Department of Electrical Engineering

College of Engineering

Salahaddin University-Erbil

Subject: Adaptive Control Systems

Course Book of 4th CC

Lecturer: Mustafa Mohammed Mustafa, M.Sc.

Academic Year: 2019/2020

Course Book

1. Course name	**Adaptive Control Systems**
2. Lecturer in charge	**Mustafa Mohammed Mustafa**
3. Department/College	**Electrical/College of Engineering**
4. Contact	**e-mail: mustafa.atrushi@su.edu.krd**
5. Time (in hours) per week	**Theory: 3** **Practical: 0**
6. Office hours	**Monday 08:30 AM - 2:30 PM** **Tuesday 8:30 AM - 10:30 AM**
7. Course code	**EE402**
8. Teacher's academic profile	**https://academics.su.edu.krd/mustafa.atrushi**
9. Keywords	**Nonlinear, Adaptive, Autonomous**

10. Course overview:

This course studies nonlinear analysis and control systems theory. The course will present engineering problems, including new techniques, depending on the analysis tools and basics. Topics include: Autonomous and Nonautonomous Systems, Input-to-State Stability, Feedback and Input/output linearization, Observers and Filters, and Adaptive Control. Mathematical analysis will be applied to some examples, taken from engineering systems, to illustrate the theory of the analysis tools. Knowledge of circuits analysis, dynamic of simple mechanical systems, calculus, linear algebra, and ordinary differential equations is assumed. The student must be able to use MATLAB to do course assignments.

11. Course objective:

The objective of this course is to introduce students to the nonlinear systems, how to analyse, and how to control these systems using adaptive control theory and some other tools.

12. Student's obligation

There are two midterm exams, a final project, and a final exam. All the assignments are important and must be accomplished, otherwise the student will not be familiar with the exams. After covering the course, each student has to do a project and submit it within the allowed time. Details about the project will be posted on the website. Students will not earn grades for attendance, **but** they are responsible for everything presented in the class. So, attendance is highly recommended.

13. Forms of teaching

This course is an analysis and design course, so I will depend on the white board in the class. Data show will be used in some lectures to support the analysis and present some examples of nonlinear systems from the industry.

14. Assessment scheme

First Term Exam	15%
Second Term Exam	15%
Project and Quiz	10%
Final Exam	60%
Total	**100%**

15. Student learning outcome:

Students will, upon completion of the course, be able to:

1. Emphasize on the basic mathematical background and experience to understand and analyze the behavior of adaptive systems.
2. Analyze the stability and performance properties of nonlinear systems.
3. Understand the design of nonlinear feedback controllers, so they can control nonlinear systems.
4. Gain insight about the complexity of nonlinear systems.

16. Course Reading List and References:

- Nonlinear Systems: Third Edition by H. Khalil, 2002.
- Applied Nonlinear Control by Jean-Jacques Slotine, Weiping Li, Pearson Education, 1990.
- Nonlinear and Adaptive Control Design by Miroslav Kristic, Ioannis Kanellakopoulos, Petar Kokotovic, John Wiley and Sons, 1995.

17. The Topics:	Lecturer's name
Introduction • An Overview of The Syllabus • Linear vs Nonlinear Systems • Motivation for Nonlinear Control • Behavior of Nonlinear Systems • Mathematics: Basic Theorems	Mustafa M. Mustafa (4 Weeks)
Phase Plane Analysis • Concepts of Phase Plane Analysis • Phase Portraits • Constructing Phase Portraits • Determining Time from Phase Portraits • Phase Plane Analysis of Linear Systems • Phase Plane Analysis of Nonlinear Systems • Existence of Limit Cycles	Mustafa M. Mustafa (5 Weeks)
Fundamentals of Lyapunov Theory • Nonlinear Systems and Equilibrium Points • Concepts of Stability	Mustafa M. Mustafa (5 Weeks)

• Linearization and Local Stability • Lyapunov's Direct Method • System Analysis Based on Lyapunov's Direct Method • Control Design Based on Lyapunov's Direct Method	
Advanced Stability Theory • Concepts of Stability for Non-Autonomous Systems • Lyapunov Analysis of Non-Autonomous Systems • Instability Theorems • Existence of Lyapunov Functions • Lyapunov-Like Analysis Using Barbalat's Lemma • Existence and Unicity of Solutions	Mustafa M. Mustafa (4 Weeks)
Feedback Linearization • Intuitive Concepts • Mathematical Tools • Input-State Linearization of SISO Systems • Input-Output Linearization of SISO Systems • Multi-Input Systems	Mustafa M. Mustafa (4 Weeks)
Adaptive Control • Basic Concepts in Adaptive Control • Adaptive Control of First-Order Systems • Adaptive Control of Linear Systems with Full State Feedback • Adaptive Control of Linear Systems with Output Feedback • Adaptive' Control of Nonlinear Systems • Robustness of Adaptive Control Systems • On-Line Parameter Estimation • Composite Adaptation	Mustafa M. Mustafa (8 Weeks)
18. Practical Topics (If there is any)	
None	None
19. Examinations: In all the exams multiple choices type questions are expected.	
20. Extra notes: None	
21. Peer review **پێداچوونەوەی هاوەڵ**	