# EEC 645/745 MCE 693/793 Intelligent Control Systems
# Spring 2018
# Cleveland State University

## General Information

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|---|---|
| Meeting time and place : | M-W 4:00-5:50 PM in MC 401 |
| Instructor: | Dr. Eric Schearer, e.schearer@csuohio.edu, FH 237 |
| Office Hours: | M-W 2:30-3:45 in lounge on east side WH second floor |
| Textbook: | None required |
| | Student edition of Matlab installed on your laptop |

## Course Description

This course offers a survey of techniques to automatically improve control of dynamical systems. The main focii are techniques for model learning, planning, and learning complex behaviors that are relevant to robotics research. This course is intended to prepare students to do research in intelligent control systems.

## Course Objectives

Upon completion of the course students will be able to

- Make simulations of dynamic systems in Matlab.
- Implement in Matlab various nonlinear regression techniques for both indirect and direct control of dynamical systems.
- Implement a nonlinear regression technique to control a physical robot.
- Implement in Matlab various motion planning techniques.
- Implement in Matlab various techniques for learning novel and complex behaviors.
- Read, understand, and explain to colleagues scholarly articles in the area of intelligent control.

## Prerequisites

EEC 510 Linear Systems (required)
Competence in Matlab programming (essential)
EEC 512 Probability/Stochastic Processes (very helpful)

## Grading

| | MCE 541 |
|---|---|
| Homework | 7 assignments, 100 points each |
| Project Demonstration | 200 points |
| Project Report | 100 points |
| Total | 1000 points |

| | |
|---|---|
| A | [93 – 100%] |
| A- | [90 – 93%) |
| B+ | [88 – 90%) |
| B | [82 – 88%) |
| B- | [80 – 82%) |
| C | [70 – 80%) |
| F | <70% |

## Homework

All homework will be submitted via Blackboard. Turn in your homework before class starts on the day it is due. Otherwise it is late. You have three cumulative free days of late homework for the entire duration of the semester. If you turn in your homework after class starts on the due date, that counts as one day of lateness, and you only have two remaining days of free lateness for the rest of the semester. If you turn it in more than 24 hours after the start of class on the due date, you have used up two days of free lateness for the semester. Weekend days, university holidays, and spring break do not count towards your total. Once you have used up all three free days you will get zero points for any subsequent late homework assignment. Reasonable exceptions for circumstances outside your control (e.g., long-term illness, family emergencies) will be considered. Unreasonable exceptions (e.g., too much work in other classes, you slept in, couldn't find a parking space) will not be considered.

Unless I explicitly state that an assignment should be done in groups you should attempt each homework problem on your own before asking the advice of your classmates. At that point you are free to discuss solution strategies with classmates. Please do not offer an entire solution to a classmate. Give general suggestions to help your classmates to solve problems on their own.

## Blackboard

All homework assignments, grades, and official course announcements will be posted to Blackboard. I will try to remind you of upcoming events in class, but please check Blackboard at least on a weekly basis.

I will open a discussion thread for each homework allowing you to post questions regarding the homework. My answers or the answers of a classmate will be available for everyone's benefit. I will not respond to emails with questions about homework.

## Academic Integrity

Integrity is very important. Do your own work and give credit to people who helped you. If you received any help or ideas on a homework problem, note where you got help from (e.g., the name of a classmate or website) and what ideas leading to the solution were not your own in the comments box with your submission on Blackboard. You will not receive any less credit if you receive help on a homework problem as long as you state where the help came from. You are welcome to discuss ideas for solving problems with your classmates, but your homework submissions must be your own work. Do not turn in computer code that resembles some one else's code.

Here is a non-exhaustive list of things that are not allowed in this course

- Turning in some one else's computer code as your own.
- Giving an electronic or paper copy of computer code that partially or completely solves a homework problem or project to a classmate.
- Receiving from a classmate or anyone else an electronic or paper copy of computer code that partially or completely solves a homework problem or project.
- Giving another student access to view your code for the purpose of copying the code.
- Receiving access to view another student's code for the purpose of copying the code.
- Using computer code downloaded from the internet that partially or completely solves a homework problem or project.
- Representing someone else's work as your own on the project report.

If you do any of the things above on a homework assignement you will receive a grade of zero for that assignment, and I will write a letter of reprimand to be placed in your student record. If you do any of the things above more than once on your homework assignments or if you do any of the things above on the project assignment, you will recceived a grade of F for the course, I will write a letter of reprimand to be placed in your student record, and a faculty committee will decide if you should be dismissed from CSU.

## Students with Disabilities

I am available to discuss appropriate academic accommodations that you may require as a student with a disability. I encourage you to make requests for academic accommodations to me during the first week of class. Please work with the Office of Disability Services for determination of reasonable academic accommodations. For more information visit www.csuohio.edu/offices/disability/students/.

## Tentative Schedule

| Day | Date | Topic | Reading | Due | Events |
|---|---|---|---|---|---|
| Mon | 1/15 | MLK Day | | | no class |
| Wed | 1/17 | Course intro and Lagrange's method | | | |
| Mon | 1/22 | Dynamic simulations in Matlab | | | interactive |
| Wed | 1/24 | Intro to model learning and Bayesian estimation | Bishop Ch. 3 | HW1 | |
| Mon | 1/29 | Physics-based models and linear regression | Bishop Ch. 3 | | interactive |
| Wed | 1/31 | Adaptive/MRAC/ILC | | | |
| Mon | 2/5 | Locally-weighted regression | Atkeson, 1997 | | |
| Wed | 2/7 | Locally-weighted regression | Atkeson, 1997 | HW2 | interactive |
| Mon | 2/12 | Presidents' Day | | | no class |
| Wed | 2/14 | Gaussian process regression | Rasmussen Ch. 2 | | |
| Mon | 2/19 | Gaussian process regression | Rasmussen Ch. 2 | | interactive |
| Wed | 2/21 | Gaussian Mixture Models | Bishop Ch. 9 | HW3 | |
| Mon | 2/26 | Gaussian Mixture Models | Bishop Ch. 9 | | interactive |
| Wed | 2/28 | Other Regression Methods - RBF/ANN | Bishop Ch. 5 | | |
| Mon | 3/5 | Other Regression Methods - RBF/ANN | Bishop Ch. 5 | | interactive |
| Wed | 3/7 | Robot Demo | | HW4 | interactive |
| Mon | 3/12 | Spring Break | | | no class |
| Wed | 3/14 | Spring Break | | | no class |
| Mon | 3/19 | Advanced Implementations of LWR/GPR | | | |
| Wed | 3/21 | Advanced Implementations of LWR/GPR | | | interactive |
| Mon | 3/26 | Optimization-Based Motion Planning | | | |
| Wed | 3/28 | Optimization-Based Motion Planning | | HW5 | interactive |
| Mon | 4/2 | Sampling-Based Motion Planning | Lavalle '98/Amato '96 | | |
| Wed | 4/4 | Sampling-Based Motion Planning | Lavalle '98/Amato '96 | | interactive |
| Mon | 4/9 | Dynamic motion primatives | Ijspeert, 2013 | | |
| Wed | 4/11 | Dynamic motion primatives | Ijspeert, 2013 | HW6 | |
| Mon | 4/16 | Dynamic motion primatives | Ijspeert, 2013 | | interactive |
| Wed | 4/18 | Learning from demonstration | Argaal, 2009 | | |
| Mon | 4/23 | Learning from demonstration | Argaal, 2009 | | interactive |
| Wed | 4/25 | Reinforcement learning | | HW7 | |
| Mon | 4/30 | Reinforcement learning | | | interactive |
| Wed | 5/2 | Project Demonstrations and Course Eval | | project report | |
| Mon | 5/9 | No Final Exam | | | |