



# Design of Analog Electronics and Industrial Instrumentation

## Course No. E3 203 (2:1)

Session: January 2023

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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,  $\Delta$ - $\Sigma$ , 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.