A) COURSE

Course Id:	Course
5633	Hydraulic and pneumatic circuits

Class Hours per Week	Lab hours per week	Complementary practices	Credits	Total hour course
4	2	4	10	64

B) GENERAL COURSE INFORMATION:

	EE (IEA)	ME (IM)	MME (IMA)	EME (IME)	MTE (IMT)
Level:		VIII	VIII	VII	
Course Type (Required/Elective)		Required	Required	Required	
Prerequisite Course:		Fluid Mechanics and Control Systems and Automation	Fluid Mechanics and Control Systems and Automation	Fluid Mechanics	
CACEI Classification:		AE	AE	AE	

C) COURSE OBJECTIVE

At the end of the course, the student will be capable of:
Design, calculate, build hydraulic and pneumatic circuits and select all the components forming part thereof. It will also develop a criterion of energy saving and maximum efficiency to provide sustainable solutions.

D) TOPICS (CONTENTS AND METHODOLOGY)

I.- INTRODUCTION.		**4 hrs**
Specific Objective:	Review the principal laws with which then analyzed hydraulic and pneumatic circuits, as well as to identify the symbolic representation of the circuits.	

1.1 Fundamental Laws. 1.1.1 Perfect Gas Law. 1.1.2 Pascal Principle. 1.1.3Ecuación Bernoulli. 1.1.4 Applications of the Pascal Principle. 1.2 Conversion, Distribution and uses of energy. 1.3 Hydraulic and pneumatic basic scheme. 1.3.1 Actuator. 1.3.2 Directional Element. 1.3.3 Hydraulic and pneumatic power unit. 1.3.4 Basic Symbology. 1.4 Differences between hydraulic and pneumatic circuits. 1.4.1 Advantages and disadvantages. 1.5 Basic representation of automatism. 1.5.1Simplified System. 1.5.2 Space-Phase Diagram. 1.5.3 Space-Time Diagram.	
Readings and other resources	Resources needed for teaching and learning specifically on this issue.
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

2.- HYDRAULIC FLUIDS.		**7 hrs**
Specific Objective:	Describe and identify the characteristics of hydraulic fluids, and to analyze the channels through which transports the fluid, meet the sealing elements that help keep the system hermetic. Identify filtering methods and storage.	
2.1 Functions of fluid. 2.2 Mineral oils. 2.2.1 Viscosity. 2.2.2 Viscosity measurements (Grades ISO SSU). 2.2.3 Viscosity behavior versus temperature. 2.2.4 Additives for hydraulic fluid. 2.3 Flame retardants fluids. 2.3.1 Water glycol. 2.3.2 Synthetic fluids 2.3.3 Emulsion. 2.4 Distribution of fluid. 2.4.1 Pipelines and hoses. 2.4.2 Card of pipelines and pressure of work. 2.4.3 Pipe connections. 2.5 The deposit. 2.5.1 Principal characteristics. 2.5.2 Functions.		

2.6.1 Static and dynamic. 2.6.2 Positive and negative. 2.6.3 Materials of seals. 2.7 Filters. 2.7.1 Filter materials. 2.7.2 Filter on the suction. 2.7.3 Filter on pressure line. 2.7.4 Filter on the return line. 2.7.5 Types of filters. 2.7.6 Efficiency filters. 2.7.7 Pressure drop in filters.	
Readings and other resources	Resources needed for teaching and learning specifically on this issue.
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

3.- PNEUMÁTIC FLUID.		**2hrs**
Specific Objective:	Describe and identify the characteristics of pneumatic fluids, and to analyze the channels through which transports the fluid, meet the sealing elements that help keep the system hermetic. Identify filtering methods and storage.	
3.1 Distribution of compressed air. 3.1.1Las pipelines. 3.1.2 Pipelines for connections. 3.1.3 Hoses. 3.1.4 Compressed air networks. 3.2 The deposit. 3.2.1 Principal characteristics. 3.2.2 Functions. 3.2.3 Accessories. 3.3 Preparation of compressed air. 3.3.1 The filter. 3.3.2 The regulator. 3.3.3 The lubricator. 3.3.4 The maintenance unit.		
Readings and other resources	Resources needed for teaching and learning specifically on this issue.	
Teaching Methods	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.	
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.	

4.- HYDRAULIC AND PNEUMATIC ACTUATORS.		**4 hrs**
Specific Objective:	Identifying and applying the different types and characteristics of linear and rotating actuators.	

4.1 Linear actuators. 4.1.1 Elements that form. 4.1.2 Types of actuators. 4.1.3 Actuating speed. 4.1.4 Forces. 4.1.5 Damping. 4.2 Rotary actuators. 4.2.1 Types of actuators. 4.2.2 Volume displaced. 4.2.3 Torque. 4.3 Differences between a hydraulic and pneumatic actuator.	
Readings and other resources	Resources needed for teaching and learning specifically on this issue.
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

5.- HYDRAULIC AND PNEUMATIC VALVES.		**9 hrs**
Specific Objective:	Analyze, describe the operation of the valves and select the valves suitable on design of a hydraulic or pneumatic system.	
5.1 Classification of valves. 5.2 Directional valves. 5.2.1 Check valves. 5.2.2 Check valve piloted. 5.2.3 Spool valves 1, 2, 3, 4 and 5 way. 5.2.4 Conditions centering spool. 5.2.5 Control valves. 5.2.6 Revolving valves. 5.2.7 Constructive characteristics of the valves. 5.3 Pressure control valves. 5.3.1 Relief Valves. 5.3.2 Discharge valves. 5.3.3 Sequence valves. 5.3.4 Counterbalance valves. 5.3.5 Braking valve. 5.3.6 Pressure reducing valve. 5.3.7 Direct operation and remote operation. 5.3.8 Constructive characteristics of the valves. 5.4 Flow Control Valves. 5.4.1 Controller through restriction valve. 5.4.2 Capacity of the valve restrictive. 5.4.3 Controller valve through detour. 5.4.4 Controller valve compensated for pressure and temperature. 5.4.5 Circuit controlling the input. 5.4.6 Circuit controlling the output. 5.4.7 Circuit of bleeding. 5.4.8 Constructive characteristics of the valves. 5.5 Valve timing. 5.6 Quick exhaust valve. 5.7 Logic valves. 5.8 Servo valves.		
Readings and other resources	Resources needed for teaching and learning specifically on this issue.	

Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

6.- PUMPS AND COMPRESSORS.	**6 hrs**
Specific Objective:	To know the machines that convert mechanical power into fluid. To analyze the main characteristics of the hydraulic pumps, as well as compressors to choose the right one.
6.1 Positive Displacement Pumps. 6.2 Rotary vane pumps. 6.2.1 Gear Pumps. 6.2.2 Vane pumps. 6.2.3 Lobe pumps 6.3 Reciprocating Pumps. 6.4 Variable flow pumps. 6.5 pressure-compensated pump. 6.6 Compressors. 6.6.1 Piston compressors. 6.6.2 Rotary Compressors. 6.6.3 Multistage compressors.	
Readings and other resources	Resources needed for teaching and learning specifically on this issue.
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

7.- ACCESSORIES	**3 hrs**
Specific Objective:	To know the various accessories that improve the efficiency of the system and allow proper operation.
7.1 Accumulators. 7.2 Measuring instruments. 7.3 Pressure intensifiers. 7.4 Coolers. 7.5 Heaters.	
Readings and other resources	Resources needed for teaching and learning specifically on this issue.
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

8.- BASIC HYDRAULIC DIAGRAMS.	**6 hrs**
Specific Objective:	To identify, distinguish and analyze the most common hydraulic circuits.

8.1 Regenerative circuit. 8.2 Circuit of high-low pressure operation. 8.3 Circuits reciprocating. 8.4 Sequence Circuit. 8.5 braking circuit for linear and rotary actuators. 8.6 Circuits feeders. 8.7 Two vented maximum pressures. 8.8 automatic venting cycle end. 8.9 Flow control and relief valve for overload. 8.10 Circuit of the store. 8.11 Accumulator auxiliary power source. 8.12 Accumulator as leakage compensator and pressure transients.	
Readings and other resources	Resources needed for teaching and learning specifically on this issue.
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

9.- BASIC PNEUMATIC SCHEMES.		**6 hrs**
Specific Objective:	To identify, distinguish and analyze the most common pneumatic circuits.	
9.1 Setting supply and exhaust flow. 9.2 Adjusting the exhaust pressure. 9.3 How to stop the cylinder rod. 9.4 Lock a cylinder at any point of its travel. 9.5 Unidirectional driven by the cylinder itself. 9.6 Output and automatic entry of a cylinder. 9.7 Out manual and automatic entry of a cylinder. 9.8 Stop Order predominant running order. 9.9 A re-return to the origin. 10.9 Cycle with reversing. 9.11 Cycle in which a back halfway. 9.12 Cylinder timer function. 9.13 Out instant and timed entry. 9.14 Circuit with quick release. 9.15 Circuits with basic logic functions.		
Readings and other resources	Resources needed for teaching and learning specifically on this issue.	
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.	
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.	

10.- DESIGN OF A HYDRAULIC CIRCUIT.		**8 hrs**
Specific Objective:	Apply knowledge to develop and design a hydraulic circuit based on project conditions. Select all components properly based on technical information from manufacturers, finishing with energy costs to operate the system.	

10.1 Definition of the problem. 10.2 Sketch of the system. 10.3Duty cycle. 10.4 Selecting the actuator. 10.5 Selecting directional element. 10.6 Calculation of the flows. 10.7 Selection of components in the discharge line. 10.8 The selection of a fluid. 10.9 Calculation of forces on the actuator. 10.10 Calculation of pressures. 10.11 Complete worktable. 10.12 Regulation and control. 10.13 Pump Selection. 10.14 Selection electric motor. 10.15 Sizing the tank. 10.16 Costs of electricity produced by the hydraulic circuit. 10.17 Hydraulic System Efficiency.	
Readings and other resources	Resources needed for teaching and learning specifically on this issue.
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.

11.- DESIGN OF A PNEUMATIC CIRCUIT		**7 hrs**
Specific Objective:	Apply knowledge to develop and design a pneumatic circuit based on project conditions. Select all components properly based on technical information from manufacturers, finishing with energy costs for optimal system operation.	
11.1 Problem 11.2 Sketch of the system. 11.3 Duty cycle. 11.4 Selection of the actuator. 11.5 Calculation of the flows. 11.6 Complete duty cycle table. 11.7 Define directional element. 11.8 Regulation and control. 11.9 Election of a compressor. 11.10 Tank Sizing. 11.11 Selection of the electric motor. 11.12 Duty cycle electric motor. 11.13 Cost of electricity produced by the pneumatic circuit. 11.14 Pneumatic system efficiency.		
Readings and other resources	Resources needed for teaching and learning specifically on this issue.	
Teaching Methodologies	Exhibition, based on the suggested bibliography, simulation programs, videos and projection equipment. Motivate the students to the discussion and analysis of the issues.	
Learning Activities	Specific activities of this topic be made the students, such as practices, readings, assignments , exercises in class, etc.	

E) TEACHING AND LEARNING METHODOLOGIES

a) Conventional exposure of each subject by the teacher, with the active participation of students.

b) The use of software for the simulation of both hydraulic and pneumatic systems.
c) Approaches to practical problems involving hydraulic and pneumatic systems.
d) Conducting laboratory practice, for testing the theoretical aspects.
e) Consultation catalogs of manufacturers of hydraulic and pneumatic components.
f) Reading scientific articles and outreach.
g) Research by students.
h) Exhibition of projects by students, focused on the optimization of hydraulic and pneumatic circuits.

PRACTICES:

For the experiments, they are considered a total of 16 sessions of two hours. The practices to be performed are listed below:

1. Description Equipment and Standards for Operation.
2. Basic Laws and fluid characteristics.
3. Pressure and flow.
4. Actuators and valves (1).
5. Actuators and valves (2) Pumps and compressors.
6. Hydraulic pumps and compressors Basic Schemes.
7. Hydraulic Basic scheme.
8. Pneumatics Basic scheme.
9. Simulation of Hydraulic and Pneumatic Circuits.
10. Power and symbology Using Sensors in pneumatics.
11. Representation of hydraulic circuits.
12. Sequence.
13. Design and Construction of a pneumatic Electro Circuit.
14. Project.

F) EVALUATION CRITERIA:

Evaluation:	Schedule	Suggested Form of Evaluation and weighing	Topics
1st. Partial Evaluation	16 Sessions	Exam 80%, 20% Tasks 1 and 2	1,2,3 y 4
2nd Partial Evaluation	16 Sessions	Exam 80%, 20% Tasks	5 y 6
3rd. Partial Evaluation	16 Sessions	Exam 80%, 20% Tasks	7,8 y 9
4th Partial Evaluation	16 Sessions	Exam 80%, 20% Tasks	10 y 11
Final Ordinary Evaluation		100% (Average Partial Ratings)	
Other activities:			
Extraordinary Exam	Week 17 of the semester in course	Exam 100%	100% Topics
Title Exam	According to the schedule of the School Secretary	Exam 100%	100% Topics
Regularization Exam	According to the schedule of the School Secretary	Exam 100%	100% Topics

G) BIBLIOGRAPHY AND ELECTRONIC RESOURCES

Main Books

MAJUMDAR S. R., Oil Hydraulic Systems,Editorial McGraw Hill, 2003

ESPOSITO ANTHONY, **Fluid Power with applications,** Editorial Prentice Hall, 2003

GUILLÉN SALVADOR ANTONIO, Introducción a la Neumática, Editorial Alfaomega, 1999.

CARULLA MIGUEL / LLADONOSA VICENT, Circuitos Básicos de Neumática, Editorial Alfaomega, 1995.

DEPPERT W. / STOLL K.,Aplicaciones de la Neumática, Editorial Marcombo, 1991.

Complementary Books

INTERNATIONAL STANDAR ISO-1219-1, Fluid Power system and components, graphic symbols and circuit diagrams; Part 1, graphic symbols.
First Edition

INTERNATIONAL STANDAR ISO-1219-2
Fluid Power system and components, graphic symbols and circuit diagrams; Part 2, circuit diagrams
First Edition

ANDREW PARR
Hydraulics and Pneumatics, A Technical and Engineer's guide.
Editorial Elsevier Butterworth Heinemann, 1998

MILLAN TEJA SALVADOR
Automatización Neumática y Electroneumática,
Editorial Alfaomega, 1996.

ROCA RAVELL FELIP
Oleohidráulica Básica
Editorial Alfaomega, 1999.

ROLDÁN VITORIA JOSÉ, Neumática, Hidráulica y Electricidad Aplicada, Editorial Thomson-Paraninfo, 10ª Edición, 2004.

Diseño y Mantenimiento de Sistemas Hidráulicos, Manual de estudio de FESTO.

MILLAN TEJA SALVADOR, Automatización Neumática y Electroneumática, Editorial Alfaomega, 1996

Internet Links

http://www.millerfluidpower.com/
http://www.lenzinc.com/
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http://www.johnson-pump.com/
http://www.festo.com/
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