ELECTROHIDRAULIC AND ELECTROPNEUMATIC SYSTEMS

LEARNING OUTCOMES

A. GENERAL LEARNING OBJECTIVE

At the end of the course, the student will be able to design a hydraulic or pneumatic system to meet the specific requirements of a process by submitting a project based on a design report that establishes the specifications and selection of the system components, as well as the use of standards and economic technical analysis.

B. EDUCATIONAL CONTENTS

STUDENT OUTCOMES TO WHICH THE TRAINING SPACE CONTRIBUTES.

Specific student outcomes	1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. 2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. 6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
Student outcomes of emphasis	Does not apply

PERFORMANCE INDICATORS, SKILLS AND SCIENTIFIC-PROFESSIONAL KNOWLEDGE
The professional performance indicators, knowledge and skills promoted by this formation space are:

Learning results that the student will achieve in this training space	
Performance indicators	The student… 1.1 Relates the physical phenomena to the theories and mathematical models that describe them. 1.2 Applies theoretical knowledge to solve complex engineering problems. 1.3 Applies knowledge of different areas of engineering to solve complex engineering problems. 1.4 Calculates the geometric dimensions and stresses of mechanical elements subjected to loads. 1.5 Applies the mathematical models of electromechanical components, such as motors, generators, transformers, pumps, hydraulic actuators, pneumatic actuators and compressors. 1.6 Identifies and calculates the different forms of energy involved in mechanical, electrical, thermal, pneumatic, hydraulic, etc. systems. 1.7 Interprets and produces mechanical, electrical, pneumatic, hydraulic and control diagrams using symbology according to standards. 1.10 Identifies opportunities and applies strategies for energy savings in electromechanical systems. 1.11 Implements preventive and corrective maintenance work in electromechanical systems. 1.12 Uses specialized software to analyze mathematical models that describe the behavior of electromechanical components or systems. 2.1 Applies a methodology for the design of a component, system or process. 2.3 Identifies and evaluates design constraints. 2.5 Establishes the technical, economic and environmental specifications that a component, system or process must meet.

	2.6 Identifies various electromechanical components that can meet the functional requirements of a system or process. 2.9 Calculates the direct and indirect costs of a project. 2.11 Makes a quote to sell engineering services. 2.12 Uses modern engineering devices to control and automate equipment or processes. 6.1 Identifies the need for experiments. 6.2 Selects the materials, devices and methods necessary to design experiments. 6.3 Uses a logical organization of procedures and applies mathematical and graphic analysis to interpret the results of an experiment. 6.4 Identifies in advance the problems that may arise in an experiment. 6.5 Describes the experimental results and their relationship with fundamental concepts and principles. 6.6 Develops a mathematical model from experimental data. 6.7 Uses modern and appropriate computing resources for engineering practice. 6.8 Uses and interprets results of materials and electrical equipment testing. 6.9 Applies techniques for acceptance testing and preventive maintenance of electromechanical equipment.
Knowledge	Basic hydraulic and pneumatic circuit. Symbology of hydraulic and pneumatic circuits. Symbology of electrical components. Conversion of energy that occurs in the hydraulic and pneumatic circuits. Topics about hydraulic and pneumatic linear actuators. Calculations for the selection of a hydraulic actuator. Technical information of linear actuators. Design flow diagrams. Exposition of scientific and technology articles. Topics hydraulic and pneumatic rotary actuators. Characteristic curves of rotary actuators. Selection of a fluid for the project. Calculation of the flow demanded from a pump. Selection of the diameter of pipes and hoses. Hydraulic reservoir design. Selection of hydraulic filters. Air treatment used in pneumatics. English language readings. Selection of the directional valve for the project. Review of technical information on directional valves. Analysis of valve size and flow drop. Selection of the relief valve for the project. Report writing. Realization of electropneumatic circuits using the XD-26 programmable logic controller to obtain the movement sequence A+A- and A+B+B-A-. Simulation of an electropneumatic sequence of 5 actuators. Selection of the pump for the project. Selection of the electric motor that will drive the pump. Design of the electrical circuit that will feed the motor. Drafting of the final report. Analysis of project costs. Realization of laboratory practices.
Skills	Teamwork.

	Problem solving. Synthesis capacity. Analysis of technical information of hydraulic and pneumatic components Management to obtain the resources. Management of software for simulation. Calculation and design procedures. Report writing Effective presentations.

C. UASLP GRADUATE: PERFORMANCE INDICATORS AND TRANSVERSAL SKILLS

Graduate profile UASLP	Performance indicators and transversal skills promoted by this training space
Professional autonomy for learning (an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.**)**	The student… 7.1 Recognizes the importance of learning and using sources different of information to prepare projects and reports. 7.2 Seeks to constantly improve their knowledge related to their profession. 7.3 Has the ability to learn through the selection of reliable information sources. 7.4 Has information of engineering state-of-the-art.
Collaborative work skills (an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives**)**	The student… 5.1 Contributes positively and widely to the work team. 5.2 Assumes responsibilities as a team member. 5.4 Assumes leadership responsibilities.
Communication skills in spanish and other languages (an ability to communicate effectively with a range of audiences**)**	The student… 3.1 Has organized oral communication, being consistent with the central message and using appropriate body language to express one's ideas. 3.2 Has organized written communication, which is consistent with the central message, identified in the introduction, where the main points are linked to transitions and a conclusion. 3.3 Uses modern presentation tools, such as audio, video, etc. effectively. 3.4 Uses extensive and appropriate vocabulary, as well as correct grammar. 3.6 Prepares technical reports where made judgments as products of the results of engineering solutions.
Scientific, professional, and/or social creative project development	This student outcomes in engineering is considered as specific professional, the performance indicators are already integrated within this training space.
Social responsibility and ethical reflection (an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts)	The student… 4.4 Safeguards the interests of the institution or persons and makes good use of the resources allocated for the performance of their activities. 4.6 Complies with the regulations to calculate, install and operate electromechanical systems. 4.8 Understands how economic factors affect professional practice. 4.10 Selects the techniques and tools to give modern engineering solutions and makes judgments comparing the results with the alternative tools or techniques.

GENERAL STRUCTURE AND SUMMATIVE EVALUATION

D. General didactic planning

During the course, the student will learn about the main components of the electrohydraulic and electropneumatic circuits and the way in which they interact for the conversion and control of energy. The student will be able to analyze and design electrohydraulic and electropneumatic circuits, acquiring the ability to select the components that adapt to the design specifications. During the course, the student will develop a project that consists of a design report for an electrohydraulic or electropneumatic circuit that meets the specifications indicated by the teacher. The project related to an electrohydraulic circuit that the student will develop must take into account the following:

1. Definition of the problem.
2. Design flowchart.
3. System sketch.
4. Duty cycle.
5. Forces calculation of in the actuator.
6. Flow calculation.
7. Selection of the actuator, directional element and components in the return line.
8. Fluid selection.
9. Calculation of pressures in the circuit.
10. Selection of pipes and hoses.
11. Selection of the relief valve, regulation and control element.
12. Selection of the pump and electric motor.
13. Reservoir sizing.
14. Electrohydraulic circuit diagrams according to ISO 1219-1 and ISO 1219-2.
15. Costs of electrical energy consumption during the operation of the hydraulic circuit.
16. Efficiency of the hydraulic system.
17. Analysis of variable and fixed direct costs.

The teaching methodology is:

- By the teacher: Facilitate learning by exposing topics, perform calculation exercises during class, encourage group discussion of the topics covered and facilitate learning through practical examples. Each topic will be illustrated with examples of hydraulic circuits and their corresponding symbols in accordance with ISO 1219-1 and ISO 1219-2.

- By the student: Carry out research, technical readings and articles in English, review standards, solve tasks, prepare the project as a team (of two people) and write the report on the calculation and selection of the components.

The course is divided into 8 topics with a total of 64 hours of theory, it consists of four partial exams which constitute 80% of the total grade, the remaining 20% corresponds to learning activities mainly related to the project.

The training and learning structure proposed for the training space is shown below.

#	Name of the unit or training phase	Unit learning objective	Specific educative contents (performance indicators, skills, knowledge)
1.	1. Introduction (4 h)	At the end of the unit, the student will be able to know the physical principles and the symbols of the main components involved in the conversion of energy that occurs in a hydraulic and pneumatic circuit to analyze	**Specific educational content:** 1.1 Purpose of a hydraulic and pneumatic circuit. 1.2 Conversion of energy in a hydraulic and pneumatic circuit. 1.3 Conversion, distribution and use of energy in Mexico.

		the way in which they interact with each other	1.4 Mathematical models. 1.4.1 Pascal's Principle. 1.4.2 Applications of Pascal's principle. 1.4.3 Bernoulli's equation. 1.4.4 Law of perfect gases. 1.5 Basic hydraulic and pneumatic scheme. 1.5.1 Actuator. 1.5.2 Directional element. 1.5.3 Relief valve. 1.5.4 FRL unit. 1.5.5 Hydraulic and pneumatic power unit. 1.5.6 Electric drive circuit for the power unit. 1.5.7 Measuring instruments 1.6 Differences between hydraulic and pneumatic circuits. 1.6.1 Working pressure range of the main components. 1.6.2 Advantages and disadvantages. 1.7 Basic representation of automatisms. 1.7.1 Simplified system. 1.7.2 Space-phase diagram. 1.7.3 Space-time diagram. 1.7.4 Grafcet. **Learning activities:** Analysis of the basic hydraulic and pneumatic circuit. Studies on symbology of hydraulic and pneumatic circuits. Studies on symbology of electrical components. Analysis of the energy conversion that occurs in the hydraulic and pneumatic circuits. Project realization. Laboratory practices realization.
2	2. Linear actuadors (12 h)	At the end of the unit, the student will be able to calculate the force a linear actuator must provide to meet a mechanical process specification and establish specifications (piston diameter, rod diameter, stroke etc.) for specification-based selection by knowing the type of linear actuators and mounting styles.	**Specific educational content:** 2.1 Analysis of force in actuators. 2.1.1 Calculation of force to perform mechanical processes. 2.1.2 Resistive and brake load. 2.1.3 Force versus time (or stem position) to move loads. 2.1.4 Force to overcome static and dynamic friction, and force to overcome inertia. 2.1.5 Movement of loads in horizontal and vertical direction with acceleration and friction. 2.1.6 Load deceleration analysis. 2.2 Calculation of the diameter of the piston. 2.2.1 Safety factor. 2.2.2 Effect of pressure to transport the fluid from the actuator to the tank. 2.2.3 Graph of pressure with respect to the position of the stem in the actuator during extension and retraction.

			2.3 Dynamic and static thrust force in pneumatic actuators. 2.4 Calculation and selection of the stem diameter. 2.4.1 Assembly of actuators. 2.4.2 Assembly factor. 2.5 Constructive characteristics of actuators. 2.5.1 Stem and plunger seals. 2.5.2 Shock absorber bushings. 2.5.3 Types of connection in the ports. 2.5.4 Safety factor of actuators. 2.5.5 Performance specifications of hydraulic and pneumatic actuators (working pressure, bursting pressure). 2.6 Types of actuators and symbols. 2.6.1 Simple and double effect. 2.6.2 Double stem. 2.6.3 Telescopic. 2.6.4 With magnetic plunger. 2.6.5 With position sensor. 2.5.6 With stem brake. 2.6.7 Prelubricated. 2.7 Linear actuators in series and parallel. 2.7.1 Methods to synchronize actuators in parallel. 2.8 Symptoms of malfunction in linear actuators and possible causes. **Learning activities:** Exercises in classes. Knowledge about hydraulic and pneumatic linear actuators. Calculations for the selection of a hydraulic actuator. Review of the technical information of linear actuators. Design flow diagrams. Report writing. English language readings. Exposition of scientific and technology articles. Project realization Laboratory practices realization
3	3. Rotary actuadors (5 h)	At the end of the unit, the student will be able to calculate the torque that a rotary actuator must provide to meet a mechanical process specification and establish the specifications for a selection by knowing the type of rotary actuators and their performance curves.	**Specific educational content:** 3.1 Analysis of mechanical torque in actuators. 3.1.1 Calculation of torque to perform mechanical processes. 3.1.2 Torque to overcome static and dynamic friction, and to overcome inertia. 3.1.3 Resistive and brake load. 3.1.4 Load deceleration analysis. 3.1.5 Equation for calculating the pressure differential in the actuator. 3.1.6 Volumetric and mechanical efficiency. 3.1.7 Displacement. 3.2 Types of rotary actuators and their symbols. 3.2.1 Construction characteristics.

			3.2.2 Gear, Vane, Piston and Bent Shaft Motors, and their main differences. 3.2.3 Motor characteristic curves (torque-efficiency with respect to speed). 3.2.4 Limited turn actuators. 3.2.5 Port connection options. 3.2.6 Safety factor of actuators. 3.3 Mounting of rotary actuators. 3.4 Hydraulic circuits to brake high inertia loads. 3.5 Symptoms of malfunction in rotary actuators and possible causes. **Learning activities:** Exercises in classes. Knowledge about hydraulic and pneumatic rotary actuators. Review of the characteristic curves of rotary actuators. English language readings. Project realization Laboratory practices realization.
4	4. Hydraulic fluid (6 h)	At the end of the unit, the student will be able to analyze hydraulic fluids, the means to keep them clean and the effect of temperature on viscosity, as well as the pipes through which they are transported to select the one that best suits the system components by analyzing the technical data sheet of the components.	Specific educational content: 4.1 Functions of the fluid. 4.2 Types of fluid. 4.2.1 Mineral oils. 4.2.2 Fire retardant fluids and compatibility with seals. 4.2.3 ISO viscosity grades. 4.2.4 Selection of fluid viscosity. 4.2.5 Effect of temperature on viscosity. 4.2.6 Heat production. 4.2.7 Type of fluid according to the technical sheet of the components. 4.2.8 Methods for temperature control (fluid coolers and heaters). 4.3 Contamination control. 4.3.1 Sources of contamination. 4.3.2 Quantification of contamination in the ISO code. 4.3.3 Fluid cleanliness requirements for various components. 4.3.4 Location of filters in the hydraulic system. 4.3.4 Filter efficiency and pressure drop. 4.4 Fluid distribution. 4.4.1 Pipes and hoses. 4.4.2 Schedule of the pipe. 4.4.3 Working pressure and bursting pressure in pipes and hoses. 4.4.4 Calculation of the flow demanded by the actuators. 4.4.5 Diameter calculation and diameter selection. 4.4.6 Connections for pipes and hoses. 4.4.7 Flow regulating valve.

			4.5 The hydraulic reservoir. 4.5.1 Main characteristics. 4.5.2 Functions. 4.5.3 Accessories. Learning activities: Fluid selection for the project. Calculation of the flow demanded towards the pump. Selection of the diameter of pipes and hoses. Design flow diagrams. Hydraulic reservoir design. Selection of hydraulic filters. Report writing. Project realization. English language readings.
5	5. Pneumatic fluid (5 h)	At the end of the unit, the student will be able to analyze the characteristics of the pneumatic fluid, how it is obtained and prepared, as well as the conduits through which it is transported to calculate fluid consumption by specifying the number of cycles required by the actuators.	**Specific educational content:** 5.1 Preparation of compressed air. 5.1.1 Free air and standard air. 5.1.2 Calculation of the condensate obtained from the compression process. 5.1.3 Cooler-separator. 5.1.4 Characteristics and selection of components of the FRL unit. 5.1.5 Pressure drop in the components of the FRL unit. 5.2 Air consumption. 5.2.1 Calculation of air consumption in actuators. 5.2.2 Calculation of the number of cycles of the actuators based on the available flow. 5.2.3 Calculation of the number of cycles of the actuators between stopping and starting the compressor. 5.3 Distribution of compressed air. 5.3.1 Pipes and hoses. 5.3.2 Working pressure and rupture pressure 5.3.3 Pipe connections. 5.3.4 Compressed air networks. 5.3.5 Sizing of the pneumatic tank. **Learning activities:** Air treatment used in pneumatics. Realization of an electropneumatic circuit using the XD-26 programmable logic controller to obtain the A+A- movement. Design flow diagrams. Report writing. English language readings. Project realization Laboratory practices realization.
6	Directional valves (8 h).	At the end of the unit, the student will be able to know the constructive characteristics of the directional valves to select them and	**Specific educational content:** 6.1 Valves classification. 6.2 Directional valves.

		apply them in various types of circuits through the analysis of the technical specifications.	6.2.1 Check valves. 6.2.2 Piloted non-return valve. 6.2.3 Hydraulic circuits for loads with vertical movement. 6.2.3 Spool valves with 2, 3, 4 and 5 connections. 6.2.4 Spool conditions. 6.2.5 Valve actuation. 6.2.6 Rotary valves. 6.2.7 Double acting directional valves. 6.3 Construction characteristics of the valves. 6.3.1 Valve size and nominal flow. 6.3.2 Pressure drop in valves. 6.3.3 Loss of energy in valves. 6.3.4 Modular construction of valves. 6.3.5 Port characteristics 6.3.6 Restrictive capacity in pneumatic valves. 6.4 Electropneumatic and electrohydraulic circuits. 6.4.1 Stroke sensors. 6.4.2 Sequential method. 6.5 Closed loop control. 6.5.1 Servo valves. 6.5.2 Servo valve actuation method. 6.5.3 Servomechanisms. 6.6 Symptoms of malfunctions in directional valves and possible causes **Learning activities:** Exercises in classes. Selection of the directional valve for the project. Review of technical information on directional valves. Analysis of valve size and pressure drop. Project realization Laboratory practices realization.
7	Valves to control pressure (8 h)	At the end of the unit, the student will be able to know the constructive characteristics of the valves to control pressure to select them and apply them in various types of circuits through the analysis of the technical specifications.	**Specific educational content:** 7.1 Relief valves. 7.1.1 Direct operation. 7.1.2 Pilot Operation. 7.1.3 Characteristics of opening pressure with respect to flow. 7.1.4 Discharge valves. 7.2 Sequence valves and their applications. 7.3 Pressure reducing valve and their applications. 7.4 Counterbalance valves and their applications. 7.5 Modular valve arrangements (relief, directional, piloted non-return and flow regulators). 7.5.1 Base plates. 7.6 Quick exhaust valve. 7.7 Hydraulic accumulator. 7.8 Pressure Intensifier. **Learning activities:** Exercises in classes. Selection of the relief valve for the project. Design flow diagrams.

			Report writing. English language readings. Realization of an electropneumatic circuit using the XD-26 programmable logic controller to obtain the A+B+B-A- movement. Simulation of an electropneumatic sequence of 5 actuators. Project. Laboratory practices realization.
8	Pumps and compressors (16 h)	At the end of the unit, the student will be able to know the constructive characteristics of the pumps and compressors to make a selection for electrohydraulic and electropneumatic circuits by analyzing the technical specifications	**Specific educational content:** 8.1 Pumps. 8.1.1 Classification of positive displacement pumps. 8.1.2 Characteristics of positive displacement pumps. 8.1.3 Characteristic curves of the pumps. 8.1.4 Fixed displacement pumps. 8.1.5 Variable displacement pumps. 8.1.6 Pumps with load sensing. 8.1.7 Application of pumps with constant flow, variable flow and load sensing. 8.1.8 Calculation of the pressure in the discharge of the pump. 8.1.9 Calculation of the power delivered by the pump to the fluid. 8.1.10 Calculation of the power of the motor that drives the pump. 8.1.11 Starting circuit of the electric motor, selection of the caliber of the conductors. 8.1.11 Control of actuators in closed loop with variable displacement pumps. 8.1.12 Control of actuators in closed loop with variable speed pumps. 8.1.13 Assembly of pumps and high-low system. 8.2 Compressors. 8.2.1 Calculation of the power delivered by the compressor to the fluid. 8.2.2 Calculation of the power of the motor that drives the compressor. 8.2.3 Calculation of the size of the pneumatic tank. 8.2.4 Variable speed compressors. 8.3 Installation of the electric motor that drives the pump or compressor. **Learning activities:** Selection of the pump for the project. Selection of the electric motor that will drive the pump. Design of the electrical circuit that will feed the motor. Drafting of the final report of the project. Analysis of project cost Laboratory practices realization

E. ASSESSMENT

The summative assessment proposal for the training space is shown below. According to it, students will receive an ordinary grade. This subject reports four partial grades before the ordinary final grade, the percentages and weighting are as presented in Table 1. The learning activities that are indicated with a value of one point are mandatory for all groups of the subject, the rubrics assessment are provided by the teacher. Additionally, the teacher will assgn learning activities that he considers convenient and will be mandatory for the right to exam, the learning activities with the right to exam can be chosen from those shown in the general didactic planning. The exam includes the topics developed by the teacher in class and the result of the learning activities developed by the student.

Table 1.

#	Time of evaluation	Proposal for the summative assessment of learning	Evaluation percentage
1.	Evaluation of the first part according to the Faculty's calendar. The first and second subject of the course is evaluated.	First project delivery 1 point Presentation of an article 1 point Written exam 8 points	20 %
2.	Evaluation of the second partial exam according to the Faculty's calendar. The third, fourth and fifth subject of the course is evaluated.	Second project delivery 1 point Report of the realization of sequence A+A- 1 point Written exam 8 points	20 %
3.	Evaluation of the third part according to the Faculty's calendar. The sixth and seventh subject of the course is evaluated.	Third project delivery 1 point Report of the realization of the sequence A+B+A-B- 1 point Written exam 8 points	20 %
4	Evaluation of the partial quarter according to the Faculty's calendar. The eighth subject of the course is evaluated.	Final project delivery 2 point Simulation of a video sequence of 5 actuators 1 point Written exam 8 points	20 %

Ordinary final assessment	The ordinary grade will be the sum of all the evaluation points referred to in Table 1 multiplied by the evaluation percentage. The grade will be reported based on 10 and will proceed according to the Examination Regulations to declare the subject accredited or, if appropriate, EE or ET. The evaluation value is 100%.
Extraordinary assessment	Written exam. 100% of the topics and the result of the learning activities of this training space will be evaluated. The evaluation value is 100%.
Sufficiency Title assessment	Written exam. 100% of the topics and the result of the learning activities of this training space will be evaluated. The evaluation value is 100%.
Regularization assessment	Written exam. 100% of the topics and the result of the learning activities of this training space will be evaluated. The evaluation value is 100%.

F. BIBLIOGRAPHIC AND DIGITAL RESOURCES

BASIC TEXTS:

1. Cundiff, John S. Fluid power circuits and controls: fundamentals and applications 2 ed, CRC Press, 2020.
2. Esposito, Anthony. Fluid power with applications, 7 ed, Pearson 2009.
3. Creus Solé, Antonio. Neumática e hidráulica 2a ed. Alfaomega 2011

4. Majumdar, S. R. Oil hydraulic systems: principles and maintenance. McGraw-Hill Professional, 2003.
5. International standar ISO-1219-1, Fluid Power system and components, graphic symbols and circuit diagrams; Part 1, graphic symbols.
6. International standar ISO-1219-2 Fluid Power system and components, graphic symbols and circuit diagrams; Part 2, circuit diagrams.
7. Aragón González, Gerardo. Introducción a la potencia fluida: neumática e hidráulica para ingenieros. Reverté, 2014.

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CURRICULAR AND SCHOOL DATA

Area	Line	Type of credit	Type of formation space	Language of instruction	Method of delivery
Professional (Engineering Topics)	N/A	Required	Course	Spanish	In person

CREDITS

According to the official curricular proposal, the school data of the formation space are:

Semester	Number of weeks	Contact hours per week	Contact hours of practice per week	Hours of autonomous student work per week	Credits per agreement 17/11/17(before 279)
7	16	4	2	4	10

REQUIREMENTS TO ATTEND THE FORMATION SPACE

The school requirements for the formation space are noted below, if necessary

#	REQUIREMENTS
1.	IME students must have accredited the Fluid Mechanics training space key 5632

EQUIVALENCIES OF THE FORMATION SPACE

Next, the equivalences of the training space with spaces of previous educational programs are indicated, if necessary.

EQUIVALENCES
There are no equivalent training spaces.

INTEROPERABILITY

This formation space is shared with other educational programs and/or academic entities: No.

ACADEMIC INSTITUTION AND EDUCATIONAL PROGRAMS
College of Engineering: Electromechanical Engineering

OTHER FORMS OF ACCREDITATION

- This formation space can be accredited through the presentation of a document certifying that the student has already acquired the necessary learning: **No**.

- This formation space can be accredited through an exam that certifies that the student has already acquired the necessary learning: **No**.

FORMATION OPTIONS

This formation space is part of the following options:

Training option	Yes / No
Bachelor's Degree	Yes
Dual formation program	No
Higher University Technician	No
Executive career	No
Partial accreditation option	No
Residency or internship	No

TEACHER PROFILE

The academic and professional training and experience that the profile of the teacher who teaches this training space must meet, and that must be considered in the hiring and training of the teacher, is:

Formation and academic experience

- Electromechanical Engineer or related career with Master's or doctorate studies.

Formation and professional and work experience

- The teacher must have experience in the course topics.

The teacher's role

- The teacher will have the task of facilitating the student's learning of the course topics, as well as providing the necessary theoretical tools for the student to develop the project. He will monitor the activities carried out by the student through reviews of the learning activities. She will issue a grade in each part according to the percentages established in Table 1.

MAXIMUM AND MINIMUM NUMBER OF STUDENTS PER GROUP

- Maximum number of students to guarantee academic, pedagogical, and financial viability: 25
- Minimum number of students to guarantee academic, pedagogical, and financial viability: 8

TYPE OF PROPOSAL

- It is a version of programs that are presented as a curricular adjustment of content within the framework of an existing educational program.

DEVELOPERS AND REVIEWERS

Developers of this programs	Reviewers of this programs

PhD Baudel Lara Lara	Eng. Julio Álvarez Tamayo
	M. Eng. Julio Alberto Boix Salazar
	M. Eng. Juan Carlos Torres Galván