UCLouvain

GBIO2M

2017 - 2018

Master [120] in Biomedical Engineering

At Louvain-la-Neuve - 120 credits - 2 years - Day schedule - In english
Dissertation/Graduation Project : **YES** - Internship : **optional**
Activities in other languages : **YES**
Activities on other sites : **optional**
Main study domain : **Sciences de l'ingénieur et technologie**
Organized by: **Ecole Polytechnique de Louvain (EPL)**
Programme acronym: **gbio2m** - Francophone Certification Framework: 7

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GBIO2M - Introduction

Introduction

Introduction

This Master's degree programme educates engineers capable of using a large set of skills (analytical, modelling, design and inventiveness) in order to face future technological challenges in the scientific and technical fields linked to biomedical engineering and this in ever evolving European and global contexts.

Upon completion of this Master's degree programme, you will have fundamental knowledge in all areas of biomedical engineering (bioinstrumentation, biomaterials, imaging and medical physics, mathematical modelling, artificial organs and rehabilitation, bioinformatics and biomechanics) as well as cutting edge knowledge of one or more major fields of study.

Your Profile

You:

- Have developed a marked interest in the biomedical field and its technological outputs (as a result of your undergraduate studies);
- Seek targeted information about current scientific or technological issues as well as the national and international job market;
- Want to play a role in development, production or management in the healthcare field.

Your Programme

This Master's degree offers:

- Knowledge of the main scientific and industrial issues in the fields of applied biomedical engineering;
- Classes that emphasize theories and practice to develop advanced professional knowledge;
- The choice of one of more major fields of study in biomedical engineering;
- The chance to complete an internship in a hospital, in industry or in a research centre;
- The possibility of completing part of your master's degree abroad (in Europe or elsewhere) and in certain cases the granting of a dual master's degree (diploma granted jointly by UCL and the institution where you studied abroad).

GBIO2M - Teaching profile

Learning outcomes

Nowadays, more and more engineers are bringing their ingenuity and analytical skills to the healthcare field. The objective of the Master's degree programme in biomedical engineering is to graduate engineers being capable of meeting the scientific and technological challenges of biomedical engineering in an ever-changing global and European context. Inherently multidisciplinary, this programme builds upon a strong collaboration between the sector of Sciences and Technologies, and the sector of Health Sciences.

Building up on students' existing knowledge in basic sciences (physics, chemistry, mathematics) and life science (biology, anatomy, biochemistry and physiology), this Master's degree programme offers the opportunity to develop multidisciplinary skills in a wide range of topics. Graduated students will be able to understand and model living systems and ultimately be able to design analytical or therapeutic tools (for example, developing new biomedical technologies).

Graduated students will have fundamental knowledge of the main fields of biomedical engineering: bioinstrumentation, biomaterials, imaging and medical physics, mathematical modelling, artificial organs and rehabilitation, bioinformatics and biomechanics. They will further acquire advanced training in one or more of these fields of expertise.

By choosing among several elective courses, students can opt either for polyvalent profile or one being more specialised. Fields of particular interest include (1) software development and algorithms for biomedical data; (2) biomaterials (implants, etc.); (3) biomechanics and medical robotics; (4) medical imaging and medical physics; (5) clinical engineering (i.e. engineering jobs in the hospital).

On successful completion of this programme, each student is able to :

1. Demonstrate mastery of a solid body of knowledge and skills in basic science and engineering science allowing them to understand and solve biomedical engineering problems (Axis 1).

1.1 Identify and use biomedical engineering concepts, laws and reasoning to solve problems in a variety of areas:

-Develop algorithms and software particularly for dealing with biomedical data; analyse biological data and medical images

- Biomaterials (interfaces, biocompatibility, etc.)

-Biomechanics, motor control and medical robotics (for surgery and rehabilitation)

-Clinical engineering

1.2 Identify and use the modelling and calculation tools necessary to solve problems raised by the fields mentioned above

1.3 Validate problem solving results, notably those expressed in orders of magnitude:

-in particular validate models by comparing them to theoretical or experimental results

2.Organise and carry out a procedure in applied engineering related to the development of a product and/or a service that meets a need or solves a particular problem in the field of biomedical engineering (Axis 2).

2.1 Analyse a problem, take stock of its functionalities and constraints; create a specifications note that takes into account technical and economic limits.

2.2 Model a problem and design one or more technical solutions using mechanical, electric, electronic and computerised approaches with the specifications note in mind.

2.3 Evaluate and classify solutions with regard to all the criteria in the specifications note: efficiency, feasibility, quality, ergonomics, security, biocompatibility, etc.

2.4 Test a solution though a mock up, a prototype and/or a numerical model.

2.5 Formulate recommendations to improve a technical solution either to reject it or to explain necessary improvements to make the product operational.

3.Organise and carry out a research project to understand a physical phenomenon or new problem related to biomedical engineering (Axis 3).

3.1 Document and summarize the existing body of knowledge.

3.2 Suggest a model and/or an experimental device allowing for the simulation and testing of hypotheses related to the phenomenon being studied.

3.3. Write a summary report explaining the potentialities of the theoretical and/or technical innovation resulting from the research project.

4.Contribute as part of a team to the planning and completion of a project while taking into account its objectives, allocated resources, and constraints (Axis 4).

4.1 Frame and explain the project's objectives (in terms of performance indicators) while taking into account its issues and constraints (resources, budget, deadlines). Understand the principal mechanisms that govern the healthcare economy as well as the financing of social security.

4.2 Collaborate on a work schedule, deadlines and roles, for example the division of labour among students.

4.3 Work in a multidisciplinary environment with peers holding different points of view; manage any resulting disagreement or conflicts.

4.4 Make team decisions and assume the consequences of these decisions (whether they are about technical solutions or the division of labour to complete a project).

5.Communicate effectively (speaking or writing in French or a foreign language) with the goal of carrying out assigned projects (Axis 5).

5.1 Identify the needs of the client or the user: question, listen and understand all aspects of their request and not just the technical aspects.

5.2 Present your arguments and convince your interlocutors (doctors, therapists, technicians, colleagues, clients, superiors) of your technological choices by adopting their language.

5.3 Communicate through graphics and diagrams: interpret a diagram, present results, structure information.

5.4 Read and analyse different technical documents (rules, plans, specification notes).

5.5 Draft documents that take into account contextual requirements and social conventions as well as the vocabulary specific to biomedical disciplines.

5.6 Make a convincing oral presentation (in French or English) using modern communication techniques.

6.Demonstrate rigor, openness and critical and ethical awareness in your work: using the technological and scientific innovations at your disposal validate the socio-technical relevance of a hypothesis or a solution (Axis 6).

6.1 Rigorously apply the standards of biomedical engineering (terms, units of measure, quality standards and security).

6.2 Find solutions that go beyond strictly technical issues by considering sustainable development and the socio-economic ethics of a project, particularly concerning the consequences of a medical or therapeutic practice;

6.3 Demonstrate critical awareness of a technical solution in order to verify its robustness and minimize the risks that may occur during implementation.

6.4 Evaluate oneself and independently develop necessary skills for “lifelong learning” in the field.

Programme structure

The Master’s degree programme includes:

- a core curriculum (35 credits) including a Master thesis and an additional industrial project;
- a set of courses in the Professional focus (30 credits);
- one or more major courses;
- elective courses to round out the programme

A project with an industrial focus (5 credits) is completed at the beginning of the programme (1st year) while the Master thesis is normally completed at the end of the programme (2nd year). It is recommended that students take courses from the Professional focus (30 credits) at the beginning of their Master’s programme (1st year). However, students may take these courses in the 1st or 2nd year as long as they have completed the course prerequisites. This is particularly the case for students who completed part of their education abroad.

If during the student’s former education, he or she already followed a course being part of the programme (either mandatory or elective) or followed an equivalent activity (pending approval by the programme jury), he or she may replace this activity by elective courses (pending the fullfillment of the programme rules). The student will also verify that he/she has obtained the minimum number of credits required for the approval of the diploma as well as for the approval of their major (in order to include their academic distinctions in the diploma appendix).

These types of programmes will be submitted for approval by the relevant Master’s degree programme jury.

For a programme-type, and regardless of the focus, options/or elective courses selected, this master will carry a minimum of 120 credits divided over two annual units, corresponding to 60 credits each.

> Core courses for the Master's degree in biomedical engineering *[en-prog-2017-gbio2m-lgbio220t.html]*

> Professional focus *[en-prog-2017-gbio2m-lgbio200s]*

Options courses

> Majors in biomedical engineering *[en-prog-2017-gbio2m-lgbio907r.html]*
  > Major in Clinical Engineering *[en-prog-2017-gbio2m-lgbio221o.html]*
  > Major in acquisition and processing of biomedical data *[en-prog-2017-gbio2m-lgbio222o.html]*
  > Major in Biomaterials *[en-prog-2017-gbio2m-lgbio226o.html]*
  > Major in Biomechanics and medical robotics *[en-prog-2017-gbio2m-lgbio227o.html]*
  > Major in Medical physics and medical imaging *[en-prog-2017-gbio2m-lgbio232o.html]*
> Majors in business creation and management *[en-prog-2017-gbio2m-lgbio908r.html]*
  > Business risks and opportunities *[en-prog-2017-gbio2m-lgbio230o.html]*
  > Major in small and medium sized business creation *[en-prog-2017-gbio2m-lgbio231o.html]*
> Elective courses *[en-prog-2017-gbio2m-lgbio910r.html]*
  > Elective courses in Genetic engineering *[en-prog-2017-gbio2m-lgbio250o.html]*
  > Elective courses in biochemical engineering *[en-prog-2017-gbio2m-lgbio251o.html]*
  > Elective courses in pharmaceutical engineering *[en-prog-2017-gbio2m-lgbio252o.html]*
  > Elective courses in statistics *[en-prog-2017-gbio2m-lgbio253o.html]*
> Elective courses *[en-prog-2017-gbio2m-lgbio955o.html]*
> Other elective courses available to students enrolled in the Master's degree in biomedical engineering *[en-prog-2017-gbio2m-lgbio952o.html]*

GBIO2M Detailled programme

Programme by subject

CORE COURSES [35.0]

O Mandatory
△ Courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018
⊠ Optional
⊘ Periodic courses not taught during 2017-2018
Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

						Year 1	2
O LGBIO2990	Master Thesis	Renaud Ronsse (coord.)		28 Credits			x
O LGBIO2220	Industrial project in biomedical engineering	Sophie Demoustier Philippe Lefèvre Renaud Ronsse	30h+30h	5 Credits	1 + 2q	x	x

O Religion courses for students in natural sciences (2 credits)

For students who did their bachelor at UCL
The student shall select

⊠ LTECO2100	Questions of religious sciences: Biblical readings	Hans Ausloos	15h	2 Credits	1q	x	x
⊠ LTECO2200	Questions of religious sciences: reflections about Christian faith	Dominique Martens	15h	2 Credits	2q	x	x
⊠ LTECO2300	Questions of religious sciences: questions about ethics	Marcela Lobo Bustamante	15h	2 Credits	1q	x	x

O Transversal skills and professional contacts

If the student takes the internship LFSA2995 the maximum authorized credits are 26
De 3 à 21 CREDITS parmi

PROFESSIONAL FOCUS [30.0]

O Mandatory
△ Courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018
⊠ Optional
⊘ Periodic courses not taught during 2017-2018
Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

The "professional focus" block of the Master in biomedical engineering offers a series of courses describing the main field of biomedical engineering, from bioinformatics to biomecanics and imaging. It thus consolidates the "general" profile of the program. Students can expect to acquire a deep level of knowledge in each of the disciplines, owing to the large volume of credits devoted to this block.

						Year 1	2
O LGBIO2010	Bioinformatics	Pierre Dupont Michel Ghislain	30h+30h	5 Credits	2q	x	x

						Year 1	Year 2
LGBIO2020	Bioinstrumentation	André Mouraux Michel Verleysen	30h+30h	5 Credits	1q	x	x
LGBIO2030	Biomaterials	Sophie Demoustier Christine Dupont	30h+30h	5 Credits	1q	x	x
LGBIO2040	Biomechanics	Greet Kerckhofs	30h+30h	5 Credits	2q	x	x
LGBIO2050	Medical Imaging	Anne Bol John Lee Benoît Macq Frank Peeters	30h+30h	5 Credits	1q	x	x
LGBIO2060	Modelling of biological systems	Philippe Lefèvre	30h+30h	5 Credits	1q	x	x

OPTIONS

Students MUST choose at least one major from the 5 biomedical engineering majors. They MAY further choose one or more other majors from those in biomedical engineering, or management and business creation.

Majors in biomedical engineering

> Major in Clinical Engineering *[en-prog-2017-gbio2m-lgbio221o]*
> Major in acquisition and processing of biomedical data *[en-prog-2017-gbio2m-lgbio222o]*
> Major in Biomaterials *[en-prog-2017-gbio2m-lgbio226o]*
> Major in Biomechanics and medical robotics *[en-prog-2017-gbio2m-lgbio227o]*
> Major in Medical physics and medical imaging *[en-prog-2017-gbio2m-lgbio232o]*

Majors in business creation and management

> Business risks and opportunities *[en-prog-2017-gbio2m-lgbio230o]*
> Major in small and medium sized business creation *[en-prog-2017-gbio2m-lgbio231o]*

Elective courses

> Elective courses in Genetic engineering *[en-prog-2017-gbio2m-lgbio250o]*
> Elective courses in biochemical engineering *[en-prog-2017-gbio2m-lgbio251o]*
> Elective courses in pharmaceutical engineering *[en-prog-2017-gbio2m-lgbio252o]*
> Elective courses in statistics *[en-prog-2017-gbio2m-lgbio253o]*
> Elective courses *[en-prog-2017-gbio2m-lgbio955o]*
> Other elective courses available to students enrolled in the Master's degree in biomedical engineering *[en-prog-2017-gbio2m-lgbio952o]*

MAJORS IN BIOMEDICAL ENGINEERING

MAJOR IN CLINICAL ENGINEERING

The objective of this major is to provide students with the necessary body of knowledge to work as an engineer in a hospital or in a biomedical products company. It covers areas related to the management of medical technologies, quality control, etc

O Mandatory	⊠ Optional
△ Courses not taught during 2017-2018	⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018	Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

Students selecting this major may choose
De 20 à 30 CREDITS parmi

O Required courses (8 credits)

						Year 1	Year 2
O LGBIO2110	Introduction to Clinical Engineering	Frédéric Crevecoeur Philippe Lefèvre	30h	3 Credits	2q	x	x
O LMECA2711	Quality management and control.	Nicolas Bronchart	30h+30h	5 Credits	2q	x	x

⊠ Elective courses

LSTAT2330 and WESP2123 are mutually exclusive, so as WFSP2218 and LBIRA2101
De 12 à 22 CREDITS parmi

⊠ LBIRA2101	Biometry : analysis of the variance	Xavier Draye (coord.) Anouar El Ghouch Bernadette Govaerts Bernadette Govaerts (compensates Anouar El Ghouch)	30h+15h	4 Credits	1q	x	x

						Year 1	2
⊠ LINGI1341	Computer networks	Olivier Bonaventure	30h+30h	5 Credits	1q	x	x
⊠ LINGI2172	Databases	Siegfried Nijssen	30h+30h	6 Credits	2q	x	x
⊠ LSTAT2110	Data Analysis	Johan Segers	22.5h +7.5h	5 Credits	1q	x	x
⊠ LSTAT2310	Statistical quality control.	Bernadette Govaerts	15h+5h	4 Credits	1q	x	x
⊠ LSTAT2330	Statistics in clinical trials.	Catherine Legrand Annie Robert	22.5h +7.5h	5 Credits	2q	x	x
⊠ LSTAT2360	Seminar in data management: basic	Catherine Legrand	7.5h+10h	5 Credits	1q	x	x
⊠ WESP2123	Principes des essais cliniques	Laurence Habimana Annie Robert (coord.) Françoise Smets	20h+10h	4 Credits	1q	x	x
⊠ WESP2234	Strategy of the medical decision	Laurence Habimana Annie Robert (coord.)	30h	3 Credits	1q	x	x
⊠ WFSP2218	Analyse longitudinale : régression linéaire, logistique et de Poisson	Annie Robert	20h+20h	4 Credits	1q	x	x
⊠ WFSP2260	Management humain et comportement organisationnel	Pierre Meurens Sophie Thunus (coord.)	40h+30h	5 Credits	2q	x	x

MAJOR IN ACQUISITION AND PROCESSING OF BIOMEDICAL DATA

The objective of this major is to provide students with the necessary body of knowledge to acquire and analyze biomedical data, i.e. either raw signal data or large bases of pre-processed data. This major is especially well-suited for students holding a bachelor in computer science, electricity or applied mathematic

O Mandatory	⊠ Optional
△ Courses not taught during 2017-2018	⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018	Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

Students selecting this major may choose
De 20 à 30 CREDITS parmi

O Required courses (10 credits)

						Year 1	Year 2
O LELEC2531	Design and Architecture of digital electronic systems	Jean-Didier Legat	30h+30h	5 Credits	1q	x	x
O LELEC2900	Signal processing	Benoît Macq Luc Vandendorpe	30h+30h	5 Credits	2q	x	x

⊠ Elective courses

The classes LSTAT2320 and LBIRC2106 are mutually exclusive as are the classes LSTAT 2120 and LBIRA2101.
De 10 à 20 CREDITS parmi

⊠ LELEC2532	Design and Architecture of analog electronic systems	David Bol Denis Flandre	30h+30h	5 Credits	2q	x	x
⊠ LELEC2811	Instrumentation and sensors	David Bol Laurent Francis	30h+30h	5 Credits	1q	x	x
⊠ LELEC2870	Machine Learning : regression, dimensionality reduction and data visualization	John Lee (compensates Michel Verleysen) Michel Verleysen	30h+30h	5 Credits	1q	x	x
⊠ LINGI2251	Software Quality Assurance	Charles Pecheur	30h+15h	5 Credits	2q	x	x
⊠ LINGI2261	Artificial intelligence: representation and reasoning	Yves Deville	30h+30h	6 Credits	1q	x	x
⊠ LINGI2262	Machine Learning :classification and evaluation	Pierre Dupont	30h+30h	5 Credits	2q	x	x
⊠ LINMA2361	Nonlinear dynamical systems	Pierre-Antoine Absil	30h +22.5h	5 Credits	1q	x	x
⊠ LINMA2370	Modelling and analysis of dynamical systems	Jean-Charles Delvenne (coord.) Denis Dochain	30h +22.5h	5 Credits	1q	x	x
⊠ LINMA2471	Optimization models and methods II	François Glineur	30h +22.5h	5 Credits	1q	x	x
⊠ LINMA2875	System Identification	Julien Hendrickx	30h+30h	5 Credits	2q	x	x
⊠ LSTAT2320	Design of experiment.	Patrick Bogaert Bernadette Govaerts	22.5h +7.5h	5 Credits	2q	x	x
⊠ LSTAT2110	Data Analysis	Johan Segers	22.5h +7.5h	5 Credits	1q	x	x
⊠ LBIRC2106	Chemometrics	Bernadette Govaerts	22.5h +15h	3 Credits	1q	x	x
⊠ LSTAT2120	Linear models	Christian Hafner	30h+7.5h	5 Credits	1q	x	x
⊠ LBIRA2101	Biometry : analysis of the variance	Xavier Draye (coord.) Anouar El Ghouch Bernadette Govaerts Bernadette Govaerts (compensates Anouar El Ghouch)	30h+15h	4 Credits	1q	x	x

MAJOR IN BIOMATERIALS

The goal of this major is to provide students with the necessary body of knowledge to understand and develop technologies related to biomaterials (implants, biocompatibility, etc.). This major is particularly well-suited for students holding a bachelor in applied chemistry and physics AND biomedical engineering.

O Mandatory	⊠ Optional
△ Courses not taught during 2017-2018	⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018	Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

Students selecting this major may choose
De 20 à 30 CREDITS parmi

O Required courses KIMA students

KIMA students must enrol in LGBIO2030 and LBIR1220A except if they took these courses during their undergraduate programme.
De 5 à 10 CREDITS parmi

					Year 1	Year 2
O LBIR1250A	Biochimie I (partim EPL)		30h+15h	5 Credits 2q	x	x
O LGBIO2030	Biomaterials	Sophie Demoustier Christine Dupont	30h+30h	5 Credits 1q	x	x

O Required courses GBIO students

GBIO students must enrol in LMAPR2481 and LMAPR1805 unless they took these courses during their undergraduate (BAC) programme.
De 5 à 10 CREDITS parmi

O LMAPR1805	Introduction to materials science	Jean-Christophe Charlier Pascal Jacques Aurélien Lherbier (compensates Jean-Christophe Charlier) Bernard Nysten Thomas Pardoen (coord.)	45h+15h	5 Credits 2q	x	x
O LMAPR2481	Deformation and fracture of materials	Thomas Pardoen	30h+30h	5 Credits 1q	x	x

⊠ Recommended courses

De 10 à 21 CREDITS parmi

⊠ LBIR1321	Biochemistry II : metabolic pathways and their regulation	Michel Ghislain (coord.) Yvan Larondelle	30h+15h	3 Credits 1q	x	x
⊠ LBIO1335	Immunology	Jean-Paul Dehoux	25h+15h	3 Credits 1q	x	x
⊠ LELEC2560	Micro and Nanofabrication Techniques	Laurent Francis Benoît Hackens Jean-Pierre Raskin	30h+30h	5 Credits 2q	x	x
⊠ LMAPR2012	Macromolecular Nanotechnology	Sophie Demoustier Karine Glinel (compensates Bernard Nysten) Karine Glinel Jean-François Gohy Bernard Nysten (coord.)	45h+15h	5 Credits 2q	x	x
⊠ LMAPR2019	Polymer Science and Engineering	Sophie Demoustier Alain Jonas Evelyne Van Ruymbeke	45h+15h	5 Credits 1q	x	x

⊠ Elective courses

Max=15 CREDITS parmi

⊠ LBIRC2101A	Analyse biochimique et notions de génie génétique: analyse biochimique	François Chaumont Charles Hachez Pierre Morsomme (coord.)	18.5h +22.5h	4 Credits 1q	x	x

						Year 1	2
⊠ LBIRC2108	Biochemical and Microbial Engineering	Iwona Cybulska	30h +22.5h	5 Credits	2q	x	x
⊠ LGBIO2020	Bioinstrumentation	André Mouraux Michel Verleysen	30h+30h	5 Credits	1q	x	x
⊠ LMAPR2010	Polymer Materials	Christian Bailly Bernard Nysten Evelyne Van Ruymbeke (compensates Bernard Nysten)	45h+15h	5 Credits	1q	x	x
⊠ LMAPR2013	Physical Chemistry for Metals and Ceramics	Pascal Jacques	30h+30h	5 Credits	1q	x	x
⊠ LMAPR2014	Physics of Functional Materials	Xavier Gonze Luc Piraux Gian-Marco Rignanese	37.5h +22.5h	5 Credits	1q	x	x
⊠ LMAPR2018	Rheometry and Polymer Processing	Christian Bailly Evelyne Van Ruymbeke	30h +22.5h	5 Credits	2q	x	x
⊠ LMAPR2631	Surface Analysis	Arnaud Delcorte Bernard Nysten	30h+15h	5 Credits	2q	x	x

MAJOR IN BIOMECHANICS AND MEDICAL ROBOTICS

The goal of this major is to provide students with the necessary body of knowledge to understand and develop technologies related to biomechanics (fluids and solids) and medical robotics (surgical assistance and rehabilitation). This major is particularly well-suited for students holding a bachelor in mechanics.

O Mandatory	⊠ Optional
△ Courses not taught during 2017-2018	⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018	Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

Students selecting this major may choose
De 20 à 30 CREDITS parmi

O Required courses (10 credits)

						Year 1	Year 2
O LMECA2170	Numerical Geometry	Vincent Legat Jean-François Remacle	30h+30h	5 Credits	1q	x	x
O LMECA2355	Mechanical design in biomedical engineering	Greet Kerckhofs Benoît Raucent Ann Vankrunkelsven (compensates Benoît Raucent)	30h+30h	5 Credits	1q	x	x

⊠ Elective courses

De 10 à 20 CREDITS parmi

⊠ LINMA2671	Advanced control and applications	Julien Hendrickx	30h+30h	5 Credits	1q	x	x
⊠ LINMA2875	System Identification	Julien Hendrickx	30h+30h	5 Credits	2q	x	x
⊠ LMECA2300	Advanced Numerical Methods	Philippe Chatelain Christophe Craeye Vincent Legat Jean-François Remacle	30h+30h	5 Credits	2q	x	x
⊠ LMECA2330	Machine components	Laurent Delannay Benoît Raucent Renaud Ronsse Thomas Servais (compensates Benoît Raucent)	30h+30h	5 Credits	2q	x	x
⊠ LMECA2660	Numerical methods in fluid mechanics	Grégoire Winckelmans	30h+30h	5 Credits	2q	x	x
⊠ LMECA2732	Introduction to robotics	Renaud Ronsse	30h+30h	5 Credits	2q	x	x
⊠ LMECA2755	Industrial automation	Bruno Dehez Paul Fisette Renaud Ronsse	30h+30h	5 Credits	1q	x	x
⊠ LMECA2802	Multibody system Dynamics	Paul Fisette	30h+30h	5 Credits	2q	x	x
⊠ LMECA2840	Project in Mechanical Design II	Bruno Dehez Christophe Everarts (compensates Benoît Raucent) Benoît Raucent Renaud Ronsse	30h+30h	6 Credits	1 + 2q	x	x

MAJOR IN MEDICAL PHYSICS AND MEDICAL IMAGING

The goal of this major is to provide students with the necessary body of knowledge to understand and develop technologies related to medical physics and medical imaging. This major is particularly well-suited for students holding a bachelor in electricity or applied chemistry and physics.

O Mandatory	⊠ Optional
△ Courses not taught during 2017-2018	⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018	Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

Students selecting this major may choose
De 20 à 30 CREDITS parmi

O Required courses (10 credits)

						Year 1	Year 2
O LELEC2885	Image processing and computer vision	Christophe De Vleeschouwer (coord.) Laurent Jacques	30h+30h	5 Credits	1q	x	x
O LGBIO2070	Engineering challenges in protontherapy	Guillaume Janssens John Lee Edmond Sterpin	30h+30h	5 Credits	2q	x	x

⊠ Elective courses

De 10 à 20 CREDITS parmi

⊠ LMECA2645	Major technological hazards in industrial activity.	Denis Dochain Alexis Dutrieux	30h	3 Credits	2q	x	x
⊠ LPHY2236	Ionizing radiation measurement: detectors and Nuclear electronics.	Eduardo Cortina Gil	37.5h +55h	5 Credits	1q	x	x
⊠ LPHY2340	Use, management and control of radio elements	Pascal Froment	22.5h	3 Credits	2q	x	x
⊠ LPHY2360	Physique atomique, nucléaire et des radiations	Krzysztof Piotrzkowski	22.5h	2 Credits		x	x
⊠ WMNUC2100	Master and compelmentary master	Véronique Roelants Thierry Vander Borght (coord.)	15h	2 Credits	1q	x	x
⊠ WRDTH3120	Dosimétrie en radiothérapie et contrôle de qualité	Edmond Sterpin	30h	3 Credits	2q	x	x
⊠ WRDTH3131	Radiobiologie	Vincent Grégoire Pierre Scalliet (coord.)	22.5h	2 Credits	2q	x	x
⊠ WRDTH3160	Dosimétrie informatisée en radiothérapie	Vincent Grégoire Pierre Scalliet Edmond Sterpin (coord.)	30h+60h	5 Credits	2q	x	x
⊠ WRPR2001	Notions de base de radioprotection	Michaël Dupont Vincent Grégoire (coord.)	10h+5h	2 Credits	1q	x	x
⊠ WRPR2330	Utilisation des radioisotopes et des molécules marquées en biologie	Bernard Gallez (coord.) Thierry Vander Borght	15h+15h	3 Credits	2q	x	x

MAJORS IN BUSINESS CREATION AND MANAGEMENT

These two majors are exclusive. Students may choose only one.

BUSINESS RISKS AND OPPORTUNITIES

O Mandatory	⊠ Optional
△ Courses not taught during 2017-2018	⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018	Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

This major may not be taken if the major in small and medium sized business creation is taken. Students selecting this major may choose
De 16 à 20 CREDITS parmi

						Year 1	2
O LFSA1290	Introduction to financial and accounting management	André Nsabimana (compensates Gerrit Sarens) Gerrit Sarens	30h+15h	4 Credits	2q	x	x
O LFSA2140	Elements of law for industry and research	Werner Derijcke Bénédicte Inghels Christophe Lazaro	30h	3 Credits	1q	x	x
O LFSA2210	Organisation and human resources	John Cultiaux	30h	3 Credits	2q	x	x
O LFSA2230	Introduction to management and to business economics	Benoît Gailly	30h+15h	4 Credits	2q	x	x
O LFSA2245	Environment and business	Thierry Bréchet Jean-Pierre Tack	30h	3 Credits	2q	x	x

O *One course between*

De 3 à 5 CREDITS parmi

⊠ LFSA2202	Ethics and ICT	Axel Gosseries Olivier Pereira	30h	3 Credits	2q	x	x
⊠ LLSMS2280	Business Ethics and Compliance Management	Carlos Desmet	30h	5 Credits	1q	x	x

⊠ *Alternative to the major in business risks and opportunities for computer science students*

Computer science students who have already taken courses in this field while pursuing their Bachelor's degree may choose between 16-20 credits from the courses offered in the management minor for computer sciences.

MAJOR IN SMALL AND MEDIUM SIZED BUSINESS CREATION

Accessible from most of the Masters' degrees in engineering, the goal of this major is to familiarize engineering students with the specifics of small and medium sized businesses, entrepreneurship, and business development in order to develop the necessary abilities, knowledge and tools to create their own business. This major is accessible only to a small number of students whose selection is based on a written application and individual interview. The written application must be submitted before the beginning of the first academic year of the Master. Applications may be sent to: Secrétariat CPME-Place des Doyens, 1 1348 Louvain-la-Neuve (tel. 010/47 84 59) Selected students will replace their Master's thesis in the core curriculum in the core curriculum with a thesis related to business creation (the number of credits remaining the same).

O Mandatory	⊠ Optional
△ Courses not taught during 2017-2018	⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018	Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

Further information about this major may be found at http//www.uclouvain.be/cpme. This major may not be taken at the same time as a major in management. Students in this major may choose 20-25 credits from the following courses:
De 20 à 25 CREDITS parmi

O Required courses for the major in small and medium sized businesses

						Year 1	Year 2
O LCPME2001	Entrepreneurship Theory (in French)	Frank Janssen	30h+20h	5 Credits	1q	x	
O LCPME2002	Managerial, legal and economic aspects of the creation of a company (in French)	Yves De Cordt Marine Falize	30h+15h	5 Credits	1q	x	x
O LCPME2003	Business plan of the creation of a company (in French)	Frank Janssen	30h+15h	5 Credits	2q		x
O LCPME2004	Advanced seminar on Enterpreneurship (in French)	Roxane De Hoe (compensates Frank Janssen) Frank Janssen	30h+15h	5 Credits	2q	x	x

⊠ Prerequisite CPME courses

Student who have not taken management courses during their previous studies must enroll in LCPME2000.

O LCPME2000	Venture creation financement and management I	Yves De Rongé Olivier Giacomin	30h+15h	5 Credits	1q	x	

ELECTIVE COURSES

ELECTIVE COURSES IN GENETIC ENGINEERING

- O Mandatory
- △ Courses not taught during 2017-2018
- ⊕ Periodic courses taught during 2017-2018
- ⊠ Optional
- ⊘ Periodic courses not taught during 2017-2018
- Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

						Year 1	Year 2
⊠ LBIR1322	General genetics	Philippe Baret Jacques Mahillon (compensates Philippe Baret)	45h+15h	4 Credits	2q	x	x
⊠ LBIRC2101B	Analyse biochimique et notions de génie génétique: Notions de génie génétique	François Chaumont Charles Hachez Pierre Morsomme (coord.)	18.5h +22.5h	4 Credits	1q	x	x
⊠ LBRMC2101	Genetic engineering	François Chaumont (coord.) Charles Hachez	30h+7.5h	3 Credits	1q	x	x

ELECTIVE COURSES IN BIOCHEMICAL ENGINEERING

- O Mandatory
- △ Courses not taught during 2017-2018
- ⊕ Periodic courses taught during 2017-2018
- ⊠ Optional
- ⊘ Periodic courses not taught during 2017-2018
- Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

						Year 1	Year 2
⊠ LBRAL2102	Physiological and nutritional biochemistry	Cathy Debier Yvan Larondelle (coord.)	52.5h	5 Credits	1q	x	x
⊠ LBRAL2104	Food microbiology	Jacques Mahillon	30h +22.5h	5 Credits	2q	x	x
⊠ LBRMC2202	Cell culture technology	David Alsteens Charles Hachez (coord.) Pascal Hols	30h	3 Credits	1q	x	x
⊠ LBRNA2202	Nano-biotechnologies	Yves Dufrêne	30h	3 Credits	2q	x	x
⊠ LBRTE2201	Human and environmental toxicology	Cathy Debier (coord.) Philippe Hantson	45h+7.5h	5 Credits	1q	x	x

ELECTIVE COURSES IN PHARMACEUTICAL ENGINEERING

- O Mandatory
- △ Courses not taught during 2017-2018
- ⊕ Periodic courses taught during 2017-2018
- ⊠ Optional
- ⊘ Periodic courses not taught during 2017-2018
- Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

						Year 1	Year 2
⊠ LINMA2300	Analysis and control of distributed parameter systems	Denis Dochain	30h+30h	5 Credits	1q	x	x
⊠ LMAPR2118	Fluid-fluid separations	Patricia Luis Alconero Denis Mignon	30h +22.5h	5 Credits	2q	x	x

						Year 1	2
⊠ LMAPR2330	Reactor Design	Juray De Wilde	30h+30h	5 Credits	2q	x	x
⊠ LMAPR2380	Solid-fluid separation	Tom Leyssens Patricia Luis Alconero	30h +22.5h	5 Credits	1q	x	x
⊠ LMAPR2430	Industrial processes for the production of base chemicals	Juray De Wilde	30h +22.5h	5 Credits	1q	x	x
⊠ WFARM1008	Design of the drug	Giulio Muccioli Véronique Préat (coord.)	15h+15h	2 Credits	2q	x	x
⊠ WFARM1232	General Pharmacology	Emmanuel Hermans	15h+7.5h	2 Credits	1q	x	x
⊠ WFARM1307	Physical pharmacy	Tom Leyssens	15h	2 Credits	1q	x	x

ELECTIVE COURSES IN STATISTICS

O Mandatory
⊠ Optional
△ Courses not taught during 2017-2018
⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018
Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

This module in statistics offers courses being useful for data processing (analysis laboratory, clinical research, quality management, etc.). Students taking at least 45 credits in this module and among courses in statistics from the majors of the Master (labels LBIRA, LBIRC, LSTAT, WESP, WFSP) will later get a direct access to the second year of the Master in Statistics: Biostatistics [120 credits]. More information about this program bridge via info-stat-actu@uclouvain.be

						Year 1	Year 2
⊠ LSTAT2020	Statistical computing	Céline Bugli (compensates Bernadette Govaerts) Bernadette Govaerts	20h+20h	6 Credits	1q	x	x
⊠ LSTAT2040	Statistical analysis	Benjamin Colling (compensates Ingrid Van Keilegom) Benjamin Colling (compensates Anouar El Ghouch) Anouar El Ghouch Anouar El Ghouch (compensates Ingrid Van Keilegom) Ingrid Van Keilegom	30h+15h	5 Credits	2q	x	x
⊠ LSTAT2130	Introduction to Bayesian statistics	Philippe Lambert	15h+5h	4 Credits	2q	x	x
⊠ LSTAT2170	Times series	Rainer von Sachs	22.5h +7.5h	5 Credits	2q	x	x
⊠ LSTAT2210	Advenced linear models	Catherine Legrand	15h+5h	4 Credits	1q	x	x
⊠ LSTAT2220	Analysis of survival and duration data	Ingrid Van Keilegom	15h+5h	4 Credits	1q	x	x

ELECTIVE COURSES

O Mandatory
⊠ Optional
△ Courses not taught during 2017-2018
⊘ Periodic courses not taught during 2017-2018
⊕ Periodic courses taught during 2017-2018
Activity with requisites

Click on the course title to see detailed informations (objectives, methods, evaluation...)

De 3 à 21 CREDITS parmi

O Compétences transversales et contact avec l'entreprise

L'étudiant choisit minimum 3 crédits parmi un stage, un ou plusieurs cours de l'option "Enjeux de l'entreprise", l'option "CPME", une UE d'activité professionnelle liée à la discipline
Min=3 credits parmi

⊠ Internship

						Year 1	Year 2
⊠ LFSA2995	Company Internship	Jean-Pierre Raskin	30h	10 Credits	1 + 2q	x	x
⊠ LFSA2996	Company Internship			5 Credits	1 + 2q	x	x

⊠ Professional integration activity specific to the program

						Year 1	Year 2
⊠ LGBIO2220	Industrial project in biomedical engineering	Sophie Demoustier Philippe Lefèvre Renaud Ronsse	30h+30h	5 Credits	1 + 2q	x	x

Year
1 2

⊠ Communication

L'étudiant choisit maximum 8 crédits visant le développement de ses compétences de communication
Max=8 CREDITS parmi

⊠ Languages

Students may select from any language course offered at the ILV. Special attention is placed on the following seminars in professional development:

⊠ LALLE2500	Professional development seminar German	Caroline Klein Ann Rinder (coord.)	30h	3 Credits	1 + 2q	x	x
⊠ LALLE2501	Professional development seminar-German	Caroline Klein Ann Rinder (coord.)	30h	5 Credits	1 + 2q	x	x
⊠ LESPA2600	Vocational Induction Seminar - Spanish (B2.2/C1)	Paula Lorente Fernandez (coord.)	30h	3 Credits	1q	x	x
⊠ LESPA2601	Vocational Induction Seminar - Spanish (B2.2/C1)	Paula Lorente Fernandez (coord.)	30h	5 Credits	1q	x	x
⊠ LNEER2500	Seminar of Entry to professional life in Dutch - Intermediate level	Isabelle Demeulenaere (coord.) Mariken Smit	30h	3 Credits	1 ou 2q	x	x
⊠ LNEER2600	Seminar of entry to professional life in Dutch - Upper-Intermediate level	Isabelle Demeulenaere (coord.)	30h	3 Credits	1 ou 2q	x	x

⊠ Group dynamics

⊠ LFSA2351A	Group dynamics	Piotr Sobieski (coord.) Vincent Wertz (coord.)	15h+30h	3 Credits	1q	x	x
⊠ LFSA2351B	Group dynamics	Piotr Sobieski (coord.) Vincent Wertz (coord.)	15h+30h	3 Credits	2q	x	x

⊠ Autre UE non disciplinaires

L'étudiant peut proposer maximum 8 crédits d'ouverture vers d'autres disciplines (maximum un cours BEST ou des UE hors EPL).
Max=8 CREDITS parmi

OTHER ELECTIVE COURSES AVAILABLE TO STUDENTS ENROLLED IN THE MASTER'S DEGREE IN BIOMEDICAL ENGINEERING

Students can also include in their curriculum any course included in other EPL masters, subject to the approval of the jury.

Course prerequisites

A document entitled (nb: not available for this programme gbio2m) specifies the activities (course units - CU) with one or more pre-requisite(s) within the study programme, that is the CU whose learning outcomes must have been certified and for which the credits must have been granted by the jury before the student is authorised to sign up for that activity.

These activities are identified in the study programme: their title is followed by a yellow square.

As the prerequisites are a requirement of enrolment, there are none within a year of a course.

The prerequisites are defined for the CUs for different years and therefore influence the order in which the student can enrol in the programme's CUs.

In addition, when the panel validates a student's individual programme at the beginning of the year, it ensures the consistency of the individual programme:

- It can change a prerequisite into a corequisite within a single year (to allow studies to be continued with an adequate annual load);
- It can require the student to combine enrolment in two separate CUs it considers necessary for educational purposes.

For more information, please consult regulation of studies and exams.

The programme's courses and learning outcomes

For each UCL training programme, a reference framework of learning outcomes specifies the competences expected of every graduate on completion of the programme. You can see the contribution of each teaching unit to the programme's reference framework of learning outcomes in the document "In which teaching units are the competences and learning outcomes in the programme's reference framework developed and mastered by the student?"

GBIO2M - Information

Admission

General and specific admission requirements for this program must be satisfied at the time of enrolling at the university..

SUMMARY

Specific Admission Requirements

Ce programme étant enseigné en anglais, aucune preuve préalable de maitrise de la langue française n'est requise. L'étudiant est supposé avoir minimum le niveau B2 en anglais dans le cadre européen commun de référence pour les langues.

University Bachelors

Diploma	Special Requirements	Access	Remarks
UCLouvain Bachelors			
Bachelor in engineering [180.0]		Direct Access	Students who have neither major nor minor in the field of their civil engineering Master's degree may have an adapted master programme.
Others Bachelors of the French speaking Community of Belgium			
Bachelor in engineering	With specific options in former institution related to biomedical engineering	Direct Access	
Bachelor in engineering		Access with additional training	Students with a Bachelor's degree in engineering sciences (with a focus on civil engineering) who have not taken the equivalent of a minor in biomedical engineering must submit a written application to the biomedical programme commission in which they list their detailed course curriculum (list of course work and marks year by year). The jury will suggest a programme in keeping with the student's previous course of study with the possible addition of a maximum of 15 supplemental credits.
Bachelors of the Dutch speaking Community of Belgium			
Bachelor in engineering	With specific options in former institution related to biomedical engineering	Direct Access	
Bachelor in engineering		Access with additional training	Students who have no specialisation in biomedical engineering must submit

			a written application to the programme commission in biomedical engineering in which they list their detailed course curriculum (list of course work and marks year by year). The jury will suggest a programme in keeping with the student's previous course of study with the possible addition of a maximum of 15 supplemental credits.
Bachelor's degree equivalent to one of those required from graduates of the French-speaking community	With specific options in former institution related to biomedical engineering	-	Students without a Bachelor's degree in engineering sciences (with a focus on civil engineering) must submit a written application to EPL in which they list their detailed course curriculum (list of course work and marks year by year). The jury will determine whether the student may be admitted (based solely on the common Bachelor's degree training for engineering sciences with a focus on civil engineering) and their decision will be in keeping with the rules pertaining to bridge years. When necessary, the jury may suggest a programme in keeping with the student's previous course of study with the possible addition of a maximum of 15 supplemental credits.
Foreign Bachelors			
Bachelor in engineering	Bachelors from the Cluster network	Access with additional training	Conditions imposed on UCL Engineering Bachelor.
Bachelor in engineering	Other institutions	Based on application: accepted, conditional on further training, or refusal	Students will submit a written application for admission to EPL in which they list their detailed course curriculum (list of course work and marks year by year). The jury will determine whether the candidate may be admitted according to the regulations. Where necessary the jury may suggest a programme in keeping with the student's previous course of study with the possible addition of a maximum of 15 supplemental credits.

Non university Bachelors

Holders of a 2nd cycle University degree

Diploma	Special Requirements	Access	Remarks
"Licenciés"			
Engineers considered equivalent to the corresponding Bachelor's degree		Direct Access	
Masters			
Master in engineering		Direct Access	

Holders of a non-University 2nd cycle degree

Adults taking up their university training

> See the website Valorisation des acquis de l'expérience (https://uclouvain.be/fr/etudier/vae)

It is possible to gain admission to all masters courses via the validation of professional experience procedure.

Access on the file

Reminder : all Masters (apart from Advanced Masters) are also accessible on file.

Students may submit an application for admission to the Louvain School of Engineering in which they list their detailed course curriculum (list of course work and marks year by year). The School in collaboration with the relevant programme commission will determine whether the student may be admitted and their decision will respect the programme rules. When necessary, they may suggest an individualised programme consisting of a part of the elective courses in the relevant Master's degree programme in civil engineering with the possible addition of a maximum of 15 supplemental credits.

The School in collaboration with the relevant programme commission will determine whether the student may be admitted and their decision will respect the programme rules. When necessary, the jury may suggest a programme in keeping with the student's previous course of study with the possible addition of a maximum of 15 supplemental credits.

Admission and Enrolment Procedures for general registration

Teaching method

Methods that promote multidisciplinarity

The Master's degree programme in biomedical engineering is by nature interdisciplinary since it lies at the interface between engineering and biomedical sciences. It is grounded on a solid course programme that provides students with knowledge of the main areas in biomedical engineering as well as various majors in related disciplines.

Various teaching strategies

The teaching methods used in the Master's degree programme in biomedical engineering are consistent with that of the Bachelor's degree programme in engineering sciences: active learning, an equal mix of group work and individual work, and emphasis on the development of non-technical skills.

A major characteristic of the programme is the immersion of students in research laboratories (for class laboratories, case studies, projects, theses) exposing them to advanced methods and allowing them to learn by questioning. This process is very central for a research perspective.

Half of the student workload in the last year consists in the Master thesis fulfillment and offers students the possibility to deeply investigate. Given its size and context it provides a true initiation into the working life of an engineer or researcher.

Diverse learning situations

Learning is achieved by various pedagogical methods such as internships, case studies, classes, projects, exposure to cutting edge research and meetings with key industrial players in the field.

This variety of teaching techniques allows students to learn in an iterative and progressive way.

The business creation major is based on an interactive teaching method and is oriented toward problem-based learning. Throughout the program, students work in multidisciplinary teams to participate in group projects. The Master's thesis is multidisciplinary in nature so that groups of three students, ideally from different academic departments, can work on a business creation project.

Evaluation

The evaluation methods comply with the regulations concerning studies and exams (https://uclouvain.be/fr/decouvrir/rgee.html). More detailed explanation of the modalities specific to each learning unit are available on their description sheets under the heading "Learning outcomes evaluation method".

Student work is evaluated according to University rules (see the rules for evaluating coursework and exams) namely written and oral exams, laboratory exams, individual or group work, public presentations of projects and theses defences. Professors provide details about evaluation methods used in their courses at the beginning of each semester.

For more information on evaluation methods, students may consult the relevant evaluation descriptions.

To obtain a passing grade, the marks received for the teaching units are offset by their respective credits.

Mobility and/or Internationalisation outlook

Since its creation, the Louvain School of Engineering (EPL) has participated in diverse exchange programs (https://uclouvain.be/epl-international.html) that were put into place at the European level and beyond.

Possible trainings at the end of the programme

Accessible complementary Master's degrees: currently under examination.

Accessible PhD curricula : by virtue of its training towards and via research, the Master in biomedical engineering gives its students an excellent preparation towards PhD studies. Instructors involved in the Master are members of various doctoral schools, which are there to welcome students who wish to further their studies via a PhD.

Contacts

Attention, you are currently reading an archived page: below contact informations were for program study 2017-2018 only. To get current contact informations please got to current program study site.

Curriculum Management

Entity

Structure entity	SST/EPL/GBIO
Denomination	(GBIO) (https://uclouvain.be/repertoires/entites/gbio)
Faculty	Louvain School of Engineering (EPL) (https://uclouvain.be/repertoires/entites/epl)
Sector	Sciences and Technology (SST) (https://uclouvain.be/repertoires/entites/sst)
Acronym	GBIO
Postal address	Place du Levant 3 - bte L5.03.02 1348 Louvain-la-Neuve Tel: +32 (0) 10 47 25 86 - Fax: +32 (0) 10 47 25 98

Academic supervisor: Renaud Ronsse

Jury

- Jean-Didier Legat
- Renaud Ronsse

Useful Contact(s)

- Isabelle Dargent

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