Essential Course Information	
Course title	LABORATORY OF DATA ACQUISITION TECHNOLOGIES
Degree Course title	PHYSICS
ECTS	6
Compulsory attendance	YES
Course teaching language	ENGLISH

Teacher	Marilisa De Serio Saverio Simone	Marilisa.Deserio@uniba.it Saverio.Simone@uniba.it

ECTS Details	Disciplinary area	SSD	ECTS
		FIS/01	6

Time management and teaching activity type	Period	Year	Lesson type
	1st semester	2nd	Lessons (24h) Laboratory (45h)

Time management	Total hours	In-class/in-lab study hours	Out-of-class study hours
	150	69	81

Course calendar	Starting date	Ending date

Syllabus	
Prerequisites	Basic knowledge of electronics. Basic knowledge of computer programming.
Expected learning outcomes (according to Dublin Descriptors)	• *Knowledge and understanding:* Understanding of basic concepts of modern digital data-acquisition systems. Knowledge of hardware and software tools for computer-based data acquisition. Knowledge of software frameworks for data representation and analysis. • *Applying knowledge and understanding:* Ability to use data acquisition boards of different complexity. Ability to develop high-level software programs for data-acquisition using computer-controlled electronic devices. Ability to use software frameworks for data representation and analysis. • *Making judgements:* Ability to consult technical specifications (datasheets). Ability to identify adequate hardware and software solutions for specific problems/applications. • *Transferable communication skills:* Ability to use technical language. Ability to work in a team.

	• *Lifelong learning skills:* Problem-solving skills. Ability to access and classify information from different sources. Ability to synthesize acquired knowledge making connections, comparing, contrasting, generalizing.
Course contents summary	The course is intended to introduce the student to the basic concepts of data-acquisition systems used in modern physics experiments: sensors, signal digitization, data quality monitoring, slow control, communication protocols, data representation and analysis. The course comprises lectures and extensive laboratory activities focussing on the development of high-level software programs for real-time data acquisition using electronic devices interfaced to the PC, data representation and analysis.
Detailed syllabus	**Introduction to modern data acquisition systems and applications.** **Computer architecture**: processor, cache memory and main memory, mother board, bus, I/O systems. Instruction fetching and execution. **I/O modules. I/O techniques**: programmed I/O, interrupt-driven I/O; Direct Memory Access. **Interfacing external devices to the PC with I/O modules**: PCI and PCI-X, USB, PCI Express. **Sampling of analog signals**: aliasing and quantization; Sample and Hold; Analog to Digital Conversion (ADC): counter type ADC, successive approximation ADC, flash ADC; Digital to Analog Conversion (DAC): binary-weighted resistor DAC. **Sensors. Readout electronics for signal detection**: signal conditioning (amplification, shaping), pedestal subtraction; FPGA-based signal processing: data timestamping, zero-suppression. Trigger. **Ethernet-based data acquisition**: transmission protocols; client – server architecture; Ethernet-based distributed data acquisition systems. **Introduction to the *Internet of Things*** (IoT): data acquisition and IoT, from smart sensors to big data processing. **Laboratory exercises**: Part 1. Introduction to programming. ➢ Fundamentals of C language. • Handling binary data and binary files, bitwise operators. ➢ Introduction to the ROOT framework for data representation and analysis. Part 2. Use of data acquisition boards with PCI interface (National Instruments PCI-6503, PCI-62212).

	➢ Programmed I/O: • Temperature monitoring using a sensor connected to an 8-bit ADC. ➢ DMA-controlled I/O: • Sampling and reconstruction of a sinusoidal signal. • Triggered acquisition of pulsed signals. Part 3 ➢ Ethernet-based data acquisition, client – server architecture. ➢ Detector calibration using FPGA-based readout electronics.
Books	W. Stalling, *Computer organization and architecture*, Pearson Edition (Ch. 3 – 7, Ch. 4 – 5 - 6); S. Derenzo, Practical Interfacing in the Laboratory, Cambridge Edition (Ch. 1, Ch. 3, Par. 5.8.1); W. Kernighan and D. Ritchie, *The C programming language*, Prentice-Hall Edition; http://root.cern.ch/ ; Lecture slides. Additional material on specific topics provided during the course.
Notes	
Teaching methods	Lectures with slides. Laboratory exercises in small groups (typically 2 students per group).
Assessment of final mark	Laboratory reports (10%). Practical exam to assess laboratory skills (40%). Oral exam (50%).
Evaluation criteria	The student **knows** the basic concepts of modern digital data-acquisition systems; **knows** the most commonly used I/O techniques for computer-controlled data acquisition; **knows how to apply** I/O techniques and implement high-level software applications for data acquisition from sensors/external devices; **knows how to** write laboratory reports; **is able to** communicate effectively using adequate technical language.
Other	