Philadelphia University
Faculty of Engineering
MSc. Mechatronics Engineering
First Semester, 2020/2021

Course Syllabus

Course Title: Intelligent Control Systems	
Course Level: MSc	**Course prerequisite:**
Class Time: Saturday 12:00-15:00	**Credit hours: 3**

Academic Staff Specifics

Name	Rank	Office No.	Office Hours	E-mail Address
Kasim Al-Aubidy	**Prof.**	**6832**		*kma@philadelphia.edu.jo*

Course description:
Industrial systems are complex and have nonlinear behaviors, therefore, new methodologies are required to design and develop intelligent controllers. Intelligent control systems are becoming very important for both academia and industry. Control methodologies are required to improve the performance of control complex and nonlinear systems. These controller are based on soft computing tools such are fuzzy logic, neural network and evolutionary computation.

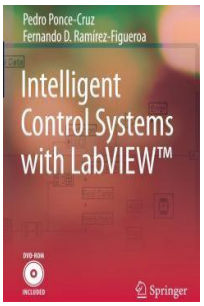
Course objectives:
The main objective of this course is to cover the principles and design methods of intelligent control systems. It covers the fundamentals of intelligent systems, fuzzy logic, neural networks and genetic algorithms. The design principles of intelligent controllers and their applications to mechatronics systems will be covered in this course.

Course Components:

Books:

1. Intelligent Control Systems Using Soft Computing Methodologies, By: Ali Zilouchian & Mo Jamshidi, CRC Press, 2001, ISBN:0-8493-1875-0. Available online: https://b-ok.asia/book/593496/3c6d6e?regionChanged=&redirect=7850341

2. Intelligent Control Systems with LabVIEW, By: Pedro Ponce-Cruz • Fernando D. Ramírez-Figueroa, Springer, 2010, ISBN 978-1-84882-683-0. Available online: https://b-ok.asia/book/812190/493ebf?regionChanged=&redirect=7855146



Support materials: Software:

(1)	MATLAB Control Systems Toolbox.	http://www.mathworks.com/help/control/index.html
(2)	MATLAB Fuzzy Logic Toolbox.	http://www.mathworks.com/help/fuzzy/index.html
(3)	MATLAB Neural Network Toolbox.	http://www.mathworks.com/help/nnet/index.html
(4)	MATLAB Optimization Toolbox.	http://www.mathworks.com/help/optim/index.html
(5)	LabVIEW Software.	http://www.ni.com/labview/

Study guide(s) (if applicable)

Homework and laboratory guide(s) if (applicable).

Teaching Methods:
Lectures, discussion groups, tutorials, problem solving, projects, debates, etc.

Learning Outcomes:
On completing the course, students will e able to have to following skills:

1. **Knowledge and understanding:**
   A1. Know the advantages and drawbacks of intelligent controllers and when to apply them
   A2. Understand how to derive, develop, and apply intelligent controllers
2. **Intellectual skills**:
   B1 Comprehend advanced mathematical models and intelligent systems
   B2. Design intelligent systems for various applications
3. **Professional and practical skills**:
   C1. Simulate and analyze responses to advanced controller concepts
   C2. Apply intelligent controllers to physical systems
4. **General and transferrable skills:**
   D1. Apply intelligent decision making techniques to engineering systems.
   D2. Optimize system performance.

Assessment Instruments:

- **Short reports and presentations**: Reading related to current topic will be assigned every week. Assignments and other Homework (HW) will be given throughout the semester, focusing on the concepts learned from these readings.
- **Project:** Project is an essential part of this course. Assessment will be based on 3 phases: System Specification, System Design, Hardware and Software Implementation with Project Demonstration. Detailed topics and schedule will be announced in due course.
- **Final examination**: 50 marks

Allocation of Marks	
Assessment Instruments	**Mark**
MID examination	**30%**
Homework, Assignments & Project	**20%**
Final Examination:	**50%**
Total	**100%**

The course will be conducted as follows:

a) There will be lectures by the instructor on Mondays.
b) Homework or project assignments will be given, via e-mail. The due is by the end of the next Monday.
c) For each student, an individual project is to be done with a literature survey and a class presentation. Topics can be chosen by the individual student, subject to the approval of the Instructor.
d) There are at least two design projects using MATLAB Toolbox or LabVIEW software.

Documentation and Academic Honesty:

- Documentation style (with illustrative examples)
  - Protection by copyright, and
  - Avoiding plagiarism.
- **Ethics and Disability Act:**
  - Students may consult with one another on solutions, but copying another student's code is strictly prohibited.
  - Students should write their own code. Using code found on books or internet is prohibited.
  - The Instructor follows general university “Academic Dishonesty/Cheating Policy”.

Course Academic Calendar:

Week	Basic and support material to be covered	Homework, Reports & Projects
1	An introduction to classical and intelligent control systems.	
2	Intelligent systems and applied artificial intelligence.	
3	Intelligent control concepts.	Project Selection
4	Artificial neural networks: fundamentals.	HW1
5	Artificial neural networks: architectures.	Assignmentn1
6	Artificial neural networks: applications.	Project (Phase1)
7	Introduction to fuzzy logic.	Mid Exam
8	Fuzzy control and stability.	HW2
9	Control applications of fuzzy logic.	Assignmentn2
10	Neuro-fuzzy controller: theory and design.	
11	Neuro-fuzzy controller: applications.	Assignmentn3
12	Probabilistic and evolutionary algorithms.	
13	Optimization of intelligent systems using GA.	Project (Phase2)
14	Intelligent control systems: research paper analysis	
15	Intelligent control systems: design methods.	Project (Phase3)
16	Project discussion	Final Exam

Expected workload:

- On average students need to spend 3 hours of study and preparation for each 50-minute class.
- **Significance of the mark for the final score:** 70%
- **Attendance policy:** Absence from classes shall not exceed 15%. Students who exceed the 15% limit without a medical or emergency excuse acceptable to and approved by the Dean of the relevant college/faculty shall not be allowed to take the final examination and shall receive a mark of zero for the course. If the excuse is approved by the Dean, the student shall be considered to have withdrawn from the course.
- The student is responsible for all assignments on a weekly basis.
- No make-up will be given for missed quizzes, tests or assignments, unless a case is made in advance with Instructor's approval.

Course References:

Books:

1. Leszek Rutkowski, "Flexible Neuro-Fuzzy Systems: Structures, Learning and Performance Evaluation", Kluwer Academic Publishers, USA, 2004.
2. Mihir Sen, "Lecture notes on Intelligent Systems", 2006, Available online: http://www3.nd.edu/~msen/Teaching/IntSyst/IntSystNotes.pdf.
3. Nguyen, Prasad, Walker, and Walker, "A First Course in Fuzzy and Neural Control", Chapman Hall /CRC Press 2003.
4. Eric A. Wan, "Control Systems: Classical, Neural, and Fuzzy, Lecture Notes" , Available online: http://www.ifko.ktu.lt/~raimund/SWOT_FCM/LECTURE%20NOTES.pdf
5. S. Y. kung, "Digital Neural Networks", Prentice Hall 1993
6. G. P. Liu, "Nonlinear Identification and Control: A neural network approach", Springer 2001
7. Simon Haykin, "Neural Networks: A comprehensive foundation", 1998
8. Vojislav Kecman, "Learning and Soft Computing: Support Vector Machines, Neural Networks and Fuzzy Logic Models", Bradford Book 2001
9. MATLAB Fuzzy Logic Toolbox 2 / MATLAB Neural Network Toolbox 6: user's guide.