

## Electromagnetic-aware High Frequency Design (E033021)

**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**

Offering	Language	Location	Teaching Methods	Hours
A (semester 1)	English	Gent	excursion seminar lecture practical	
B (semester 1)	Dutch	Gent	excursion practicum guided self-study	7.5h 5.0h 55.0h

**Lecturers in academic year 2023-2024**

Rogier, Hendrik	TW05	lecturer-in-charge
Vande Ginste, Dries	TW05	co-lecturer

**Offered in the following programmes in 2023-2024**

Programme	crdts	offering
<a href="#">Bridging Programme Master of Science in Electrical Engineering(main subject Communication and Information Technology )</a>	6	A
<a href="#">Bridging Programme Master of Science in Electrical Engineering(main subject Electronic Circuits and Systems )</a>	6	A
<a href="#">Master of Science in Electrical Engineering (main subject Communication and Information Technology )</a>	6	A
<a href="#">Master of Science in Electromechanical Engineering(main subject Control Engineering and Automation)</a>	6	A
<a href="#">Master of Science in Electromechanical Engineering(main subject Electrical Power Engineering)</a>	6	A
<a href="#">Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)</a>	6	A
<a href="#">Master of Science in Electromechanical Engineering(main subject Maritime Engineering)</a>	6	A
<a href="#">Master of Science in Electromechanical Engineering(main subject Mechanical Construction)</a>	6	A
<a href="#">Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering)</a>	6	A
<a href="#">Master of Science in Electrical Engineering</a>	6	B
<a href="#">Master of Science in Photonics Engineering</a>	6	A

**Teaching languages**

English, Dutch

**Keywords**

multi-port, microwave circuits, circuit models, EMC, signal and power integrity, interference, norms

**Position of the course**

- Insight in circuit and EMC concepts
- Application of the concepts to interconnections and IC-packages
- Familiarise students with EMC norms

**Contents**

- Black box models for multi-port circuits: Concept of port and port impedance and S-parameters, Passivity and lossless properties of multi-port circuits, Multi-port applications and

measurements

- Extraction of circuit models of multi-port circuits: Circuit models for multi-port circuits, Parameter extraction for transfer function models, Parameter extraction for physical models
- Analysis and design of passive microwave components: circulator, isolator, directional coupler, filters, matching networks
- Circuit properties of interconnections and IC-packages: Models for reflection, transmission and attenuation, Crosstalk and differential versus even mode, Measurements on interconnections and IC-packages
- Non-linear termination of interconnections: Circuit models for non-linear terminations, Circuit simulation techniques
- Concepts for EMC in circuits: Emission, immission and interference, Routes for an EMC problem
- Intra-system interference: Concepts of ground, earth, and reference, Static and dynamic noise margin, Modelling of the power supply circuit, Switching noise
- Inter-system interference: Radiative sources, Shielding (cables, connectors, housing), Conductive sources, Filtering for conductive interference
- EMC norms and certification: Emission and immission norms, certification process

### Initial competences

Having successfully completed the courses on "Applied Electromagnetics" or "Electromagnetism II" or having acquired the final competences provided by these courses in any other way.

### Final competences

- 1 Analyse and design microwave circuits based on impedance, admittance and scattering matrices.
- 2 Synthesize filters and matching networks.
- 3 Have insight in the role of electromagnetic phenomena on EM aware design, including radiated/conducted emission/immunity.
- 4 Be familiar with EMC norms.

### 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, Excursion, Lecture, Practical, Independent work

### Extra information on the teaching methods

Classroom lectures: Mix of on-campus and online teaching; Flipped classroom with interactive contact sessions; Scored exercises as homework; Classroom problem solving sessions; Lab sessions

In particular the part EMC/SI/PI consists of lectures about theory and exercises, without making a strict, traditional distinction between them. All lectures are seminars which require interaction with and input from the students. If circumstances permit (e.g., COVID-dependent circumstances), a mandatory company visit takes place. There are also mandatory lab sessions.

### Learning materials and price

syllabus (10EUR in print, free electronic version on UFora) + handouts with notes (free electronic version on UFora)

### References

**David M. Pozar, Microwave Engineering**, third edition, John Wiley & Sons, 2004

**Jasper Goedbloed, Electromagnetic Compatibility**, Prentice Hall 1992, ISBN 0-13-249293-8, 381 pp

Prentice Hall, 2nd edition: 2010

**Introduction to Electromagnetic Compatibility**

**C. R. Paul**

ISBN: 978-0-471-75500-5

John Wiley & Sons, Inc., 2nd edition: 2006

**Signal and Power Integrity -- Simplified**

**E. Bogatin**

ISBN: 978-0-13-234979-6

### Course content-related study coaching

## Assessment moments

end-of-term and continuous assessment

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

Written assessment open-book, Written assessment

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

Written assessment open-book, Written assessment

## Examination methods in case of permanent assessment

Skills test, 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

### *During examination period:*

#### **Part EMC/SI/PI:**

Written closed-book assessment

- Theory + theoretical exercises
- Questions about EMC norms in the context of the Certification Lab visit

#### **Part Design of Passive Microwave Circuits:**

A) Written closed-book assessment

- Theory

B) Written open-book assessment

- Exercises

*During semester:* Graded lab sessions, Graded exercises as homework.

*Second chance:* Possible in adapted form

## Calculation of the examination mark

Evaluation throughout semester as well as during examination period. Special conditions:  $\frac{1}{2}$  Exam Design of Passive Microwave Circuits ( $\frac{1}{6}$  theory exam +  $\frac{1}{6}$  exercise exam +  $\frac{1}{6}$  scored exercises as homework) +  $\frac{3}{8}$  Exam EMC/SI/PI +  $\frac{1}{8}$  Lab reports + Certification Lab visit.

Students who eschew one or more parts of the assessment (part Design of Passive Microwave Circuits, part EMC/SI/PI, part continuous assessment) cannot obtain a pass mark for the course unit. Should the final mark be higher than  $\frac{7}{20}$ , it will be reduced to the highest non-passable mark (i.e.  $\frac{7}{20}$ ). When the student obtains less than  $\frac{8}{20}$  for at least one of the components (part Design of Passive Microwave Circuits, part EMC/SI/PI, part continuous assessment), they can no longer pass the course unit as a whole. If the total score does turn out to be a mark of ten or more out of twenty, this is reduced to the highest fail mark ( $\frac{9}{20}$ ).