



Design of Analog Electronics and Industrial Instrumentation

Course No. E3 203 (2:1)

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Lab Instructor: G. V. Satisha

Course goal:

The goal of the course is to introduce students to different aspects of analog instrumentation to enable them to:

- a) analyze sensor requirements and derive specifications for the interface and processing circuits
- b) understand circuit specifications to be able to maintain signal fidelity in a chain of circuit blocks
- c) design and implement an analog signal chain using off-the-shelf ICs and circuit components
- d) establish communication with digital control/acquisition systems

Course syllabus:

1. Sensors and transducers
 - Transducer characteristics
 - Requirements of the sensor signal chain
2. Strain sensor – voltage sensing signal chain
 - Strain sensor physics
 - Wheatstone bridge
 - Instrumentation amplifier
3. Photodetector – current sensing signal chain
 - Photodetector physics

- Open loop and closed loop transimpedance amplifier
- 4. Piezoelectric sensors – charge sensing signal chain
 - Piezoelectric sensor physics
 - Charge sense amplifiers
- 5. Analog signal processing: filters
 - Filter characteristics – magnitude and phase, ripple, group delay
 - Linear filters – Butterworth, Chebyshev
- 6. Interfacing circuits: drivers
 - Load type considerations – resistive and capacitive
 - Large current drive
- 7. Interface to digital processors: Analog to Digital Circuits
 - ADC characteristics – Data rate, ENOB, SFDR, INL, DNL
 - ADC architectures and choices – Flash, SAR, Δ - Σ , Pipeline
- 8. Digital communication interface – USB, I2C, USART, UART
- 9. Power supply considerations: regulators
 - Linear regulators, LDOs
 - Switched capacitor step up/down

Pre-requisites: Understanding of basic concepts of circuit theory is required.

- Frequency response analysis
- Noise analysis
- Basic MOSFET circuit analysis

Project: A single project will be executed by a team of two students. The project will be based on the development of a sensor interfacing circuit. A list of eligible projects will be announced. Students are welcome to propose their own project. Instruction Lab will be used for the execution of the project.

References:

1. Dally, J.W., et al., Instrumentation for Engineering Measurements, John Wiley and Sons, 1984.