

University of Puerto Rico  
 Mayagüez Campus  
 College of Engineering  
 Department of Electrical and Computer Engineering  
 Graduate Program in Electrical Engineering

**Course Syllabus**

<b>1. General Information:</b>	
Alpha-numeric codification: INEL 6000 Course Title: INTRODUCTION TO NONLINEAR CONTROL Number of credits: 3 Contact Period: 3 hours of lecture per week	
<b>2. Course Description:</b>	
English: Analysis and synthesis of nonlinear control systems; phase plane and describing function techniques; Lyapunov's second method and its application in the design and stability determination of nonlinear systems.	
Spanish: Analisis y sintesis de sistemas de control no lineal; técnicas del plano de fase y funciones descriptivas; segundo método de Lyapunov y su aplicación en el diseño y el analisis de estabilidad de sistemas no lineales.	
<b>3. Pre/Co-requisites and other requirements:</b>	
<b>4. Course Objectives:</b>	
This course introduces theory and techniques for the analysis of nonlinear dynamical systems and the design of nonlinear control. It emphasizes rigorous analysis supplemented with computer simulation.	
<b>5. Instructional Strategies:</b>	
<input checked="" type="checkbox"/> conference <input type="checkbox"/> discussion <input checked="" type="checkbox"/> computation <input type="checkbox"/> laboratory  <input type="checkbox"/> seminar with formal presentation <input type="checkbox"/> seminar without formal presentation <input type="checkbox"/> workshop  <input type="checkbox"/> art workshop <input type="checkbox"/> practice <input type="checkbox"/> trip <input type="checkbox"/> thesis <input type="checkbox"/> special problems <input type="checkbox"/> tutoring  <input type="checkbox"/> research <input checked="" type="checkbox"/> other, please specify: Literature review	
<b>6. Minimum or Required Resources Available:</b>	
MATLAB Software with linear and nonlinear control system toolboxes.	
<b>7. Course time frame and thematic outline</b>	
<b>Outline</b>	<b>Contact Hours</b>
Introduction to Nonlinear Systems	1
Second order systems and analysis in the phase plane	6
Fundamental properties of ordinary differential equations	3
Lyapunov Stability (first and second method)	12
Frequency domain analysis of nonlinear systems (describing functions)	3
Introduction to nonlinear feedback control systems	2
Design of nonlinear control systems using linearization	6
Input/State and Input/Output Feedback linearization	6

Research topics in nonlinear systems and control	3
Tests	3
<b>Total hours: (equivalent to contact period)</b>	<b>45</b>

### 8. Grading System

Quantifiable (letters)  Not Quantifiable

### 9. Evaluation Strategies

	Quantity	Percent
<input checked="" type="checkbox"/> Exams	3	40
<input checked="" type="checkbox"/> Final Exam	1	20
<input type="checkbox"/> Short Quizzes		
<input checked="" type="checkbox"/> Oral Reports	1	5
<input type="checkbox"/> Monographies		
<input type="checkbox"/> Portfolio		
<input checked="" type="checkbox"/> Projects	1	20
<input type="checkbox"/> Journals		
<input checked="" type="checkbox"/> Homework	2-4	10
<input checked="" type="checkbox"/> Other, specify: Paper review	1	5
<b>TOTAL:</b>		<b>100%</b>

### 10. Bibliography:

H. Khalil, Nonlinear Systems, 3rd Edition, Prentice Hall, 2001.

H.J. Marquez, Nonlinear Control Systems: Analysis and Design, Wiley, 2003.

W.E. Dixon, S. Nagarkatti, D. Dawson, A. Behal, Nonlinear Control of Engineering Systems: A Lyapunov-Based Approach, Birkhäuser Boston, 2003.

Classical textbooks still among the best in the subject:

A. Isidori, Nonlinear Control Systems II, Third Edition, Springer-Verlag, 1999.

S. Sastry, Nonlinear Systems: Analysis, Stability, and Control, Springer-Verlag, 1999.

M. Vidyasagar, Nonlinear Systems Analysis, Second Edition, Prentice Hall, 1993

### 11. According to Law 51

Students will identify themselves with the Institution and the instructor of the course for purposes of assessment (exams) accommodations. For more information please call the Student with Disabilities Office which is part of the Dean of Students office (Chemistry Building, room 019) at (787)265-3862 or (787)832-4040 extensions 3250 or 3258.

### Person who prepared this description and date of preparation:

Miguel Vélez-Reyes, August 2007