
| C+ | 75 – 79 |
| C | 70 – 74 |
| D | 60 – 69 |
| F | 0 -- 59 |
| | |

**Course Policies:** See course website.

Prepared by Prof. Horacio G. Rotstein, April 18, 2023