



**INTER AMERICAN UNIVERSITY OF PUERTO RICO
BAYAMON CAMPUS
SCHOOL OF ENGINEERING
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT**

**ELEN 4513 – Digital Control Systems
Technical Elective**

Catalog Description: Analysis and design of discrete-time control systems, digital control systems. The Z transform. Z- plane analysis of discrete-time control systems. State space analysis. Computer aided control systems design.

Pre-requisite(s): ELEN 4509 – Control Systems

Textbook: Goodwin, Graham, Graebe, Stefan and Salgado, Mario, *Control System Design*, Prentice Hall, 2001.

References: Dorf, Richard C. and Bishop, Robert H., *Modern Control Systems*, 10th Ed., Pearson Prentice Hall, 2005.
Franklin, Gene F., Powell J. David and Emami-Naeni, Abbas, *Feedback Control of Dynamic Systems*, 5th Ed., Prentice Hall, 2005.
Strum Robert, *Linear Discrete Systems*, Pearson Prentice Hall, 2005.
Nise S., Norman, *Control Systems Engineering*, 4th Ed., John Wiley & Sons, Inc., 2004
Dorsey, John, *Continuous and Discrete Control Systems*, McGraw Hill, 2002.
Electronic references of Control Systems from
<http://www.engnetbase.com/>

Course Objectives

Upon successful completion of the course, the student will be able to:

1. Demonstrate a basic understanding of digital control systems.
2. Explain the principles and fundamentals of digital control systems.
3. Represent mathematical models of digital control systems.
4. Analyze and design digital control systems through mathematical models.
5. Analyze and operate experimental equipment for digital control systems simulation.
6. Indicate the components that represent a digital control system.
7. Understand the use of digital controllers in control systems.
8. Use specialized computer software in the analysis and design of digital control systems.
9. Perform engineering analyses of digital control systems operations.
10. Operate measurement instruments for digital control systems analyses.
11. Operate equipment of computer automatic digital control.
12. Analyze and test of digital control systems.
13. Design and modify digital control systems
14. Understand the methods and the principles for digital control systems design
15. Understand the fundamentals of automated digital control systems.

Topics Covered

Lecture Topic*	Hours
1. Introduction to discrete-time control systems	3
2. Z –Transform	3
3. Z – Plane analysis of discrete-time control systems	3
4. Impulse sampling and data hold	3
5. Reconstructing original signals from sampled signals	3
6. The pulse transfer function	3
7. Realization of digital controllers and digital filters	3
8. Design of discrete-time control systems by conventional methods	9
9. Mapping between the S – plane and the Z – plane	3
10. State-space analysis	3
11. State space representation of discrete-time systems	6

12. Pole placement and observer design	3
Laboratory Topic*	Hours
1. Introduction	3
2. Digital Control of DC Motor module	3
3. Digital Control Systems Simulation	6
4. Characteristics of a Speed Control System	6
5. Rectilinear Control II	6
6. Torsional Control II	6
7. PID controllers	9
8. Temperature Control Simulation	6
9. Aliasing	6

*Schedule is subject to change

Class/Lab Schedule: Four credit hours. Forty-five hour lecture and forty-five laboratory per term.

Evaluation Strategies

1. Exams (60%): Two partial exams and a final exam will be scheduled early in the semester. You are expected to take the exams at the times and dates specified. All calculations must be done clearly, stating units and showing a coherent procedure to arrive to the results.
2. Laboratory (20%): Laboratory reports must be submitted by each group, one week after the experiment is done. The report must be written in a professional format.
3. Homeworks: Homeworks will be made weekly and are due at the first meeting class of the next week. Solutions will be available to provide immediate feedback. Each student must work individually but team work is also encouraged for challenging problems.
4. Portfolio: A course portfolio in which you will assemble your syllabus, class notes, homeworks, assignments, examinations, lab reports and the final project will be prepared by each student. The portfolio format is described in the guidelines.
5. Project (20%) A team open design project is required at the end of the course. Partial and final written reports will be submitted. A presentation is required at the end of the semester.

Grading Policy

Grades are reported according to the following standard grading system:
 A (90-100), B (80-89), C (70-79), D (60-69), F (0-59)

Contribution of Course to Meeting Professional Component

Three credit hours of engineering science and three credit hours of engineering design.

Relationship of Course to Program Educational Objectives**

1	2	3	4
√	√	√	

Relationship of Course to Program Outcomes**

a	b	c	d	e	f	g	h	i	j	k
√	√	√	√	√		√				√

**The numbers and letters correspond to the Program Educational Objectives and Program Outcomes of electrical engineering, respectively. The program objectives and outcomes can be found in the ECE department website at <http://bc.inter.edu/ingeelectrica>.

Prepared by: Dr. Edgardo V. Oliveros

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