COURSE: Thermofluidynamic measurements and controls			
ACADEMIC YEAR: 2017/2018			
TYPE OF EDUCATIONAL ACTIVITY: Characteristic			
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Language: Italian			
ECTS: 9	n. of hours: 81 n. of hours for lessons: 48 .n. of hours for tutorials/practice: 33	Campus: Potenza Dept./School: Engineering Program: 235	Semester: I

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

The course examines physical principles necessary to know methodologies and instruments of thermofluidodynamic measurement and control.

The main goal to be reached is to provide students with basic skills needed to measure different physical quantities of (mechanical, thermal, electrical) and to get thermofluidodynamic control of a system.

- **Knowledge and learning ability:**

The student must demonstrate to know and understand all problems concerning with measurement of different quantities (mechanical, thermal, electrical) and with thermofluidodynamic controls.

Particulary, the student will have to:

1. *Understand and interpret the main physical and chemical phenomena essential to measure physical quantities and for thermofluidodynamic control.*
2. *Know parts and mode of operation for measuring instruments.*
3. *Know types of regulation and control systems.*
4. *Know characteristic parameters of transducers and their influence on control systems.*
5. *Know tmeasurement errors and their classification.*
6. *Understand main measurement methods for physical quantities and understand the contexts of use.*
7. *Understand the main thermofluidodynamic control methods and understand the relative contexts of use.*

- **Ability to apply knowledge:**

  The student must demonstrate that he is able to apply the acquired knowledge - particulary for new contexts, different than those in which learned knowledge is traditionally used- and to design measuring devices as well as specific controls.

  In detail, the student will have to:

  1. *Apply knowledges about physical and chemical phenomena useful to measure physical quantities and for thermofluidodynamic control.*
  2. *Know how to interpret findings of a measurement and make deductions.*
  3. *Know how to analyze the mode of operation of a system by measuring its physical quantities.*
  4. *Design measuring devices as well as basic control systems to solve specific problems*

- **Indipendent judgment:**

  The student must be able to know how to evaluate, by himself/herself, measurement and control processes and how to indicate main methodologies concerning with measurement and control.

- **Communicative Skills:**

  The student must have the ability to explain, in a simple, clear and complete way, methodologies for measurement and control also to people who are not familiar with these concepts and he must have the ability to submit an elaborate (also a thesis) using the correct scientific language.

- **Learning ability:**

  The student must progressively become indipendent from the teacher by acquiring the ability to refine and deepen his / her knowledge through an original training course, and he/she must be able to continuously update by consulting texts and publications related to measurement and control, in order to acquire the ability to take part in specific Seminars and Masters.

PRE-REQUIREMENTS

It is necessary to acquire and assimilate knowledges about fundamental concepts of Mathematical Analysis and Physical provided by courses of "Mathematical Analysis I", "Mathematical Analysis II", "Physics I" and "Physics II", as well as a critical analysis capacity .

SYLLABUS

Details about measurement Units, Instruments and Errors (15 hours)

Types of measuring instrument applications. (3 hours)
Classification of application types for measurements

International measurement system (3 hours)
Quantities and measurement units. International and national Organism for metrology. Units of International measurement System: base units, derived units. Units out of the IMS. Logarithmic units. Multiple and decimal subtotal. Writing rules. Physical constants.

Measurement, measurement approximation, measurement errors (4.5 hours)

Casual and systematic errors. Probability distribution. Expected value. Assessment of approximation according to controls. Indication of approximation. Error propagation. Error correction.

Functional description of measuring instruments. (1.5 hours)

Functional elements of a measuring instrument.

Performance of measuring instruments (3 hours)

Static features. Linearity. Hysteresis. Measuring range. Threshold. Resolution. Static sensitivity. Precision.
Dynamic features. Zero-order instruments. First-order instruments. Second-order instruments.
Calibration of measuring instruments.

Measuring instruments (48 hours)

Dimensional sizes (6 hours)

The meter. The gauge. The micrometer.
The comparator.

Moving measures (6 hours)

Linear and angular potentiometers. Differential Transformers. Syncro. Resolver. Capacitive transducers. Piezoelectric transducers. Electro-optical instruments. Digital displacement transducers (linear and rotary encoders).

Speed measurements (3 hours)

Speed Transducers. Tachometric. Dynamo Tachometer alternators. Incremental encoders. Accelerometers.

Force, torque and power transmitted by trees (6 hours)

Transducers with glued electrical resistance strain gauges. Differential Transformer Transducers. Piezoelectric transducers. Load cells. Torque measurements on rotating shafts. Measurement of the power transmitted by a shaft (dynamometers). Vibrating wire force transducers.

Pressure and Sound Measures (3 Hours)

Torometer . Torricelli Barometer. Metal gauges. Pitot tube.
Extensimetric transducers. Capacitive transducers. Potentiometric transducers.
Sound measurements. Acoustic intensity. Sound level meter (phonometer). Microphones. Condenser microphones.

Flow Measures (6 Hours)

Local flow speed, by probes. Pitot tube. Wire and hot wire anemometer.
Flow measurements by optical methods. Laser Doppler Anemometer (LDA) and Laser Doppler Velocimeter (LDV). Particle Image Velocimetry (PIV).
Volumetric flow measurements. Constant area meters and variable pressure drops meters ("obstruction" meters). Constant pressure drop meters and variable area meters (rotamethers). The Venturimeter. Munchies and diaphragms. Turbine gauges. Pump meter. Electromagnetic flow meters. Flowmeter with resistance force. Ultrasonic flow meters. Flow switches with calorimetric exchange. Vortex flow switches.
Mass flow rates. Volumetric flowmeter coupled to density measurement. Direct mass flow meters.

Temperature and heat flows measurements (9 hours)

Thermal expansion methods. Glass liquid thermometers. Bimetal thermometers. Pressure Thermometers. Ideal gas thermometer.

Thermoelectric sensors. Thermocouples. Peltier Cell.

Electrical resistance sensors. Conductor sensors (thermoresistance). Semiconductor sensors (thermistors). Digital Thermometers.

Radiation methods. Optical pyrometers. Infrared imager.

Heat flow sensors. Calorimeters.

Level measures (3 Hours)

Conductive transducers. Capacitive transducers. Ultrasonic transducers. Microwave transducers. Vibrating lamella transducers. Hydrostatic pressure transducers. Electromechanical pulsating transducers.

Humidity measures (1.5 hours)

Aluminum oxide humidity sensor. Cooled mirror humidity sensor.

Time, frequency and phase angle measures. (1.5 hours)

Electronic counter clock

Voltage , current and electrical power measurements (3 hours)

Voltage measures. Analogic Voltmeters and potentiometers. Digital Voltmeters and multimeters. Oscilloscopes.

Electricity measurements. Ammeter. Current sensors converting electricity into a voltage.

Data processing (6 hours)

Handling, transmitting and recording data (3 hours)

Handling.

Amplifiers. Filters. Amplitude modulation and demodulation. Voltage/frequency and frequency/voltage converters. Analog-digital and digital-analog converters.

Data transmission.

Data transmission devices and instrument connectivity.

Data Recording.

Magnetic and disc tape recorders / players.

Fourier algorithms for signal analysis (1.5 hours)

Representation of harmonic functions. Fourier Series. Fourier transform.

Sampling design (1.5 hours)

Analog signals and digital signals.

Analog-digital conversion

Thermofluidodynamic control (9 hours)

Control systems (3 hours)

Control systems. The problem of control.

Types of control (3 hours)

On-off adjustment. Proportional adjustment. Integral adjustment. Derivative adjustment. Mixed adjustment: PI, PD, PID, PIDP.

Controllers (3 hours)

Mechanical controllers.

Electronic controllers.

TEACHING METHODS

The course provides for 81 hours of teaching organised with lessons and exercises. In detail, 48 hours are for classroom lesson and 33 hours for guided exercises.

EVALUATION METHODS

Oral examination.

The objective of the exam is to check the level of achievement of goals previously indicated.

The exam consists of an oral test in which the acquired knowledge and skills will be evaluated ability to connect and compare different knowledge and skills learned during the course to solve new problems will be considered acquired skills; in order to pass the test it is necessary to acquire at least a vote of 18/30.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

Reference textbooks:

- *Strumenti e metodi di misura 2/ed*
  Author: Ernest 0. Doeblin
  Curator of the Italian edition: Alfredo Cigada, Michele Gasparetto
  Publishing house: McGraw-Hill Education
  ISBN: 9788838664359

The part of course related to Hydrometry also refers to the text:

- *Corso di meccanica, macchine ed energia. Vol.1*
  Author: Cipriano Pidatella, Giampietro Ferrari Aggradi, Delia Pidatella
  Publishing house: Zanichelli
  ISBN: 9788808920904

For the course section about Transducers and Controllers refer also to the text:

- *Sistemi e automazione 3 Edizione mista*
  Author: Graziono Natali, Nadia Aguzzi
  Publishing house: Calderini
  ISBN: 9788852803819

INTERACTION WITH STUDENTS

At the beginning of the course, after describing objectives, program and verification methods, the list of students who intend to attend the course will be collected, together with their names, surnames, identification number and e-mail addresses.

Reception hours: Wednesdays from 3:00 pm to 5:30 pm at the Campus of Macchia Romana, Faculty of Engineering (3rd floor building of Engineering, Offices of the Laboratory of Physical Engineering, room no. 13).

In addition to the weekly reception time, the teacher is available at any time through his email and telephone contact.

EXAMINATION SESSIONS (FORECAST)[1]

07/02/2018, 07/03/2018, 11/04/2018, 16/05/2018, 13/06/2018, 11/07/2018, 12/09/2018, 10/10/2018, 07/11/2018, 06/12/2018

SEMINARS BY EXTERNAL EXPERTS YES □ NO ⊟

FURTHER INFORMATION

[1] Subject to possible changes: check the web site of the Teacher or the Department/School for updates.