EP/ER 241 SIGNALS AND SYSTEMS

IES Abroad Madrid

DESCRIPTION:

Signals and systems are fundamental concepts in the field of electrical and computer engineering. This course provides an introduction to the analysis and design of continuous-time and discrete-time signals and systems. The course covers the following main topics: signal types and properties, Fourier series and Fourier transforms, Laplace transforms, Z-transforms, system types and properties, convolution, frequency response, and feedback systems. In addition the course cover the numerical simulation using MATLAB in order to clarify the concepts and to use them to solve relevant engineering problems using digital signal processing.

CREDITS: 4 credits

CONTACT HOURS: 60 hours

LANGUAGE OF INSTRUCTION: English

PREREQUISITES: Circuits. Some knowledge of Linear Algebra, Ordinary Differential Equations (ODE's) and Complex Variable.

ADDITIONAL COST: None

METHOD OF PRESENTATION:

The different lessons will develop in backboard, explaining the theoretical concepts needed to understand each of the module, and combined with explanations for the simulations of the results with numerical simulations. After each module is completed, several problems will be solved and selected lab projects will be proposed, in order to reinforce all the concepts. Some assignments will also be proposed, in which students will put in practice everything learnt in the course.

REQUIRED WORK AND FORM OF ASSESSMENT:

- Final exam: 30%
- Midterm exam: 20%
- Individual Project :20%
- Homework Assignments:20%
- Class participation: 10%

Course Components:

- **Lectures:** 2 weekly sessions of 2 hours each where theory and practice will take place in each session. The instructor will present the theory and cover examples.
- **Final exam:** Exam that will be comprehensive and cover all the course content.
- **Midterm exam** will cover introduction and LTI systems.
- **Homework assignments:** Different readings, problem solving and lab projects that will be assigned weekly. No late homework will be accepted.
- **Participation:** This includes the interaction of the student in the classroom, the ability to answer questions made by the instructor, engagement with the course material, keeping up week-to-week and the general interest shown in the course. Some of the in-class assignments will use tools such us Kahoot verifying understanding of concepts.

LEARNING OUTCOMES:

By the end of the course, students will be able to:

- Understand the fundamental concepts of signals and systems.
- Analyze and design continuous-time and discrete-time signals and systems.
- Apply mathematical tools such as Fourier series and transforms, Laplace transforms, and Z-transforms for signal analysis
- Develop an understanding of system types and properties.
- Analyze system behavior using convolution and frequency response.

- Tools for design feedback control systems and filters.

ATTENDANCE POLICY:
Attendance is mandatory for IES Abroad Madrid classes. Please read our attendance policy posted in Moodle and in IES Abroad Madrid Student Handbook.

CONTENT:

Week	Content	Assignments
Week 1	Introduction to signals and systems **Session 1:** Introduction to signals and systems Signal types and properties **Session 2:** Continuous-time and discrete-time signals	• HW assignment 1. • Perform the simulations with Matlab. • Read sections 1.1-1.3 from [1] • Read chapter 2.1-2-2 from [1]
Week 2	**LTI Systems (I)** **Session 3:** System types and properties Linear and nonlinear systems **Session 4:** Time-invariant and time-varying systems Modeling applications	• HW assignment 2. • Perform the simulations with Matlab. • Sections 1.5.1, 1.5.2, 4 and 5.1–5.2 from [3]
Week 3	**LTI Systems (II)** **Session 5:** Causal and non-causal systems Convolution properties **Session 6:** Convolution examples Simulations	• HW assignment 3 • Perform the simulations with Matlab. • Read chapter 2 from [1]
Week 4	**Fourier series and Fourier transforms** **Session 7:** Fourier series Fourier transform Properties of Fourier transform **Session 8: MIDTERM EXAM**	• HW assignment 4. • Perform the simulations with Matlab. • Read chapter 4 from [1] • Review exercises for Midterm
Week 5	**Laplace transforms** **Session 9:** Definition of Laplace transform Properties of Laplace transform **Session 10:** Inverse Laplace transform	• HW assignment 5 • Perform the simulations with Matlab. • Read chapter 3 from [1]
Week 6	**Feedback systems** **Session 11:** Transfer function Feedback control systems **Session 12:** Closed-loop and open-loop systems Stability analysis	• HW assignment 6. • Perform the simulations with Matlab. • Read chapter 6 from [1]

Week	Content	Assignments
Week 7	**Frequency response** **Session 13:** Frequency response of linear time-invariant systems **Session 14:** Bode plots Frequency response of filters	• HW assignment 7. • Perform the simulations with Matlab. • Read chapter 5 from [1]
Week 8	**Session 15:** Summary of Continuus signals and systems **Session 16**: Applications to control, signals processing and comunincations.	• HW assignment 8. • Perform the simulations with Matlab. • Read chapter 4 from [1]
Week 9	**Discrete systems** **Session 17:** Digitalization: Sampling and reconstruction of continuous-time signals. **Session 18:** Nyquist theorem. Aliasing and quantization.	• HW assignment 9. • Perform the simulations with Matlab. • Read chapter 7.1-7.3 from [1]
Week 10	**Z-transforms** **Session 19:** Definition of Z-transform Properties of Z-transform **Session 20:** Inverse Z-transform Relation between s and	• HW assignment 10. • Perform the simulations with Matlab. • Read chapter 9 from [1]
Week 11	**Digital Filters** **Session 21:** FIR filters, windowing method, frequency sampling method, and least-squares method. **Session 22:** Digital controllers / Filters	• HW assignment 11. • Perform the simulations with Matlab. • Read chapter 11 from [1]
Week 12	**Session 23&24: Projects of applications of Digital signal processing**	• Individual project – develop MATLAB script for solve an engineering problem
Week 13	**Session** 25&26**: Projects of applications of Digital signal processing**	• . Individual project – develop MATLAB script for solve an engineering problem
Week 13	**Session** 27: **Projects of applications of Digital signal processing** **Session 28:** Review	• Individual project – develop MATLAB script for solve an engineering problem

Week	Content	Assignments
Week 14	**Session 29:** Final review of the course **Session 30:** FINAL EXAM	

COURSE-RELATED TRIPS:

- None

REQUIRED READINGS:

- [1] Signals and Systems Using MATLAB – Luis Chaparro and Aydin Akan, 3rd Edition, Elsevier. ISBN 13-978-0128142042
- [2] Digital Signal Processing using MATLAB for students and researchers – John Leis. Wyley, ISBN-13-978-0470880913
- [3] Oppenheim, Alan V., and A. S. Willsky. *Signals and Systems. 2nd edition,* Prentice Hall

RECOMMENDED READINGS:

- Feedback Control of Dynamics Systems – Franklin et al. Pearson