HYDROMECHANICAL SYSTEM A

LEARNING OUTCOMES

A. GENERAL LEARNING OBJECTIVE

At the end of the course, the student will be able to design and select the essential components in the operation of hydraulic machines based on their theoretical and practical foundations.

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. 1.5 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. 1.9 Identifies and performs calculations for the integration of renewable energy systems. 1.10 Identifies opportunities and applies strategies for energy savings 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. that must be met by the design of a component, system or process. 2.3 Identifies and evaluates design constraints. 6.3 Uses a logical organization of procedures and applies mathematical and graphic analysis to interpret the results of an experiment. 6.5 Describes the experimental results and their relationship with fundamental concepts and principles. 6.7 Uses modern and appropriate computing resources for engineering practice.

Knowledge	Energy conversion in turbomachines. Hydraulic power fundamentals. Speed triangles. Pump Analysis Using Engineering Software. Turbomachines: components, classification, energy balance and fundamental equations. Optimal point of operation in pumps. Cavitation and NPSH required and available. Fans calculation Classification of hydroelectric plants, energy conversion and components. Selection and analysis of hydraulic turbines. Similarity in turbomachines. Fundamentals of hydraulic transmissions..
Skills	Teamwork. Problem resolution. Synthesis capacity. 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.
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. 3.5 Communicates orally and in writing in a language other than the first language. 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… 4.6 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

The course is designed for a deep assimilation of the contents through the teaching of theoretical and practical classes, exhibitions, presentation of projects and use of engineering software.

The teaching methodology is:
- By the teacher: Teaching of the subject through in-depth presentation of the topics, problem solving, assignment of research projects and the application of knowledge, advice and group activities.

- By the student: Readings of the recommended bibliography, including those in English, fulfillment of assigned tasks, identification of essential components in the operation of turbomachines, as well as their selection according to operational conditions.

The course is divided into 8 topics with a total of 48 hours of theory, it consists of three partial exams which make up 80% of the total grade, the remaining 20% corresponds to learning activities.

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.	Introduction to hydraulic machines (3 hours)	At the end of the unit, the student will be able of know the notions of fluid machines and hydraulic energy to apply the principles in solving problems.	**Specific educational content:** 1.1. Definition, classification of fluid machines. 1.2. Characteristic elements of a turbomachine. 1.3. Classification of turbomachines. 1.4. Hydraulic power. 1.4.1. Definition and classification. 1.4.2. The hydraulic resource. 1.5. Energy balance of a hydraulic machine. 1.6. Review of fundamental equations for the analysis of hydraulic machines. **Learning activities:** Class exercises related to energy conversion in turbomachines.

			Research report on fundamentals of hydraulic energy.
2	General theory of turbomachines (4 h)	At the end of the unit, the student will be able to know the tools for the design of new machines through the analysis of the behavior of a turbomachine of defined geometry.	**Specific educational content:** 2.1. speed triangles. 2.2. Control volume and continuity equation. 23. Euler's theorem. 2.4. Alternative form of Euler's equation. 2.5. Degree of reaction. **Learning activities:** Calculation problems with velocity triangles
3	Pumps (12 h)	At the end of the unit, the student will be able to analyze the operation of hydraulic pumps, types, effect of losses on performance, their selection and determination of the operating point.	**Specific educational content:** 3.1. Definition and classification of pumps. 3.2. Components. 3.3. Construction types. 3.4. Pumping installations. 3.5. Manometric or effective head of a pump. 3.6. Power and performance. 3.7. System characteristic curve. 3.8. Selection of a centrifugal pump. 3.9. Point of operation. 3.10. Series and parallel pumps. 3.11. Laws of similarity in pumps 3.12. Flow regulation. **Learning activities:** Pump Analysis Using Engineering Software. Problem to determine the optimal point of operation. Problems of calculation of height, power and performance in pumps. Similarity problems in pumps
4	Cavitation in turbomachines (4 h)	At the end of the unit, the student will be able to design a hydraulic installation to avoid cavitation by analyzing the factors that influence this phenomenon and its consequences.	**Specific educational content:** 4.1. Basic concepts and effects of cavitation. 4.2. NPSH. 4.3. Cavitation conditions in a hydraulic machine. 4.4. Thomas parameter. 4.5. Installation design parameters to avoid cavitation. **Learning activities:** Design project to avoid cavitation. Investigation of favorable conditions to increase NPSH. NPSH calculation problems.
5	Fans (4 h)	At the end of the unit, the student will be able to analyze fans as generating machines with negligible fluid compressibility	**Specific educational content:** 5.1. Definition and classification. 5.2. Operating parameters depending on the pressure drop. 5.3. Radial fans. 5.4. Applications. 5.5. Laws of similarity in fans. **Learning activities:** Fan calculation problems Similarity in fans
6	Hydroelectric Power Plants (5 hours)	At the end of the unit, the student will be able to analyze the energy conversion,	**Specific educational content:** 6.1. Classification and general description. 6.2. Energy conversion.

		components and operation of a hydroelectric power plant	6.3. Major rivers and hydroelectric plants. 6.4. Components and operation. 6.5. Types of plants. 6.6. Estimation of the design flow. 6.7. Power of a hydraulic power station. **Learning activities:** Report and presentation about the main rivers and power plants in the world, components and operation of hydroelectric power plants. Calculation problem of a hydroelectric plant
7	Hydraulic turbines (12 hours)	At the end of the unit, the student will be able to analyze the hydraulic motor machines in their operation, classification, types and application of each existing design.	**Specific educational content:** 7.1. Definition and classification. 7.2. Components. 7.3. Selection of hydraulic turbines. 7.4. Action or impulse turbines. 7.4.1. Components. 7.4.1. Speed triangles. 7.4.1. Design criteria for optimal performance. 7.5. reaction turbines. 7.5.1. Components. 7.5.2. speed triangles. 7.5.13. Classification. 7.6. Evolution of the impeller with the specific speed. 7.7. Laws of similarity in turbines. **Learning activities:** Turbine selection. Calculation of turbines and identification of optimal operating conditions. Similarity problems in turbines. Turbine Analysis Using Engineering Software
8	Hydraulic transmissions (4h)	At the end of the unit, the student will be able to analyze the operation of the hydrodynamic coupling and the hydrodynamic torque converter, as a principle of hydraulic transmission.	**Specific educational content:** 8.1. Classification of hydraulic transmissions. 8.2. Hydrodynamic transmissions operation and applications 8.3. Hydrostatic transmissions operation and applications. **Learning activities:** Research and presentation of fundamentals of hydraulic transmissions.

E. ASSESSMENT

The evaluation proposal for the training space is shown below. According to it, students will receive an ordinary grade.
This course reports three partial grades before the ordinary final grade. The percentages and weighting are as presented in Table 1. Additionally, the teacher will leave learning activities that he deems appropriate. The exams include the topics developed by the teacher in class and the result of the learning activities developed by the student. The following projects to be carried out are described:
Project 1: Determination of the optimum operating point of a pump considering the curves of the installation and the pump.
Project 2: Design of a piping system to transport hot water, taking into account geometric and operating parameters to avoid cavitation.
Project 3: Report and presentation about the main rivers and power plants in the world, components and operation of hydroelectric power plants.

Table 1

#	Time of evaluation	Proposal for the summative assessment of learning	Evaluation percentage
1.	Evaluation of the first part according to the College calendar. The first, second and third topic of the course is evaluated	Written exam 8 points Pump Analysis using Engineering Software 1 point Project 1 1 point	33 %
2.	Evaluation of the second partial exam in accordance with the College calendar. The fourth, fifth and sixth subject of the course is evaluated.	Written exam 8 points Project 2 1 point Project 3 1 point	33 %
3.	Evaluation of the third part according to the College calendar. The sixth, seventh and eighth topic of the course is evaluated.	Written exam 8 points Calculation of turbines and identification of optimal operating conditions 1 point Turbine Analysis using Engineering Software 1 point	33 %

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 curse accredited or, if appropriate, EE or ET. The evaluation value is 100%.
Extraordinary assessment	100% of the topics and the result of the learning activities of this training space will be evaluated. The written exam is worth 100%.
Sufficiency assessment	100% of the topics and the result of the learning activities of this training space will be evaluated. The written exam is worth 100%.
Regularization assessment	100% of the topics and the result of the learning activities of this training space will be evaluated. The written exam is worth 100%.

F. BIBLIOGRAPHIC AND DIGITAL RESOURCES

BASIC TEXTS:

1. Mataix, C. Turbomáquinas hidráulicas, 2ª ed., ICAI-ICADE, Madrid, 2009.
2. Zamora Parra B., Viedma Robles A. Máquinas hidráulicas (teoría y problemas), CRAI UPCT, 1° Ed., 2016.
3. Lecuona, A., Nogueira, J.I. Turbomáquinas, Ariel Ciencia y Tecnología, Barcelona, 2000.
4. Ehrlich R, Geller H. Renewable Energy: A First Course, Taylor & Francis CRC Press, 2da Ed., 2017
5. Potter, M.C., y Wiggert, D.C., Mechanics of fluids, Prentice-Hall, 1991.
6. Munson B., Young D., Okiishi T., HUEBSCH W. Fundamentals of Fluid Mechanics, 6° Ed, Wiley, 2009
7. Almandoz Berrondo, J., Mongelos Oquiñena, M., Pellejero Salaberria, I. Apuntes de máquinas hidráulicas, Universidad del país vasco, 2007

ELECTRONIC ADDRESSES OF INTEREST:

https://www.youtube.com/watch?v=Vhc-hEjh12I
https://www.youtube.com/watch?v=0_3Yl-VQRio
https://www.youtube.com/watch?v=SpKuTfw560U
https://www.youtube.com/watch?v=k0BLOKEZ3KU

CURRICULAR AND SCHOOL DATA

Area	Line	Type of credit	Type of formation space	Language of instruction	Method of delivery
Deepening (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	Classroom hours per week	Contact hours of practice per week	Hours of autonomous student work per week	Credits per agreement 17/11/17(before 279)
8	16	3	1	-	7

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 Electrohydraulic and Electropneumatic Systems Training Space. IM and IMA students must have accredited the Hydraulic and Pneumatic Circuits Training space:

EQUIVALENCIES OF THE FORMATION SPACE

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

EQUIVALENCES
None

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 teacher must know about the student outcomes that are promoted in the students of the electromechanical engineering program.

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 topics of the course.

The teacher's role

- The teacher will have the task of explain the topics of the subject, propose basic and advanced exercises for the correct assimilation of the fundamental topics for an engineer, related to turbo machinery. This will be executed based on the methodology

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: 5

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. Geydy Luz Gutiérrez Urueta	• Eng. Julio Álvarez Tamayo
• M.I. Julio Alberto Boix Salazar	• PhD. Baudel Lara Lara