University of Puerto Rico
Mayagüez Campus
College of Engineering
Department of Electrical and Computer Engineering
Bachellor of Science in Electrical Engineering

Course Syllabus

1. General Information:

Alpha-numeric codification: INEL 5516
Course Title: AUTOMATION AND ROBOTICS
Number of credits: 3
Contact Period: 3 hours of lecture per week and 12 hours of laboratory in the semester
Elective in INEL

2. Course Description:

English: Analysis and design of automated pneumatic systems using programmable controllers. Programming of industrial robots .

Spanish: Analisis y diseño de sistemas neumáticos usando controladores programables. Programación de brazos mecánicos industriales.

3. Pre/Co-requisites and other requirements:

Prerequisites: INEL 4206 and INEL 4102 or
For students in Industrial Engineering : ININ 4057 or being in graduate standing.
For students in Mechanical Engineering: INME 4009, INEL 4076, INEL 4077 and INGE 3016, or being in graduate standing.
Prerequisites by topic:

1. Programming and design of flowchart algorithms.
2. Transfer functions, and physics (concepts such as pressure, temperature, fluid flow, voltage, current, electromagnetism, etc.)
3. Synchronous sequential machines and state diagrams.
4. Calculus and matrices math. Knowledge of MATLAB is encouraged.

4. Course Objectives:

After completing the course, the student should be able to understand, analyze and design automatic control systems for manufacturing processes using pneumatic equipment, programmable controllers and robotic arms.

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:

Labs are considered a major part of the class, and all students are expected to participate.
Radios, tape recorders, and other audio or video equipment are not permitted in the lab or classroom at any time.
Smoking is not permitted in any area other than those areas designated for smoking.
Laboratory Projects:

- Familiarization with programmable controllers. Demonstrations on how to use the equipment and applications. Small projects are required.
- Familiarization with the CRS A255 or equivalent robot system. Demonstrations on how to use the equipment and applications. Small projects are required.
- A final design project is required.

7. Course time frame and thematic outline

Outline	Contact Hours
Automation: definitions and manufacturing terminology, equipment used, and justifications	3
Manufacturing process simulation and design for assembly techniques	3
Industrial on-off sensors and actuators such as stepper and DC motors	5
Pneumatic systems: compressors, valves, cylinders, and air preparation devices	4
Programmable controllers	17
Robotics	12
Test	1
Total hours: (equivalent to contact period)	45

8. Grading System

☒Quantifiable (letters) ☐ Not Quantifiable

9. Evaluation Strategies

(Suggested): The faculty member teaching the course will provide the student with the evaluation strategy he/she will be using throughout the semester. This will be done within the first week of classes.

	Quantity	Percent
☐ **Exams**		
☒ **Final Exam**	**1**	**15**
☒ **Short Quizzes**	**4 to 6**	**15**
☒ **Oral Reports**	**1**	**12.25**
☒ **Laboratory Report**	**4**	**20**
☐ **Assignment**	**4 to 6**	**15**
☒ **Projects**	**1**	**22.75**
☐ **Journals**		
☐ **Other, specify:**		
TOTAL:		**100%**

10. Bibliography:

- Professor notes and Supplemental Reading
- David W. Pessen, Industrial Automation: Circuit Design and Components, John Wiley and Sons, 1989.
- M.P. Groover, M. Weiss, R.N. Nagel, N.G. Odrey, Industrial Robotics: Technology, Programming and Applications, McGraw-Hill 1986.
- L.A. Bryan, E.A. Bryan, Programmable Controllers: Theory and Implementation, Industrial Text Co., 1988.
- H.L. Stewart, Pneumatics and Hydraulics, The Bobbs - Merrill Co., Inc., 1984.
- R.E. Bateman, R.G. Bowden, T.J. Gogg, C.R. Harrell, and J.R.A. Mott, System Improvement Using Simulation, IST Corporation and JMI Consulting Group, Fifth Edition, 1997
- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Addison Wesley Longman, 1999.
- NAIS Corporation, Programmable Controller: FPO Series—Hardware, Matsuhita Electric Works, 1998.
- NAIS Corporation, Programmable Controller: FPO Series—Programming, Matsuhita Electric Works, 2002.

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.

12. Contribution of Course to meeting the requirements of Criterion 5:

Math	Basic Science	General	Engineering Topic
			√

13. Course Outcomes

1. Relationship of the course with program outcomes

Outcome (a) Ability to apply knowledge of mathematics, science, and engineering necessary to carry out analysis and design appropriate to electrical engineering problems.

- The student must show sufficient knowledge of the basic physical and engineering sciences to implement a control project either by using pneumatic systems, robotic arms, or automation using PLC.
- Extra credits will be awarded in this outcome if numerical cost analysis is included in the final report.
- Extra credits will be awarded if a combination of technologies is presented in the final project.

Outcome (b) Ability to design and conduct experiments, as well as analyze and interpret data

- Students will conduct laboratory works. Data will be collected and report in four laboratory reports. Part of the grade on this report includes the presentation and analysis of the data collected. These reports will not be collected for ABET purposes unless the final project does not reflect competency of this outcome.
- The student will provide a final project of an original idea proposed by his group. Implementation is a major portion of the grade of the course.

Outcome (c) Ability to design a system, component, or process to meet desired needs

- The students must show that they follow logical and orderly design procedures, choosing the best solution for their criteria.
- Students must provide a final report that reflects competency documenting their work.

Outcome (d) Ability to function on multidisciplinary teams

- Groups no greater of four members will be working towards all laboratory and project work. Peer evaluation will be asset, and an individual interview with the professor will be required previous to grant the final grade.
- Each group must show originality in their work, the procedure to subdivide a complex problem in parts, and finally combining peer work into the final solution.

Outcome (e) Ability to identify, formulate, and solve engineering problems

- Students will identify a problem where the automation skills could be applied.
- Their idea, along with a plausible procedure, will be submitted by the working group in a proposal. The final report will include the explanation of the idea in the introduction part of the report.

Outcome (f) Understanding of professional and ethical responsibility.

- Students should be able to identify the ethical issues faced on the solution of their final project.
- Laboratory reports will provide practice to identify ethical and social issues. In the cases that the final report does not show evidence of competency on this outcome, one of this laboratory works will be provided as evidence.

Outcome (g) Ability to communicate effectively

- Project groups must present an oral presentation and a written final report of their work.
- Oral presentation and working demonstration of the students work is open to the public, and therefore should be understandable for the interested parties. Mathematical derivation and technical content is allowed in oral presentations. Attendants to these sessions should at least understand why the derivation is needed although fully comprehension is not expected.

Outcome (h) Broad education necessary to understand the impact of engineering solutions in a global and societal context

- Ideas for projects should reflect awareness of societal needs.
- Students should comment the impact to society reflected by acceptance of their design into society, impact in low skills personnel being replaced by their solution, impact to the environment, or benefits to the intended group of person.

Outcome (i) Recognition of the need for, and an ability to engage in lifelong learning

- Student must include enough references to prove their ability to search for information. This information could be reflected in the theory part of the report, or in the finding of a technical tool or part not easily found in hardware store (as for example, an inductive sensor, or pneumatic valve).

Outcome (j) Knowledge of contemporary issues

- Student should comment on different alternatives to solve their problem. These alternatives should include emerging technologies and their associated cost, although they are not implemented.

Outcome (k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

- Student must be able to program a PLC, or a robotic arm using the tools presented in class. The ladder logic diagram or the structured robotic program should go beyond the examination exercise by using them in the solution of their final project.

2. Relationship of the course with program objectives

Objective 1: Obtain a broad educational experience necessary to understand the impact of electrical engineering problems and solutions within a global and societal context.

Related Activity: Laboratory work and project.

Objective 2: Posses a combination of knowledge and analytical, computational, and experimental skills necessary to solve practical engineering problems.

- Basic engineering design skills and in-depth knowledge of at least one EE area: (control).
- Physical thinking, approximation, and simplification
- Ability to integrate knowledge and skills across discipline boundaries.
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- Ability to integrate knowledge and skills across discipline boundaries.

Related Activity: Laboratory work, project, and assignments.

Objective 3: Have adequate communications skills both as an individual and as part of a team.

- Ability to communicate effectively verbally and in writing in English and Spanish.
- Ability to interpret graphical, numerical, and textual data
- Ability to communicate effectively technical information to varied audiences in oral, written and graphical forms, both in English and Spanish
- Ability to organize information
- Ability to work in groups and to interact with the social environment
- Ability to lead effectively.

Related Activity: Written proposal, oral presentation, laboratory reports and final project report.

Objective 4: Value the importance of lifelong learning.

- Knowing how to ask questions and that there may be multiple answers.
- Commitment to constantly upgrading fundamental knowledge and skills
- Understanding that every situation is an opportunity for learning

Related Activity: Laboratory work and project.

Objective 5: Be aware of contemporary issues and thus be able to make decisions taking into consideration professional and societal needs, and ethical implications.

- Consciousness of the ethical and societal aspects of their profession.

Related Activity: Laboratory work and project.

Person(s) who prepared this description and date of preparation: Raúl E. Torres, Submitted by: Raúl E. Torres, abril 2007