



UNIVERSITÀ
DEGLI STUDI
DI BRESCIA

Università degli Studi di Brescia

Corso di Studio	05751 - INDUSTRIAL AUTOMATION ENGINEERING
Insegnamento	A003787 - FUNDAMENTALS OF ELECTRONICS AND INSTRUMENTATION
Anno Offerta	2025/2026
Responsabile	FERRARI VITTORIO
Periodo	Secondo Semestre
Modalità didattica	Convenzionale
Lingua	ita

ATTIVITÀ FORMATIVA DI RIFERIMENTO

Corso di Studio	05751 - INDUSTRIAL AUTOMATION ENGINEERING
Insegnamento	A003787 - FUNDAMENTALS OF ELECTRONICS AND INSTRUMENTATION
Titolare	FERRARI VITTORIO

CAMPI

LINGUA INSEGNAMENTO

Italian

CONTENUTI

Analog and digital signals, signal elaboration and the analog-to-digital conversion process.
Operating principles of electronic measuring instruments and analysis of the characteristics of basic instrumentation.

Semiconductor electronic devices: diodes, bipolar and field-effect transistors.

Analog circuits and systems: amplification and feedback, operational amplifiers, filters, oscillators, comparators, instrumentation amplifiers.

Digital combinatorial and sequential circuits: logic gates and basic blocks, flip flops, dividers, counters,

memories.

Mixed-signal circuits for analog-to-digital (AD) and digital-to-analog (DA) conversion.

LIBRI DI TESTO/LIBRI CONSIGLIATI

Lecture short notes and support material prepared by the instructor and made available on line.

Reference textbooks:

- C. K. Alexander, M. N. O. Sadiku, "Circuiti elettrici" 3rd ed., McGraw-Hill, 2008 (or following editions).
 - P. Horowitz, W. Hill, "L'arte dell'elettronica Analisi e progettazione di circuiti", Zanichelli, 2018.
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OBIETTIVI FORMATIVI

The course is intended to provide basic knowledge and analysis skills on electronic circuits and systems and electronic instrumentation. Fundamental concepts and theory will be integrated by problem solving and laboratory activities.

At the end of the course the students will gain the capability to:

- know the nature and formal description tools of the main electrical/electronic phenomena and components;
 - understand the structure and functioning of most common electronic devices, circuits and systems, and of instrumentation;
 - analyze in detail their operation by solving problems on circuits and systems;
- and the ability to:
- apply the acquired knowledge in the interpretation of circuit and systems in real scenarios, accomplish the ideation of elementary blocks, and operate basic electronic instrumentation.
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PREREQUISITI

The acquaintance with the contents of the following courses is necessary, though it is not strictly required that the respective tests are passed before that of the present course:

Calculus. Physics. Electric circuits.

METODI DIDATTICI

Lectures and training classes, complemented by practical laboratory experiences. Lectures cover the theoretical fundamentals and the analysis concepts and formal tools. Training classes cover the application of the acquired concepts and skills to the solution of analysis problems on circuit and systems, even using software simulation tools.

ALTRE INFORMAZIONI

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MODALITÀ DI VERIFICA DELL'APPRENDIMENTO

Consistently with the course teaching goals, the final assessment is composed of a written test possibly complemented by an oral exam.

The written test has a duration of 2 hours and is made of: - Seven exercises in the form of multiple-choice questions (total points up to 21/30) - One question on theory (points up to 4/30) - One open exercise (points up to 5/30). Test passed for points of written test >21. Test failed for points of written test <18.

The oral exam is mandatory for $18 \leq \text{points of written test} \leq 21$. The oral exam is voluntary for points of written test >21.

The final assessment procedure is the same for both attending and nonattending students.

PROGRAMMA ESTESO

1. Signals and signal elaboration: Analog signals: time and frequency domain, Fourier analysis, discrete and continuous spectra. Analog signal elaboration: linear and nonlinear functions, amplifiers, filters. Digital signals: fundamental characteristics and binary coding. Analog-to-digital conversion (A/D): sampling, aliasing, quantization, resolution and number of bits. Digital signal elaboration: algorithms, memory storage.

2. Instrumentation: Measuring techniques for static and dynamic electrical quantities. General characteristics of electronic measurement instruments. Main metrological characteristics: sensitivity, resolution, measurement accuracy and uncertainty, influencing quantities. General characteristics of sensors and transducers. Laboratory instrumentation: multimeter, analog oscilloscope, digital oscilloscope, signal generator.

3. Devices: Basic concepts on semiconductors. PN-junction diodes and applications. Bipolar junction transistors (BJT) and field-effect transistors (FET). Signal amplification and on/off switching.

4. Analog circuit and systems: Structure and characteristics of operational amplifiers (OA). Feedback amplifiers. Linear applications of OAs: noninverting, inverting, summing, differential amplifiers, configurations with impedances, filters and oscillators. Brief notes on nonlinear applications of OAs. Nonidealities of OAs. Comparators, example of on/off regulation circuit. Instrumentation amplifiers. Examples of measurement systems comprising sensors, signal conditioning, elaboration and output blocks.

5. Digital blocks and logic gates: Binary coding and logic operators. Logic functions and logic gates. Ideal logic inverter. Noise margins. Static and dynamic power dissipation. Rise, fall and propagation times. Logic families. CMOS inverter and dynamic power dissipation.

6. Combinational circuits: Combinatorial logic. Adder, subtractor, ALU. Parity check generator and detector. Multiplexer and demultiplexer. Gates with 3-state output. Coders and decoders. ROM, PROM, EPROM, EEPROM memories.

7. Sequential circuits: Sequential logic. Set-Reset bistable cell and applications. Timing and clock. Flip flop types: SR, JK, D, T. Flip flop applications. Dividers. Shift registers. Counters. RAM memories. Brief notes on programmable logic devices, microcontrollers, microprocessors.

8. Analog-to-digital converters (ADC) and digital-to-analog converters (DAC): Counting ADC. Tracking ADC. Successive approximation ADC. Flash ADC flash. Single and double-ramp ADC. Outline on oversampling ADCs. Binary weight DAC. R/2R DAC. Pulse width modulation DAC.

DOCENTI ASSOCIATI

NASTRO ALESSANDRO

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