SILLABUS OF THE COURSE

Academic Year: 2020-2021

Identification and characteristics of the course			
Code	501339	ECTS Credits	6
Course name (English)	HYDRAULIC AND PNEUMATIC MECHANISMS		
Course name (Spanish)	MECANISMOS HIDRÁULICOS Y NEUMÁTICOS		
Degree program	Degree in Mechanical Engineering (industrial branch)		
Faculty/School	Industrial Engineering School		
Semester	8	Type of course	Optional
Module	Optional courses		
Matter	Thermodynamics and Fluids Mechanics		

Instructor/s			
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Department	Mechanical, Energetic and Materials Engineering		
Coordinator			

Competences (see table at http://bit.ly/competenciasGrados)

Basic Competences	Check With an "X"	General Competences	Check With an "X"	Transversal Competences	Check With an "X"	Specific Competences Basic Formation	Check With an "X"	Specific Competences Common to the Industrial Branch	Check With an "X"	Specific Competences Specific Technology	Check With an "X"
CB1	X	CG1	X	CT1	X	CEFB1		CECRI1		CETE1	
CB2	X	CG2	X	CT2	X	CEFB2		CECRI2		CETE2	
CB3	X	CG3	X	CT3	X	CEFB3		CECRI3		CETE3	
CB4	X	CG4	X	CT4	X	CEFB4		CECRI4		CETE4	
CB5	X	CG5	X	CT5	X	CEFB5		CECRI5		CETE5	
		CG6	X	CT6	X	CEFB6		CECRI6		CETE6	X
		CG7	X	CT7	X			CECRI7		CETE7	
		CG8	X	CT8	X			CECRI8		CETE8	
		CG9	X	CT9	X			CECRI9		CETE9	
		CG10	X	CT10	X			CECRI10		CETE10	
		CG11	X					CECRI11		CETE11	
		CG12						CECRI12		CETFG	

Contents

Summary

Fluid power actuators. Flow rate fluctuations. Hydraulic technology. Hydraulic fluids characteristics. Regulation and control valves. Hydraulic circuits and applications. Hydraulic (hydrostatic) transmission. Compressed air generation, distribution and treatment. Pneumatics and vacuum circuits. Pneumatic applications.

Units

Name of unit 1: Introduction
Contents of unit 1:
- Fundamentals of fluid power.
- Components of a basic hydraulic circuit.
- Hydraulic fluids.
- Components of a basic pneumatic circuit.
- Compressed air generation, distribution and treatment.
- Hydraulic and pneumatic differences.
- Fluid power applications.

Practical activities: (see below)

Name of unit 2: Hydraulic pumps
Contents of unit 2:
- Hydraulic pump types.
- Hydraulic pump performance. Characteristic curves and performance.
- Pump selection for an application.

Practical activities: (see below)

Name of unit 3: Cylinders
Contents of unit 3:
- Hydraulic and pneumatic cylinders types and components.
- Cylinder performance.
- Cylinder selection for an application.
- Direct and indirect control basic circuits and applications.

Practical activities: (see below)

Name of unit 4: Motors.
Contents of unit 4:
- Motor types and components.
- Performance and characteristics curves.
- Motor selection for an application.
- Direct and indirect control basic circuits and applications.
- Hydrostatic transmissions.

Practical activities: (see below)

Name of unit 5: Pressure valves.
Contents of unit 5:
- Pressure valves types and components.
- Performance and characteristics curves.
- Pressure valve selection for an application.
- Circuits and applications.

Practical activities: (see below)

Name of unit 6: Flow valves.
Contents of unit 6:
- Flow valves types and components.
- Performance and characteristics curves.
- Flow valve selection for an application.
- Circuits and applications.

Practical activities: (see below)

Name of unit 7: Directional control valves.

Contents of unit 7:

- Directional control valves (DCV) types and components.
- Performance and characteristics curves.
- DCV selection for an application.
- Circuits and applications.

Practical activities: (see below)

Practical activities for all units:

Practical activities cannot be associated to just one unit. Circuits include different components and complexity is increased.

Hydraulics (2 hours sessions)

H1: Relief pressure valve set point. Pump and motor characteristics and performance.
H2: Characteristics and performance of a double acting cylinder. Pressure losses in the circuit.
H3: Vertical loads in circuits. Load velocity regulation.
H4: Counterbalance valves. Load velocity regulation circuits comparative.
H5: Performance of several actuators circuits.

Pneumatics (all sessions are 2 hours, but N3 that is 1,5hour long)

N1: Direct control of single and double acting cylinders.
N2: Indirect control of single and double acting cylinders. Velocity regulation.
N3: Logic valves in pneumatic.
N4: Circuits with several cylinders. Signal temporization.
N5: No rod cylinder and vacuum ejector.

Learning activities

Student workload in hours		**Lectures and practical activities**					**Homework**
Unit / Assessment	**Total**	**GG**	**S**	**O**	**L**	**TP**	**EP**
Presentation	1,5	1					0,5
1	8	4					4
2	8	4					4
3	19,5	9				1,5	9
Lab practice H1, H2, N1, N2	24				8		16
Midterm exam	7	1					6
4	6	3					3
5	6	3					3
6	5,5	2				1,5	2
7	4	2					2
Lab practice H3-H5 y N3-N5	34,5				11,5		23
Project	12						12
Final exam	14	1					13
Total	150	30			19,5	3	97,5

GG: Lectures (100 students)
S: Seminar (40 students)
O: Computer (30 students)
L: Lab (15 students)
TP: Small group (10 students)
EP: Homework and exams preparation

Teaching methodology

Among the teaching methodologies included in the formative program, in this course the following are used:

Teaching methodology	Check with an "X" the ones used
1. Explanation and discussion of contents	X
2. Solution, analysis and discussion of examples and exercises	X
3. Oral presentation of assignments	X
4. Development of practical cases in labs, computer rooms, seminars, etc.	X
5. Attention to the student and advice of the assignments in small groups	X
6. Search of information prior to the explanation of the contents of an unit or search of complementary information once the activities of a unit have been developed	X
7. Elaboration of assignments either individually or in groups	X
8. Study of each unit: study of contents, preparation of exercises or cases, preparation of the final exam, etc.	X

Learning outcomes

When passing this course, students will know:

- how power transmission in a fluid works.
- How to evaluate hydraulic and pneumatic systems and stablish differences between them.
- the applicable standards.
- the volumetric pumps and how to select an adequate one.
- the linear actuators and how to attach them to a mechanism
- the motors and their application
- how to regulate flow and pressure in a circuit.
- How to select the adequate component size
- How hydraulic transmissions work in closed loop, both in stationary and non stationary.

Assessment

Assessment criteria

Evaluation will be done considering the criteria listed below.

CE1. Understands real and theoretical performance of hydraulic and pneumatic circuits and their components.

CE2. Know the standard symbols used in technical documentation. Understands how a medium complexity circuit operates. Can design a circuit for a simple operation.

CE3. Uses catalogues and technical documentation. Interprets technical information correctly and selects components valid for a particular application.

CE4. Express clearly and with the proper language the operation of a hydraulic or pneumatic circuit, and can justify decision related to the design or selection of its components.

CE5. Can build a simple circuit with real components.

CE6. Can work in a team, collaborating in the work organization and decision making.

Criteria CE1-CE4 are applied in all evaluations activities and criteria CE5-CE6 are only applied in the evaluation of the practical work in the laboratory. Evaluation criteria allow to control the achievement of the competences corresponding to the course. Relation between competences and criteria is shown in the table below.

	CB1	CB2	CB3	CB4	CB5	CG1	CG2	CG3	CG4	CG5	CG6	CG7	CG8	CG9	CG10	CG11	CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8	CT9	CT10	CETE6
CE1	X	X	X		X	X		X		X		X					X							X			X
CE2	X	X	X		X	X		X	X				X	X			X	X	X								X
CE3	X	X	X			X		X	X	X	X	X	X	X	X	X		X		X	X		X	X		X	X
CE4	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X		X		X	X
CE5	X	X	X			X		X	X	X								X		X				X			X
CE6	X	X	X	X			X			X				X	X			X	X	X	X			X	X		

Assessment activities

Among the assessment activities included in the formative program, in this course the following are used:

	Range fixed	Ordinary call	Extraordinary call	Global assessment
1. Final exam and/or partial examinations.	0%–80%	50%	50%	60%
2. Practical activities in: classroom, lab, computers room, visits, etc.	0%–50%	30%	30%	40%
3. Solution and submission of activities (cases, exercises, assignments, projects, etc.), individually and/or in groups.	0%–50%	20%	20%	0%
4. Active participation in the learning activities.	0%–10%	0%	0%	---
5. Attendance to the learning activities.	0%–10%	0%	0%	---

Description of the assessment activities

Midterm exam (EP) with three sections:

(1) one test of 5 questions with 4 possible answers related to the theoretical contents and their application;

(2) one practical problem with typical calculation done in the selection or analysis of real components; and

(3) one design exercise for a practical application.

Each section will be graded from 0 to 10. In the test each wrong answer rest one third of the right answer corresponding value. Midterm exam grade will be the average of the three section grades. Non recoverable* activity.

Cumulative final exam (EF) with three sections:

(1) one test of 10 questions with 4 possible answers related to the theoretical contents and their application;

(2) two practical problems with typical calculation done in the selection or analysis of real components; and

(3) one design exercise for a practical application.

Each section will be graded from 0 to 10. In the test each wrong answer rest one third of the right answer corresponding value. Midterm exam grade will be the average of the three section grades. Recoverable* activity.

Laboratory practice (PL) done in group and summarized in the practice report that includes the circuits' sketches, the previous calculation and the analysis of measurement results. The activity will be graded from 0 to 10. Students that obtain grades over 6 can keep the grade for the next course if necessary. Non recoverable* activity.

Project (PR) of design of a hydraulic mechanism. Recoverable* activity.

* Non recoverable: activity can only be done when scheduled and cannot be repeated in the extraordinary call. Grade in this activity is kept for the whole academic year.

Recoverable: activity can be repeated in the extraordinary call. Newer grades when repeated replace previous ones.

Final grade:

Final grade (CF) for the course will be calculated with the formula below:

If $EF \geq 4$, $CF = C$; else $EF < 4$, $CF = min(4, C)$

ordinary call $C = 0.2 \cdot EP + 0.3 \cdot EF + 0.3 \cdot PL + 0.2 \cdot PR$

extraordinary call $C = 0.5 \cdot EF + 0.3 \cdot PL + 0.2 \cdot PR$

where EP is the midterm exam grade, EF the final exam grade, PL the laboratory work grade and, PR the project grade.

The global assessment will be held the same day scheduled for the final exam of each call. It will consist of the following parts:

Cumulative final exam (EF) with three sections:

(1) one test of 10 questions with 4 possible answers related to the theoretical contents and their application;

(2) two practical problems with typical calculation done in the selection or analysis of real components; and

(3) one design exercise for a practical application.

Each section will be graded from 0 to 10. In the test each wrong answer rest one third of the right answer corresponding value. Midterm exam grade will be the average of the three section grades. Recoverable* activity.

Laboratory practice exam (EPL) consisting of building a hydraulic or/and pneumatic circuit with real components in the laboratory workstations for a particular application. This activity will be graded from 0 to 10. Grades over 6 can be maintained for next academic year if necessary. Recoverable* activity.

Final grade:

Final grade (CF) for the course will be calculated with the formula below:

If $EF \geq 4$ and $EPL \geq 4$, $CF = C$; else, $CF = min(4, C)$

where $C = 0.6\, EF + 0.4 \cdot EPL$

being EF the final exam grade and EPL the laboratory practice exam one.

Bibliography

Basic bibliography

B1. Notes from the course.

B2. Fluid Power Technology. *F. Don Norvelle.* West Publishing Company 1995.

Complementary bibliography

C1. Fluid powder basics. Fluid powder basics. *B. Trinkel*. Hydraulics and pneumatics 2007. http://hydraulicspneumatics.com/ebooks/fluid-power-ebook-fluid-power-basics

C2. Fluid power circuits explained. *B. Trinkel*. M. Gannon and R. Schneider. Hydraulics and pneumatics 2007. http://hydraulicspneumatics.com/ebooks/fluid-power-ebook-fluid-power-circuits-explained

Other teaching and material resources

Hydraulic and pneumatic catalogues

W1. Boxch Rexroth http://www.boschrexroth.es

W2. Festo http://www.festo.com

W3. SMC http://www.smc.eu

Recommendations

Contents of this course are related to other courses that is convenient to have passed or be enrolled before. These are:

- Fluid Mechanics
- Industrial and commercial installations II
- Fluid mechanics systems and machines

Contents of this course are necessary for professional activities related to industrial equipment design and maintenance. Students enrolled in this course should have interest in this field.