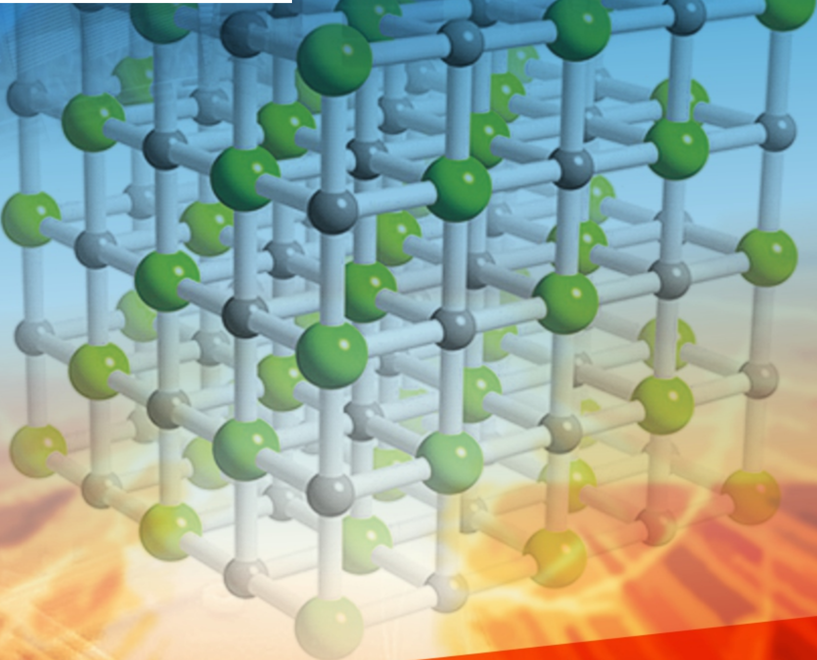
Bachelor and Master of Science in

# ENGINEERING PHYSICS



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GHENT UNIVERSITY

# ENGINEERING PHYSICS

This brochure aims to guide you through the study programme of the Bachelor and Master of Science in Engineering Physics. This programme is unique in Flanders and combines an engineering perspective with a thorough physical background. The Engineering Physics programme is therefore by nature the most fundamental of all engineering studies. However, through its focus on state-of-the-art physical concepts and recent research developments, you will be at the forefront of the newest technological advancements.

FACULTY OF ENGINEERING
AND ARCHITECTURE

# Hello!

Have you been waiting all day to read this brochure? Or did you only stumble upon it by accident? In both cases, we recommend you to keep reading.

Graduates of the study programme of the Bachelor and Master of Science in Engineering Physics are able to investigate engineering applications from the point of view of their most fundamental physics, allowing them to tackle challenges in some of the most exciting emerging technologies. The programme is supported by research groups from both the Faculty of Engineering and Architecture and the Faculty of Sciences. Their classes highlight a broad variety of application domains, ranging from nanoscale materials and plasma technology to electromagnetic and integrated (opto-)electronic devices. Students are moreover able to determine the focus of their own Master's curriculum thanks to the possibility of choosing several elective courses.

The first part of this brochure focuses on the courses of the study programme, of which the most recent version can always be found in the UGent course catalogue ([https://studiekiezer.ugent.be](https://studiekiezer.ugent.be)). The second part of the brochure contains a large number of testimonials from alumni, painting a picture of the opportunities opening up to our students.

We hope that our study programme appeals to you and maybe we will be able to welcome you in the future. Enjoy reading!

Jeroen Beeckman
Louis Vanduyfhuys
Study Programme Committee of Engineering Physics

GHENT UNIVERSITY

Bachelor

Master

ENGINEERING PHYSICS

# Overview

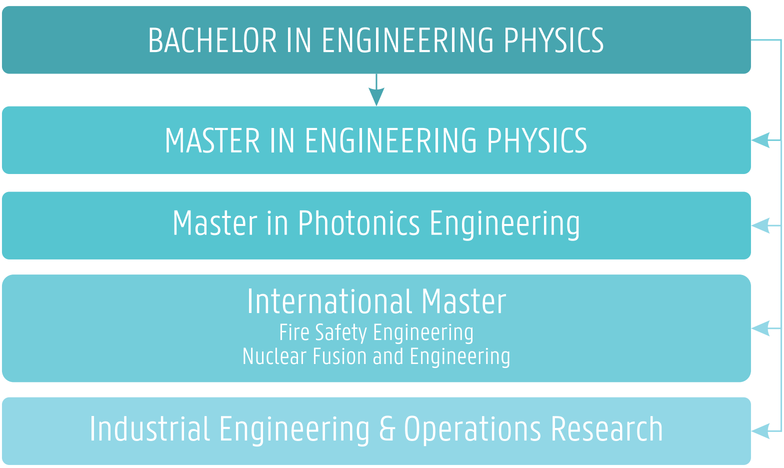
The study programme Engineering Physics combines the basic concepts of an engineering education with the essence of a training as a physicist. Physical engineers perform and manage technical and scientific research at universities, research institutes, and industry.

Throughout the curriculum, we therefore aim for a balance between **physics** and **engineering** sciences. This is reflected in both the available courses and the teachers' backgrounds.

## After the Bachelor...

... **the Master!** The Bachelor in Engineering Physics does not only grant direct access to the Master in Engineering Physics, but also to other Masters in Engineering: Photonics Engineering, Industrial Engineering & Operations Research, and on an international level: Fire Safety Engineering and Nuclear Fusion & Engineering Physics.

Other Master's programmes can be followed as well, but not without taking some preparatory classes.



## After the Master...

... a profession! Although the study programme Engineering Physics also allows taking a job in management or production, we mainly prepare our graduates for a future career in research and development. The curriculum is designed to provide a broad background, enabling physical engineers to work for any company or research institute where research and development are performed, jobs for which a thorough knowledge of physics is wanted or even indispensable. This multifaceted training also makes the Master in Engineering Physics particularly suited to later assume an executive position. On the other hand, many alumni choose to take their first job at a university or research facility, and only make the transition to corporate life after obtaining a PhD.

At the end of this brochure, you find a number of testimonials from graduated Masters in Engineering Physics in diverse professions. They demonstrate how a degree of physical engineer can open doors to all kinds of sectors.

# Bachelor

## The curriculum

The Bachelor programme aims to provide a thorough background in mathematics, physics, and engineering sciences. Besides some broad and generalist courses, shared by all engineering students, a number of important learning paths are developed. They not only elaborate on subjects in mathematics and classical mechanics, but also dig into the four areas of expertise essential to Engineering Physics: quantum mechanics, thermodynamics, solid-state physics, and electromagnetism. These topics are then further built on for advanced applications in the Master (see p. 10 for a visual representation of the learning paths).

### Quantum mechanics

At very small length scales, the deterministic laws of classical physics break down and are replaced by the probabilistic ones of quantum mechanics. Taking into account quantum mechanical phenomena for engineering purposes is essential due to the increasing miniaturization of many technologies (e.g. nanoscale transistors, quantum dots) or to understand many light-based applications (e.g. lasers, spectroscopy).

### Thermodynamics

Thermodynamics describes how different forms of energy are exchanged and balanced with one another. It is the most essential field of science to understand equilibria between different phases of matter, heat flow, or energy conversion efficiencies. As such, a good grasp of thermodynamics is vital to develop any engineering application related to energy or materials.

### Solid-state physics

Many technological advances in the last 50 years are based on innovations in solid-state materials. It was only by understanding the fundamental operation of silicon, for example, that chips with electronic (e.g. transistors) and photonic devices (e.g. LEDs) could be designed. The development of advanced materials such as superconductors also heavily relies on a firm background in solid-state physics.

### Electromagnetism

Electromagnetism is a broad area that relates to any phenomenon that is based on static or time-dependent electromagnetic fields. Visible light is a well-known example, but also radio waves or X-rays are indispensable in a wide range of applications (e.g. telecommunication). In addition, electromagnetic effects are important to understand the make-up of matter itself, as is the case for plasmas or liquid crystals.

## 1st Bachelor

The Bachelor programme in Engineering is designed to facilitate the transition from secondary to university education.

The curriculum contains three important parts:

- Basic knowledge and skills in mathematics & science
- Engineering courses and a corresponding attitude
- Practical project classes

The first Bachelor mostly focuses on the first and third aspect: mathematics and sciences, and projects. Wherever possible, the courses are linked to engineering applications, but the main goal of the first year is to provide the necessary basis upon which (more advanced) engineering classes can be built.

The first Bachelor is common to all engineering programmes. Afterwards, you need to choose a particular study programme. “Toegepaste Natuurkunde” (Engineering Physics) is one of the seven possible Bachelors in Engineering, all of which are (mainly) taught in Dutch.

| 1st Bachelor | sem. | cred. |
|---|---|---|
| Basiswiskunde | 1 | 3 |
| Discrete wiskunde I | 1 | 4 |
| Wiskundige analyse I | 1 | 6 |
| Scheikunde: bouw van de materie | 1 | 4 |
| Natuurkunde I | 1 | 6 |
| Modelleren, maken en meten | 1 | 4 |
| Informatica | 1 + 2 | 6 |
| Wiskundige analyse II | 2 | 4 |
| Meetkunde en lineaire algebra | 2 | 7 |
| Waarschijnlijkheidsrekening en statistiek | 2 | 6 |
| Scheikundige thermodynamica | 2 | 3 |
| Materiaaltechnologie | 2 | 4 |
| Duurzaamheid, ondernemerschap en ethiek | 2 | 3 |

## 2nd Bachelor

The second Bachelor forms a bridge between the basic mathematical and scientific courses of the first Bachelor and the basic engineering courses of the third Bachelor. It hence does not only contain classes common to all engineering studies, but also a few introductory topics unique to the Engineering Physics programme. The latter courses are indicated in colour in the following table.

| 2nd Bachelor | sem. | cred. |
|---|---|---|
| Wiskundige analyse III | 1 | 6 |
| Natuurkunde II | 1 | 6 |
| Elektrische schakelingen en netwerken | 1 | 6 |
| Transportverschijnselen | 1 | 6 |
| Theoretische mechanica I | 1 | 6 |

| | | |
|---|---|---|
| Wiskundige ingenieurstechnieken: lineaire algebra | 2 | 3 |
| Natuurkunde III | 2 | 6 |
| Materialen en velden | 2 | 6 |
| Kwantummechanica I | 2 | 6 |
| Theoretische mechanica II | 2 | 3 |
| Ingenieursproject | 2 | 6 |

## 3rd Bachelor

The third Bachelor elaborates on applied physical aspects by means of a number of basic courses in physics and engineering. They aim to provide you with an overview of all key research domains of the programme. The Bachelor programme is completed by a Bachelor Dissertation ('Vakoverschrijdend project').

| 3rd Bachelor | sem. | cred. |
|---|---|---|
| Systemen en signalen | 1 | 6 |
| Vastestoffysica en halfgeleiders I | 1 | 6 |
| Wiskundige ingenieurstechnieken: complexe analyse | 1 | 3 |
| Kwantummechanica II | 1 | 6 |
| Elektromagnetisme I | 1 | 6 |
| Duurzame bedrijfsvoering | 1 | 3 |
| Vastestoffysica en halfgeleiders II | 2 | 3 |
| Fotonica | 2 | 6 |
| Modelleren en regelen van dynamische systemen | 2 | 6 |
| Elektronische systemen en instrumentatie | 2 | 6 |
| Elektromagnetisme II | 2 | 3 |
| Vakoverschrijdend project | 2 | 6 |

# Master

## The curriculum

The curriculum of the Master in Engineering Physics contains **8 mandatory courses** (48 ECTS credits), all of them taught in the first Master. The rest of the first Master and the entire second Master are exclusively reserved for **elective courses** (some dedicated for the study programme, some social, and some free). The second Master also requires writing a **Master Dissertation**. Except for the free and social elective courses, all classes balance an engineering point of view (system analysis, design, and optimization) with a physics approach (experiments and mathematical modelling).

The mandatory classes build upon the learning paths that were established in the Bachelor and introduce a broad set of advanced technological applications that make up the focus of Engineering Physics. These applications are situated in the fields of energy, photonics, electronics, biomedical engineering, nanosensors and nanoactuators, and information technology. In addition, the mandatory classes provide the necessary background to follow specialized elective courses, which are strongly linked to the university's research in the area of engineering physics. Finally, the mandatory courses include a project in close contact with industrial partners, which applies all of your engineering physics skills with a broader view on entrepreneurship, sustainability and societal value.

One of the main principles of the study programme is **the ability to compose your personalized curriculum**, following your own focus or interests. For this reason, the second Master entirely consists of elective courses. Five classes can be chosen from a shortlist of engineering physics key topics. They provide a detailed description in specialized subdomains. In addition, there are also 12 ECTS credits worth of free elective courses, which allow you to broaden your knowledge or to elaborate one particular expertise. These classes can be chosen freely from any Master's programme of a beta faculty (Faculty of Engineering and Architecture, Faculty of Sciences, Faculty of Bioscience Engineering). The remaining six credits are reserved for elective courses that highlight the aspects of engineering in society, and are chosen from a faculty-wide list. Internships also belong to this category.

## 1st Master

| | sem. | cred. |
|---|---|---|
| Plasma Physics | 1 | 6 |
| Mathematical Techniques for Engineers: Advanced Topics | 1 | 6 |
| Atomic and Molecular Physics | 1 | 6 |
| Computational Solutions of Wave Problems | 1 | 6 |
| Nuclear Physics: Principles and Applications | 2 | 6 |
| Physical Chemistry | 2 | 6 |
| Physics of Semiconductor Devices | 2 | 6 |
| Engineering Physics and Industry | 2 | 6 |
| Elective courses | | |
| Elective courses from the lists of Engineering Physics key topics, elective social courses or beta faculty Master's courses | 1 | 6 |
| | 2 | 6 |

## 2nd Master

| | sem. | cred. |
|---|---|---|
| Master Dissertation | 1 + 2 | 24 |
| Elective courses | | |
| Elective courses from the lists of Engineering Physics key topics, elective social courses or beta faculty Master's courses | | 36 |

## Elective courses 1st and 2nd Master

| | sem. | cred. |
|---|---|---|
| Elective courses from the list of Engineering Physics (key topics) | | 30 |
| Faculty elective courses from the list of elective social courses | | 6 |
| Beta faculty Master's courses | | 12 |

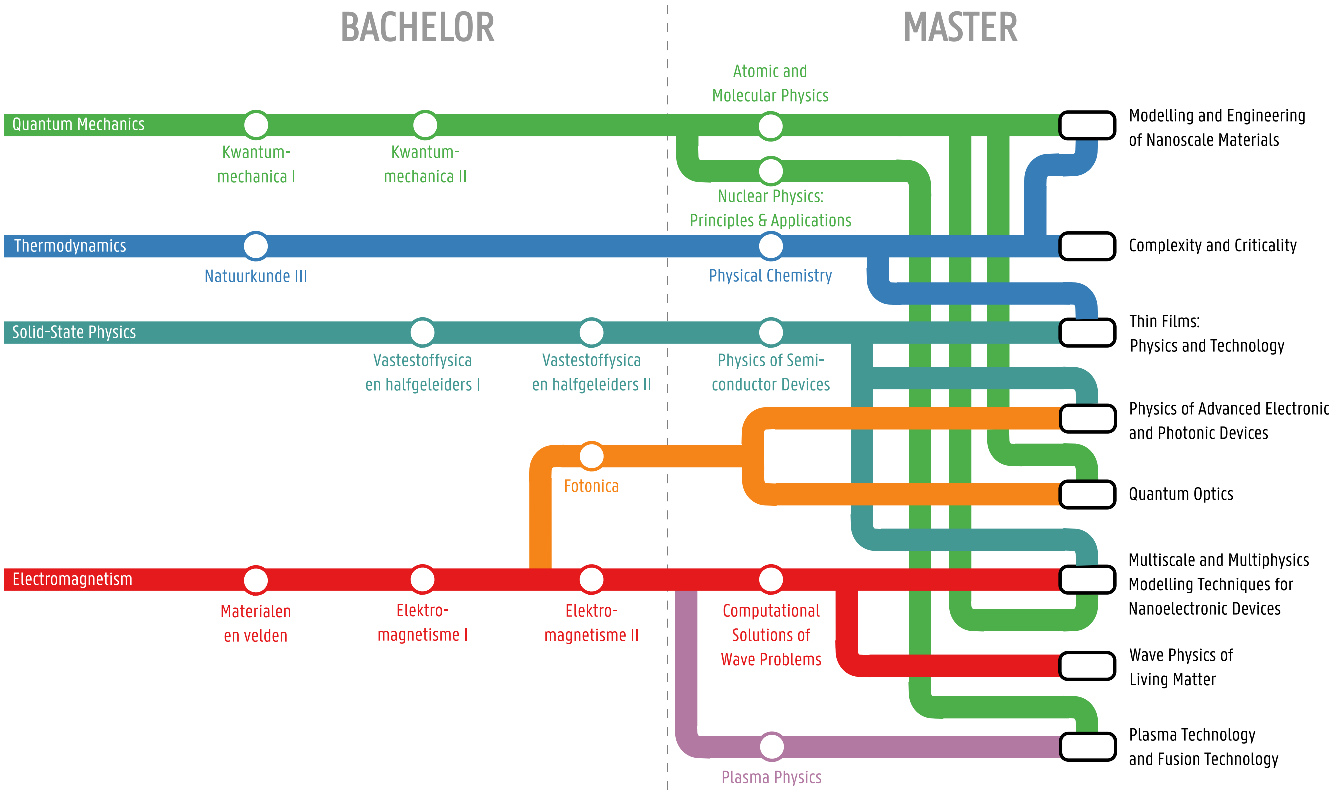
# Elective courses in Engineering Physics (key topics)

The elective courses in Engineering Physics (key topics) are supported by state-of-the-art scientific research at an international level from the teachers and their research teams. This allows you to come in close contact with cutting-edge physical research.

Moreover, all key topics are taught in English and possess the same number of ECTS credits (i.e. six). The study load is then equal for all students, independent of the particular choices in the curriculum. Finally, the class schedules of all 8 possible key topics have been attuned to each other, making sure that you will always be able to follow the five courses of your preference over the course of the two years of the Master.

| Elective courses from the list of Engineering Physics (key topics) | sem. | yr. | cred. |
|---|---|---|---|
| Quantum Optics | 1 | 1/2 | 6 |
| Thin Films: Physics and Technology | 1 | 1/2 | 6 |
| Modelling and Engineering of Nanoscale Materials | 1 | 2 | 6 |
| Physics of Advanced Electronic and Photonic Devices | 1 | 1/2 | 6 |
| Plasma Technology and Fusion Technology | 1 | 2 | 6 |
| Complexity and Criticality | 2 | 1/2 | 6 |
| Multiscale and Multiphysics Modelling Techniques for Nanoelectronic Devices | 2 | 1/2 | 6 |
| Wave Physics in Living Matter | 2 | 1/2 | 6 |

The elective courses in Engineering Physics can be considered as the culmination of the important learning paths in the programme: quantum mechanics, thermodynamics, solid-state physics, and electromagnetism, as well as two important side branches of the electromagnetic line: photonics and plasma physics.


BACHELOR
MASTER
Quantum Mechanics
Kwantum-
mechanica I
Kwantum-
mechanica II
Atomic and
Molecular Physics
Nuclear Physics:
Principles & Applications
Thermodynamics
Natuurkunde III
Physical Chemistry
Solid-State Physics
Vastestoffysica
en halfgeleiders I
Vastestoffysica
en halfgeleiders II
Physics of Semi-
conductor Devices
Fotonica
Electromagnetism
Materialen
en velden
Elektro-
magnetisme I
Elektro-
magnetisme II
Computational
Solutions of
Wave Problems
Plasma Physics
Modelling and Engineering
of Nanoscale Materials
Complexity and Criticality
Thin Films:
Physics and Technology
Physics of Advanced Electronic
and Photonic Devices
Quantum Optics
Multiscale and Multiphysics
Modelling Techniques for
Nanoelectronic Devices
Wave Physics of
Living Matter
Plasma Technology
and Fusion Technology

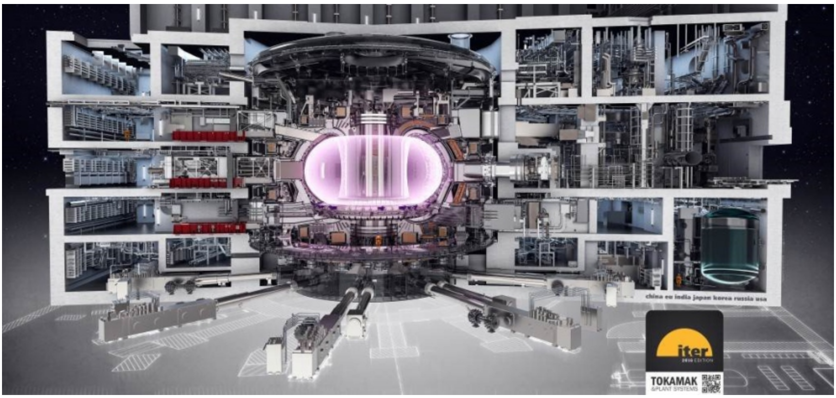
The key topics use knowledge obtained in these branches of physics for a wide range of exciting state-of-the-art application domains.

## Energy applications

Our society devours energy at an ever increasing pace. This not only requires an increasing number of energy resources (43% more by 2040), but also leads to higher $CO_2$ emissions (35% more by 2040). To sustain our current standard of living in an environmentally friendly way, there is therefore an urgent need for innovative sources of energy. As a student in Engineering Physics, you are at the forefront of these evolutions thanks to your background in nuclear and particle physics (fission and fusion), atomic-scale materials science (hydrogen storage, batteries, superconductors), and semiconductor technology (solar cells).

**Related key topics**: "Plasma Technology and Fusion Technology", "Physics of Advanced Electronic and Photonic Devices", "Modelling and Engineering of Nanoscale Materials", "Thin Films: Physics and Technology"

**Related employers**: Umicore (batteries, solar cells), FANC (fission), EUROfusion (fusion), Nexans (cables), OCAS (metals for energy applications), imec (solar cells), SCK.CEN (nuclear technology).

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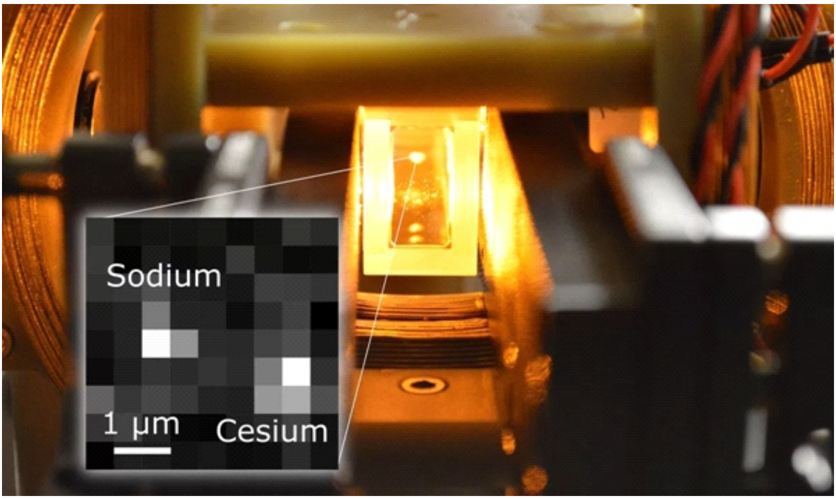
**APPLICATION IN THE SPOTLIGHT** **Nuclear fusion** is the opposite of traditional thermonuclear fission. Whereas classical fission reactors use neutrons to split heavy nuclei, fusion reactors combine light nuclei into heavier ones. Nuclear fusion promises an almost limitless supply of energy without $CO_2$ emission and a minimum of radioactive waste. It is worked on by a worldwide collaboration, running on a multibillion budget (e.g. € 20 billion for ITER, the test reactor currently under construction in France). Successful development of nuclear fusion requires dealing with a number of interesting challenges, such as heating and magnetically containing the plasma, harnessing the immense amount of released energy and designing materials that are able to withstand high neutron fluxes and temperatures up to 900 °C.

## Photonic applications

Photonics forms the technological basis for the conversion of sunlight into other forms of energy or electricity, for visualization purposes, and for the manipulation of matter. Recognized as one of the European Commission's key enabling technologies, photonics plays a major role in the production of renewable energies and in the development of components such as photodiodes, LEDs, liquid crystal displays, and lasers. Photonic applications are therefore inherently multidisciplinary, with a strong connection to energy (solar cells), electronic (communication technology, displays), and biomedical applications (lasers, microscopy). Due to the continuous downscaling of photonic devices, a quantum mechanical description of photonic devices is crucial to fully understand and predict their performance. As a student in Engineering Physics, you possess the necessary skill set to meet these evolutions head on thanks to your background in photonics, quantum mechanics, and semiconductor technology.

**Related key topics**: "Physics of Advanced Electronic and Photonic Devices", "Quantum Optics"

**Related employers**: Barco (displays), Esterline (displays), OIP (optics), Lambda X (optics), Luceda (optics, UGent spinoff), Indigo Diabetes (optics, UGent spinoff), imec (opto-electronics), Morrow Optics (opto-electronics, UGent spinoff).



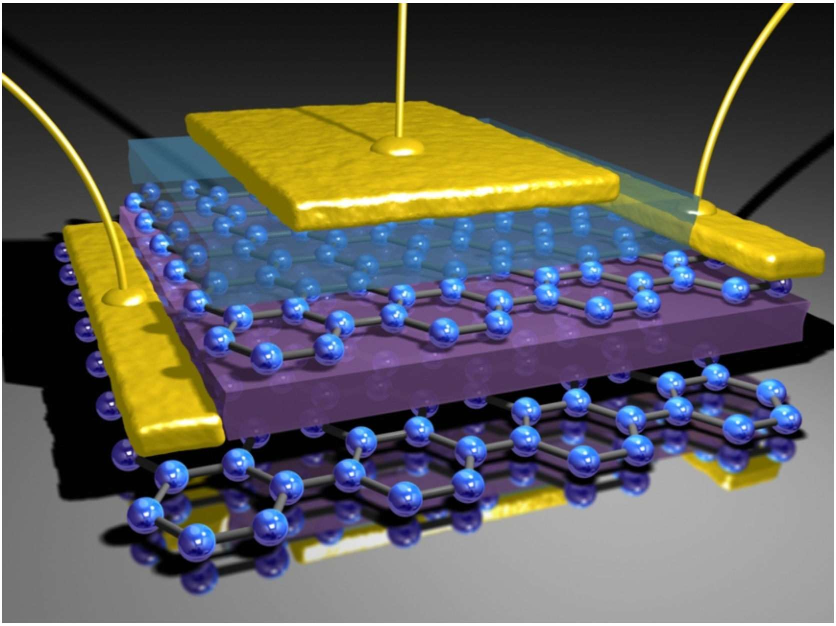
**APPLICATION IN THE SPOTLIGHT** Similar to conventional tweezers holding macroscopically sized objects, **optical tweezers** can be used to hold and manipulate objects as small as a single atom. Optical tweezers are very sensitive photonic devices that generate a highly focused laser beam able to detect and trap sub-micron particles in its path by exerting small forces on it (on the order of a few piconewtons). They are often used to manipulate and study single atoms and molecules. In the figure, optical tweezers are used to hold single sodium and cesium atoms before their combination into a single molecule, but also larger molecules such as DNA can be manipulated. Developing these optical tweezers poses challenges on both fundamental – how to reliably generate a well-defined laser beam – and practical levels – how to combine these beams into a microscope.

### Electronic applications

As the world economy has evolved to a digital economy and the smartphone seems to have become a natural human extension, electronic devices are now indispensable for both the individual and society in general. More and more domestic electronic applications are systematically labelled “smart” as they become more advanced, with a further integration of the abilities that used to require separate devices. All devices are moreover expected to steadily increase in performance and speed, while getting more compact at the same time. As a student in Engineering Physics, you become acquainted with all the fundamental physics that make these devices thrive, ranging from electromagnetism over semiconductor technology to quantum mechanics for the smallest devices. Thanks to this fundamental understanding of the different applications, new challenges in the development of more advanced devices can be easily tackled.

**Related key topics**: “Physics of Advanced Electronic and Photonic Devices”, “Multiscale and Multiphysics Modelling Techniques for Nanoelectronic Devices”, “Modelling and Engineering of Nanoscale Materials”, “Thin Films: Physics and Technology”

**Related employers**: onsemi and BelGaN (production semiconductor devices), imec (research on electronic devices), Caeleste (CMOS), OIP (opto-electronics), Antwerp Space (satellite communication), QinetiQ Space (space instruments), Melexis (microelectronics)



© Kurzweil Network, http://www.kurzweilai.net/multi-layer-3d-graphene-transistor-breakthrough-may-replace-silicon

APPLICATION IN THE SPOTLIGHT Given the insatiable need for more performant electronic devices, metal-oxide-semiconductor field-effect transistors (MOSFETs), the basic switching units in the integrated circuits of digital logic devices, have been systematically reduced in size to meet new performance standards. As MOSFET scaling is approaching its limits, new technological advances in the material and device concepts will be required to ensure a continued progress in the FET's performance. One of the particularly interesting materials researched within this context is graphene. Since the discovery of the exceptional electric field effect exhibited by graphene, the **graphene transistor** has become a widely investigated electronic device. Especially the possibility of designing transistors with a channel that is just one atomic layer thick, makes them very attractive, along with the promising high speeds they can achieve, as already demonstrated experimentally. Issues regarding their ability to be switched off make up one of the remaining barriers to become fully competitive with the governing MOSFET technology.

### Biomedical applications

Many recent advances in medicine are thanks to progress in physics and engineering. The increased understanding in elementary particle physics allowed for the construction of high-tech imaging equipment, such as X-ray tomography, electron-positron tomography (EPT), or nuclear magnetic resonance (NMR/MRI). In addition, several medical procedures are based on insights in plasma treatment, electromagnetic or acoustic stimulation, or the development of new biologically compatible materials. On the other hand, technology can have an undesired biological impact (noise pollution, electromagnetic stray fields). All of these aspects are ideally tackled by physical engineers.

**Related key topics**: "Wave Physics of Living Matter", "Plasma Technology and Fusion Technology"

**Related employers**: Siemens (medical imaging), Philips (medical imaging, surgical devices), Cochlear (hearing aids), UZ Gent (device operation and monitoring)

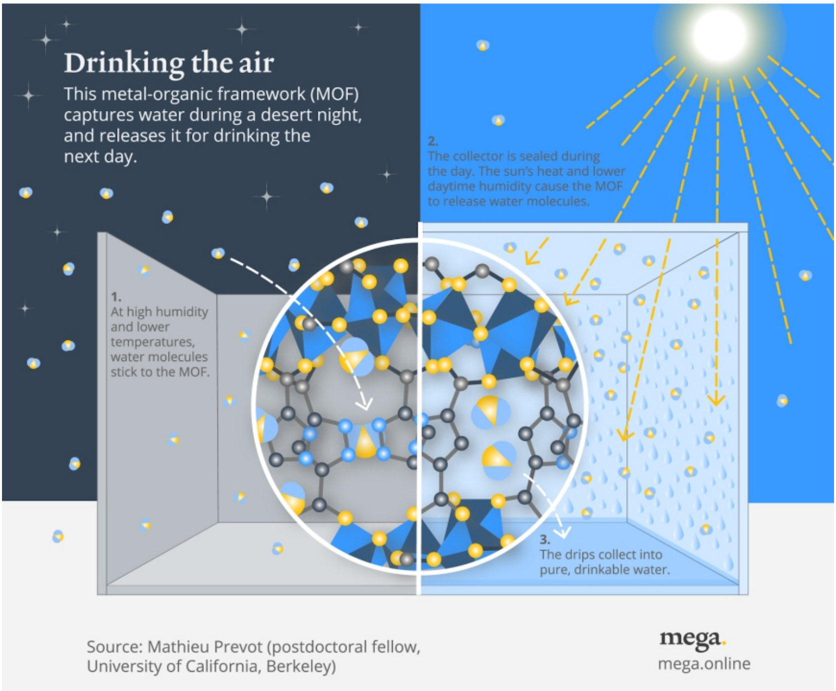
#### APPLICATION IN THE SPOTLIGHT

We are in ever closer contact to **electromagnetic radiation**. Think of our constant exposure to signals from cell phone, GPS, or Wi-Fi, and broadcasts from radio and television, for example. This exposure is expected to increase even further, since the deployment of a 5G network will require installing additional antennas. There is moreover an omnipresent background "noise" due to high-voltage applications, which operate at a frequency near 50 Hz. It is currently not unambiguously clear how these various levels and frequencies of electromagnetic emissions affect the human body. Resolving that question necessitates advanced insight into the interaction between electromagnetic waves and matter.

## Nanosensor and nanoactuator applications

Various aspects of modern life depend critically on the ability to detect specific signals and react correspondingly. The sensors in airbags, for example, detect sudden changes in acceleration by means of capacitance measurements and quickly release a propellant to inflate a fabric bag. In today's society, however, it becomes increasingly crucial to be able to detect the smallest signals (e.g. minuscule amounts of highly toxic compounds) or to miniaturize a device capable of both sensing and acting (lab-on-a-chip). Therefore, scientists all over the world are developing new devices capable of sensing with an unseen sensitivity as well as acting with extreme precision by designing their composition and structure on the atomic scale. Because of these small length (and time) scales, an accurate description of the behaviour of such devices requires taking into account not only macroscopic solid-state properties, but also quantum mechanical phenomena (e.g. tunnelling).

**Related key topics**: "Modelling and Engineering of Nanoscale Materials", "Multiscale and Multiphysics modelling techniques for nanoelectronic devices", "Physics of advanced electronic and photonic devices", "Complexity and criticality", "Quantum optics"



**Related employers**: Verotech (consulting and engineering services for high-tech R&D projects), imec (nano-electronics for healthcare, smart cities, energy …), nanocyl (manufacturing carbon nanotubes)

APPLICATION IN THE SPOTLIGHT For millions of people, access to drinkable water remains a formidable challenge. Researchers at UC Berkeley showed that they were able to capture and re-release water from the air using an advanced nanostructured material, a so-called **metal-organic framework (MOF)**. MOFs are hybrid materials consisting of metal-oxide clusters connected by means of organic linking molecules. The resulting materials are crystalline, but they possess a large number of nanometer-sized holes, so-called nanopores. These pores allow the material to adsorb large amounts of various compounds, such as water, carbon dioxide, methane, or even certain chemical warfare agents. In the case of the MOF of UC Berkeley, the release of water occurs when the material senses sunlight, making it ideal for use in desert conditions. Metal-organic frameworks are also interesting for other applications, however. Some MOFs exhibit a large degree of flexibility, in which the material can shrink or expand as a response to a change in temperature, mechanical pressure, or the presence of specific gases. These features make MOFs highly promising materials for an even wider range of applications, e.g. nanodevices to store and release energy from mechanical shocks.

## Information technology applications

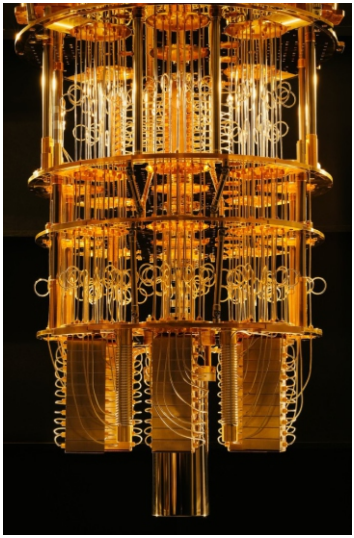
Data have an ever increasing importance in today's digital society. Information technology is used to treat this massive amount of information and transfer it as fast as possible, without loss of accuracy of the transmitted message. With a strong knowledge of electromagnetics (5G, antennas) and photonics (optical fibers), students in Engineering Physics can make a major contribution to this crucial area. In addition, the strong analytic insight and programming skills developed during the education can be used to analyze enormous amounts of information (big data analysis, artificial intelligence (AI)). Finally, physical engineers are also on the first row for the development of quantum computers, the next game-changing computers, thanks to their strong understanding of the quantum mechanical principles.

**Related key topics**: "Multiscale and Multiphysics modelling techniques for nanoelectronic devices", "Physics of advanced electronic and photonic devices", "Quantum optics", "Complexity and Criticality"

**Related employers**: imec (digital technology), Nokia (telecommunication), IBM (computers and IT), Google (IT and digital technology), Open Analytics (data science), ML6 (artificial intelligence), radix.ai (artificial intelligence), RoboVision (artificial intelligence)

APPLICATION IN THE SPOTLIGHT

The bits of classical computers can only be in two states: 0 or 1. **Quantum computers** use a fundamentally different kind of bit, the quantum bit (qubit), which allows for a superposition of the classical 0 and 1 states. Problems that are not feasible to solve using a classical computer, can be tackled in a reasonable time frame using a quantum computer, since multiple outcomes can be considered simultaneously. In order to build a working quantum computer at room temperature, the main challenge is to create stable qubits that can be processed without collapse of the superposition, which would make it nothing more than a classical bit. Also new quantum gates (the quantum version of a logical gate) need to be assembled. While waiting for the first commercially available quantum computer, new quantum algorithms are already on their way. These algorithms use the extraordinary behaviour of qubits to treat data several orders of magnitudes faster. This paves the way for a whole new branch of applications, such as quantum cryptography and more humanoid AI systems.



© Scientific American: https://www.scientificamerican.com/article/is-the-u-s-lagging-in-the-quest-for-quantum-computing/

## Elective social courses

As an engineer, you do not work alone. Instead, you join forces with other professionals to work on projects that eventually shape our society. To increase your awareness of this social environment, the Faculty of Engineering and Architecture created or selected a number of classes. Each engineering student is required to choose at least six ECTS credits from the following list of elective social courses, which also includes the internship (see further).

| Elective social courses | sem. | cred. | lang. |
|---|---|---|---|
| Industry Internship Engineering and Architecture | 1 + 2 | 6 | nl/en |
| Macroeconomics | 1 | 6 | nl |
| Psychology of Adolescence | 1 | 4 | nl |

| Elective social courses | sem. | cred. | lang. |
|---|---|---|---|
| Basic Entrepreneurship | 1 | 3 | nl |
| Introduction to Entrepreneurship | 1 | 3 | en |
| Technology and Environment | 1 | 3 | en |
| Biosystems | 1 | 3 | nl |
| The Information Society and ICT | 1 | 3 | en |
| Commercial Law | 1 | 3 | nl |
| Introduction to Psychology | 1 | 3 | nl |
| Philosophy and Science | 1 | 3 | nl |
| Principles of Law and Construction Law | 1 | 3 | nl |
| Financial and Cost Price Reporting in Companies | 1 | 6 | nl |
| Powerful Learning Environments | 1 | 6 | nl |
| The Teacher within School and Society | 1 | 4 | nl |
| Dare to Venture | 2 | 4 | en |
| Dare to Start | 2 | 3 | en |
| Ethics, Engineering and Society | 2 | 3 | nl |
| Philosophy and Science | 1 | 3 | nl |
| Safety of Electrical and Mechanical Installations | 2 | 3 | nl |
| Sustainable Energy and Rational Use of Energy | 2 | 4 | en |
| Sustainability Thinking | 1 + 2 | 5 | nl |
| Sustainable Use of Materials: Metals | 1 | 3 | nl |
| Sustainable Use of Materials: Plastics and Derived Materials | 2 | 3 | nl |
| Business Skills | 2 | 4 | nl/en |
| Introduction Industrial Psychology | 2 | 5 | nl |
| Classroom Management and Reflection | 2 | 4 | nl |
| Coaching and Diversity | 1 + 2 | 3 | nl |

## Free elective courses

In the programme of Engineering Physics, we realize that you may have some interests that are even broader than the choices that are available through the previous two lists of elective courses. You are therefore offered the opportunity to select two elective courses from the entire list of Master courses on offer at the beta faculties (Engineering and Architecture, Sciences, Bioengineering).

Some popular courses in the past are listed below:

- Relativity Theory and Classical Fields (Physics and Astronomy)
- Photovoltaic Energy Conversion and Sustainable Energy (Electrical Engineering)
- Symmetry Groups (Physics and Astronomy)
- Microphotonics (Photonics)
- Quantum Field Theory (Physics and Astronomy)
- Many-Particle Physics (Physics and Astronomy)
- Nuclear Reactor Technology (Electromechanical Engineering)
- Machine Learning (Computer Science Engineering)
- Continuum Mechanics (Nuclear Fusion and Engineering Physics)
- Nonlinear Systems (Electromechanical Engineering)
- Computational Materials Physics (Sustainable Materials Engineering)

Obviously, you are also allowed to select your free elective courses from the list of key topics.

## The thesis (Master Dissertation)

The Master Dissertation is closely related to the current scientific research of the engineering physics departments. Results often lead to contributions at conferences, or even to publications. In this respect, our study programme really gets the highest marks!

Several theses also contain an international dimension: short stays at foreign research institutes belong to the possibilities. Some Master Dissertations are even entirely performed abroad, at universities or research centres. This is not only the case for participants in a one-semester or one-year Erasmus programme; several past theses were written at research institutes like the Forschungszentrum Jülich (D), DESY Hamburg (D), Center for Advanced Radiation Technology (NL), ILL and ESRF Grenoble (F), Commissariat à l'énergie atomique et aux énergies alternatives (F), Natlab Philips Eindhoven (NL), ISOLDE-CERN (CH), Grand Accélérateur National d'Ions Lourds, Caen (F)...

## The internship

In the study programme Engineering Physics, an internship is not mandatory, but you can take one as an elective social course or as a free elective course. You can choose either an internship in industry (Industry Internship Engineering and Architecture, 6 ECTS credits social elective course) or a research internship (Research Internship, 6 ECTS credits free elective course). These internships may take place at a domestic or foreign company, or at a foreign research centre (in the latter case only the Research Internship is applicable).

You can find more information at the 'Internship' webpage of the Faculty (in Dutch):
https://www.ugent.be/ea/nl/faculteit/studentenadministratie/stage

## Erasmus

An Erasmus programme is possible in the first or the second Master, and can take one or two semesters. Although you can choose your particular Erasmus curriculum with a promoter or the Erasmus coordinator, it is essential that your choices maintain the Engineering Physics philosophy. This means that you still have to take all mandatory courses of the Master's programme and five elective courses from the list of 'key topics'. You can follow these classes at Ghent University, or (in an equivalent form) abroad during your Erasmus stay. Take this into account when planning your Erasmus programme (especially when you're abroad during your first Master). It is moreover necessary to discuss the equivalence of certain courses with the Erasmus responsible of Engineering Physics and the chairperson of the Study Programme Committee.

Ghent University has a nice webpage about Erasmus programmes:
https://www.ugent.be/student/nl/studeren/naar-buitenland/erasmus.

Much information can also be found on the website of the Faculty:
https://www.ugent.be/ea/nl/faculteit/uitwisseling/internationalisering.htm.

# External intake

The Bachelor in Engineering Physics is not the only way to start a Master in Engineering Physics. Other study programmes give access to it as well. To compensate for the difference in background knowledge, a bridging or preparatory programme is required. In some cases, a few courses suffice, which can be combined with the Master programme into a modified 2-year Master, while other cases require you to follow a full 90 ECTS preparatory programme.

A modified 2-year Master in Engineering Physics is available to four other Masters:

- Master of Physics
- Master of Physics and Astronomy
- Master of Electrical Engineering
- Master of Photonics Engineering

The modified Masters for the first two programmes are the same, and so are the Masters for the last two programmes. Both curricula are listed below.

| Modified Master programme for the Master of Physics and the Master of Physics and Astronomy | sem. | yr. | cred. |
|---|---|---|---|
| Transportverschijnselen | 1 | 1 | 6 |
| Elektrische schakelingen en netwerken | 1 | 1 | 6 |
| Elektromagnetisme I | 1 | 1 | 6 |
| Computational Solutions of Wave Problems | 1 | 1 | 6 |
| Mathematical Techniques for Engineers: Advanced Topics | 1 | 1 | 6 |
| Materialen en velden | 2 | 1 | 6 |
| Elektronische systemen en instrumentatie | 2 | 1 | 6 |
| Modelleren en regelen van dynamische systemen | 2 | 1 | 6 |
| Physical Chemistry | 2 | 1 | 6 |
| Plasma Physics | 1 | 2 | 6 |
| Physics of Semiconductor Devices | 2 | 2 | 6 |
| Master Dissertation | - | 2 | 24 |
| Elective courses from the list of Engineering Physics (key topics) | - | 2 | 24 |

## Modified Master programme for the Masters of Electrical and Photonics Engineering

| | sem. | yr. | cred. |
|---|---|---|---|
| Vastestoffysica en halfgeleiders I | 1 | 1 | 6 |
| Elektromagnetisme I | 1 | 1 | 6 |
| Wiskundige ingenieurstechnieken: complexe analyse | 1 | 1 | 3 |
| Theoretische mechanica I | 1 | 1 | 6 |
| Natuurkunde III | 2 | 1 | 6 |
| Kwantummechanica I | 2 | 1 | 6 |
| Physics of Semiconductor Devices | 2 | 1 | 6 |
| Wiskundige ingenieurstechnieken: lineaire algebra | 2 | 1 | 3 |
| Plasma Physics | 1 | 2 | 6 |
| Kwantummechanica II | 1 | 2 | 6 |
| Mathematical Techniques for Engineers: Advanced Topics | 1 | 2 | 6 |
| Atomic and Molecular Physics | 1 | 2 | 6 |
| Nuclear Physics: Principles and Applications | 2 | 2 | 6 |
| Physical Chemistry | 2 | 2 | 6 |
| Master Dissertation | - | 2 | 24 |
| Elective courses from the list of Engineering Physics (key topics) | - | 1/2 | 18 |

For some other studies, a preparatory programme is required:

- Bachelor of Science in Engineering with another main subject than Engineering Physics (Toegepaste Natuurkunde)
- Bachelor of Physics, Bachelor of Physics and Astronomy
- Master of Science in Industrial Sciences

If your preliminary training is not listed above, it may be possible to compose an individual programme. Contact studietrajectplateau.ea@ugent.be and provide them with the necessary information about your previous education (exam records).

The preparatory programme contains a fixed part of 30 ECTS credits and a variable part of 0 to 60 ECTS credits. The entire preparatory programme hence amounts to 30 to 90 ECTS credits, depending on your preliminary training. It is moreover possible to receive an exemption for some course units in the ensuing Master (see https://www.ugent.be/ea/en/for-degree-students/your-studies-in-ghent/pag.htm). This depends on your particular background.

The fixed part is equal to all students:

| Preparatory programme for the Master in Engineering Physics: fixed part | sem. | cred. |
|---|---|---|
| Wiskundige modellering in de ingenieurswetenschappen | 1 | 6 |
| Natuurkunde II | 1 | 6 |
| Kwantummechanica I | 2 | 6 |
| Meetkunde en lineaire algebra | 2 | 8 |
| Waarschijnlijkheidsrekening en statistiek | 2 | 4 |

The variable part of the preparatory programme is determined for each student individually and takes into account your preliminary training. In principle, it consists of a number of Bachelor courses. Candidates with a preliminary training very similar to Engineering Physics can follow a lighter programme than candidates with a substantially different background. When you can also be exempted of several Master courses, such a lighter preparatory programme can simultaneously be combined with the Master programme itself.

Although the combined preparatory and Master programme are determined for each student individually, based on their previous background, Masters in Industrial Sciences (industrial engineers) generally need to follow a three-year programme (180 ECTS credicts).

Further information can be obtained from the student counsellors of the Faculty and the Study Programme Committee of Engineering Physics.

# ENGINEERING PHYSICS

## Testimonials

# Wouter Nys

Physical Engineer 2017
Current occupation: Research & Development
Software Engineer, Bricsys

Shortly after graduating, I started my professional career at Bricsys, provider of BricsCAD, a Computer-Aided-Design software package. BricsCAD is used by engineers, designers and architects around the world. As a member of the R&D Artificial Intelligence team, I develop innovative and creative solutions that make the jobs of engineers and architects much easier by automating all kinds of time consuming tasks in the design process of a mechanical part, a building, a plant...

As a graduate from the engineering physics programme, I am convinced that the programme really makes a difference for my current job. In my opinion, three main aspects are particularly important. A first aspect is that the programme succeeds in combining interesting and relevant topics in multiple domains: from fundamental, purely physical to more technical. As all these topics are addressed in a highly rigorous way, graduates have developed knowledge and skills that are widely applicable in the work field. Moreover, the wide range of elective courses in the Master's programme offers the possibility to relate this knowledge to other scientific disciplines. In my case, I chose the Machine Learning course, which made it possible to build a bridge between engineering physics and computer sciences.

Second, in my current job, a profound mathematical foundation is crucial, as I am working with geometrical and optimization problems. A solid mathematical approach is present in almost every course of this programme, which is highly valuable for me day after day.

Finally, I want to highlight the fact that physical engineers are trained in making abstractions in real-life problems very quickly. Although our colleagues from other engineering backgrounds are developing these problem-solving skills as well, I feel that the pace at which physical engineers make abstractions is really impressive. This skill is of great importance both in an engineering as in a more business-related context.

Testimonial

# Karel Dumon

## Physical Engineer 2015
## Current occupation: Machine Learning Engineer at ML6

I started my studies in Engineering Phyics from a very utopian view: I wanted to know how things worked, in theory ánd in practice. It was very fascinating to get an education where you go from a low level in nature (photons, electrons...) to applications which shape the world of today: lasers, displays, telecommunication, solar panels, nuclear fusion, batteries...

Both the bachelor and master provided a good balance between rigorous mathematical models, physics simulations and practical experiments. Studying a wide array of topics in such depth makes it sometimes challenging to connect the dots, but this definitely enabled me to grow my problem solving skills, both on a conceptual and technical level.

Currently, I work as a Machine Learning Engineer at ML6. I joined the company at a very early stage - when machine learning was not yet part of as many curricula as it is today. My background in Engineering Physics ensures that I have the right multidisciplinary mindset in combination with a solid technical skill set. I work on a lot of different projects, going from laser modelling to HR. Today I co-lead the company's R&D efforts. This entails working together with clients on applications that require algorithms which go beyond the current available set and translate these into scalable products. In general, I see my background in mathematical and physical modelling as a big asset in my job, since it enables me to deep dive into the fundamentals of machine learning and even allows me to explore innovative technologies like quantum computing. Interesting anecdote: my thesis in computational materials physics provided me with practical experience in e.g. python, linux, databases, high performance computing and machine learning - skills I still use on a daily basis!

Summarizing: Engineering Physics brings you to the edge of knowledge in a wide variety of fields, while providing you with the fundamental skills in physics, mathematics and engineering that are needed to research and push the state-of-the-art.

Testimonial

# Inge Nys

Physical Engineer 2013, Doctor in Engineering Physics 2018
Current occupation: postdoctoral researcher at
Ghent University, Liquid Crystals and Photonics Group

During the master in Engineering Physics I came into contact with a broad diversity of research domains (material physics, nuclear physics, electronics, etc.). After graduating in 2013 I decided to specialize in soft matter physics and photonics and I started a PhD in the Liquid Crystals and Photonics Group at Ghent University. I received my PhD in 2018 and am now working as a postdoctoral researcher.

Two things that I appreciated most about the Engineering Physics programme are the combination of fundamental science with an engineering approach and the large variety of elective courses in the master programme. The programme brings you into contact with many different disciplines and allows you to discover which domains are most appealing and what kind of professional career will suit you best. This gives you the freedom to explore many options after graduating. I started a PhD in photonics but some of my fellow students started working in electronics engineering, software engineering and consulting. The goal of the Engineering Physics programme is not to make you an expert in a specific discipline but it hands you the tools to analyse and tackle all kinds of problems in an efficient way. You learn to think out of the box and develop a critical attitude: in general, you become a good problem solver. It is clear that these skills are highly appreciated in many different jobs and will help you to make the best out of your professional career!

# Ward Poelmans

Physical Engineer 2009, Doctor in Engineering Physics 2015
Current occupation: HPC System Administrator, VUB

I work for the high performance computing team of the Vrije Universiteit Brussel. During my PhD I heavily used computational simulations and it was a natural choice to continue in this field. Our team supports researchers in the computational aspects of their work and we deal with all aspects of keeping a large computational cluster online which we continuously try to improve.

I always had a very strong interest in physics and how things work. Engineering Physics was a logical choice as it combines both aspects. The strong mathematical aspect made it all the more fun. The broad scope of the programme gives you a wide vision on the engineering field. I really enjoyed figuring out how the fundamental forces of our universe work and yet trying to find out how we can manipulate them for practical applications. The programme gives you a lot of freedom to follow your own path and pick the courses that interest you the most.

My current job doesn't involve a lot of physics anymore but the tools and skills I learned during my study still serve me very well. My horizon is broad and I can quickly pick up on anything new that comes on my path. I can go both very deep on the technical aspects and yet keep an eye on the global picture. Not once have I regretted my choice for this programme.

# Bart Desoete

Physical Engineer 1997
Current occupation: Head of Project Management Office, Antwerp Space

The combination of technological, purely physical and more theoretical courses really appealed to me. The large choice in elective courses was also one of my main reasons of choosing this programme. I think the study programme Engineering Physics provided me with the ideal basis for my PhD in microelectronics.

After my PhD, I switched to Alcatel Microelectronics, now ON Semiconductor, where I was responsible for the development and manufacturing of new semiconductor technologies. For this function too, I think the main subject of Engineering Physics is very suitable. I'm currently leading the Project Management Office of Antwerp Space.

Testimonial

# Andy Van Yperen-De Deyne

Physical Engineer 2009, Doctor in Engineering Physics 2014
Current occupation: Data Analytics Specialist at ArcelorMittal Ghent

At the Systems and Models group of ArcelorMittal Ghent, we use mathematical models to optimize a wide variety of processes at our site. This varies from the physical processes of steel production, to logistic and planning models. The focus on mathematical models allows to increase the efficiency and productivity of our site at Ghent - and even other sites - even further. As the first data scientist at our site, exploring and performing data mining techniques for process optimization, as well as educating these techniques to my colleagues are my key responsibilities.

Specialization in physics requires a very diverse mathematical tool set and the education in Engineering Physics increases your capabilities in abstract thinking, but always with the aim to solve real problems. The education focuses on a wide variety of the fundamentals of both established and state-of-the-art technologies, which makes this a very interesting four years and prepares the students for jobs in very diverse industries, depending on your own interests.

Testimonial

# Reinout Declerck

Physical Engineer 2005, Doctor in Engineering Physics 2008
Current occupation: Director EFESO Digital

In 2011 I founded a new entreprise together with a colleague from The Boston Consulting Group. EFESO Digital improves the productivity in management environments; we consult a number of big European companies and work on a commercial software product.

The study programme Engineering Physics is both broad and fundamental. Broad, because of the important points of contact with the programmes Electrical Engineering, Chemical Engineering and Computer Science Engineering. Fundamental, because the elementary building blocks of the world around us are thoroughly studied. This combination is a huge asset in both the research community and in corporate life. I have experienced this in my career until now: as a researcher I helped in developing the description of magnetic resonance effects on molecules via computer models; as a management consultant I advised on a wide variety of strategic challenges for some prominent companies; as an entrepreneur I maintain relationships with clients and oversee the development of our software.

# An Beazar

## Physical Engineer 2004
## Current occupation: Business Manager of Enprove bvba

In 2010 I decided to start an own business. Today, I lead a small team that consults industrial companies on how to save energy. We are also developing a software system to monitor the (energy) efficiency of plants.

What appealed to me in the study programme Engineering Physics, is that you could still put your own focus by choosing your elective courses well. At that time, I did not have a clue what I wanted to do afterwards. In hindsight, I feel I have built a broad theoretical basis to fall back on. The practical applications followed later in my job.

To counter the theoretical courses, I followed a minor in Industrial Engineering. My thesis discussed music and signal processing: the recognition of tonalities in music signals. After my final year, I immediately started working as an industrial engineer. An ideal job to get to know the practice of corporate life.

I would summarize my experiences during my studies as follows: on the one hand, I got to know various research topics (relativity, semiconductors, signal processing, business law...). On the other hand, a well-founded scientific approach also provides you with a clear view of the complexity of the matter.

Testimonial

# Francis Ryckaert

Physical Engineer 2016
Current occupation: patent attorney trainee, brantsandpatents

Being a patent attorney trainee, I assist our clients in all matters of intellectual property. Often this involves analysing their innovative products, filing patent applications and guiding them through the process of obtaining a granted patent. The topics are highly diverse. They cover physics, mechanics, electronics, and computer sciences.

The same topic diversity is found in the engineering physics programme. Those undertaking the journey should not be afraid of first exploring some theoretical fields in depth. In any case, you will need to have a good understanding of some basic quantum mechanics and advanced engineering mathematics. A solid basis is provided. Subsequently there is a wide freedom to pick courses according to your own interests. I preferred a more applied approach, electing courses on nanophysics and solar energy. Accordingly, my master thesis related to luminescent quantum dots. In the light of television screen technology today, those should ring a bell, do they not?

Besides all physical theories and phenomena I learned about, the programme most importantly left me with a well-sharpened, analytical mind-set. This comes in handy for the job I now have. More generally, I am convinced that engineering physics offers an ideal springboard to a vast range of jobs, whether physics-related or not. And in the end, a lot boils down to physics as you think of it.

Testimonial

# Joris Creemers

Physical Engineer 2006
Current occupation: Counselor to the Deputy Prime Minister and Minister of Security and the Interior on Nuclear Safety and Security

My previous job as an inspector-expert at FANC was very diverse. The FANC, among other things, watches over the safe use of applications with ionizing radiation. Together with my colleagues, I monitored the state of several large (class I) nuclear plants by means of specific inspections and analysis of both technical and more organisational aspects.

The last few years I have met several fellow physical engineers in different functions in the most diverse sectors (research, industry, government, consultancy…), all leaving me with a very competent impression. Many graduates aim for a PhD or another research position in Belgium or abroad, and the study programme Engineering Physics is the ideal preparation for that. But in my experience, the mindset and skills that are taught, are equally advantageous in other sectors, both in a profession (understanding processes, for example) and in various continued study programmes. After all, the programme Engineering Physics offers a unique combination of detailed knowledge in a broad range of domains. It allows graduated physical engineers to maintain the big picture, while comprehending complex processes. Because of the large number of elective courses and the thesis, you can determine your own specialisation in a simple way, gathering the knowledge that can give you an edge in your subsequent career.

Testimonial

FACULTY OF ENGINEERING
AND ARCHITECTURE

# More questions?
# Drop by some time.

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