high tech institute

Design of analog electronics – analog electronics 1

Price:	€ 4,500.00 excl. VAT
Duration:	9 days in a period of 16 weeks
Contact:	training@hightechinstitute.nl, +31 85 401 3600

Methods

Lectures, practical training, home-work and final assignment.

Objective

After having attended the course, the participant:

- will know the characteristic properties of ideal(ised) amplifiers and will be able to derive the functional requirements for amplifiers from their application;
- will be able to characterise the non-ideal behavior of amplifiers and will know to derive performance requirements from the application description;
- will know about other relevant design aspects of amplifiers;
- will be able to design low-noise and power efficient amplifier structures for arbitrary port impedance and port isolation requirements with the aid of feedback techniques, balancing techniques and isolation techniques;
- will be able to relate the properties of the components in the feedback network to important performance aspects and costs factors of the amplifier, as: inaccuracy, noise, nonlinearity, power dissipation, area and costs;
- will be able to model individual performance aspects of voltage-feedback and current-feedback operational amplifiers;
- will know about other relevant performance aspects of operational amplifiers, such as: input voltage range, output voltage and current drive capability and voltage slew rate;
- will know in which way and to what extent the equivalent input noise sources of an operational amplifier affect the noise performance of the negative feedback amplifier;
- will be able to apply the asymptotic-gain negative feedback model to derive budgets for properties of the operational amplifiers and the passive components of the negative feedback amplifier.

Intended for

Designers with little or no experience in analog electronic design as well as for experienced analog designers who want to improve their skills.

Education: At least BSc in physics or electrical engineering. Prior knowledge: linear algebra and matrices, complex numbers, transformations, network theory.

Certification

Participants receive a High Tech Institute course certificate after completing homework and final assignment for this training.

Course leader

Hans Vink MSc

Trainers

Anton Montagne MSc

Program

Day1: Introduction

- Signal modeling and characterisation, selected topics;
- System modeling and characterisation, selected topics;
- Noise in electronic systems, physical mechanisms and modeling;
- Network theory, selected topics;
- Exercises.

Day 2: Application, modeling and characterisation of amplifiers

- Introduction to amplification and amplifiers;
- Modeling and characterisation of ideal behavior;
- Modeling and characterisation of non-ideal behavior;
- Exercises.

Day 3: Application, modeling and characterisation of operational amplifiers

- Types of operational amplifiers;
- Modeling of specific behavioral aspects:
  - Noise behavior
  - Statistical modeling of offset and bias quantities
  - Modeling of the small-signal dynamic behavior
  - Modeling of PSRR and CMRR
- Use of macro models.

Day 4: Design of amplifier configurations

- Techniques for the synthesis of negative-feedback amplifiers:
  - Sensing and comparison techniques
  - The nullor as ideal controller
  - Balancing and port isolation techniques
- Negative feedback implementation techniques:
  - Direct and indirect feedback
  - Nonenergic, passive and active feedback

Day 5: Negative feedback modelling

- Black’s feedback model;
- Asymptotic-gain model;
- Deriving controller requirements from amplifier requirements:
  - Design considerations regarding noise behavior
  - Design considerations regarding accuracy and linearity
  - Design considerations regarding low-frequency and high-frequency cut-off

Day 6: Frequency compensation techniques

- Compensation strategies;
- High-frequency compensation techniques and their interaction with other performance aspects;
- Low-frequency compensation techniques and their interaction with other performance aspects.

Day 7: Other design considerations

- Temperature stability;
- Linearity, slew-rate, overdrive recovery, latch-up and phase-reversal;
- Implementation aspects (availability of components, component models, and design and analysis tools).

Day 8: Guidance of assignments intended for

Day 9: Presentation of the results of the final assignment by the participants and group discussion

Intro

The course modules 'Analog electronics 1 and 2' focus on specifying and designing the most essential analog functions for embedded systems using standard integrated circuits and passive components.

The course “Analog Electronics 1” is the basic course. It presents the basic design theory and its application in the design of application-specific amplifiers using operational amplifiers.

Included in the course price are the course book and the use of the symbolic simulator SLiCAP (Read more here).
Course participants require a laptop and a license for MATLAB including the Symbolic Math Toolbox. For those who cannot make use of a company license, a low-cost home version of MATLAB including the Symbolic Math Toolbox for self-study can be acquired. This license is not included in the course price.
Those who cannot or do not want to use MATLAB, can use an open source tool.