ENGR-E502 – Introduction to Cyber Physical Systems:

1. Class Information

- Instructor: Prof. Lantao Liu (lantao@iu.edu)
- Time: Tu/Th 11:30am-12:45pm
- Location: IF 4063
- Office hours: after lecturing time or by appointment.

2. Course Description

Cyber-Physical Systems (CPS) involve transdisciplinary technologies and are typically regarded as "smart" systems. This course covers fundamental CPS technologies and their applications. Lectures will include basic frameworks of dynamical and control systems, perception modeling, state estimation, communication in networked systems, as well as their applications to CPS such as smart homes, vehicles, and transportation.

Evaluation of this course will include exams and coding assignments.

3. Course Prerequisites

Enrollment is open to all graduate students. The course will involve certain mathematical subjects including Calculus, Linear Algebra, and Probability Analysis. (A sample book chapter is provided in the Canvas Files/Bookchapter folder.) This course will also include coding assignments/projects, so students are expected to know at least one programming language such as C/C++ or Python or Matlab or Java.)

Undergraduate students need approval from the instructor to take this course.

4. Course Content Overview

Weeks	Topic	Details and Activities
1	Introduction	Cyber-physical Systems in our life
2	State space and dynamics	Differential equations, linear systems.
3	Classic control	Intro to feedback
4	Optimal control	Optimal control basics
5	Optimal control	Linear Quadratic Regulator
6	Other popular control	Model predictive control
7	Control wrap up	Brief summary
8	Sensors	Modern sensors in vehicles and smart homes
9	Sensor noise and modeling	Probabilistic modeling
10	Sensor fusion	Intro to sensor fusion
11	State estimate	Kalman filtering
12	Cyber-physical system apps	Mobile sensor networks, resource allocation
13	Cyber-physical system apps	IoT, Cloud in CPS

14	Cyber-physical system apps	Other applications
15	Course wrapup, project	Project/exam

5. Grading Policy

Grade Item	Percentage
Homework/Coding assignments	30%
Mid-term exam	30%
Final exam (tentative, determined in first week after survey in class)	40%

Mid term exam will be before Spring break.

Final exam (tentative) will be in the term exam week.

For coding assignments, evaluation will be based on your efforts if you cannot get the final results. This course assumes you know basic programming skills (this is not a programming course which specially teaches how to program). The coding implementation process allows you to think, to design, and to eventually realize your own thoughts.

5. Useful Books

This class does not require you to buy a textbook. However, there are a few books that partially cover our topics and most of them have electronic versions that can be found either on the internet or in our university libraries:

- Donald E Kirk. Optimal Control Theory: An Introduction. Any edition.
- Bertsekas, Dimitri P., et al. Dynamic Programming and Optimal Control. Any edition.
- Lee, Edward Ashford, and Sanjit A. Seshia. Introduction to Embedded Systems: A Cyber-Physical Systems Approach. MIT Press, 2016
- Probabilistic Robotics. Sebastian Thrun, Wolfram Burgard, and Dieter Fox. 2005.

Certain related chapters in electronic copies will also be distributed in class.

6. Plagiarism

IU's integrity policy does not allow plagiarism in any form. For assignments/projects, you will need to document your source materials. If you take any idea, text, or code module, from anywhere publicly available, you need to make it clear with acknowledgement of the sources. Self-plagiarism is defined as when you submit your own previously produced work, for which you have received credit in another course.

For all our assignments, any person should not share the results with other classmates. In particular, anyone should not "borrow" other peer classmates' finished work and revise/renovate the solution to become their own (this will lead to 0 for that assignment). That being said,

discussions of basic solution ideas are encouraged so that one can help another to understand how to do it (as opposed to just giving or showing the finished/detailed solution).