PURDUE UNIVERSITY | Elmore Family School of Electrical and Computer Engineering

Engineering Faculty Document No. EFD 38-22
January 18, 2022

Memorandum

To: The College of Engineering Faculty

From: The Elmore Family School of Electrical and Computer Engineering

Re: new Automatic Control Concentration

The faculty of the Elmore Family School of Electrical and Computer Engineering has approved the following new concentration from the College of Engineering. This action is now submitted to the Engineering Faculty with a recommendation for approval.

Description: The Automatic Control Concentration focuses on the area of control of dynamical systems, spanning a variety of application domains. The courses in this concentration will establish the fundamental theory and tools for modeling, analyzing, and designing controllers, including stability, performance, and robustness. It spans core topics such as frequency domain design, state-space control, digital control, robotics, optimization for control, as well as advanced courses in emerging topics.

Reasons: Current and future engineers will be faced with significant challenges in designing, analyzing, and controlling complex dynamical systems, both in engineered domains (e.g., autonomous systems, robots, cyber-physical systems), and in natural systems (e.g., biological systems, social networks, epidemics). As such, there is a significant demand for students that have the core skills and knowledge in control theory and practice. Further, these control theoretic foundations will also be essential for students who wish to develop and use ML/AI techniques such as reinforcement learning.

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Concentration in Automatic Control for the Bachelor of Science degrees in Electrical Engineering or Computer Engineering

Automatic Control

A few paragraphs on what the goal of the concentration is:

1. What is the topic focus of the concentration?

The concentration in Automatic Controls focuses on the area of control of dynamical systems, spanning a variety of application domains. The courses in this concentration will establish the fundamental theory and tools for modeling, analyzing, and designing controllers, including stability, performance, and robustness. It spans core topics such as frequency domain design, state-space control, digital control, robotics, optimization for control, as well as advanced courses in emerging topics.

2. Why might students want to take/benefit from this concentration?

Current and future engineers will be faced with significant challenges in designing, analyzing, and controlling complex dynamical systems, both in engineered domains (e.g., autonomous systems, robots, cyber-physical systems), and in natural systems (e.g., biological systems, social networks, epidemics). As such, there is a significant demand for students that have the core skills and knowledge in control theory and practice. Further, these control theoretic foundations will also be essential for students who wish to develop and use ML/AI techniques such as reinforcement learning.

3. **What might the demand be from students?**

Our undergraduate control systems courses are already well subscribed, with 70+ students typically taking ECE 382 during each offering. Given the significant growth in industry needs for controls and autonomous systems engineers (for applications such as autonomous vehicles, automation and manufacturing, power systems, etc.), and the large numbers of applicants to the online MS program (indicating a focus on AC), we expect to have a reasonable demand for this concentration.

Proposing [Sub]area

The Automatic Control area is proposing this concentration. The proposal was unanimously approved by the area.

Target Degree

This concentration will apply to the BSEE degree.

Concentration Requirements

Core: Required (4 credits)

- ECE 38200 Feedback System Analysis and Design (3 credits)
- ECE 30800 Systems Simulation and Control Laboratory (1 credit)

Selectives: (6 credits)

- ECE 48300 (Digital Control Systems Analysis and Design, 3 credits)
- ECE 56900 (Introduction to Robotic Systems, 3 credits)
- ECE 58000 (Optimization Methods for Systems and Control, 3 credits)
- With approval of the Associate Head of Undergraduate Programs or Associate Head of Teaching and Learning, can include up to 3 hours of:
    - VIP 37920 (2 credits)
    - VIP 47920 (2 credits)
    - ECE 49600 (1-3 credits)

If allowed, these courses can be part of the “optional” list:

- ECE 60200 (Lumped System Theory)
- ECE 69500 (Epidemic Processes over Networks)
- ECE 69500 (Structure and Dynamics of Large-Scale Networks)
- More courses added as they are developed.

The above courses span foundational concepts and theory (feedback control systems, digital control system analysis and design, control system analysis and design via MATLAB), hands-on experience (with the control systems lab), and advanced topics (robotics, optimization).