DOCTORATE IN PHILOSOPHY
BIOMEDICAL ENGINEERING
AND SPECIALIZATION
BIOINFORMATICS

Summary

• Degree offered: Doctorate in Philosophy (PhD)
• Registration status option: Full-time
• Language of instruction: English
• Program option (expected duration of the program):
  • within four years
• Academic units: Faculty of Engineering (https://engineering.uottawa.ca/), School of Electrical Engineering and Computer Science (http://engineering.uottawa.ca/eecs/), Department of Mechanical Engineering (http://engineering.uottawa.ca/mechanical/), Department of Chemical Engineering (http://engineering.uottawa.ca/chemical/), Ottawa-Carleton Institute of Biomedical Engineering (http://www.ocibme.ca/).

Program Description

The program prepare candidates for a variety of careers in teaching and research both within and outside of academia.

Graduate students are actively involved in laboratory research, coursework, and presentation of research seminars. Thus, they acquire autonomy in conducting research and in preparing publications.

The programs create a stimulating and challenging environment which will allow students to achieve excellence in research. Graduates of the programs must demonstrate research skills and credibility as professionals in their area of research.

The Department is a participating unit in the Bioinformatics collaborative program.

Collaborative Program Description

Bioinformatics is an emerging and increasingly important scientific discipline dedicated to the pursuit of fundamental questions about the structure, function and evolution of biological entities through the design and application of computational approaches. Fundamental research in these areas is expected to increase our understanding of human health and disease which translates into innovation in industry. Bioinformaticians today must be able to appreciate significant research in other fields and therefore require an understanding of the basic principles of other disciplines.

The degree awarded specifies the primary program and indicates "specialization in Bioinformatics.”

Main Areas of Research

• General biochemistry
• Molecular biology
• Metabolism

Other Programs Offered Within the Same Discipline or a Related Area

• Doctorate in Philosophy Biomedical Engineering (PhD)

Fees and Funding

• Program fees

The estimated amount for university fees (https://www.uottawa.ca/university-fees/) associated with this program are available under the section Finance your studies (http://www.uottawa.ca/graduate-studies/programs-admission/finance-studies/).

International students enrolled in a French-language program of study may be eligible for a differential tuition fee exemption (https://www.uottawa.ca/university-fees/differential-tuition-fee-exemption/).

• To learn about possibilities for financing your graduate studies, consult the Awards and financial support (https://www.uottawa.ca/graduate-studies/students/awards/) section.

Notes

• Programs are governed by the general regulations (http://www.uottawa.ca/graduate-studies/students/general-regulations/) in effect for graduate studies.
• In accordance with the University of Ottawa regulation, students have the right to complete their assignments, examinations, research papers, and theses in French or in English.

Program Contact Information

Graduate Studies Office, Faculty of Engineering (https://engineering.uottawa.ca/graduate-studies-office/)
STE 1024
800 King Edward Ave.
Ottawa ON Canada
K1N 6N5
Tel.: 613-562-5347
Fax.: 613-562-5129
Email: engineering.grad@uottawa.ca

Twitter | Faculty of Engineering (https://twitter.com/uOttawaGenie/?lang=en)
Facebook | Faculty of Engineer (https://www.facebook.com/uottawa.engineering/)

Admission Requirements

For the most accurate and up to date information on application deadlines, language tests and other admission requirements, please visit the specific requirements (https://www.uottawa.ca/graduate-studies/programs-admission/apply/specific-requirements/) webpage.

To be eligible, candidates must:

• Hold a master’s degree in Biomedical Engineering or a related discipline with a minimum average of 75% (B+).

Note: International candidates must check the admission equivalencies (https://www.uottawa.ca/graduate-studies/)
international/study-uottawa/admission-equivalencies/) for the diploma they received in their country of origin.

- Demonstrate a good academic research performance.
- Identify at least one professor who is willing to supervise your research and thesis.
  - We recommend that you contact potential thesis supervisors as soon as possible.
  - To enroll, you need to have been accepted by a thesis supervisor.
  - The supervisor’s name is required at the time of application.
  - The choice of research supervisor will determine the primary campus location of the student. It will also determine which university awards the degree.

**Language Requirements**
Courses are delivered in English as the international language for advanced technology in engineering. However, the program will provide an appropriately supportive environment for francophone students to develop professional competence in technical English at their own pace. Students have the right, as stipulated in the University’s bilingualism regulations (Academic Regulations I-2), to complete all their work, including their thesis, in the official language of their choice (French or English). There are fully bilingual professors and advisors who can support students in French.

Applicants whose first language is neither French nor English must provide proof of proficiency in the language of instruction.

**Notes:**
- Candidates are responsible for any fees associated with the language tests.
- Test scores cannot be more than two-years-old as of September 1 of the year of potential entry into the program.

**Language tests recognized by the University of Ottawa:**
- TOEFL: 550 (Paper-based) or 79-80 (Internet-based); or
- IELTS: Overall 6.5 – Individual 5.0 (Paper-based or internet-based); or
- An equivalent language test (http://www.uottawa.ca/graduate-studies/programs/admission/apply/required-documents/).

Note: Candidates are responsible for any fees associated with the language tests.

**Notes**
- The admission requirements listed above are minimum requirements and do not guarantee admission to the program.
- Admissions are governed by the general regulations in effect for graduate studies and by the general regulations of the Ottawa-Carleton Institute for Biomedical Engineering (OCIBME).
- Research facilities are shared between the two campuses. Students have access to the professors, courses and facilities at both universities.
- Students must indicate in their initial application for admission to the Doctoral program in Biomedical Engineering that they wish to be accepted into the collaborative program in Biomedical Engineering specialization in Bioinformatics. Students must be admitted in one of the primary programs participating in the collaborative program. Students will normally be informed about their acceptance into the collaborative program at the same time as being informed about their admission into the primary program.
- Research activities can be conducted either in English, French or both, depending on the language used by the professor and the members of his or her research group.

**Fast-Track from Master’s to PhD**
Students enrolled in the master’s program in Biomedical Engineering at the University of Ottawa may be eligible to fast-track directly into the doctoral program without writing a master’s thesis, provided the following conditions are met:

- Achieved an 80% (A-) average in their last two years of undergraduate studies
- Completion of 5 graduate courses (15 units) with a grade of A- or better in each;
- Satisfactory progress in the research program;
- Written recommendation from the supervisor and the thesis advisory committee;
- Approval by the graduate studies committee.

Note: The transfer must take place within sixteen months of initial enrolment in the master’s. Following transfer, all the requirements of the doctoral program must be met.

**Program Requirements**

**Doctorate with Collaborative Specialization**
Students must meet the following requirements:

**Compulsory Courses:**

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<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>BMG 5112</td>
<td>Introduction to Biomedical Engineering</td>
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<tr>
<td>BNF 5106</td>
<td>Bioinformatics</td>
<td>3</td>
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<td>3 course units from:</td>
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<tr>
<td>BMG 5103</td>
<td>Biomedical Instrumentation</td>
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<td>BMG 5104</td>
<td>Biological Signals</td>
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<td>BMG 5105</td>
<td>Medical Imaging Modalities</td>
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<td>BMG 5106</td>
<td>Introduction to Medical Imaging Principles and Technology</td>
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<td>BMG 5107</td>
<td>Applications in Biomedical Image Processing</td>
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<td>BMG 5300</td>
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<td>BMG 5301</td>
<td>Biomechanics of Skeletal System, Motion and Tissue</td>
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<td>BMG 5302</td>
<td>Biofluid Mechanics</td>
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<td>BMG 5306</td>
<td>Special Topics in Mechanical and Aerospace Engineering: Biomechanics</td>
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<tr>
<td>BMG 5311</td>
<td>Design of Medical Devices and Implants</td>
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Development in Research (SADRs): uOttawa focuses research strengths and efforts in four Strategic Areas of research universities.

Parliament Hill, the University of Ottawa is among Canada's top 10 Located in the heart of Canada's capital, a few steps away from Research Fields & Facilities

La note de passage dans tous les cours est de B.

Exigences minimales

With cutting-edge research, our graduate students, researchers and educators strongly influence national and international priorities.

Research at the Ottawa-Carleton Institute of Biomedical Engineering (OCIBME)

Established in 2006, the Ottawa-Carleton Institute of Biomedical Engineering (OCIBME) combines the teaching and research strengths of many academic units across the University of Ottawa and Carleton University.

Graduate education in biomedical engineering is multidisciplinary, and it combines the teaching and research input of seven primary participating academic units at:

- University of Ottawa:
  - Department of Mechanical Engineering (MCG)
  - Department of Electrical Engineering and Computer Science (EECS)
  - Department of Chemical Engineering (CHG)
- Carleton University:
  - Department of Systems and Computer Engineering Department of Mechanical and Aerospace Engineering School of Computer Science
  - Department of Physics

Research facilities are shared between the two campuses. Students have access to the professors, courses and facilities at both universities; however, they must enroll at the “home university” of their thesis supervisor if they are enrolled in the MASc option, or of their project supervisor if they are enrolled in the MEng with project/internship.

The Institute benefits from the expertise of a number of prominent medical researchers and well established University of Ottawa medical research units including: the University of Ottawa Heart Institute and the University of Ottawa Eye Institute. In addition to the participating academic units listed above, a number of others are involved in the program through the research activities of some of their faculty members, or through graduate courses that may be taken as electives by students in the program.

Members of the Institute are engaged in five main research fields:

1. Medical instrumentation
2. Biomedical image processing
3. Biomechanics and biomaterials
4. Medical informatics
5. Telemedecine

For more information, refer to the list of faculty members and their research fields on Uniweb.

IMPORTANT: Candidates and students looking for professors to supervise their thesis or research project can also consult the website of the faculty or department (https://www.ualberta.ca/graduate-studies/students/academic-unit-contact-information/) of their program of choice.

Uniweb does not list all professors authorized to supervise research projects at the University of Ottawa.

Courses

**BNF 5106 Bioinformatics (3 units)**
Major concepts and methods of bioinformatics. Topics may include, but are not limited to: genetics, statistics & probability theory, alignments, phylogenetics, genomics, data mining, protein structure, cell simulation and computing.

**Course Component:** Lecture

**BNF 5107 Applied Bioinformatics (3 units)**
Computational knowledge discovery in and the dynamic nature of cellular networks. Includes, but is not limited to, knowledge representation, large scale data integration, data mining and computational systems biology.

This course is equivalent to BIOL 5516 at Carleton University.

**Course Component:** Lecture

**BNF 5504 Laboratoire de bioinformatique (3 crédits)**
Principes d'organisation, de récupération, de manipulation et d'analyse de données moléculaires en génomique, protéomique et transcriptomique. Analyses pratiques de ces données pour résoudre des questions biologiques en utilisant des méthodes quantitatives et computationnelles.

**Volet:** Théorie et laboratoire

Les cours BPS 4504 et BNF 5504 ne peuvent être combinés pour l'obtention de crédits.

**BNF 5506 Bioinformatique (3 crédits)**
Concepts and methods in bioinformatics. Les sujets abordés peuvent inclure, entre autres, la génétique, les statistiques et les théories des probabilités, les alignements, la phylogénétique, la génomique et la structure de protéines.

**Volet:** Cours magistral

**BNF 6100 MSc Seminar (3 units)**
Current topics in bioinformatics presented by program professors and invited speakers. Oral presentation and written report required. Graded S (Satisfactory) / NS (Not satisfactory).

**Course Component:** Lecture

**BNF 6500 Séminaire de maîtrise (3 crédits)**
Sujets courants en bioinformatique présentés par des professeurs membres du programme et des conférenciers invités. Présentation orale et rapport écrit requis. Noté S (satisfaisant) ou NS (non satisfaisant).

**Volet:** Cours magistral

**BNF 8166 Seminar in Bioinformatics (3 units)**
Current research topics in bioinformatics presented by PhD students and invited speakers. Oral presentation required. Graded S (Satisfactory) / NS (Not satisfactory).

**Course Component:** Seminar

**BNF 8301 Evolutionary Bioinformatics (3 units)**
Fundamental concepts in molecular evolution and hands-on experience with computer analysis of DNA sequences. Topics may include molecular sequence databases, multiple alignments and phylogenetic trees. This course is equivalent to BIOL 5201 at Carleton University.

**Course Component:** Lecture

Prerequisite: Graduate standing plus basic courses in genetics and evolution.

**BNF 8766 Séminaire en bioinformatique (3 crédits)**
Sujets courants en bioinformatique présentés par des étudiants en PhD et des conférenciers invités. Présentation orale requise. Noté S (satisfaisant) ou NS (non satisfaisant).

**Volet:** Séminaire

**BMG 5001 Stage en génie clinique / Clinical Engineering Internship (6 crédits / 6 units)**
Stage en génie clinique dans un établissement extérieur à l'université. Rédaction d'un rapport ayant trait aux activités menées durant l'internat. Noté S (satisfaisant) ou NS (non satisfaisant) par le superviseur et un professeur nommé par le directeur du programme. / Internship in an institutional setting outside the university. Requires a formal written paper relating to the internship activities. Graded S (Satisfactory) / NS (Not satisfactory) by the supervisor and a professor appointed by the program director. Préalable : approbation du directeur du programme. / Prerequisite: approval of the program director. Ce cours est équivalent à BIOM 5801 à la Carleton University. / This course is equivalent to BIOM 5801 at Carleton University.

**Volet / Course Component:** Stage / Work Term

Préalable : approbation du directeur de programme. / Prerequisite: approval of the program director.

**BMG 5103 Biomedical Instrumentation (3 units)**
Instrumentation designed to measure physiological variables related to the function of the heart, lungs, kidney, nervous and musculo-skeletal systems; emergency, critical care, surgery and anesthesia equipment.

This course is equivalent to BIOM 5100 at Carleton University.

**Course Component:** Lecture

**BMG 5104 Biological Signals (3 units)**
Modeling of neuromuscular biological signals, including subthreshold phenomena, active behaviour of cell membranes, and innervation processes. Measurement of biological signals, including electrode effects. Time domain, frequency domain, and adaptive filtering techniques for noise reduction. This course is equivalent to BIOM 5101 at Carleton University.

**Course Component:** Lecture

**BMG 5106 Bioinformatics (3 units)**
Phenomena, active behaviour of cell membranes, and innervation.

**Courses**

**BMG 5107 Medical Imaging Modalities (3 units)**
Mathematical models of image formation based on the image modality and tissue properties. Linear models of image degradation and reconstruction. Inverse problems, regularization for image reconstruction. Image formation in radiology, computed tomography, MRI, nuclear medicine, ultrasound, positron emission tomography. This course is equivalent to BIOM 5200 at Carleton University.

**Course Component:** Lecture

Courses BMG 5103, ELG 6320 cannot be combined for units.

**BMG 5108 Biological Signals (3 units)**
Modeling of neuromuscular biological signals, including subthreshold phenomena, active behaviour of cell membranes, and innervation processes. Measurement of biological signals, including electrode effects. Time domain, frequency domain, and adaptive filtering techniques for noise reduction. This course is equivalent to BIOM 5101 at Carleton University.

**Course Component:** Lecture

Courses BMG 5103, ELG 6320 cannot be combined for units.

**BMG 5109 Medical Imaging Modalities (3 units)**
Mathematical models of image formation based on the image modality and tissue properties. Linear models of image degradation and reconstruction. Inverse problems, regularization for image reconstruction. Image formation in radiology, computed tomography, MRI, nuclear medicine, ultrasound, positron emission tomography. This course is equivalent to BIOM 5200 at Carleton University.

**Course Component:** Lecture

Courses BMG 5103, ELG 6320 cannot be combined for units.

**BMG 5106 Introduction to Medical Imaging Principles and Technology (3 units)**
Basic principles and technological implementation of x-ray, nuclear medicine, magnetic resonance imaging (MRI), and other imaging modalities used in medicine; contrast, resolution, storage requirements for digital images; applications outside medicine, future trends. This course is equivalent to BIOM 5201 at Carleton University.

**Course Component:** Lecture

Permission of the Department is required.
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>BMG 5107</td>
<td>Applications in Biomedical Image Processing (3 units)</td>
<td>Image processing methods applied to biomedical images. Overview of medical imaging modalities. Image enhancement, segmentation, registration, and fusion. Image quality metrics. Image formats. Application examples. Includes: Experiential Learning Activity This course is equivalent to BIOM 5202 at Carleton University.</td>
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<td>Course Component: Lecture</td>
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<tr>
<td>BMG 5108</td>
<td>Advanced Topics in Biomedical Image Processing (3 units)</td>
<td>Recent and advanced topics in the field of biomedical image processing and its related areas. Prerequisite: permission of the program director. This course is equivalent to BIOM 5203 at Carleton University.</td>
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<td>Course Component: Lecture</td>
<td>Permission of the Department is required.</td>
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<tr>
<td>BMG 5109</td>
<td>Advanced Topics in Medical Instrumentation (3 units)</td>
<td>Recent and advanced topics in the field of medical instrumentation and its related areas. This course is equivalent to BIOM 5106 at Carleton University.</td>
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<td>Course Component: Lecture</td>
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<tr>
<td>BMG 5110</td>
<td>Advanced Topics in Biomechanics and Biomaterials (3 units)</td>
<td>Recent and advanced topics in the field of biomechanics and biomaterials and its related areas. This course is equivalent to BIOM 5304 at Carleton University.</td>
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<td>Course Component: Lecture</td>
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<tr>
<td>BMG 5111</td>
<td>Advanced Topics II Medical Informatics and Telemedicine (3 units)</td>
<td>Recent and advanced topics in the field of medical informatics and telemedicine and its related areas. This course is equivalent to BIOM 5403 at Carleton University.</td>
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<td>Course Component: Lecture</td>
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<tr>
<td>BMG 5112</td>
<td>Introduction to Biomedical Engineering (3 units)</td>
<td>Research ethics and methods. Engineering systems approach to analysis and modelling of human anatomy and physiology. Introduction to topics including biomechanics, electrophysiology, and computational biology. Biomedical technologies. Impact of technology on society. This course is equivalent to BIOM 5010 at Carleton University.</td>
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<td>Course Component: Lecture</td>
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<tr>
<td>BMG 5113</td>
<td>Clinical Engineering (3 units)</td>
<td>Overview of the Canadian health care system; brief examples from other countries; clinical engineering and the management of technologies in industrialized and in developing countries; safety, reliability, quality assurance; introduction to biomedical sensor technologies; applications of telemedicine; impact of technology on health care. This course is equivalent to BIOM 5406 at Carleton University.</td>
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<td>Course Component: Lecture</td>
<td>Permission of the Department is required.</td>
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<tr>
<td>BMG 5120</td>
<td>Biomechanics of Movement (3 units)</td>
<td>Human and animal movement examined through the lens of mechanics. Biological, mechanical, and neurological processes by which muscles produce movement. Experimental, mathematical, and computational tools. Clinical and sports applications. Recent advances in biomedical research. Assignments, computer simulations, and a small research project.</td>
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<td>Course Component: Lecture</td>
<td>The courses BMG 5120, MCG 4153, and MCG 4553 cannot be combined for units.</td>
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<tr>
<td>BMG 5122</td>
<td>Biomaterials and Tissue Engineering: Theories and Applications (3 units)</td>
<td>This course covers principles of materials science and cell biology that apply to biomaterials and tissue engineering. Polymers, ceramics, metals, biomaterial surface modifications, molecular and cellular interactions with biomaterials, immune response, tissue engineering principles, ethical considerations and regulatory overview. Technical analysis of a biomaterial-based medical device.</td>
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<td>Course Component: Lecture</td>
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<td>BMG 5130</td>
<td>Fundamentals of Policy I: Policy Analysis (3 units)</td>
<td>Policy analysis and policy processes with an emphasis on the stages of the policy process, as well as the influences of institutions, ideas and interests. This course is equivalent to HLTH 5201 at Carleton University.</td>
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<tr>
<td>BMG 5300</td>
<td>Biological and Engineering Materials (3 units)</td>
<td>Properties of structural biological materials (bone, tendon, ligament, skin, cartilage, muscle, and blood vessels) from an engineering materials viewpoint. Selection of engineering materials as biomaterials. Introduction to biocompatibility. Histology of soft tissues. Viscoelasticity, mechanical properties and models of muscles, ligaments and tendons. This course is equivalent to BIOM 5300 at Carleton University.</td>
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<td>Course Component: Lecture</td>
<td>Permission of the Department is required.</td>
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<tr>
<td>BMG 5301</td>
<td>Biomechanics of Skeletal System, Motion and Tissue (3 units)</td>
<td>Analysis of human motion. Kinematics and kinetics of various activities. Engineering analysis and modeling techniques applied to human motion. Injury mechanics, treatment, prosthetic replacements. Fracture behaviour and healing processes. This course is equivalent to BIOM 5301 at Carleton University.</td>
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<td>BMG 5304</td>
<td>Interactive Networked Systems and Telemedicine (3 units)</td>
<td>Telemanipulator; human motoring and sensory capabilities; typical interface devices; mathematical model of haptic interfaces; haptic rendering; stability and transparency; remote control schemes; time delay compensation; networking and real-time protocols, history and challenges of telemedicine; telemedicine applications: telesurgery, tele-monitoring, tele-diagnosis and tele-homecare. This course is equivalent to BIOM 5402 at Carleton University.</td>
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<td>Course Component: Lecture</td>
<td>Courses BMG 5304 ad ELG 6133 cannot be combined for units.</td>
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BMG 5305 Pattern Classification and Experiment Design (3 units)
Introduction to a variety of supervised and unsupervised pattern classification techniques with emphasis on correct application. Statistically rigorous experimental design and reporting of performance results. Case studies will be drawn from various fields including biomedical informatics. This course is equivalent to BIOM 5405 at Carleton University.
Course Component: Lecture
Courses BMG 5305 and MCG 6102 cannot be combined for units.

BMG 5306 Special Topics in Mechanical and Aerospace Engineering: Biomechanics (3 units)
Overview of human anatomy and physiology with emphasis on artificial organ and prosthetic device design requirements. Application of engineering principles to cells and tissues, biofluid mechanics, human body energetics, measurement techniques, mechanics of human body systems, with emphasis on the artificial heart. This course is equivalent to BIOM 5306 at Carleton University.
Course Component: Lecture

BMG 5307 Introduction to Microfluidics (3 units)
Review of electromagnetic waves at radio and microwave frequencies. Electrical and magnetic properties of tissue. Impact of electromagnetic waves on tissue. Cellular effects. This course is equivalent to BIOM 5330 at Carleton University.
Course Component: Lecture
Prerequisite: knowledge of electromagnetic theory.

BMG 5311 Design of Medical Devices and Implants (3 units)
Solutions to clinical problems through the use of implants and medical devices. Pathology of organ failure and bioengineering and clinical aspects of artificial organs. Examples: blood substitutes, pacemakers, ventricular assist devices, artificial hearts and heart valves. This course is equivalent to BIOM 5311 at Carleton University.
Course Component: Lecture
Permission of the Department is required.

BMG 5312 Design of Orthopaedic Implants and Prostheses (3 units)
Anatomy of the musculo-skeletal system. Electromyography. Static and dynamic analysis of the human skeleton. Materials and manufacturing considerations for orthopaedic devices. Strength and failure theories. Implant fatigue, fracture and corrosion. This course is equivalent to BIOM 5312 at Carleton University.
Course Component: Lecture
Permission of the Department is required.

BMG 5315 Biorobotics (3 units)
Interpretation of physical laws as applied to human motion; kinematics and dynamics of humanoid robots, modeling of biological sensors and actuators, artificial muscles, tele-manipulation, dual arm robots, robot-assisted surgery, and multi-fingered end-effectors. Approaches to design of mechatronic devices to support and enhance human movement including rehabilitators, extenders, haptic devices, and minimally invasive surgery systems. This course is equivalent to BIOM 5315 at Carleton University.
Course Component: Lecture
Permission of the Department is required.

BMG 5317 Biomedical Informatics (3 units)
Statistically rigorous experimental design and reporting of performance results. Case studies will be drawn from various fields including biomedical informatics. This course is equivalent to BIOM 5405 at Carleton University.
Course Component: Lecture

BMG 5318 Design of Medical Devices and Implants (3 units)
Solutions to clinical problems through the use of implants and medical devices. Pathology of organ failure and bioengineering and clinical aspects of artificial organs. Examples: blood substitutes, pacemakers, ventricular assist devices, artificial hearts and heart valves. This course is equivalent to BIOM 5311 at Carleton University.
Course Component: Lecture
Permission of the Department is required.

BMG 5319 Introduction to Microfluidics (3 units)
Physics of liquid transport in micro-fabricated systems including physics at the microscale, hydrodynamics of microfluidic systems, diffusion mixing, introduction to microfabrication, examples of microfluidics devices and Micro PIV techniques, project.
Course Component: Lecture
The courses BMG 5319, MCG 4112, and MCG 4512 cannot be combined for units.

BMG 5330 Electromagnetic Fields and Biological Systems (3 units)
Review of electromagnetic waves at radio and microwave frequencies. Electrical and magnetic properties of tissue. Impact of electromagnetic waves on tissue. Cellular effects. This course is equivalent to BIOM 5330 at Carleton University.
Course Component: Lecture

BMG 5501 Étude technique et modélisation de l’anatomie et de la physiologie du corps humain (3 crédits)
Méthodes de systèmes d’ingénierie pour analyser et modeler les systèmes anatomiques et physiologiques du corps humain. Propriétés mécaniques et électriques des tissus. Systèmes musculo-quitectiques, cardiovasculaires et pulmonaires. Ce cours est équivalent à BIOM 5001 à la Carleton University.
Volet : Cours magistral

BMG 5502 Éthiques, normes et méthodes de recherche (3 crédits)
Theories éthiques, prise de décision, codes de déontologie; expérimentation sur des animaux et des êtres humains, consentement, comités de déontologie; méthodes de recherche et règlements concernant la conception, la fabrication et la certification d’appareils médicaux; collecte, contrôle et analyse des données, y compris la protection de la confidentialité, dilemmes bioéthiques, effets (sociaux, politiques, financiers) de la technologie et de la recherche. Les cours ELG 7514/EACJ 5300, BMG 5502 ne peuvent être combinés pour l’obtention de crédits. Ce cours est équivalent à BIOM 5002 à la Carleton University.
Volet : Cours magistral

BMG 5503 Éthiques et réglementations (3 crédits)
Études sur les problèmes éthiques et réglementaires liés à la conception, confection et mises en marché des appareils médicaux. Les cours MBG 5502 et ELG 7514/EACJ 5300 ne peuvent être combinés pour l’obtention de crédits. Ce cours est équivalent à BIOM 5003 à la Carleton University.
Volet : Cours magistral

BMG 6000 Projet en génie biomédical / Biomedical Engineering Project (6 crédits / 6 units)
Projet en génie biomédical supervisé par un professeur approuvé par le directeur du programme. Rédaction d’un rapport approfondi, qui doit être présenté oralement. Noté S (satisfaisant) ou NS (non satisfaisant) par le superviseur du projet et un autre professeur nommé par le directeur du programme. Le projet peut normalement être complété en une session d’études à temps complet. Ce cours est équivalent à BIOM 5900 à la Carleton University. / Project in biomedical engineering supervised by a professor approved by the program director. Requires an in-depth report that must be presented orally. Graded S (Satisfactory) or NS (Not satisfactory) by the supervisor and by another professor appointed by the program director. The project can normally be completed in one session of full-time study. This course is equivalent to BIOM 5900 at Carleton University.
Volet / Course Component: Recherche / Research
Permission of the Department is required.

BMG 6001 Projet en génie clinique / Clinical Engineering Project (6 crédits / 6 units)
Projet en génie clinique supervisé par un professeur du programme et un ingénieur clinique. Rédaction et présentation orale d’un rapport approfondi. Noté S (satisfaisant) ou NS (non satisfaisant) par les superviseurs du projet et un autre professeur nommé par le directeur du programme. Le projet peut normalement être complété en une session d’études à temps complet. Ce cours est équivalent à BIOM 5901 à la Carleton University. / Project in clinical engineering supervised by a professor in the program and a clinical engineer. Requires an in-depth report that must be presented orally. Graded S (Satisfactory) or NS (Not satisfactory) by the co-supervisors and by another professor appointed by the program director. The project can normally be completed in one session of full-time study. This course is equivalent to BIOM 5901 at Carleton University.
Volet / Course Component: Recherche / Research
Permission of the Department is required.
BMG 6996 Séminaire en génie biomédical / Biomedical Engineering Seminar
Cours composé d’une série de séminaires présentés par des étudiants de deuxième cycle et des chercheurs en génie biomédical. En plus d’avoir à animer un séminaire, tous les étudiants doivent assister à au moins dix séances. Ce cours est équivalent à BIOM 5800 à Carleton University. / This course is in the form of seminars presented by graduate students and other researchers in the area of Biomedical Engineering. To complete this course, a student must attend at least ten seminars and make one presentation in the context of this seminar series. This course is equivalent to BIOM 5800 at Carleton University.

Volet / Course Component: Séminaire / Seminar

BMG 7199 Directed Studies in Biomedical Engineering (3 units)
Various possibilities exist for pursuing directed studies on topics approved by a course supervisor, including the above-listed course topics where they are not offered on a formal basis. This course is equivalent to BIOM 5906 at Carleton University.

Course Component: Research

BMG 9901 Séminaire de doctorat en génie biomédical / Biomedical Engineering PhD Seminar
Une série de séminaires présentés par des étudiants aux cycles supérieurs et des chercheurs invités. En plus d’avoir à présenter deux séminaires, les étudiants doivent assister et participer à au moins 20 séminaires. Noté S (satisfaisant) ou NS (non satisfaisant). Ce cours est équivalent à BIOM 6800 à Carleton University. / This course is in the form of seminars presented by graduate students and other researchers in the area of Biomedical Engineering. To complete this course, a student must attend at least 20 seminars and make two presentations in the context of this seminar series. This course is equivalent to BIOM 6800 at Carleton University.

Volet / Course Component: Séminaire / Seminar

BMG 9997 Rapport et soutenance du projet de thèse / Report and Defence of Thesis Proposal
Inscription requise de tous les candidats au doctorat jusqu’à la réussite à l’examen de synthèse. / Following completion of the comprehensive examination, registration required for all PhD candidates until the thesis proposal is accepted by the Advisory Committee

Volet / Course Component: Recherche / Research

BMG 9998 Examen de synthèse / PhD Comprehensive Exam
À la suite de la réussite à l’examen de synthèse, inscription requise de tous les candidats au doctorat jusqu’à ce que le projet de thèse soit accepté par le Comité consultatif. / Registration required for all PhD candidates until the comprehensive examination is passed.

Volet / Course Component: Recherche / Research