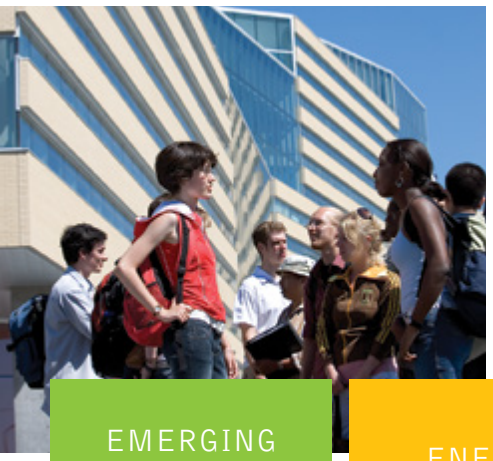
FALL 2022



EMERGING BIOMEDICAL TECHNOLOGIES

ENERGY SYSTEMS

ENGINEERING PHYSICS

INDUSTRIAL & SYSTEMS ENGINEERING

MATERIALS SCIENCE AND ENGINEERING

RESOURCES INFRA-STRUCTURES

SOFTWARE

SUSTAINABLE DEVELOPMENT

SUSTAINABLE TRANSPORT

INTERNATIONAL THEMATIC CLUSTERS IN ENGINEERING

Join us and add an expertise to your engineering training that will help you stand out thanks to our brand-new engineering courses taught in English that build on the strengths of Canada and Polytechnique Montréal in training and research.

Become part of our vibrant student community, mix with local students and have an unforgettable international experience in one of the best student cities in the world!

Click on the cluster of your choice for more information!

INTERNATIONAL THEMATIC CLUSTERS IN *ENGINEERING*

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TECHNOLOGICAL UNIVERSITY

UT TENSIO SIC VIS

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Update: September 2021

EMERGING BIOMEDICAL TECHNOLOGIES

FALL TERM

Polytechnique has become a hub of biomedical engineering activity, supported by an internationally recognized translational institute, TransMedTech, established academic programs at the undergraduate and graduate levels, a research alliance with Montréal hospital networks, and a critical mass of researchers. This cluster targets students looking to learn about and take part in emerging-technology development in the field of biomedical engineering. Note that the following courses are advanced specialized courses destined for students enrolled in their final years of a biomedical, computer, electrical, mechanical or physics engineering program.

Students must take 12 to 15 credits among the following :

GBM6700E // 3D Reconstruction from Medical Images (3 cr.)

3D reconstruction systems from medical images. Passive vision systems: cameras and X-ray systems calibration, stereo-matching, geometric features, intensity-based features, Epipolar geometry, 3D reconstruction, multimodal medical image fusion. 3D reconstruction from image sequences: self-calibration, features tracking, 3D reconstruction from motion, shading and texture. Active vision systems: interferometry principle, active triangulation, 3D surface registration, rigid registraion, elastic registration, texture mapping. Application: 3D reconstruction of anatomical structures from medical images.

Prerequisites: Biomedical imaging, signal processing.

GBM8810E // Biomedical Nanotechnologies (3 cr.)

Physical concepts of nanotechnology. Fabrication and functionalization of nanomaterials. Bionanoplasmonics: concept of plasmons, Mie theory, nanophotothermy and therapeutic applications. Optical nanobiosensors: Theory and application of plasmonics. Biomedical nanophotonics: quantum dots, optical tweezers and laser nanosurgery. Biomedical nanomagnetism: properties of magnetic nanomaterials and applications in biosensing and therapy. Ethics and social issues of nanotechnologies in biomedical.

Prerequisites: Notions of optics, quantum mechanics, thermodynamics.

GBM6330E // Emerging Biomedical Technologies (3 cr.)

Selected topics in biomedical instrumentation. Study of emerging measurement, monitoring, diagnosis and intervention systems in medicine. Case studies of five emerging technologies that will transform biomedical practice in the short to medium term. Presentations by the professor and external experts. Assessment and critique of scientific articles by students. Writing a review articles.

Prerequisites: Background courses in biomedical engineering.

SL303E // Research Internship or Final Project (3 cr.)
SL306E // Research Internship or Final Project (6 cr.)

Exchange students can pursue a research internship in one of Polytechnique laboratories. These serve as introduction to research through the execution of a project in a research environment.

French Language Course (3 cr.)

Exchange students have access to the Université de Montréal credited French language course offer and will receive by email several weeks before the beginning of classes the detailed application procedure. For more information regarding the French as a second language course offer *click here*.

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Course content may vary slightly from year to year.

FALL TERM

ENERGY SYSTEMS

Energy systems is a combination of all subsystems and components related to the generation, transmission, distribution and conversion of electrical energy to other kinds or vice-versa. Join the department where the EMTP software was originally developed in partnership with key industry players such as Hydro-Québec, RTE France and EDF France. Practical work will take place in the recently built state-of-the art microgrid laboratory equipped with the OPAL-RT real-time simulator. Note that the following courses are advanced specialized courses destined for students enrolled in their final years of an electrical engineering or a mechanical engineering degree program with a solid background in control and circuit theory.

Students must take 12 to 15 credits among the following :

ELE6427E // **Microgrid Control (3 cr.)**
Introduction to distributed generation (DG), microgrids and smart grids. Mathematical tools for modeling and control of microgrids. Enhanced phase-locked loops (PLLs). Islanding Detection methods. Control strategies of DG units in grid-connected and islanded modes. Power quality improvement of microgrids.
Prerequisites: Linear control (advanced level).

ELE8455E // **Electromechanical Systems (3 cr.)**
Electromechanical energy conversion devices. Electromechanical conversion and equations of motion. Fundamentals of electrical machines. Synchronous and asynchronous machines: steady state and dynamic regimes; modelling and numerical simulation. Special machines. Speed variator: implementation and operation.
Prerequisites: Knowledge of controlled systems and magnetic circuits.

ELE8452E // **Electrical Networks (3 cr.)**
Planning and operation of interconnected networks. Mathematical models of power components. Steady-state analysis, and power flows. Faults. Operation strategies, economical dispatching, voltage and frequency regulation, power transfer and interconnections.
Prerequisites: Linear control and circuit theory.

Select 1 of the 2 following courses depending of your level in this field:

ELE8541E // **Power Electronics Systems (3 cr.)**
Industrial electronics. The role of power electronics in the efficient conversion and the use of electrical energy. Semiconductors and their environment. Analysis of natural commutation and forced switching converters: rectifiers, choppers, inverters. Applications to electrical networks. Modeling and evaluation of converters using both experimental and simulation.
Prerequisites: Linear Control.

or

ELE6428E // **Advance Power Electronics (3 cr.)**
Modeling DC/DC and DC/AC converters. Converter Dynamics and Control. Controller design for DC/DC and DC/AC converters.

French Language Course (3 cr.)
Exchange students have access to the Université de Montréal credited French language course offer and will receive by email several weeks before the beginning of classes the detailed application procedure. For more information regarding the French as a second language course offer *click here*.

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FALL TERM

ENGINEERING PHYSICS

Engineering physics bridges the gap between physics and engineering by utilizing fundamental principles and phenomena for the development of radically new technologies solving outstanding challenges in the fields of energy, communications and processing, and biomedicine.

Students must take 12 to 15 credits among the following :

PHS8205E // Guided Waves in Photonics (3 cr.)

Wave approach to optical waveguides. Hamiltonian formulation of Maxwell's equations and fundamental properties of guided modes. Transfer matrix method. Guided modes, leaky modes, surface waves. Modal excitation and coupling efficiency. Optical fiber communications. Metamaterial waveguides and anti-resonant waveguides. Perturbation Theory and Coupled Mode Theory. Waveguide components. Optical systems. Numerical modeling of the behavior of guided optical devices using the finite element method.

Prerequisites: Principles of quantum mechanics and numerical computing.

PHS8310E // Microfabrication (3 cr.)

Introduction to micro- and nano-fabrication. Photolithography: optical technology and photoresists. Thin films: physical processes (evaporation, sputtering and laser), chemical processes, electrochemical processes and oxidation. Etching: wet and dry (plasma). Fundamentals of nanofabrication. Processes for microelectronics, for photonics, for micro-electro-mechanical systems, and bio sensors. Applications of microfabrication. Laboratory of microfabrication.

PHS8604E // Direct Energy Conversion (3 cr.)

Classification of energy conversion systems. Introduction to energy conversion limitations. Limitations imposed by our planet: sensitivity study. Thermodynamic limitations. Electromagnetic energy conversion. Magneto hydrodynamic (MHD) energy conversion: efficiency of Faraday and Hall MHD systems. Thermoelectric, photovoltaic and fuel cell systems. Comparative study of different energy conversion technologies. Analyses of advanced energy conversion cycles.

GBM8810E // Biomedical Nanotechnologies (3 cr.)

Physical concepts of nanotechnology. Fabrication and functionalization of nanomaterials. Bionanoplasmonics: concept of plasmons, Mie theory, nanophotothermy and therapeutic applications. Optical nanobiosensors: Theory and application of plasmonics. Biomedical nanophotonics: quantum dots, optical tweezers and laser nanosurgery. Biomedical nanomagnetism: properties of magnetic nanomaterials and applications in biosensing and therapy. Ethics and social issues of nanotechnologies in biomedical.

Prerequisites: Notions of optics, quantum mechanics, thermodynamics.

SL803E // Research Internship or Final Project (3 cr.)
SL806E // Research Internship or Final Project (6 cr.)

Exchange students can pursue a research internship in one of Polytechnique laboratories. These serve as introduction to research through the execution of a project in a research environment.

French Language Course (3 cr.)

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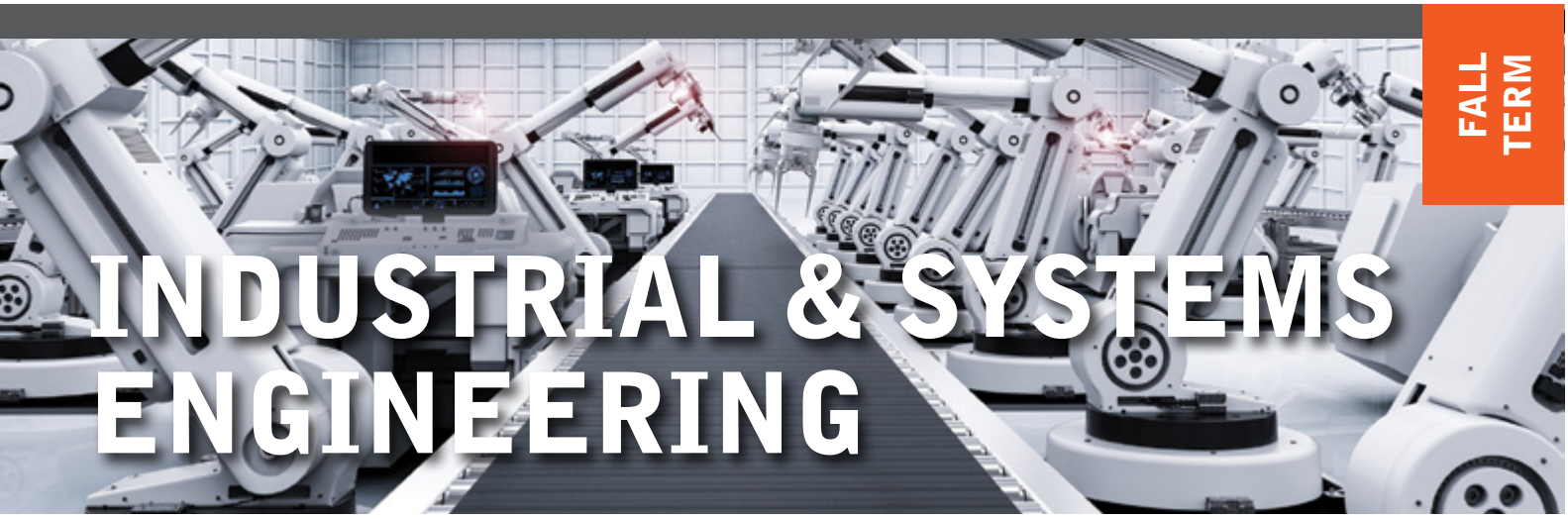

FALL TERM

INDUSTRIAL & SYSTEMS ENGINEERING

This cluster will appeal to students interested in industrial and systems engineering as well as Industry 4.0. The Department of Mathematics and Industrial Engineering houses Polytechnique Montréal's Industry 4.0 laboratory, and the faculty members teaching the five courses are members of this laboratory. Industrial engineering research at Polytechnique aims to provide training to address the full complexity of technological, economical, social, organizational and environmental issues by offering the opportunity to study in multidisciplinary fields. Note that the following courses are advanced specialized courses destined for students in their final years of an engineering degree program or who are currently pursuing graduate studies in various fields.

Students must take 12 to 15 credits among the following :

IND8137AE // Techno-entrepreneurship (3 cr.)

Entrepreneurial phenomenon. Incubators. Techno-entrepreneurs: motivations, characteristics, values, career, role. Starting-up: screening ideas, choosing partners and legal issues. Establishing supplier-customer value chains. Organization of the critical functions of a company. Outsourcing. Technology transfers and other contractual aspects. Business plans and business models. Short-, medium- and long-term funding sources. Creating a budget. Financial ratios. Control of investments and stocks. Strategic planning. Leadership. Motivation of employees.

IND8217E // Analytics of Faults and Maintenance (3 cr.)

The objective of this course is to present the principal tools and techniques for physical assets'integrity management. It prepares the students to be reliability and maintenance engineers whose ultimate goal is to insure the highest performance and safety of equipment. The course consists of the following topics: Basic statistical knowledge that is needed to optimize maintenance actions, analytics of diagnosis and prognosis of physical assets' states, the different types of maintenance actions, machine learning techniques for detection of abnormal equipment' performance, optimization of life cycle cost of an equipment, selection of performance indices.
Prerequisites: Probability & Statistics.

IND8841E // Industrial Safety (3 cr.)

Introduction to industrial safety; Basic principles; Legislation and regulations in North America and Europe (e.g. Machine Directive); Standardization (ISO, IEC, CSA); Role of engineers in risk management; Principles for risk assessment and risk reduction; Risk reduction by design, methods and procedures ; Risk for machinery – fixed, mobile, robots, collaborative robots; Risk management for confined spaces; Risk when working at heights; Electrical safety; Risk management in industrial maintenance; Risk in different sectors: construction, mining, forestry and transportation. Challenges and opportunities for risk management with Industry 4.0 in different sectors.

IND6240E // Industry 4.0 (3 cr.)

Definition, tools, technologies and concepts of industry 4.0 for the implementation of business processes digital transformation in the context of the 4th industrial revolution. Application of technologies: Internet of things (IoT), big data, cloud computing and cloud manufacturing, cyber-physical systems (CPS), artificial intelligence, etc. Challenges: strategic positioning, development of new processes, products and services; implementation of new monitoring, control, optimization and autonomy capabilities. Key principles: interoperability, decentralized decision-making, real-time, integration, agility. Deployment strategies in various industries: Manufacturing, Construction, Mining, agri-food, etc. Information system for industry 4.0.

IND6215E // Distributed Production and Logistics (3 cr.)

Design of distributed control systems in manufacturing networks; coordination of operations in distributed environments; distributed organizational paradigms for manufacturing and logistics operations; bullwhip effect and supply chain management techniques; collaborative decision-making in a distributed environment; agent-based control architectures; agent-based negotiation; applications of agent-based manufacturing; agent-based simulation for manufacturing and logistics operations.

French Language Course (3 cr.)

Exchange students have access to the Université de Montréal credited French language course offer and will receive by email several weeks before the beginning of classes the detailed application procedure. For more information regarding the French as a second language course offer *click here*.

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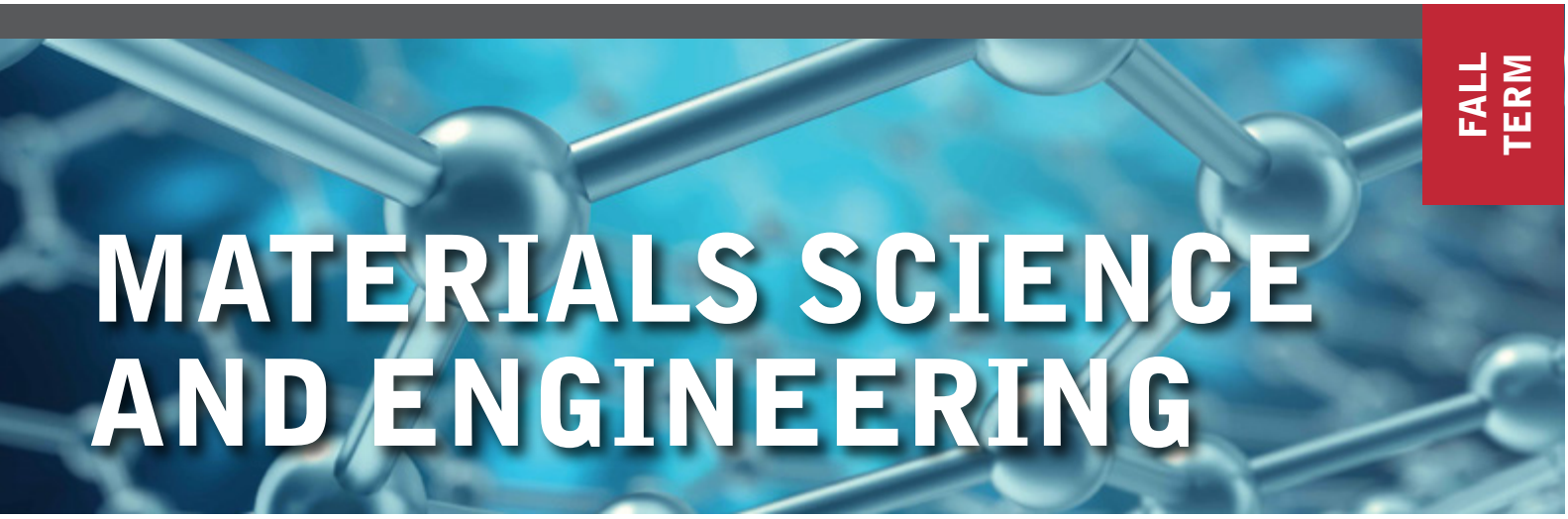

FALL TERM

MATERIALS SCIENCE AND ENGINEERING

Materials science and engineering is an interdisciplinary field that studies the rich and complex interrelations between atomic structures, material processing, and material properties and performance. It addresses an extremely wide family of materials (metals, composites, semiconductors, superconductors, organic materials) for applications spanning all scales, from molecular-sized low-energy transistors to lighter and more efficient airplane wings. Note that the following courses are advanced specialized courses destined for students in their final years of an engineering degree program with a background in materials science or a related engineering field (chemical, mechanical, physics).

Students must take 12 to 15 credits among the following :

PHS8310E // Microfabrication (3 cr.)

Introduction to micro- and nano-fabrication. Photolithography: optical technology and photoresists. Thin films: physical processes (evaporation, sputtering and laser), chemical processes, electrochemical processes and oxidation. Etching: wet and dry (plasma). Fundamentals of nanofabrication. Processes for microelectronics, for photonics, for micro-electro-mechanical systems, and bio sensors. Applications of microfabrication. Laboratory of microfabrication.

MTR6010E // Structure and Properties of Materials (3 cr.)

Interatomic bonding. Crystal structure: concept of microstructure, postulates of crystallography, direct lattices, reciprocal space, imperfections, microstructure. Symmetry and physical properties of crystals, point groups, space groups, international crystallography tables. Non-crystalline materials: glasses, amorphous, polymers, macromolecular solids. Mechanical properties: mechanical behaviour, elasticity, plastic deformation. Material degradation: corrosion, fatigue, creep. Electromagnetic properties: metals, semiconductors, insulators, photonic materials, magnetic materials.

GCH8102E // Polymer Processing Fundamentals (3 cr.)

Overview of industrial polymers, their rheology and their flow inside simple geometries. Single screw and twin-screw extrusion processes. Extrusion dies: design principles and calculations. Fiber spinning and films processes (blowing, cast and biaxial). Blow molding, thermoforming and injection molding processes. Process-structure-performance relationships.

GCH8106E // Polymer Packaging Engineering (3 cr.)

Polymer packaging engineering: significance of packaging in food and other products industries. Introduction to polymer-based packaging. Food packaging processes. Mass transfer across a package: permeability and diffusion of gases, multilayer structures, estimation of the shelf life of a food product. Design and manufacturing of packages: materials used, fabrication processes. Environmental considerations: recycling, source reduction, biodegradable materials, principles of life cycle analysis of a package.

Prerequisites: Polymers, polymer processing.

French Language Course (3 cr.)

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FALL TERM

RESOURCES INFRASTRUCTURES

Natural resources are under unprecedented pressure due to rapid population growth and socio-economic activities, as well as the increasing impacts of climate change and environmental degradation. To tackle current and future challenges of sustainable development, Polytechnique Montréal provides world-class teaching and research solutions for better diagnoses, analyses, modeling and management of natural resource systems. The six internationally recognized professors dedicated to this initiative have a range of expertise in the subject matter, with the focus on renewable resources. The courses offered at Polytechnique closely follow the United Nations Sustainable Development Goals and provide students with the knowledge set and skills for pursuing sustainable design and engineering of natural resources. Note that the following courses are advanced specialized courses destined for students in their final years of an engineering degree program or who are currently pursuing graduate studies.

Students must take 12 to 15 credits among the following :

MIN1101E // Introduction to Mining Operations (3 cr.)

Importance of the mining industry. Definition of mining companies, roles and responsibilities of mining engineers. Mining Regulations. Financial analysis of mining projects. Physical and economic characteristics of orebodies and criteria to go into production. Typical operations: drilling, blasting and transport. Surface and underground mining methods: characteristics, selection and equipment used. Basics of minerallurgy. Environment and mine waste management.

GML6112E // Mining Environment and Mine Site Reclamation (3 cr.)

Mine waste management. Acid mine drainage (AMD) generation and prediction. Geochemical modeling of AMD. Water and gas flow in unsaturated media. Mine site reclamation: water covers, mono- and multilayer cover systems. Biological passive treatment of AMD. Case studies.

CIV8330E // Climate Change and Sustainable Development (3 cr.)

Climate versus weather, signs of change in climate conditions, climate models, downscaling climate model outputs, climate change impact assessment, challenges of water management under climate change, adaptation to climate change, decision-making under climate uncertainty, communication of climate change with stakeholders, sustainable development under climate change. Examples are provided for water resource management at local and regional scales.

CIV8320E // Perspectives & Challenges in Applied Hydraulics (3 cr.)

Criteria for hydraulic performance of an urban drainage system, adaptation of water infrastructure to climate change impacts, best management practices for rainwater. Sediment transport and estimation of solid flows; establishment of criteria for riverbank restoration and renaturalization of rivers; safety of dikes, earth dams and rockfill. Traditional and innovative methods of measuring flowrate, precipitation and evapotranspiration. Estimation of numerical model parameters.

Prerequisites: Hydraulics of water networks and open channel flow.

French Language Course (3 cr.)

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FALL TERM

SOFTWARE

Software is ubiquitous in today's world of information and interdisciplinarity: in our smartphones and computers, in our cars and public transport, in our communication centres, in industries and in all facets of entertainment. This thematic cluster offers students the opportunity to advance their knowledge in all aspects of software design, including the requirements study, choice of architecture, detailed design, construction, commissioning, operation and maintenance. Students enrolled in this thematic cluster will benefit from the recognized expertise of Polytechnique Montréal's team of software engineering professors, some of whom have recently been identified as the most productive researchers in their field (Karanatsiou et al., "A bibliometric assessment of software engineering scholars and institutions (2010–2017)," *Journal of Systems and Software*, 2018). Note that the following courses are advanced specialized courses destined for students in their final year of an engineering degree program and must have completed courses in software design, software processes, software testing and validation, and computer networks.

Students must take 12 to 15 credits among the following :

LOG6406E // Human Centered Inquiry for Software and Computer Engineering (3 cr.)

Human-centered research methods for understanding and supporting computer and software developers, designers, users, and other stakeholders. Interview for understanding users/developers and eliciting requirements. Survey for collecting large-scale user and developer-centered data. Lab-based human-centered study for evaluating computer and software systems. Structured observation of usage and development activities. Automated human-centered data collection and open data. Qualitative and quantitative analysis of human-centered development and usage data. Reporting and presentation of results. Ethical concerns when working with human subjects. Exemplars of these methodologies and methods in real-world computer and software engineering research scenarios.

LOG8371E // Software Quality Engineering (3 cr.)

Basic concepts and definitions relevant to software quality, quality assurance, tests, quality engineering and quality planning. Anomaly prevention and fault classification. Fault tolerance. Software reliability engineering. Quality models. Comparison of different quality assurance techniques. Improvement of the software development process. Measuring the software and its processes. Identification of risks for the quantifiable improvement of quality.

LOG8430E // Software Architecture and Advanced Design (3 cr.)

Advanced software design methods and choosing architecture. Software architectures: multitier, client-server, extendible and dynamic. Advanced concepts of software library installation and dynamic loading of components. Advanced design patterns for distributed systems: service access and configuration, event processing, synchronization and simultaneous access. Emerging approaches in design and architecture: aspect-oriented design, service-oriented architecture and others.

LOG8415E // Advanced Concepts of Cloud Computing (3 cr.)

Key concepts of cloud computing. Key mechanisms and key architectures of cloud computing platforms. Service delivery models of a cloud computing architecture. Virtualization. Big data analytics with MapReduce and NoSQL. Migration of applications to the cloud. Cloud computing patterns. Interoperability issues in the cloud. Quality of Service metrics and Service Level Agreement (SLA). Dependability and security in the cloud. Legal issues related to cloud computing. Mobile cloud computing.

INF8900E // Directed Readings in Computer and Software Engineering (3 cr.)

Selection of a research problem to be explored under the supervision of a professor. Literature review. Critical analysis of selected publications. Preparation and submission of a report.

French Language Course (3 cr.)

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FALL TERM

SUSTAINABLE DEVELOPMENT

The Sustainable Development thematic cluster deals with the broad cross-disciplinary issues related to sustainability, with a particular emphasis on the social responsibility of engineers and working in a multidisciplinary environment. Concepts studied include life-cycle analysis, energy conversion, and circular flow, all of which are essential components of sustainable engineering. Note that the following courses are advanced specialized courses destined for students in their final years of an engineering degree program or who are currently pursuing graduate studies, all disciplines.

Students must take 12 to 15 credits among the following :

DDI8001E // Sustainable Development for Engineers (3 cr.)

Historical context, benchmarks and actors of sustainable development. Theoretical concepts, models, indicators and measures, such as: gross domestic product, Human Development Index, Genuine Progress Indicator, ecological footprint. Legal framework: Sustainable Development Act of Quebec, Quebec Environment Quality Act, Quebec Engineers Act. Levers and implementation tools: organizational social responsibility, life cycle assessment, eco-design. Accountability tools, certifications: standards from the International Standardization Organization and the Bureau de Normalisation du Québec, Global Reporting Initiative, ecolabels. Sustainability issues: biodiversity, water, soil, energy, climate change, extractive industries, manufacturing processes, waste, built environment, transportation, ethics, society. Challenges and constraints.

PHS8604E // Direct Energy Conversion (3 cr.)

Classification of energy conversion systems. Introduction to energy conversion limitations. Limitations imposed by our planet: sensitivity study. Thermodynamic limitations. Electromagnetic energy conversion. Magneto hydrodynamic (MHD) energy conversion: efficiency of Faraday and Hall MHD systems. Thermoelectric, photovoltaic and fuel cell systems. Comparative study of different energy conversion technologies. Analyses of advanced energy conversion cycles.

Prerequisites: Notions relating to EM fields and statistical physics.

DDI8003E // Life Cycle Analysis (3 cr.)

Detailed study of life cycle analysis (LCA). ISO 14040 and 14044 standards. Definition of objectives and field of study. Inventory analysis: mathematical aspects, bottom-up and top-down approaches, attributional and consequential approaches, multifunctionality. Life cycle impact assessment: causality chains, characterization models and factors, life cycle impact assessment methods. Environmental impact and indicators. Classification, characterization, standardization and weighing. Interpretation of results: contribution, sensitivity, uncertainty, and scenario analyses. LCA databases and software. Critical analysis of a published LCA. Real-life LCA project in the student's field of expertise. Different types of LCA studies: internal, third-party, public comparative study.

Prerequistes: Environmental sciences, life cycle analysis.

CIV8330E // Climate Change and Sustainable Development (3 cr.)

Climate versus weather, signs of change in climate conditions, climate models, downscaling climate model outputs, climate change impact assessment, challenges of water management under climate change, adaptation to climate change, decision-making under climate uncertainty, communication of climate change with stakeholders, sustainable development under climate change. Examples are provided for water resource management at local and regional scales.

IND8111E // Economic Aspects of Circular Flow (3 cr.)

Economics, circular economy and material flow balance. Life cycle approach. Material loops and engineering perspective. Municipal waste and recycling: technology, incentives, policies, taxation, subsidies, extended producer responsibility, theoretical models and empirical results, social standards, corruption, city size and density. Reconditioning: lease models and contracts, property rights, cannibalization and competition on the secondary market. Ecodesign: innovation, Porter's hypothesis, recyclability, reusability and durability, planned obsolescence. International aspects: market and material flows, resource dependency, international agreements, illegal trade and corruption, donation. Green market: ecolabeling and greenwashing. Selected engineering topics such as corporate social responsibility, green industry, environmental lobbying.

French Language Course (3 cr.)

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FALL TERM

SUSTAINABLE TRANSPORT

Transport continues to be a major source of climate change emissions, health and wellbeing problems, as well as a large financial burden on individuals and society. At Polytechnique Montreal, we are dedicated to researching and teaching ways to address these issues through better planning, infrastructure and soft interventions such as improved information communication. The five dedicated professors internationally recognized for their work, including the Canada Research Chair on personal mobility, have a range of expertise including: travel behaviour, transport modeling, public transport planning, road safety, accessibility, future modes, health and wellbeing, and behaviour change. The courses offered here will give the student a range of tools to address sustainable transport problems. Note that the following courses are advanced specialized courses destined for students in their final years of an engineering degree program or who are currently pursuing graduate studies, all fields.

Students must take 12 to 15 credits among the following :

CIV2710E // Transport Systems (3 cr.)

Place of transport in civil engineering and institutional organization of transport in an urban region. Transportation planning. Prediction of transport demand using classical models (generation, distribution, modal split and assignment). Transport network concepts, path calculation and distribution problem solving. Demand and transport offer. Transport survey methods and data analysis. Traffic flow. Computer practical work.

CIV8750E // Sustainable Transport Planning (3 cr.)

Transportation plans, strategic plans (moving people), urban development plans, decision-making processes, consultation mechanisms. Innovative strategies to promote the use of sustainable modes of transportation: case studies and analysis. Transport demand forecasting: classical models, new approaches and results. Planning software. Externalities related to transport infrastructures and their use: public health, safety, pollution, use of space, urban sprawl and dependence on cars. Indicators of transport and sustainable mobility: databases and evaluation mechanisms. Alternative travel approach: car sharing, bike sharing, carpooling, reserved lanes, active modes, inter-modal, parking management.

CIV8740E // Traffic Engineering (3 cr.)

Fundamental traffic elements: the user (driver, cyclist, pedestrian), the vehicle, the infrastructure. Methods for traffic data collection. Traffic studies and analyses for all motorized and non-motorized modes: volumes, speeds, travel times, delays, parking and accidents. Measurement and analysis of road and lane capacity. Traffic management for all users: intersections, traffic light coordination, control devices (signs, markings). Road, corridor, or network-wide traffic management programs.

CIV8760E // Transport Data Management (3 cr.)

Main steps of transport data collection: planning, management, validation, analysis and dissemination. Main databases and microscopic data relevant to the study of transport problems. Types and properties of spatio-temporal data. Data models. Methods and tools for data processing, analysis, modeling and visualization. Geographic information systems: projection systems, concepts and integration. Spatial analysis methods applicable to transport data and relevant tools. New technologies of data collection in transport and opportunities of analysis. Data fusion methods. Data mining and machine learning methods. Econometric models.

CIV8710E // Transport, Society and Behaviour Change (3 cr.)

Sustainable development and sustainable transportation as critical concepts. Transport and the three domains of health and well-being (physical, social, and psychological). Evolution of transport in different societies leading to different mobility systems. Behaviour change towards sustainable transportation through both hard and soft interventions. Interaction between transport and land-use. Influence of road design on behaviour. Psychological models for explaining behaviour and changing behaviour as they relate to transport are introduced.

French Language Course (3 cr.)

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