2025
2026

- SOFTWARE & COMPUTING*
- INDUSTRIAL & SYSTEMS ENGINEERING
- ENGINEERING PHYSICS & MATERIALS ENGINEERING
- ENERGY SYSTEMS
- SUSTAINABLE DEVELOPMENT
- SUSTAINABLE TRANSPORT
- EMERGING BIOMEDICAL TECHNOLOGIES

INTERNATIONAL THEMATIC CLUSTERS IN ENGINEERING

Add an expertise to your engineering training. Join us for our speciality courses taught in English, that build on Canadian and Polytechnique Montréal strengths in training and research.

Become part of vibrant student community. Engage with local and other international students for an unforgettable experience in one of the best student cities in the world!

* **NEW! The Software and Computing Cluster is now offered in both the Fall and Winter terms!**

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POLYTECHNIQUE MONTRÉAL
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Update: April 2025

FALL TERM

SOFTWARE & COMPUTING

The Software and Computing Cluster is now offered in both the Fall and Winter terms!

Software and computer systems are ubiquitous in today's world, found in smartphones, vehicles, home devices, and every aspect of entertainment. This thematic cluster offers students the opportunity to advance their knowledge in many key areas of modern technology design, including AI and machine learning, software design and maintenance, software quality engineering, cloud computing and Internet of Things (IoT), cybersecurity, human-computer interaction, and more. Through a blend of coursework and hands-on practices, students will gain valuable skills relevant to today's evolving tech landscape, prepared for addressing the engineering, development, and research challenges of software and computer systems. Note that the following courses are advanced specialized courses destined for students in their final year of an engineering degree program or pursuing graduate studies in various fields.

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.

LOG6307E // Release Engineering - Applications of Mining Software Repositories (3 cr.)

Software release engineering process: integration, build, multi-staged testing, deployment, release and operations. Definition and base concepts of mining software repositories. Different types of repositories: version control, bug reports, code review, mailing lists, StackOverflow, project ecosystems, collaboration platforms. Techniques for empirical analysis of repositories: data mining, statistical analysis, natural language processing, source code analysis, qualitative analysis. Integration: configuration management, branching patterns, feature toggles, merge conflicts. Build: maintenance and verification of build, build failures, continuous integration, infrastructure-as-code, software configuration. Multi-staged testing: bug prediction, test selection, continuous testing. Deployment/release: large-scale distributions, deployment/release strategies, source code provenance, app stores. Operations: log analysis, rollback.

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.

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.

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.

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FALL TERM

SOFTWARE & COMPUTING

LOG8505E // Model-Driven Software Engineering (3 cr.)

Software Modelling and Design, Model-Driven Engineering, Model-Based Software Development, Model Driven Architecture, Conceptual Modelling, Domain Modelling, Meta-Models, Unified Modeling Language (UML) Profiling, Modelling Behaviour and Interactions, Domain-Specific Modelling Languages, Model Validation and Verification, Model Transformation (e.g., Model to Model (M2M), Model to Text (M2T), Template-Based transformations), Action Specification, Action Languages, Automatic Code Generation.

LOG6309E // Intelligent DevOps of Large-Scale Software Systems (3 cr.)

Modern software DevOps process. State-of-the-art DevOps research. Concepts and techniques of DevOps monitoring: logging, tracing, and performance monitoring. Concepts and techniques of DevOps data analytics: static analysis, dynamic analysis, statistical analysis, data mining. Applications of DevOps data analytics: log analytics, performance analytics, anomaly detection, failure diagnosis, incident prediction, security analytics, system configuration, and self-adaptive and self-healing systems. DevOps for machine learning applications.

INF8245AE // Machine learning (4 cr.)

Introduction - Prediction - Statistical Decision Theory - Linear Regression - Non-linear Regression - Bias-variance tradeoff - Linear Classification - Indicator Regression - PCA - LDA - QDA - GDA - Naive Bayes - Logistic Regression - Perceptron - Separating Hyperplanes - SVM - Decision Trees - ensemble learning - bagging - boosting - stacking - Neural Networks - Backpropagation - Training Deep Neural Nets - Optimization Methods - Convnets - RNNs - Estimation Theory - Maximum Likelihood Estimation - Maximum A Posteriori Estimation - Bayesian Learning - Bayesian Linear Regression - Kernel Methods - Gaussian Process - Computational Learning Theory - Frontiers in ML.

INF8250AE // Reinforcement Learning (4 cr.)

Introduction to Reinforcement Learning. Multi-armed bandits. Contextual Bandits. Finite Markov Decision Process. Dynamic Programming. Policy Iteration. Value Iteration. Monte Carlo Methods. Temporal Difference Learning. n-step bootstrapping. On-policy prediction with function approximation. On-policy control with function approximation. Off-policy control with function approximation. Policy Gradient Methods. REINFORCE. Actor-Critic. Deterministic Policy Gradients. Natural Policy Gradient. TRPO and PPO. Model-based RL. Planning. Eligibility Traces. Hierarchical RL. POMDPs. inverse-RL. Exploration in RL. Off-line RL. Multi-agent RL.

INF6953QE // Security for IoT (3 cr.)

Foundational Understanding: Introduction to IoT fundamentals and core security principles. Threat Awareness: Exploration of common IoT threats through real-world examples. Secure Device Design: Principles for designing secure IoT hardware and firmware. Network Security: Strategies for securing IoT networks and detecting intrusions. Authentication and Access Control: Implementation of robust authentication and access control mechanisms. Data Security and Privacy: Techniques for protecting IoT data and ensuring user privacy. Incident Response: Development of strategies to detect, respond to, and recover from IoT security incidents. Future Trends Analysis: Examination of emerging trends and future challenges in IoT security. Practical Application: Hands-on projects and capstone presentations to apply learned principles to real-world scenarios.

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

Choice of a research problem to explore under the supervision of a professor. Literature search. Critical reading of the selected articles. Writing a summary report.

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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WINTER TERM

SOFTWARE & COMPUTING

INF6400E // **Vehicular Networks (3 cr.)**
Concepts of vehicular networks and motivation. Vehicular communication models. Types of vehicular network applications. Overview of use cases (e.g. autonomous vehicles, remote driving, extended sensors, vehicle platoons, advanced driving). Standards and protocol stacks for vehicular communication. Performance evaluation in vehicular networks. Routing in vehicular networks. Security and privacy in vehicular networks. Overview of current developments in vehicular networks (e.g., machine learning, virtualization).

INF8900E // **Directed Readings in Computer and Software (3 cr.)**
Choice of a research problem to explore under the supervision of a professor. Literature search. Critical reading of the selected articles. Writing a summary report.

INF6422E // **Advanced Concepts in Computer Security (3 cr.)**
Performance Evaluation in Computer Security. Defensive System Performance vs. Attack Tool Performance. Quantitative Methods for Evaluating Computer Security Performance: Mathematical Models, Simulation, and Emulation. Laboratory Experimentation Methods. Intrusion Detection Systems (IDS): Research, Commercial Deployment, and Limitations. Detection by Rule and Anomaly. IDS Evasion and Mimicry Attacks. Malicious Code Detection: Basic Principles and Current Issues. Zombie Networks: Types, History, and Operation. Detection and Mitigation Methods. Denial of Service Attacks: Economic and Political Use, Proposed and Used Solutions. Semantic Models of Security Concepts and Semantic Attacks. Trust Management Models and Systems. Privacy Protection and Sociopolitical Impacts.

INF6805E // **Swarm intelligence (3 cr.)**
Introduction to complex systems. Basic concepts of self-organization: positive and negative feedback, symmetry breaking (how random fluctuations create structure), emergence (how simple components can create complex behaviors). Network models: information cascades, epidemics as an information propagation model. Consensus-reaching in multi-agent systems via voting. Examples of self-organized systems from physics, biology, finance. Swarm robotics and swarm algorithms. Decentralized task allocation. Collective motion (flocking, shepherding, milling). Multi-agent consensus and collective decision-making. Optimization by swarm intelligence: ant colony optimization, particle swarm optimization.

INF6953PE // **Deep Learning Dynamics (4 cr.)**
Deep Learning (DL) Review. Optimization for DL. Initialization. Neural Networks Loss Landscape. Implicit Regularization of Stochastic Gradient Descent (SGD). Sharpness Aware Minimization (SAM). Sharp minima and flat minima. Edge of Stability of Training. Geometric complexity. Normalization. Residual Connections. Double descent. Grokking. Lottery Ticket Hypothesis (LTH). Invariance. Pruning. Scaling and phase transitions. Understanding Transformers. Mode connectivity. Plasticity. Continual Learning.

LOG6953FE // **Engineering Digital Twins (3 cr.)**
Definitions, examples, benefits, and application areas of digital twins (DTs). DTs, digital shadows, and digital models. DT platforms and DT realization. DT components (services, enablers, models/data). Processes and metrics for DT Engineering. Modelling and simulation principles. Co-simulation. Communication and sensing. Visualization, monitoring, formal verification, and advanced DT services. DT reporting.

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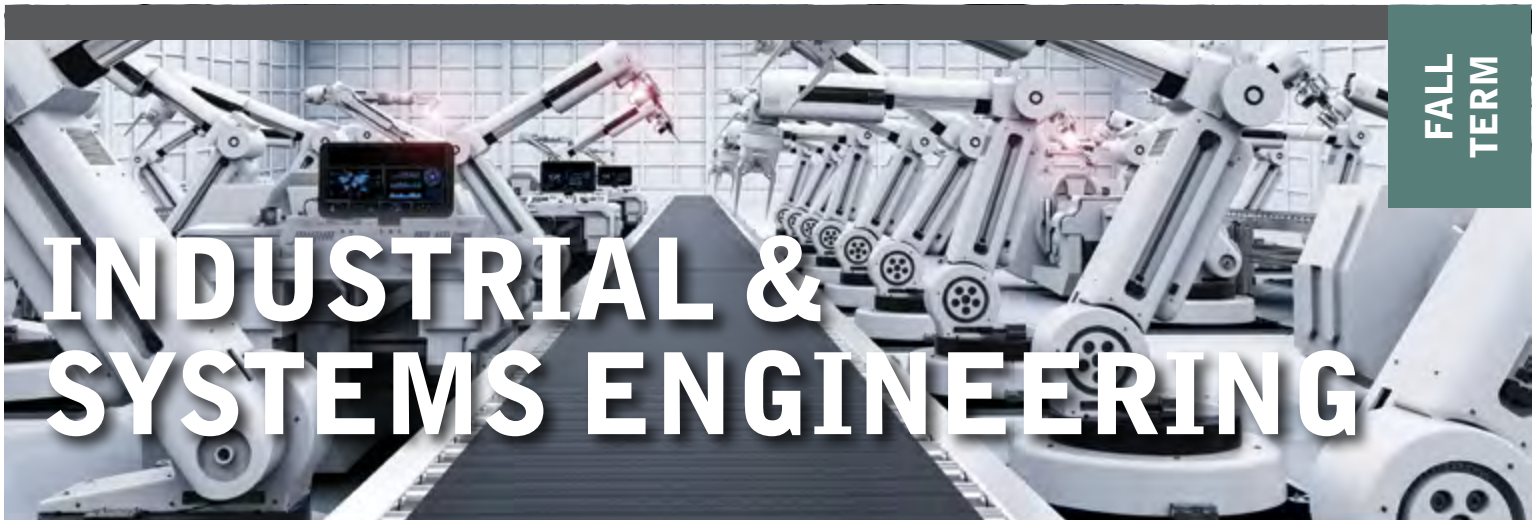

FALL TERM

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 :

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.

IND6240E // Industry 4.0: Concepts and Applications (3 cr.)

Definition, tools, technologies and concepts of industry 4.0 for the implementation of digital transformation of business processes in the context of the 4th industrial revolution. Application of technologies: Internet of things (IoT), massive data (big data), cloud computing (cloud computing and cloud manufacturing), cyber-physical systems (CPS), artificial intelligence. 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. Information system for industry 4.0.

IND8137AE // Techno-entrepreneurship (3 cr.)

Entrepreneurial phenomenon. Technological entrepreneurs: motivations, characteristics, values, career, role. Process of creation of a technology company: sources of the idea, choice of partners and legal aspects. Business plan and business models. Value chains: supplier-customer relationship, technological and commercial partnerships. Organization of the critical functions of the company: start-up and new product development; growth and organization. Intellectual property protection, technology transfer and other contractual aspects. Identification of clients, market analysis and marketing plan. Support organizations, programs and policies to support technological start-ups. Sources of credit in the short, medium and long term. Budgeting. Financial ratios. Funding sources.

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

Health management of industrial systems. Preventive maintenance. Condition-based maintenance. Failure rate and renewal theory. Weibull analysis. Analytics of faults. Diagnosis and prognosis of physical asset state. Estimation of residual life. Data-based decision-making. Maintenance actions of repair and replacement. Optimal inspection strategies. Processing massive data of system's state. Machine learning techniques for fault detection and predication. Life cycle cost analysis. Measures of performance and performance indices.

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.

French Language Course (3 cr.)

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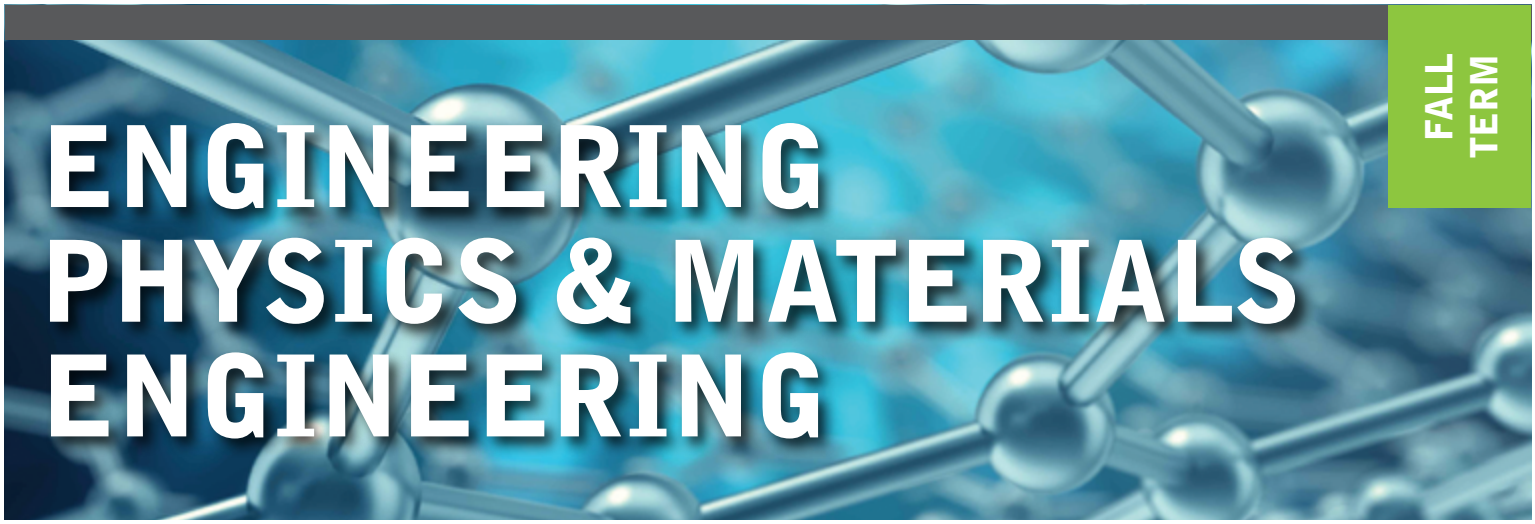

ENGINEERING PHYSICS & MATERIALS ENGINEERING

FALL TERM

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 equations and fundamental properties of guided modes. Transfer matrix method: planar waveguides and circular optical fibers. 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: couplers, Bragg gratings, tapered fibers. Optical systems. Numerical modeling of the behavior of guided optical devices using the finite element method.

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.

PHS8280E // Lasers (3 cr.)

Temporal and spatial coherence. Light-matter interaction: stimulated emission, Einstein A and B coefficients, absorption and gain, rate-equation model. Resonators and cavities: longitudinal and transverse modes, stability criteria, Gaussian beam propagation. Laser operating parameters: frequency selection, output power, efficiency, laser threshold condition. Laser dynamics: gain switching and relaxation oscillations, Q-switching, mode-locking. Semiconductor lasers: optoelectronic properties, modeling and operation. Survey of main laser types and laser-based applications.

PHS8230E // Quantum Optics (3 cr.)

Classical and quantum radiation. The photon. Field quantization. Vacuum fluctuations. Number states, coherent states, compressed states. Einstein-Podolsky-Rosen paradox. Bell's inequalities. Intricate states. Teleportation and quantum cryptography. Quantum non-demolition. Light-matter interaction. Two- and three-level systems in the classical regime. Resonant fluorescence. Two-level system in the quantum regime. Single-photon and single photons, entangled photons. Spin-photon entanglement and entangled photon chains.

GCH8102E // Polymer Processing Fundamentals (3 cr.)

Fundamentals of industrial polymer processes. 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.

French Language Course (3 cr.)

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FALL TERM

ENERGY SYSTEMS

The Energy Systems Cluster at Polytechnique Montréal offers one of Canada's premier specializations in power and energy systems engineering, delivering a unique blend of academic excellence and industrial relevance. Our program benefits from internationally recognized faculty members specializing in power systems, smart grids, and renewable energy integration, supported by strong partnerships with major utilities and leading equipment manufacturers. The cluster leverages Polytechnique's research excellence in simulation technologies and grid modernization, while fostering international collaborations with renowned institutions worldwide.

The Energy Systems Cluster provides a solid foundation for both industry careers and advanced research opportunities in the rapidly evolving field of electrical power engineering. This program is particularly well-suited for final-year electrical or mechanical engineering students with a strong background in circuit theory and control systems.

Students must take 12 to 15 credits among the following :

ELE6427E // Microgrid Control (3 cr.)
Introduction to distributed generation (DG), microgrids and smart grids. Role of DG as an interface between renewable energy sources and electrical networks. Fundamental components of smart grids: control systems, measurement units, communication systems and computer systems. Problems related to smart microgrids: islanding detection and islanding protection. Mathematical tools for the modelling and control of smart microgrids. Active islanding detection and introduction to an enhanced phase-locked loop (PLL). Control strategies of electronically-coupled DG units interfaced to grid through L-filter, LCL-filter and LC-filter. Control of islanded DG units and islanded microgrids with passive loads, balanced/unbalanced loads, and nonlinear loads. Design of robust controllers for microgrid systems based on Linear Quadratic Tracker (LQT). Power quality challenges associated with microgrids and the proposed solutions using enhanced control techniques. Stability analysis of microgrids with uncertain dynamics.

ELE8451E // Power Electronics Systems (3 cr.)
Definition of industrial electronics and relevance of power electronics in the conversion and efficient use of electrical energy. Power semiconductors and their environment. Structural characteristics and functional analysis of natural and forced switching converters: rectifiers, choppers, inverters. Applications to power grids and energy conversion. Converter modelling and evaluation, both experimental and numerical, of the actual behaviour of converters.

ELE8452E // Electrical Networks (3 cr.)
Principles of planning and operation of interconnected networks. Mathematical models of the components of a network. Established regime analysis and power flows: formulation and solutions. Fault currents. Operation strategies, economic dispatching, voltage and frequency regulation, power transits and interconnections.

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.

ELE8462E // Modern Protection Methods (3 cr.)
Introduction to power systems protection in transmission and distribution networks, covering fault analysis, numerical protective relay architecture, and coordination. Focus on overcurrent, numerical distance, and differential protection, with special emphasis on systems containing inverter-based resources (IBRs), digital substations, and modern protection challenges.
Prerequisites: Knowledge of power systems

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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 :

CIV8330E // Climate Change and Water Resources (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.

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.

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.

IND8111E // Circular Economics (3 cr.)

Economics, circular economy and material flow balance. Life cycle approach and material loops. Perspectives of the engineer. Municipal waste and recycling: technologies, incentives, public policies, taxes, subsidies, extended producer responsibility, theoretical models and empirical results, social norms, corruption, city size and density. Remanufacturing: leasing models and contract theory, property rights, cannibalization and secondary markets competition. Eco-design: innovation and the Porter's hypothesis, recyclability, reusability, durability, and planned obsolescence. International aspects: markets and material flows, resource dependence, international agreements, illegal trade and corruption, donations. Green markets: eco-labeling and greenwashing. Selected topics in engineering such as corporate social responsibility, eco-industries, environmental lobbying.

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.

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. Dynamics of traffic. Computer practical work.

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

Sustainable mobility challenges. Historical concepts of sustainable development. Concept of sustainable mobility. Basic concepts related to the spheres of sustainable mobility. Conceptual frameworks of transport behaviors. Influences on transport behaviors. Examples of transport behavior changes in history. Examples of international cities. Models and theories of behavior. Theories of behavior change and their application in transport.

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.

CIV8750E // Sustainable Transport Planning (3 cr.)

Transport plans, strategic plans (movement of people), urban development plans, decision-making processes, consultation mechanisms. Innovative strategies to promote the use of sustainable modes of transport: case studies and analysis. Transport demand forecasting: classic models, new approaches and results. Planning software. Externalities linked to transport infrastructures and their use: public health, safety, pollution, use of space, urban sprawl and car dependency. Transport and sustainable mobility indicators: databases and evaluation mechanisms. Alternative travel approach: carsharing, bikesharing, carpooling, reserved lanes, active modes, intermodality, parking management.

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 mining and machine learning methods. Econometric models.

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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 :

GBM6330E // Emerging Biomedical Technologies (3 cr.)

Students learn about emerging biomedical technologies through reading research articles and talking to the people behind them. Every two weeks a different topic is covered that has the potential to transform biomedical research and advance human health. Lectures are given by the professor and external experts in the fields of imaging, genetics, prosthetics, big data and artificial intelligence. Students are expected to produce written and multi-media summaries of research articles. The final project consists of an interview with a biomedical researcher that will be published on the course website (https://gbm6330.edublogs.org/)

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

3D reconstruction systems from multimodal medical images. Passive vision systems: camera calibration, X-rays systems calibration, stereo matching, epipolar geometry, geometry-based primitives, intensity-based primitives, primitives matching using classifiers. Medical image registration. 3D reconstruction from image sequences: self-calibration, primitive temporal tracking, 3D structure from motion, shading and texture. Active vision systems: interferometry approach, active triangulation, 3D surface registration, elastic registration, texture mapping. Applications on 3D reconstruction of anatomical structures from medical images.

GBM8810E // Biomedical Nanotechnologies (3 cr.)

Physical concepts nanotechnology and applications in the biomedical realm. Different approaches to nanotechnology: Fabrication and functionalization of metallic and semiconductor nanomaterials used in biomedical applications. Bioplasmonics: concept of plasmon, Mie theory, nanophotothermy and therapeutic applications. Optical nano-sensors: theory and application of plasmonics, biosensors based on surface plasmon resonance. Biomedical nanophotonics: quantum dots, laser nano-surgery. Biomedical nano-magnetism: properties of magnetic nanomaterials and applications in biodetection, imaging and therapy. Ethics and social impact of biomedical nanotechnologies.

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*.

INTERNATIONAL THEMATIC CLUSTERS IN ENGINEERING

POLYTECHNIQUE MONTRÉAL
TECHNOLOGICAL UNIVERSITY

FOR MORE INFORMATION

Internationaly Mobility Program: *etudiant.echange@polymtl.ca*
Partnerships and quotas: *point@polymtl.ca*

Course content may vary slightly from year to year.

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