

## High Speed Photonic Components (E030630)

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

**Credits 4.0**                      **Study time 120 h**

**Course offerings and teaching methods in academic year 2025-2026**

|                |         |      |                  |
|----------------|---------|------|------------------|
| A (semester 1) | English | Gent | group work       |
|                |         |      | independent work |

**Lecturers in academic year 2025-2026**

|                   |      |                    |
|-------------------|------|--------------------|
| Morthier, Geert   | TW05 | lecturer-in-charge |
| Verschaffelt, Guy | VUB  | co-lecturer        |

**Offered in the following programmes in 2025-2026**

|   | <b>crdts</b> | <b>offering</b> |
|---|--------------|-----------------|
| <a href="#">Bridging Programme Master of Science in Photonics Engineering</a> | 4            | A               |
| <a href="#">Master of Science in Photonics Engineering</a>                    | 4            | A               |

**Teaching languages**

English

**Keywords**

modulation, optical pulses, optical switching

**Position of the course**

To acquire a thorough understanding of the dynamics of laser diodes. To acquire an overview of the field as well as the necessary insight and skills to be able to do research or follow-up research in the field. Partly taught at UGent and partly at VUB.

**Contents**

- Introduction: Components, General approximations, Applications
- Laser diode descriptions: Longitudinal equations, Rate equation descriptions, Non-linear material properties
- Laser diode modulation and noise: Small signal modulation, large signal modulation, Linewidth and intensity noise, External feedback, Experimental characterisation
- Non-linear laser dynamics: bifurcations, Chaos and its characterisation
- Mode locking and short pulse generation: Mode locking theory, Q-switching and self-pulsations, Characterisation of short pulses
- Capita selecta: laser diodes with very high modulation bandwidth, external modulators, all-optical flip-flops

**Initial competences**

wave propagation theory, laser theory, notions of noise.

This course relies heavily on several competences acquired in the course Lasers. It is not advised to take this course without first having taken the course Lasers (or having acquired a thorough knowledge about lasers).

**Final competences**

- 1 Being able to use the rate equations for the derivation of large and small signal dynamic behaviour.
- 2 Being able to derive the different noise characteristics from the rate equations.
- 3 Understanding the different methods for the generation of short laser pulses.
- 4 Understanding the influence of external reflections on the laser diode behaviour.
- 5 Understand the context of scientific or technical documents in the field of photonics and further investigate unclear parts independently.

6 Acquire sufficient knowledge to perform research in the domain of laser dynamics.

#### **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**

Group work, Lecture, Independent work

#### **Study material**

Type: Syllabus

Name: High speed photonic components

Indicative price: Free or paid by faculty

Optional: no

Language : English

Oldest Usable Edition : NA

Available on Ufora : Yes

Online Available : Yes

Available in the Library : No

Available through Student Association : No

#### **References**

- Petermann, K.; Laser Diode modulation and noise
- Agrawal, G.P.; Long wavelegnth semiconductor lasers
- San Miguel M. and Toral R.; Stochastic effects in physical systems, arXiv:cond-mat/9707147v1, 14 july 1997

#### **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**

Oral assessment

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

Oral assessment

#### **Examination methods in case of permanent assessment**

Assignment

#### **Possibilities of retake in case of permanent assessment**

examination during the second examination period is not possible

#### **Extra information on the examination methods**

During examination period: oral closed-book exam, written preparation. During semester: graded project reports; graded team work.

#### **Calculation of the examination mark**

Special conditions: 1 computer exercise and 1 paper. Final score depends half on the marks for these exercises (1/4th per exercise).