Bio-Control - CDS 270-4

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Class objectives: The class will provide students with an organized overview of research work at the edge of control theory and biology. Both theoretical and experimental perspectives will be considered. Modeling, robustness and modularity will be the main topics. This fascinating field offers a wide range of challenging open questions, which the students will be encouraged to critically discuss.
Prerequisites: CDS 110a, CDS 140, Aph 161 or equivalent classes/background. The class is intended for graduate students or senior undergraduates, who have a strong interest in control theory and systems and synthetic biology.
Homework and grading: The class is offered as Pass/Fail only. Students are required to work on an individual or team project. Project proposals are due at 5pm on the last day of the Midterm examination period (May 4) and are due by 5pm on the last day of the final examination period (June 7).

PART 1: MODELING AND ANALYSIS

Week 1 March 29 - April 2. Introduction.
Lecture 1: Class introduction, overview and objectives. Class policies.
Lecture 2: Deterministic models for biological systems.

Week 2 April 5 - April 9. Modeling.
Lecture 1: Review of CDS tools for stability and periodic behaviors.
Lecture 2: Stochastic models and simulation methods.

Week 3 April 12 - April 16. Identification.
Lecture 1: Introduction to system identification.
Lecture 2: Experimental approaches to identification of biological systems.

Week 4 April 19 - April 23. Chemical Reaction Networks.
Lecture 1: Chemical Reaction Networks: general introduction and examples.
Lecture 2: Deficiency theory.

Week 5 April 26 - April 30. Monotone Systems.
Lecture 1: Monotone systems theory: Definitions and basic theorems.
Lecture 2: Predicting oscillations and case study.

PART 2 - DESIGN PRINCIPLES AND SYNTHESIS

Week 6 May 3 - May 7. Design principles.
Lecture 1: Design of molecular control mechanisms
Lecture 2: Comparing transcriptional and translational control.

Week 7 May 10 - May 14. Design principles.
Lecture 1: Ultrasensitivity
Lecture 2: Network motifs, structural and dynamic properties.

Week 8 May 17 - May 21. Robustness.
Lecture 1: Theoretical aspects of robustness.
Lecture 2: The concept of robustness in experimental biology

Week 9 May 24 - May 28. Modularity.
Lecture 1: Modular cell biology and time-scale separation principle.
Lecture 2: Modularity in experimental biology