NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHANICAL-ELECTRICAL ENGINEERING PROGRAM

ML611 – ELECTRIC CONTROL AND AUTOMATION

I. GENERAL INFORMATION

CODE	: ML611 Electric Control and Automation
SEMESTER	: 9
CREDITS	: 3
HOURS PER WEEK	: 4 (Theory – Practice – Laboratory)
PREREQUISITES	: MT221
CONDITION	: Compulsory

II. SUMMARY

The course is part of the area of professionalization of Engineering Sciences and is of theoretical and practical character. It is to provide students with knowledge of the industrial automation techniques for the maintenance and optimization of automatic control systems of industrial processes consequently reducing drastically the time of manufacture purpose

This course uses the conceptual tools, operational automation techniques and programming using equipment PLC and modern components for practical learning in the field of analog and digital control and its applications in industrial electronics and robotics and in the tire field and Hydraulics.

The course is designed to know the systems of supervision, transmission and control of other intelligent equipment in an industrial plant or process; problems of application in engineering will be developed and will make use of specialized software, that are developed in two didactic units, with 28 theoretical sessions that introduce the student to the field of control and automation and programming and their applications in industrial electronics, that is behind the controls In the control system for industrial motors and their automation.

III. COURSE OUTCOMES

The student:

1. Explains and determines how performs control over a system of industrial processes asynchronous and synchronous sequential controls.
2. Understands and applies modeling systems with PID controllers using Simulink.

3. Understands and applies automatic control systems of engines, hardwired logic system using relays and automation using timers.
4. Understands and applies Programmable Logic Controllers and configuration of the interface man-machine PLC and performs the comparison between the control circuits wired logic and programmed into a PLC and the choice of "Programming Languages" standard.
5. Understands and applies programming automation with logic functions the development of control circuits and routing inputs and outputs (list sorting), programming using instruction list, program diagrams contact (ladder) and programming by plane functions.
6. Interprets the concept of structured programming for SFC programming sequential processes industrial systems, simultaneous sequences and conditional jump to another stage.
7. Designs and builds automation models pneumatic control systems and electro-pneumatic and oleo-pneumatic systems.
8. Designs and build models of hydraulic automation systems and electro-hydraulic systems.

IV. LEARNING UNITS

Unit I
Comparison between the control circuits wired logic and the logic programmed into a PLC and Applications / 7 weeks

1. **10 HOURS**
   Introduction: Important definitions - Control - Classification of the.Control Systems - Different ways to represent the control systems. Example cases.

   Definition of automation: Ways to perform control over a process system - Type of industrial processes: Continuous - Discrete – Batch Processes - Mathematical Models - Transfer function - PID Controller Block Diagram - Modeling systems using Simulink

   Monographs assignment

2. **10 HOURS**
   Automatic control devices: wiring system - Wiring through relays - realization of basic automatism - automatism with timers.

   Procedure of the automatic start of engines: Direct start - Direct start with reverse rotation - Start in connection Y - Δ - start by auto transformers - starting with stator resistors - Starter with rotor resistance - Commissioning of synchronous and asynchronous motors. Example cases.

   Programmable Logic Controllers (PLC): Architecture - configuration of the programmable controllers - Interface man-machine - technical characteristics of a PLC - comparison between wired control circuits and programmed control circuits in a PLC - type of signals - choice of standard " Programming Languages ". Example cases.

   Monographs assignment

3. 10 HOURS

Programming of automation: fundamental concepts of programming - Logic functions - Development of control circuits and main circuits - Addressing of inputs and outputs (sorting list) - Programming via list of instructions - Ladder program – Programming by function plane.

Monographs assignment

Unit II
Pneumatic and hydraulic controls, control circuits and Applications. / 7 weeks

4. 10 HOURS

Advanced Program: Structured Programming - Programming in GRAFCET for industrial sequential processes systems: Basic Principles - Stage - Transition Condition – Evolution rules of GRAFCET - Logic Equations - Simultaneous Sequences - Conditional Choice between several sequences – Simultaneous sequences - Conditional jump to another stage.
GRAFCET program; Example cases.

Monographs assignment

5. 10 HOURS

Pneumatic automation systems: Principles of compressed air - Production and distribution of compressed air - Main components of pneumatic systems.
Pneumatic controls - Control circuits - Electro systems - pneumatic tires and oil. case example
Automation of hydraulic systems: physical quantities Principles - Hydraulic pumps. Example cases.

Monographs assignment

6. 10 HOURS

Hydraulic controls - basic hydraulic installations - electro hydraulic systems. Example cases.
Delivery of monographs, which will be evaluated with the Final Exam.

Monographs assignment

V. LABORATORY AND PRACTICAL EXPERIENCES (monographs)

Practical experiences were developed in computer labs:

Lab 1: PID controllers - Modeling systems using Simulink Software

Laboratory 2: Automatism for automatic start-up of motors: Direct start - Direct start with spin reversal - Start in connection Y - Δ - Timed - Startup of timed sequential motors. Use of the Cade-Sim Software

Lab 3: Programming with FBD - Program contact diagrams (Kop-ladder) - Programming Using a Semaphore Software Logo.

Lab 4: Programming for Automation of Industrial Sequential Processes - Conveyor Belts - Filling of Liquids - Using the Software Step 7 MicroWin

Lab 5: Programming for automation of pneumatic systems:
Using the Software Festo Fluid Sim

VI. METHODOLOGY

Classes will be theoretical lectures and computer laboratories of the fundamentals and criteria for mastering the Automation and Control Systems used in the training of Mechanical and Electrical Engineers.

At the end of the course the student must submit and present an integration job or project. In all sessions, active student participation is encouraged.

a. **EDUCATIONAL MATERIALS AND OTHER TEACHING RESOURCES**
In the development of the course the following is used:

Equipment and materials:

- Multimedia-board computer
- Demonstration models: Operation model of engine controls with wired logic
- A video or a visit to a production plant and industrial control. UNI College of Chemical Engineering
- Specialized laboratories: PLC Programmed Logic
- Specialized facilities: Cristal Brewery ATE-VITARTE; Gloria Milk Factory, Cement plants, Vulcanizing plants, etc.
- Pushbuttons and contactors of control and force systems (laboratory)

Guides:

- For visits
- For testing laboratorios

b. **THEME BANK FOR THE FINAL WORK (models, papers, etc.) IN TEAMS:**
At the beginning of the course, it is necessary to assign the topics to the Work Teams, preferably by affinity of the participants, with the proposed topics or at the judgement of the course teachers.

- " PID systems Modeling Exercises using Simulink program”
- "Wired Logic exercises" Cade-Sim program
- "Programmed Logic exercises" Logo Software Comfort program
- "Programmed Logic exercises" Step7 Micro-Win program
- Pneumatic press - clothes ironing - plates bending
- Bending machine – Flattening machine – Stamping Machine
- Filling and sealing of dairy products
- Hydraulic Press – Heavy Machinery Application - Lift trucks - Trucks - Elevators - Boats - Airplanes

VII. FORMULA EVALUATION

Bank of questions for the (written) semiannual evaluations:

- Learning Unit 1: 5 questions
- Learning Unit 2: 5 questions

1. **Qualification:**
   Rating System: vigesimal scale (0-20)

2. **Evaluation of results Teaching Units:**
   Note Teaching unit I Partial Test Weight 1 (0-20)
   Note Learning Unit II Final Exam Weight 2 (0-20)

3. **Final evaluation of the course** :

   Final note: $NF = \frac{EP + 2xEF}{3}$

4. **Course Approval** :

   System: F
   Partial examination 40%
   Final exam 40%
   Monograph work 20%

The monographs will be delivered to assessed only for partial exam or the final exam.
The final project of the course will be integrated into the final grade

VI. BIBLIOGRAPHY

Journal Articles

1. National Instruments www.ni.com/pdf/manuals/32099e.pdf
2. ControlP: http.///www.alfredoroca.com
3. MecatronicaUNI http.///www.mecatronicauni.edu.pe.
4. Microcontrol Control http.///www.roso

books (Suggested)

[5] Automatic Control Systems by Richard C. Dorf.
Modern Control Engineering by: Katsuhiko Ogata.

[6] Control Systems: GH Hostetter, CJ Savant and Raymond T. Stefani.

[7] Analysis of Dynamical Systems and Automatic Control by: R. and R. Ruiz Canales Rivera Barrera

[8] Automatic Process Control Theory and Practice by: Carlos A. Smit and Armando B. Corripio.

[9] Automation by: J- Pedro Romera, J. Antonio Lorite and Sebastián Montoro.

[10] Automatic Circuit by: Vicente Lladonosa.

[11] Programmable Logic Controllers by: Elmer Ramirez Quiros.

Unit 2: pneumatic and hydraulic controls, control circuits and Applications

Journal Articles

[12] ANENTI, Fabio M. and SCIALA, Anto

books (Suggested)

[13] Electrical, pneumatic and hydraulic Automations by: Florencio Jesus Cembranos Nistal.