LA-CoNGA Physics

Instrumentation Syllabus

Dennis Cazar Ramírez

Universidad San Francisco de Quito

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Latin American alliance for Capacity buildiNG in Advanced physics

LA-CoNGA physics

Cofinanciado por el programa Erasmus+ de la Unión Europea

Instrumentation course

- 10 ECTS - 16 weeks
- Three modules:
  - Introduction to Electronics (2 ECTS - 4 weeks)
  - Particle Detectors and Complex Systems (3 ECTS - 8 weeks)
  - Research Projects (5 ECTS 10 weeks)

Timeline

18/01/21	25/01/21	01/02/21	08/02/21	15/02/21	22/02/21	01/03/21	08/03/21	15/03/21	22/03/21	29/03/21	05/04/21	12/04/21	19/04/21	26/04/21	03/05/21	10/05/21
W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17
Intro to Electronics										Easter						
E0	E1	E2	E3							Break						
		Particle Detectors and Complex Systems														
		D1	D2	D3	D4	D5	D6	D7	D8							
						Research Project										
						P1	P2	P3	P4		P5	P6	P7	P8	P9	P10

Introduction to Electronics

- **Week 1:** Assessment
  - Session 1
    - Review of AC circuit analysis
    - Measuring voltage, current and resistance
    - Errors in measurements
  - Practice 1
    - RLC circuit characterization
    - Simulating the circuit
    - Prototyping
    - Testing
- **Week 2:** Sensors
  - Session 2
    - Principal characteristics
    - Analog vs Digital sensors
    - Conditioning circuits
  - Practice 2
    - Sensor characterization
    - Temperature: thermistor
    - Light intensity: photoresistor and LDR
    - Light detection: photodiode

Introduction to Electronics

- **Week 3:** Signal Conditioning
  - Session 3
    - Filtering, Linearization
    - Amplification, attenuation
    - Operational Amplifiers (Opamps)
  - Practice 3
    - Measuring signals
    - Voltage and current
    - Resistance, capacitance, inductance
- **Week 4:** Data acquisition Systems
  - Session 4
    - ADC principles
    - Resolution
    - Input range
    - Sampling rate
  - Practice 4
    - DAQ system
    - Simulating an acquisition chain
    - Measuring Light

Equipment

Basic Electronics testbench: Oscilloscope, function generator, power supply, passive components

Particle Detection & Complex Systems

- **Week 1:** Introduction
  - Session 1: Detector basics
  - Session 2: Complex Systems
- **Week 2:** Interaction of particles with matter
  - Session 3: Neutrons and Neutrinos
  - Practice 1/A: γ Spectroscopy
  - Practice 1/B: β Spectroscopy
- **Week 3:** Solid State Detectors
  - Session 4: Basic Concepts
  - Practice 2/A: Light detection I
  - Practice 2/B: Light detection II
- **Week 4:** Gaseous Detectors
  - Session 4: Basic Concepts
  - Practice 3: Acquiring Signals from RPCs
- **Week 5:** Particle Identification
  - Session 5: dE/dx, Cerenkov, etc
  - Practice 4: Acquiring Signals from PMTs

Equipment

Educational Kit CAEN, Emulation kit CAEN, PMT testbench, RPC testbench

Particle Detection & Complex Systems

- **Week 6:** Complex Systems I
  - Session 6: Exploring Non-Linear systems
  - Practice 5: Chua's circuit
- **Week 7:** Complex Systems II
  - Session 7: Deterministic Chaotic Systems
  - Practice 6: The double pendulum
- **Week 8:** From Detectors to Data
  - Session 8: Trigger & Data Acquisition
  - Practice 7: ADC characterization

Equipment

Electronics testbench: Oscilloscope, function generator, power supply, passive components, DAQ system, laser source, stroboscope, digital camera

Research Projects

- Particle Detection
  - PMT technology (YT, UIS)
    - Space weather
  - RPCs (USFQ)
    - Detecting muon boundles
  - Solid State Detectors (UAN)
    - Muon mean lifetime
  - Others
- Complex Sysytems
  -

Development

- Literature revision (2 weeks)
- Project Definition (1 week)
- Setup & Measurements (3 weeks)
- Data processing and analysis (2 weeks)
- Final report writing & revision (2 weeks)

To Do List

- Define content in detail
- Propose Research projects
- Double check Equipment shopping list

Open points

- Several instructors must be involved
- Invited lectures
- Define Lab responsible for each HEI