UNIVERSITÀ DI PAVIA

Anno Accademico 2018/2019

ELECTRONIC INSTRUMENTATION AND TECHNOLOGIES

Anno immatricolazione	2017/2018
Anno offerta	2018/2019
Normativa	DM270
SSD	ING-INF/01 (ELETTRONICA)
Dipartimento	DIPARTIMENTO DI INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE
Corso di studio	ELECTRONIC ENGINEERING
Curriculum	Space Communication and Sensing
Anno di corso	2°
Periodo didattico	Primo Semestre (01/10/2018 - 18/01/2019)
Crediti	9
Ore	76 ore di attività frontale
Lingua insegnamento	ENGLISH
Tipo esame	ORALE
Docente	TORELLI GUIDO (titolare) - 5 CFU RATTI LODOVICO - 4 CFU
Prerequisiti	Basics of: physics and thermal sciences; chemistry; electronics (including basics of pn junction and MOS and bipolar junction transistors). Additional lectures can be agreed with interested students to refresh missing background prerequisites.
Obiettivi formativi	The main purpose of the course is to provide the student with the basics of silicon monolithic integrated circuit fabrication technology, piezoelectric devices operation, and specialized instrumentation for device and circuit characterization. At the end of the course, the student is expected to know the basics of monolithic integration technology (in particular, of CMOS technology) and piezoelectric devices, and be able to evaluate the impact of integration technology on the design and the performance of integrated circuits. The student is also expected to be capable of understanding the main specifications of advanced electronic

instrumentation and the most critical points in their design as well as of selecting a measuring instrument for a given application. The course is intended for students who will carry on their future professional activity in the areas of design, production, application, and management of integrated circuits and devices, equipments, and systems including such circuits, as well as in those areas which involve the design and/or the use of electronic instrumentation.

Programma e contenuti

1) Silicon planar technology
Semiconductors. Silicon ingot fabrication and wafer preparation. Basic processing steps for silicon planar technology: thermal oxidation; thermal diffusion; ion implantation; chemical vapour deposition; physical vapour deposition (vacuum evaporation, sputtering); other thin film deposition techniques; epitaxy; annealing; gettering; lithography (selective exposure, exposure techniques, mask making; selective etching); advanced exposure techniques. Planarization. Clean rooms.

2) Integrated circuit packaging
Production flow from fabricated wafer to packaged die. Yield; yield at the wafer level. Testing (wafer sort; final testing). Packages for integrated circuits: metallic, ceramic, and plastic packages. Assembly and packaging process. Use of non encapsulated devices. Multi-chip modules.

3) Monolithic integration technologies
Bipolar fabrication technology. MOS technology; CMOS fabrication process: technology with localized oxidation isolation and aluminum metallization; technology with shallow trench isolation and copper metallization. Mixed fabrication technologies. Electrostatic discharges and latch-up in CMOS integrated circuits.

4) Piezoelectric and electrostrictive devices
Piezoelectricity: basic principles; general equation. Quartz crystal: electrical characteristics; resonance; equivalent circuit; fabrication technology; applications; quartz crystal based oscillator. Electrostrictive and magnetostrictive materials; general characteristics; applications: actuators and transducers.

5) Instrumentation for semiconductor device and passive component characterization
Semiconductor parameter analyzers. Semi-automatic bridges for impedance measurement.

6) Instrumentation for circuit analysis in the time domain
Digital storage oscilloscopes. Digital pattern generators. Logic and timing analyzers.

7) Instrumentation for circuit analysis in the frequency domain
Real-time (multichannel) spectrum analyzers. Signal analyzers. Swept-frequency (tunable filter or superheterodyne) spectrum analyzers.

8) Noise sources in electronics devices

9) Instrumentation for noise measurement in single devices
Noise measurement in single devices. Instrumentation for noise measurement in field-effect transistors. Instrumentation for noise measurements in bipolar transistors.

10) Instrumentation for charge measurement from capacitive detectors
Capacitive detectors. Optimum chain for processing the charge signal from capacitive detectors: charge preamplifier and shaper. Equivalent noise charge (ENC). Equivalent noise charge measurement. Shaping filter optimization. Minimum noise design of charge preamplifiers.

Metodi didattici

Lectures (hours/year in lecture theatre): 61
Practical class (hours/year in lecture theatre): 10
Practicals / Workshops (hours/year in lecture theatre): 5

Testi di riferimento

Lecture notes on integrated circuit fabrication technology (items 1, 2, and 3 of the program):
G. Torelli and A. Cabrini. Introduction to Silicon Integrated Circuit Technology. 2018.

Lecture notes on piezoelectric and electrostrictive devices (item 4 of the program).

Lecture notes and transparencies on electronic instrumentation (items 5 to 10 of the program).

For better details:

R. C. Jaeger. Introduction to Microelectronic Fabrication, 2nd Edition. Prentice-Hall, Upper Saddle River, NJ, USA, 2002. For better detail on the part of the program regarding integrated circuit technology.

J. D. Plummer, M. D. Deal, P. B. Griffin. Silicon VLSI Technology: Fundamental, Practice and Modeling. Prentice-Hall, Upper Saddle River, NJ, USA, 2000. For more details on integrated circuit technology.

C. Y. Chang, S. M. Sze. ULSI Technology. The McGraw-Hill Companies, New York, NY, USA, 1996. For more details on integrated circuit technology, together with the textbook just below.

S. M. Sze. VLSI Technology. McGraw-Hill International Editions, 1988. For more details on integrated circuit technology, together with the textbook just above.

N. Kularatna. Digital and Analogue Instrumentation. The Institution of Electrical Engineers, London, 2003.

C. F. Coombs, Jr. Editor. Electronic Instrumentation Handbook. McGraw-Hill, New York, 1999.

J. J. Carr. Elements of Electronic Instrumentation and Measurements. McGraw-Hill, Inc, 1996.

	W. D. Cooper, A. D. Helfrick. Electronic Instrumentation and Measurements Techniques. Prentice-Hall International, Inc., 1985.
Modalità verifica apprendimento	Oral examination, divided in two parts, one regarding the part of the course on electronic technologies, the other regarding the part of the course on electronic instrumentation. For the part concerning electronic technologies, during the exam, some components and/or electronic parts will also be provided to the student for discussion. For the electronic instrumentation section, the exam aims at testing the student skills, in particular her/his ability to correctly evaluate the characteristic of measurement instrumentation, also with reference to specific applications. The Examination Commission can decide that the oral examination be preceded by a written examination.
Altre informazioni	
Obiettivi Agenda 2030 per lo sviluppo sostenibile	$lbl_legenda_sviluppo_sostenibile