University: Benha University
Faculty: Faculty of Engineering at Shoubra
Department offering the program: Electrical Engineering Department
Department offering the course: Electrical Engineering and Control Program

1- Course Data (Basic Information)

Course Code & Title: EEC522 Intelligent Control **Semester/Year:** First / 2022/2023
Prerequisite Course(s): EEC415 Automatic Control (2) **Core or Elective:** Core Course
Credit Hours: 3 **Weekly Contact Hours**: **Lecture:** 2 **Tutorial:** 0 **Laboratory:** 3

2- Course Aims

The aim of this course is to provide students with the basic knowledge of intelligent control systems, their components, subsystems, and applications. Moreover, analyze the system performance using Fuzzy, PID-Like Fuzzy, ANN, and Neuro-Fuzzy controllers. Finally, apply optimization methods such as particle swarm and ant colony on control system applications.

3- Course Contents (As indicated in the program Bylaw)

Artificial intelligence basics, fuzzy set theory, fuzzy logic controllers (e.g., fuzzy PI & PID), Neural networks introduction, perception model, classification problem, multilayer networks, Feed forward networks, back propagation learning algorithms, recurrent networks, radial basis networks, neural network control. Neuro-fuzzy systems, introduction to optimization methods such as particle swarm optimizations and ant colony, application examples.

4- Program Competencies Served by The Course (C1 and C4)

Level (C) Electrical Engineering & Control Competencies

C.1 Demonstrate additional abilities to model, design and integrate computer-operated systems including analog, digital and intelligent systems.
C.4 Develop and/or redesign components/systems in the field of industrial control for improving the quality life of humans.

5- Learning Outcomes (LO's)

At the end of the course, the student will be able to:

Cognitive Domain	
LO1	Recognize the capabilities of intelligent controllers to select the suitable one for the corresponding application.
LO2	Analyze the system performance using Fuzzy, PID-Like Fuzzy, ANN, and Neuro-Fuzzy controllers.
Psychomotor Domain	
LO3	Design the proper intelligent controller to meet the required specifications of LTI system
Affective Domain	
LO4	Optimize the control system performance to meet the required specifications of system.

6- Mapping Learning Outcomes (LO's) with Competencies

LO's / NARS	C1	C4
Cognitive Domain		
LO1	■	
LO2	■	
Psychomotor Domain		
LO3		■
Affective Domain		
LO4		■

7- Lecture Plan

a) Topics to be Covered weekly & Matrix of LO's

Week	Topics	Planned Hours	Learning Outcomes			
			LO1	LO2	LO3	LO4
W1	• Quality Assurance requirements for the course • Introduction to artificial intelligence and intelligent control, and their applications.	5	■			
W2	• Introduction to fuzzy logic, fuzzy sets • Lab. (1): review MATLAB basics for control.	5	■			
W3	• Fuzzy membership functions, fuzzy properties, and basic operations. • Lab. (2): Fuzzy operations using MATLAB software	5	■			
W4	• Composition of fuzzy relations, fuzzy logic control system (FLC) and FLC design. • Lab. (3) FLC using MATLAB software	5	■			
W5	• De-Fuzzification methods. • Lab. (4) De-Fuzzification using MATLAB software	5	■			
W6	• Fuzzy logic control using Matlab. • Lab. (5) FLC toolbox using MATLAB	5		■	■	
W7	• PID-like fuzzy controller. • Lab. (6) PID-like fuzzy controller simulation	5		■	■	
W8	• Introduction to Artificial Neural Network (ANN), multilayer perceptron architecture, and Feed forward networks. • Lab. (7) NN toolbox in MATLAB-part I	5	■			
W9	• Back propagation learning algorithms, system identification using ANN. • Lab. (8) NN toolbox in MATLAB-part II	5	■			

Week	Topics	Planned Hours	Learning Outcomes			
			LO1	LO2	LO3	LO4
W10	• Introduction to Neural network control and Neuro-Fuzzy control. • Lab. (9) ANFIS in MATLAB-part I	5	■			
W11	• Neuro-Fuzzy control applications • Lab. (10) ANFIS in MATLAB-part II	5		■	■	
W12	• Introduction to optimization. • Lab. (11) optimization toolbox in MATLAB-part I	5	■			■
W13	• Particle swarm optimizations and application examples. • Lab. (12) optimization toolbox in MATLAB-part II	5	■			■
W14	• Ant colony and application examples.	5	■			■

b) Additional private/self-study/learning hours expected for students per week is Four hours

8) Teaching and Learning Methods

Learning Outcomes		Teaching and Learning Methods									
		Face-to-face Lecture	Online Lectures	Tutorial / Exercise	Group Discussions	Laboratory	Self-Reading	Presentation	Collaborate Learning (Team Project)	Research and Reporting	Brain Storming
Cognitive Domain	LO1	●				●					
	LO2	●				●	●		●		●
Psychomotor Domain	LO3	●			●	●	●		●		●
Affective Domain	LO4	●			●	●		●	●	●	●

Student Academic Counseling and Support

- Students are directed to contact teaching staff for academic support during specific office hours.
- Regarding this course, Instructor and TA will be available two hours a week as indicated on the timetable declared for students from the beginning of the semester.

9- Student Assessment

a- Student Assessment Methods

Learning Outcomes		Assessment Methods									
		Written Exams	Online Exams	Oral Exam	Quizzes	In-class Problem Solving	Take-Home Exam	Research Assignments	Reporting Assignments	Project Assignments	In-class Questions
Cognitive Domain	LO1	●				●			●		●
	LO2	●			●	●			●	●	●
Psychomotor Domain	LO3							●	●	●	●
Affective Domain	LO4			●	●			●	●	●	●

* There is one formative assessment (quiz), and all other assessments are summative.

b- Assessment Schedule and Weight

Assessment Tools	Week	Weight
First Midterm Examination	7	30 %
Final Examination	(As Scheduled)	40 %
Quizzes (2 times)	4, 9	10 %
Home assignments	3, 5,10,11	10%
Mini Project	8	10 %
Total		**100** %

10- Facilities

The following facilities are needed for this course:

■ Classroom	□ Smart Board	□ Computer with software
□ Lecture Hall	■ White Board	■ MIS system
□ Sound and Microphone	■ Data Show	■ Internet Access
□ Other: ……		

11- List of References

a- Course Notes

Lectures Notes in PDF
https://bu.edu.eg/staff/mohamedselmy3-courses/18432 (to be updated)

b- Books

1. Liu, Jinkun, Intelligent control design and MATLAB simulation, Springer, 2017.
2. S. Sumathi, S. Paneerselvam, Computational Intelligence Paradigms: Theory & Applications using MATLAB, CRC press, 2010.
3. Nguyen H.T., Prasad N.R., Walker C.L. and Walker E.A., A first Course in Fuzzy and Neural Control, Chapman & Hall/CRC, 2003.

c- Recommended Books

1- S. N. Sivanandam, S. N. Deepaand S. Sumathi, Introduction to Fuzzy Using Matlab, Springer, 2007.

d- Web Sites

1. https://www.mathworks.com/academia/books/intelligent-control-design-and-matlab-simulation-liu.html
2. https://www.mathworks.com/solutions/control-systems.html
3. Tze-Fun Chan, Keli Shi, Fundamentals of Intelligent Control Simulation, Wiley, 2011, doi: 10.1002/9780470825587.ch4, https://0810e1s05-1105-y-https-onlinelibrary-wiley-com.mplbci.ekb.eg/doi/10.1002/9780470825587.ch4

- Course Coordinator: Dr. Ahmed M. Hussein / Dr. Mohamed S. Selmy Signature:

- Program Coordinator: Assoc. Prof. Mohamed Anwar Signature: