University of Puerto Rico
Mayagüez Campus
College of Engineering
Department of Mechanical Engineering
Bachelor of Science in Mechanical Engineering

Course Syllabus

1. General Information:	
Alpha-numeric codification: INME 4009 Course Title: Automatic Controls Number of credits: 3 Contact Period: Two hours of lecture and one two-hour laboratory per week	

2. Course Description:

English: Use, calibration and sensitivity of instruments for measuring temperature, pressure, volume, strain, and fluid flow: analysis of electrical, electronic, hydraulic, mechanical and pneumatical servomechanism; control systems and their characteristics, such as: response, sensitivity and stability.

Spanish: Uso, calibración y sensibilidad de los instrumentos de medir la temperatura, presión, volumen, deformación y flujo. Análisis de servomecanismos eléctricos, electrónicos, hidráulicos, mecánicos y neumáticos. Sistemas de controles y sus características tales como: respuesta, sensibilidad y estabilidad.

3. Pre/Co-requisites and other requirements:

Pre-requisites: MATE 4009 and INGE 3032 and INEL 4075 and (INEL 3105 or INEL 4005)

4. Course Objectives:

Upon successful completion, students are expected to be proficient in:
- Performing Transient analysis, a SISO control system
- Performing Root-Locus analysis on a SISO control system
- Performing Frequency-response analysis on a SISO control system
- Designing a Lead, Lag and Lag-Lead Compensator using Root-Locus or Frequency Response methods.
- Obtaining the State representation of a SISO system
- Determining the observability and controllability of a SISO system

5. Instructional Strategies:

☒conference ☐discussion ☐computation ☒laboratory

☐seminar with formal presentation ☐seminar without formal presentation ☐workshop

☐art workshop ☐practice ☐trip ☐thesis ☐special problems ☐tutoring

☐research ☐other, please specify:

6. Minimum or Required Resources Available:

Materials, equipment, and physical facilities needed to fulfill the course objectives

7. Course time frame and thematic outline

General Topics	Contact Hours

Transient and Steady-State Response
     1st, 2nd, and higher order systems
     Routh's Stability Criterion
     Steady-state error
	4

Root-Locus Method Control System Analysis and Design
     Root-Locus Plots
     Root-Locus Approach to Control-System Design
          Lead Compensation, Lag Compensation
          Lag-Lead Compensation
          Parallel Compensation
	6

Control Systems Analysis and Design by the Frequency-Response Method
     Bode Diagrams
     Polar Plotes (Nyquist Plots)
     Log-Magnitude-versus-Phase Plots (Nichols Plot)
     Nyquist Stability Criterion
     Stability analysis
          Phase and gain margins,
          Cutoff frequency and bandwidth
     Closed-loop Frequency-response of Unity-Feedback Systems
          Constant-magnitude loci (M circles)
          Constant-phase angle loci (N circles)
          Nichols Chart
     Control Systems Design by Frequency Response Approach
          Lead Compensation
          Lag Compensation
          Lag-Lead Compensation
	10

PID Controllers
     Ziegler-Nichols Rules for Tuning PID Controllers
     PID Controller design with Frequency-Response
	4

State-Space
     State-Space representations of Transfer Function systems
     Transformation of System models with MATLAB
     Solving the Time-Invariant State Equation
     Controllability
     Observability
     Pole Placement
	6

Lab Outline	
MATLAB review	2
Simulink Modeling	2
Transient Response analysis with MATLAB	4
Plotting Root Loci with MATLAB	2
Root-Locus Lead Compensation Root-Locus Lag Compensation Root-Locus Lag-Lead Compensation	4
Bode Diagram, Polar Plots, Log-Magnitude Plots with MATLAB	4
Experimental Determination of Transfer Functions	2
Frequency Design Lead Compensation	4

Frequency Design Lag Compensation Frequency Design Lag-Lead Compensation	
Project	6
Total hours: (equivalent to contact period)	**60**

8. Grading System

☒Quantifiable (letters) ☐ Not Quantifiable

9. Evaluation Strategies

	Quantity	Percent
☒ **Exams**	**2**	**20**
☒ **Final Exam**	**1**	**20**
☐ **Short Quizzes**		
☐**Oral Reports**		
☐ **Monographies**		
☐ **Portfolio**		
☒ **Projects**	**1**	**20**
☐**Journals**		
☒**Other, specify: Lab Tests**	**1**	**20**
TOTAL:		**100%**

10. Bibliography:

Textbook:
Katsuhiko Ogata,(2015), Modern Control Engineering, Pearson India, ISBN 978-9332550162
Other references:
- Farid Golnaraghi, Benjamin C. Kuo, (2017), Automatic Control Systems, McGraw-Hill Education, 10th edition, United States, ISBN 978-12596438353
- Norman S. Nilse, (2014) Control Systems Engineering, Wiley, 7th edition, United States, ISBN 978-11189633597,
- Richard C. Dorf, Robert H. Bishop, (2016), Modern Control Systems, Pearson 13th edition, New York, United States, ISBN 978-1034407623

11. Law 51: The Comprehensive Educational Services Act for People with Disabilities:
States that after identifying with the instructor and the institution, the student with disabilities will receive reasonable accommodation in their courses and evaluations. For more information, contact the Department of Counseling and Psychological services at the Office of the Dean of Students (Office DE 21) or call 787-265-3864 or 787-832-4040 x 3772, 2040 and 3864.

12. Academic Integrity
The University of Puerto Rico promotes the highest standards of academic and scientific integrity. Article 6.2 of the UPR Students General Bylaws (Board of Trustees Certification 13, 2009-2010) states that academic dishonesty includes, but is not limited to: fraudulent actions; obtaining grades or academic degrees by false or fraudulent simulations; copying the whole or part of the academic work of another person; plagiarizing totally or partially the work of another person; copying all or part of another person answers to the questions of an oral or written exam by taking or getting someone else to take the exam on his/her behalf; as well as enabling and facilitating another person to perform the aforementioned behavior. Any of these behaviors will be subject to disciplinary action in accordance with the disciplinary procedure laid down in the UPR Students General Bylaws.─

13. Certification 06-43 of the Academic Senate
"The academic guidelines for offering online courses," defines: Traditional face-to-face courses are those that have less than 25% of the course's regular contact hours via the Internet. Therefore, a three-credit course will be considered "face to face" if, of the 45 hours of regular contact, 11 or less are taught via the Internet. According to certification 06-43 of the Academic Senate, a course may include up to 25% of its total contact hours via the Internet. The objective of this is so that all professors have this alternative in the case of any unscheduled eventuality.

14. Sexual Harassment: Certification 130-2014-2015 states:
Sexual harassment in the workplace and in the study environment is an illegal and discriminatory act and is against the best interests of the University of Puerto Rico. All persons who understand they have been subject to acts of sexual harassment at the University of Puerto Rico may file a complaint and request that the institution investigate, where necessary, and assume the corresponding action by the university authorities. If the complainant is a student, he or she must refer his or her complaint to the Office of the Student Ombudsperson or that of the Dean of Students.

Revised: February, 2019