Last update: 02-06-2015

820052 - MCT - Mechatronics

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2015
Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: HERMINIO MARTÍNEZ GARCÍA.

Others: HERMINIO MARTINEZ GARCIA and other Professors.

Opening hours

Timetable: To determine at the semester beginning. It will be announced to the whole students the first week of the course.

Prior skills

Basically, those associated with the folllowing courses:

- Electronic Systems / Sistemes Electrònics (820017).
- Electrical Systems / Sistemes Eléctrics (820016).

Requirements

- Electronic Systems / Sistemes Electrònics (820017).
- Electrical Systems / Sistemes Eléctrics (820016).

Degree competences to which the subject contributes

Specific:

1. Summarise information and undertake self-directed learning activities.

2. Design analogue, digital and power systems.

3. Understand the applications of electronic instrumentation.

4. Identify, Understand and apply the principles of sensors, conditioners and biomedical signal acquisition systems.

5. Design automatic control systems.

6. Model and simulate systems.

Transversal:

7. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
8. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Teaching methodology

Please, see Spanish or Catalan version.

Learning objectives of the subject

Please, see Spanish or Catalan version.

Study load

Total learning time: 150h	Hours large group:	45h	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	15h	10.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

1.- Introduction to Mechatronics.	Learning time: 13h Theory classes: 3h Self study : 10h

Description:
1.1. - Electrical Engineering and Mechanical Engineering.
1.2. - The union of Electronic Engineering and Mechanical Engineering.
1.3. - What is Mechatronics?
1.4. - Applications of Mechatronics.

2.- Sensors and Transducers.	Learning time: 17h Theory classes: 6h Laboratory classes: 1h Self study : 10h

Description:
2.1. - General concepts and terminology in data acquisition systems (DASs).
2.2. - General Structure of a measurement and control system.
2.3. - Classification of Sensors.

2.3.1. - Analog and digital sensors.
2.3.2. - Modulator and generator sensors.

2.4. - Temperature sensors.

2.4.1. - Thermistors (NTCs and PTCs).
2.4.2. - Resistance temperature detectors (RTD).
2.4.3. - Sensors based on semiconductor junctions.
2.4.4. - Thermocouples.

2.5. - Pressure transducers and strength.

2.5.1. - Strain gauges.
2.5.2. - Transformers (LVDT).
2.5.3. - Potentiometric transducers.
2.5.4. - Capacitive sensors.
2.5.5. - Piezoelectric transducers.

2.6. - Proximity and rotating machines speed sensors.

2.6.1. - Capacitive sensors.
2.6.2. - Magnetic sensors.
2.6.3. - Hall effect sensors and magnetoresistance.
2.6.4. - Position encoders.

2.7. - Optical Sensors.

2.7.1. - Photodiodes and phototransistors. Optocouplers.
2.7.2. - Photovoltaic cells.
2.7.3. - Photoresistors (LDRs).

2.8. - Linearization of sensors.
2.9. - Voltage divider for the measurement acquisition.
2.10. - Wheatstone bridge for the measurement acquisition.
2.11. - Alternatives to the Wheatstone bridge: Pseudobridges.

3.- Signal Conditioning for Mechatronic Systems.	Learning time: 17h Theory classes: 6h Laboratory classes: 1h Self study : 10h

Description:
3.1. - The operational amplifier as a basic device in amplification and analog signal processing.
3.2. - Review of basic stages based on operational amplifiers.
3.3. - Differential amplifier (DA).
3.4. - Instrumentation amplifier (IA).

3.4.1. - CMRR (Common Mode Rejection Ratio) problems.
3.4.2. - Examples of application.

3.5. - Isolation amplifiers (AA).

3.5.1. - IMRR (Isolation Mode Rejection Ratio) problems.
3.5.2. - Examples of application.

3.6. - Exponential and logarithmic amplifiers (antilogarítmics).
3.7. - Analog multipliers: Properties and uses.

3.7.1. - Circuits for computing powers.
3.7.2. - Analog dividers circuits.
3.7.3. - Circuits for computing square roots.

3.8. - Linear signal filtering.

3.8.1. - Introduction. Passive filters.
3.8.2. - Active RC filter cells for first and second order.

3.9. - Analog switches and multiplexers.

3.9.1. - Applications to the PGDA (programmable differential amplifier gain).

3.10. - Shannon sampling theorem (Nyquist theorem) and Whitthcker theorem.

3.10.1. - Sample-and-hold (S&H) circuits.

3.11. - Analog-to-digital converters (ADC).
3.12. - Digital-to-analog converters (DAC).

4.- Data Reporting Systems.	Learning time: 16h Self study : 6h Self study : 10h

Description:
4.1. - Introduction to visualization systems.
4.2. - Displays BCD-7 segment.
4.3. - BCD-7 segment decoders.
4.4. - Displays and LCD screens.
4.5. - The electronics for data reporting systems.
4.6. - Examples of hardware and software for data reporting systems.

5.- Actuation: Pneumatic, Hydraulic, Mechanical and Electrical.	Learning time: 16h Theory classes: 6h Self study : 10h

Description:
5.1. - Introduction. Electronics associacted to electromechanical actuators.
5.2. - Input and output optical isolation.
5.3. - Power amplifiers.

5.3.1. - Darlington stages.
5.3.2. - 'Push-Pull' stages with complementary symmetry.
5.3.3. - Power operational amplifiers.
5.3.4. - Commercial power and low frequency integrated circuit amplifiers.

5.4. - Stages with thyristors (SCR).

5.4.1. - Control of the activation.

5.5. - Stages with TRIACs.

5.5.1. - Control of the activation. Activation based on DIACs.

5.6. - Stages with GTOs and IGBTs.
5.7. - relay and solenoid drives.
5.8. - Motor drives.

5.8.1. - DC motor and servo-motor drives.
5.8.2. - AC mnotor and servo-motor drives.
5.8.3. - Stepper motor drives.

5.9. - Hydraulic and pneumatic actuators.

5.9.1. - Valves.
5.9.2. - Servo-valves.
5.9.3. - Cylinders.
5.9.4. - Vacuum clamping.
5.9.5. - Pumps and hydraulic motors.

6.- Modeling and Simulation of Mechatronic Systems.	Learning time: 18h Theory classes: 6h Laboratory classes: 2h Self study : 10h

Description:
6.1. - Concept of modeling of a system.
6.2.- Why modeling is necessary?
6.3. - Introduction and review of the Laplace transform.
6.4. - Modelling of physical systems.
6.5. - Examples of modeling of physical systems: Electrical, mechanical, thermal, etc..

7.- Control Based on Microcontrollers.	Learning time: 20h Theory classes: 6h Laboratory classes: 4h Self study : 10h
Description:	

7.1. - Introduction.
7.2. - Discontinued-type controllers.

7.2.1. - Two-position controllers ('all or nothing').
7.2.2. - Two-position controller with hysteresis.
7.2.3. - Multi-position controller.
7.2.4. - Floating-Type Controller.

7.3. - Continuous-type controllers.

7.3.1. - Proportional controller (P).
7.3.2. - Integral-action controller (I).
7.3.3. - Derivative-action controller (D).

7.4. - compound controllers.

7.4.1. - Proportional-derivative (PD) controllers.
7.4.2. - Proportional-integral (PI) controllers.
7.4.3. - Proportional-integral-derivative (PID) controllers.

7.5. - Implementation of analog-electronic controllers.
7.6. - Tuning Process of electronic controllers.

7.6.1. - Method of closed loop response or limit cycle method (first method of Ziegler and Nichols).
7.6.2. - Method of open-loop transient response or reaction curve process (second method of Ziegler and Nichols).
7.6.3. - Methods of the frequency response.
7.6.4. - Introduction to auto tuning for electronic controllers.

7.7. - Modifications for PID controllers.
7.8. - Historical development of programmable machines.
7.9. - The programmable machine of John von Neumann.
7.10. - The architecture of von Neumann versus Harvard architecture.
7.11. - The microprocessor (uP) as the general purpose programmable sequential machine.
7.12. - General architecture of a microcomputer system for data acquisition.

7.12.1. - Introduction to digital memory subsystems.
7.12.2. - Input and output ports.
7.12.3. - Inputs and outputs of alarm signals, digital orderrs and analog signals.
7.12.4. - Multiple input analog signals.

7.13. - Characteristics of a uP and uC. Historical development of common uP.
7.14. - Internal architecture of an 8-bit uP: The 8086/8088 of Intel as an example.
7.15. - Definition of microcontroller (uC). Main differences between uP and uC.
7.16. - Internal architecture of an 8-bit uC: INTEL 8x51/52 and PIC microcontroller families as examples.

7.16.1. - Control signals exchanged with external devices.
7.16.2. - Operation of a uC in the execution of the instructions.
7.16.3. - Handling of the uC stack and subroutine calls.
7.16.4. - General operating states of a uC.
7.16.5. - Treatment of interruptions in a uC.

7.16.6. - Hardware for the treatment of multiple interruptions.

8.- Design and Development Example of a Mechatronic System.	Learning time: 33h Theory classes: 6h Laboratory classes: 7h Self study : 20h

Description:
8.1. - Introduction.
8.2. - Approach for the problem to be solved.
8.3. - Design specifications.
8.4. - Problem solution.
8.5. - Simulations of the designed system.
8.6. - Implementation of the prototype.

Qualification system

Please, see Spanish or Catalan version.

Regulations for carrying out activities

Please, see Spanish or Catalan version.

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Bibliography

Basic:

Bolton, W. Mecatrónica : sistemas de control electrónico en la ingeniería mecánica y eléctrica. 4ª Ed. Barcelona: Marcombo, 2010. ISBN 9788426716323.

Bishop, R. H. Mechatronic systems, sensors, and actuators : fundamentals and modeling. 2nd Ed. Boca Raton: CRC Press, 2008. ISBN 9780849392580.

Alciatore, D. G.; Histand, M. B. Introducción a la mecatrónica y los sistemas de medición. 3 ed. México [etc.]: McGraw-Hill, cop.2007. ISBN 9789701063859.

Complementary:

Johnson, C. D. Process control instrumentation technology. 8th ed. Upper Saddle River: Prentice Hall, cop. 2006. ISBN 0131976699.

Pérez García, M. A. [et al.]. Instrumentación electrónica. 2ª ed. Madrid: Thomson, cop. 2004. ISBN 8497321669.

Others resources:

Hyperlink

Moodle ATENEA: http://atenea.upc.edu/moodle/