GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2023-2024

Analogue Electronics I (E731038)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2023-2024

A (semester 2)	Dutch	Gent	lecture seminar practical

Lecturers in academic year 2023-2024

Van Torre, Patrick	TW05	lecturer-in-charge

Offered in the following programmes in 2023-2024	**crdts**	**offering**
Bachelor of Science in Engineering Technology(main subject Electronics and ICT Engineering Technology)	6	A
Linking Course Master of Science in Electronics and ICT Engineering Technology(main subject Electronics Engineering)	6	A
Linking Course Master of Science in Electronics and ICT Engineering Technology(main subject Embedded Systems)	6	A
Linking Course Master of Science in Electronics and ICT Engineering Technology(main subject ICT)	6	A

Teaching languages

Dutch

Keywords

OpAmps, MOSFETs, bipolar transistors, diodes, rectifiers, amplifiers, oscillators, PTAT sources, current mirrors, simulation, measurement techniques

Position of the course

Thorough understanding of the behavior and characteristics of analog standard components.
Performance-oriented design and analysis of circuits with the above components, including circuits that go further than the standard configurations.
Methods to design circuits for reliability and series production.
Performance oriented simulation of circuits.
Practical realization of circuits and accurate measurement of their behavior.
Debugging of circuits containing errors.
Development of research competences for electronics.

Contents

Operational amplifiers:

- Design of amplifiers using OpAmps, taking into account in- en output impedance, frequency behavior, offset, slew-rate, current- and voltage limits, symmetric or asymmetric power supplies.
- Behavior of OpAmps at higher frequencies; 1st order model, bandwidth. OpAmps with bipolar, JFET or MOS inputs, rail-to-rail OpAmps.
- 2nd-order active filters.
- Specific points of attention in order to make OpAmp circuits as seen in theory courses work in practice.
- Advanced applications, including precision rectifiers, log and antilog amplifiers, bandgap references, electronic thermometer (PTAT source), analog multiplier.
- Measurement of amplifiers and filters in the lab.

Two-terminal non-linear devices:

- Introduction to semiconductors.

- Diodes.
- Application of diodes for rectifying and signal processing.
  Clipping and clamping circuits, protection circuits.
- Calculating rectifiers, including smoothing of the output voltage. Conduction time, ripple voltage, diode peak and average current.
- Practical complications when measuring double-sided rectifiers in the lab and how to avoid them.

Three-terminal non-linear devices; Bipolar junction transistors (BJT)

- Operating regions.
- Standard circuits for biasing.
- Stabilizing the bias via collector feedback or emitter feedback. How to obtain a stable bias in a design for series production?
- PTAT sources (electronic thermometer)
- Base-width modulation (Early effect)
- Using bipolar transistors as amplifier; voltage amplification, current amplification, power amplification.
- Push-pull configuration.
- Transistors as switching elements.
- BJT Small-signal model
- BJT Current Mirrors

Field-effect transistors (MOS):

- Different types: JFET, NMOS, PMOS.
- Operating regions.
- Basic circuits for biasing.
- Importance of minimizing the number of resistors in IC design.
- Amplifiers circuits with and without resistors. Operation in the triode region of the saturation region.
- Channel length modulation
- CMOS structure.
- Applications of MOS in digital circuits.
- Applications of MOS as a switch in power electronics.
- MOS Small-signal model
- MOS Current mirrors

Research competences:

Selection of a A1-level journal paper related to electronic components used in this course. Studying the content of the paper and writing a 2-page summary in English or Dutch, as preferred by the student.

Simulation of circuits from the course.

- Knowledge and understanding of the different methods of analysis and related parameter settings.
- Extensive simulation of many circuits treated in the lab as well as circuits from theoretical exercises.

Initial competences

Analysis of electrical networks in DC and AC. Maths: complex numbers; analysis: limits, derivatives and integrals.
This course unit builds on certain course competencies/learning outcomes of course units Electronics and Electronics II.

Final competences

1 To analyze and calculate the behavior of advanced analog circuits
2 To simulate analog circuits efficiently and correctly.
3 To practically realize analog circuits and measure their behavior.
4 To possess initial research competences concerning hardware R&D.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture, Practical

Extra information on the teaching methods

Theory:

(Online) lectures.

Exercises:

Calculating circuits, design of circuits, simulations in MICROCAP.

Labs:

Construction of circuits. Using power supplies, multimeters, oscilloscopes and function generators. Measuring amplifiers and oscillators with OpAmps, transistors and FETs.

Learning materials and price

- Book: "Microelectronic Circuits" by Adel Sedra and Kenneth Smith (The Oxford Series in Electrical and Computer Engineering) 8th edition.
- Supporting material available via the electronic learning platform

References

"Microelectronic Circuits", Adel Sedra & Kenneth Smith
"Introduction to electronic circuit design", Richard Spencer & Mohammed Ghausi.
"The Art of Electronics", Horowitz & Hill.
"Troubleshooting Analog Circuits", Robert Pease

Course content-related study coaching

Lectures + emailing and appointments for further questions possible.
Permanent supervision during lab sessions.
Exercises and simulations with online coaching via MS Teams.

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment with open-ended questions

Examination methods in case of periodic assessment during the second examination period

Written assessment with open-ended questions

Examination methods in case of permanent assessment

Professional practice, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

Theory: written open-book exam
Lab: permanent evaluation during the lab, assessment of research paper summary
Examination during the 2nd exam period is not possible for lab.

Calculation of the examination mark

3/4 theory ; 1/4 lab courses
When a student is absent without officially accepted reason (eg. doctor's notice) for 2 or more times in the on-campus lab, the student obtains an AFWE (absent) mark for the full course.
First and second exam period: in order to pass the course a minimum mark of 8/20 should be obtained for the theory part. In case this condition is not fulfilled, a final mark of 10/20 or more is reduced to 9/20.