MAÎTRISE ÈS SCIENCES APPLIQUÉES GÉNIE ÉLECTRIQUE ET GÉNIE INFORMATIQUE

En bref

- Grade universitaire offert : Maitrise ès sciences appliquées (M.Sc.A.)
- Options de statut d'inscription : Temps complet ou temps partiel
- Langue d'enseignement : Anglais
- Option d'étude (durée prévue du programme) :
  - dans une période de 2 ans à temps complet
- Unités scolaires : Faculté de génie (http://genie.uottawa.ca/), école de science informatique et de génie électrique (http://genie.uottawa.ca/sige/), Institut de génie électrique et de génie informatique d'Ottawa-Carleton (http://www.ociece.ca/bi_ling/?lang=2).

Description du programme

Programme conjoint Ottawa-Carleton

Fondé en 1983, l'Institut de génie électrique et génie informatique d'Ottawa-Carleton (IGEIOC) combine les ressources et capacités de recherche de l'École de science informatique et de génie électrique (SIGE) de l'Université d'Ottawa, ainsi que du *Department of Electronics* et du *Department of Systems and Computing Engineering* de la *Carleton University.*

L'Institut est l'une des unités participant à la spécialisation pluridisciplinaire en science, société et politique publique (niveau maîtrise seulement).

Principaux domaines de recherche

- Réseaux informatiques, systèmes multimédia et distribués
- Conception assistée par ordinateur pour les circuits électroniques
- Génie informatique et logiciel
- Transmission sans fil et transmission de données
- Électromagnétisme et micro-ondes
- Traitement d'image, du signal et du langage
- Circuits et dispositifs intégrés
- Intelligence artificielle et des systèmes
- Systèmes photoniques
- Génie biomédical

Note : De plus amples renseignements sont affichés sur les sites web des départements.

Autres programmes offerts dans la même discipline ou dans une discipline connexe

- Maîtrise ès sciences appliquées Génie électrique et génie informatique Spécialisation en science, société et politique publique (M.Sc.A.)
- Maîtrise en ingénierie Génie électrique et génie informatique (M.Ing.)
- Doctorat en philosophie Génie électrique et génie informatique (Ph.D.)

Coût et financement

- Frais reliés aux études :

Le montant estimé des droits universitaires (https://www.uottawa.ca/droits-universitaires/) de ce programme est disponible sous la section Financer vos études (http://www.uottawa.ca/etudes-superieures/programmes-admission/financer-etudes/).

Les étudiants internationaux inscrits à un programme d'études en français peuvent bénéficier d'une exonération partielle des droits de scolarité (https://www.uottawa.ca/droits-universitaires/exoneration-partielle-des-droits-de-scolarite/).

- Pour des renseignements sur les moyens de financer vos études supérieures, veuillez consulter la section Bourses et appui financier (https://www.uottawa.ca/etudes-superieures/etudiants/bourses/).

Notes

- Les programmes sont régis par les règlements généraux (http://www.uottawa.ca/etudes-superieures/etudiants/reglements-generaux/) en vigueur pour les études supérieures les règlements de l'Institut de génie électrique et génie informatique d'Ottawa-Carleton (IGEIOC).
- Conformément au règlement de l'Université d'Ottawa, les étudiants ont le droit de rédiger leurs travaux, leur thèse et de répondre aux questions d'examen en français ou en anglais.

Coordonnées du programme

Bureau des études supérieures, Faculté de génie (https://genie.uottawa.ca/bureau-des-etudes-superieures/)
STE 1024
800 King Edward Ave.
Ottawa ON Canada
K1N 6N5

Tél. : 613-562-5347
Téléc. : 613-562-5129
Courriel : etudesup.genie@uottawa.ca

Twitter | Faculté de génie (https://twitter.com/uottawagenie/)
Facebook | Faculté de génie (https://www.facebook.com/uottawa.engineering/)

Exigences d'admission

Pour connaître les renseignements à jour concernant les dates limites, les tests de langues et autres exigences d'admission, consultez la page des exigences particulières (https://www.uottawa.ca/etudes/etudes-superieures/exigences-admission-particulieres/).

Pour être admissible, vous devez :

- Être titulaire d'un baccalauréat spécialisé ou avec majeure en génie électrique et génie informatique (ou l'équivalent) avec une moyenne minimale de 70 % (B).

  Note : Les candidats internationaux doivent vérifier les équivalences d'admission (https://www.uottawa.ca/etudes-superieures/

international/etudier-uottawa/equivalences-admission/) pour le diplôme obtenu dans leur pays de provenance.

- Démontrer une bonne aptitude à la recherche que ce soit dans le contexte d'un projet de quatrième année au baccalauréat ou par la rédaction de rapports de recherche, de résumés ou d'autres documents démontrant des habiletés de recherche.
- Identifier au moins un professeur prêt à diriger votre recherche et votre thèse.
  - Il est recommandé de communiquer avec le directeur de thèse dès que possible.
  - Pour pouvoir vous inscrire, vous devez faire accepter votre candidature par un directeur de thèse.
  - Le nom du professeur est requis lors de la demande d'admission.

Le cheminement accéléré a deux exigences additionnelles :

- Compléter jusqu' à 6 crédits de maîtrise en génie électrique et informatique avec une note de B ou plus (70 %) suivis pendant le baccalauréat en génie électrique et génie informatique ou en génie logiciel;
- Avoir une moyenne d'admission d'au moins A- (80 %).

Exigences linguistiques

Les candidats doivent comprendre et parler couramment la langue d'enseignement, soit le français, soit l'anglais, du programme dans lequel ils veulent s'inscrire. Une preuve de compétence linguistique peut être requise.

Ceux dont la langue maternelle n'est ni le français ni l'anglais doivent fournir une preuve de compétence dans la langue d'enseignement.

Note : Les coûts des tests de compétences linguistiques devront être assumés par le candidat.

Notes

- Le choix du professeur détermine le campus où il faut poursuivre la recherche et ce sera aussi l'université qui octroie le diplôme.
- Les installations de recherche sont partagées entre les deux campus. Les étudiants ont accès aux cours, à l'équipement et aux professeurs des deux universités mais doivent s'inscrire à l'université d'attache de leur directeur de recherche.
- Les activités de recherche peuvent se dérouler soit en anglais, soit en français, soit dans les deux langues selon les compétences linguistiques des professeurs et des membres du groupe de recherche concernés.
- Les conditions d'admission décrites ci-dessus représentent des exigences minimales et ne garantissent pas l'admission au programme.
- L'admission aux programmes d'études supérieures en génie électrique et génie informatique est régie par les règlements généraux (http://www.uottawa.ca/etudes-superieures/etudiants/reglements-generaux/) en vigueur pour les études supérieures et les règlements de l'Institut de génie électrique et génie informatique d'Ottawa-Carleton (IGEIOC).

Exigences du programme
Maîtrise avec thèse

Les exigences à remplir sont les suivantes :

Cours obligatoires :	
15 crédits de cours optionnels en génie électrique (ELG) de niveau gradué [1]	15 crédits
Thèse :	
THM 7999 Thèse de maîtrise [2]	

Note(s)

1

Il est permis de suivre jusqu'à la moitié des cours dans un programme autre que génie électrique et génie informatique (par exemple, mathématiques, informatique, physique). Pour ce faire, il faut obtenir au préalable la permission du directeur du Département.

2

L'étudiant est responsable de s'assurer de rencontrer les exigences relatives à la thèse (http://www.uottawa.ca/etudes-superieures/etudiants/theses/). La thèse doit être basée sur des travaux de recherche originaux effectués sous la direction immédiate d'un membre du corps professoral du département.

Maîtrise avec thèse, cheminement accéléré

Les étudiants doivent satisfaire aux exigences de la maîtrise régulière avec thèse, mais peuvent recevoir des crédits, au cours de leur premier semestre d'inscription, pour les cours qu'ils ont déjà suivis dans un microprogramme ou un baccalauréat de l'Université d'Ottawa.

Exigences minimales

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

Les étudiants qui échouent 6 crédits doivent se retirer du programme.

Passage accéléré de la maîtrise au doctorat

Les étudiants inscrits au programme de maîtrise en génie électrique et génie informatique à l'Université d'Ottawa ont la possibilité de passer directement au programme de doctorat sans avoir à rédiger la thèse de maîtrise. Pour de plus amples renseignements, veuillez consulter la section « Exigences d'admission » du programme de doctorat.

Recherche
La recherche à l'Université d'Ottawa

Située au cœur de la capitale du Canada, à quelques pas de la colline du Parlement, l'Université d'Ottawa se classe parmi les 10 meilleures universités de recherche au Canada. Notre recherche est fondée sur l'excellence, la pertinence et l'impact et s'effectue dans un esprit d'équité, de diversité et d'inclusion.

Notre communauté de recherche se développe dans quatre axes stratégiques :

- Créer un environnement durable,
- Promouvoir des sociétés justes,
- Façonner le monde numérique
- Favoriser santé et bien-être tout au long de la vie.

Qu'il s'agisse de faire progresser les solutions en matière de soins de santé ou de relever des défis mondiaux comme les changements

climatiques, les chercheurs de l'Université d'Ottawa sont à l'avant-garde de l'innovation et apportent des contributions importantes à la société et au-delà.

La recherche à la Faculté de génie

Principaux domaines de recherche :

- Génie chimique et biologique
- Génie civil
- Science informatique et génie électrique
- Génie mécanique

Pour d'autres informations, veuillez consulter la liste des membres du corps professoral et leurs domaines de recherche sur **Uniweb**.

IMPORTANT : Les candidats et les étudiants à la recherche de professeurs pour superviser leur thèse ou leur projet de recherche peuvent aussi consulter le site Web de la faculté ou du département **(**https://www.uottawa.ca/etudes/etudes-superieures/coordonnees-unites-academiques/**) du programme de leur choix. La plateforme Uniweb n'est pas représentative de l'ensemble du corps professoral autorisé à diriger des projets de recherche à l'Université d'Ottawa.**

Cours

Quel que soit le programme, avec l'approbation du directeur ou de la directrice de recherche, de la personne chargée de la coordination du programme ou du Comité consultatif, on peut choisir des cours du programme des études supérieures de l'une ou l'autre université. Les cours de niveau supérieur sont énumérés ci-dessous et sont regroupés par domaines. Les descriptions de cours figurent dans les sections relatives aux départements concernés dans les annuaires appropriés.

Tous les cours durent un trimestre. Pour identifier le département qui offre les cours, il suffit de se référer aux préfixes selon le code donné ci-dessous.

UNIVERSITÉ D'OTTAWA / UNIVERSITY OF OTTAWA:

ELG / EACJ SIGE (École de science informatique et de génie électrique)

EECS (School of Electrical Engineering and Computer Science)

CARLETON UNIVERSITY:

SYSC Department of Systems and Computer Engineering

ELEC Department of Electronics

Seule une sélection des cours énumérés est offerte chaque année. Les cours durent une session et ont une valeur de trois crédits à l'Université d'Ottawa (0,5 crédit à Carleton University).

ELG 5100 Software Engineering Project Management (3 units)
Software system engineering and organization methods; work breakdown structure and task determination; effort, duration and cost estimation; scheduling and planning. Monitoring and control; analysis of options; management of risks, change, and expectations. Process and product metrics, post-performance analysis, process improvement and maturity. Management of Agile Programming methodologies such as Extreme Programming. Case studies. This course is equivalent to EACJ 5211 at Carleton University.
Course Component: Lecture

ELG 5103 Optical Communications Systems (3 units)
Optical communication system concepts and basic characteristics. Optical Transmitters. Optical detection. Optical noise sources and their mathematical models. Non-coherent (direct) detection: system model, direct detection of intensity modulation, application of photo-multiplication, optimal post-detection processing, and subcarrier systems. Coherent detection: heterodyne receivers, the field matching problem and receiver performance. Optical binary digital system, single-mode binary and heterodyne binary systems. Block coded digital optical communication systems: PPM, PAM, PSK, and FSK signalling. Integration of device technology and system architecture. Selected topics in optical communications and networking. This course is equivalent to EACJ 5201 at Carleton University.
Course Component: Lecture

ELG 5104 Electromagnetic Waves Theory and Applications (3 units)
The homogeneous wave equation. Uniform and nonuniform plane waves. Inhomogeneous wave equations. Green's functions. Theory of potentials. Scattering problems. Numerical methods. Boundary value problems. Perturbation and variational techniques. This course is equivalent to EACJ 5401 at Carleton University.
Course Component: Lecture

ELG 5106 Fourier Optics (3 units)
Diffraction: Plane waves expansions, angular spectra, 2D Fourier transform, scalar and vector diffraction theory, Fresnel and Fraunhofer diffraction, coherence. Linear optical systems: Thin lenses, Gaussian beam optics, transmission functions, linear systems theory, imaging, transfer functions, aberration. Applications: Holography, diffractive optics, gratings, optical correlation. This course is equivalent to EACJ 5003 at Carleton University.
Course Component: Lecture

ELG 5119 Stochastic Processes (3 units)
Probability. Random variables. Distribution and density functions. Expectation. Functions of random variables. Moments and characteristic functions. Random vectors. Sequences of random variables and convergence. Limit theorems. Stochastic processes: basic notions. Stationarity. Ergodicity. Poisson and Gaussian processes. Second order processes. Representation theorems. Markov processes and chains. Courses ELG 5119, ELG 6153 (SYSC 5503) cannot be combined for units. This course is equivalent to EACJ 5109 at Carleton University.
Course Component: Lecture

ELG 5121 Multimedia Communications (3 units)
Introduction, applications, standards. Networking technologies. Image, video and audio compression. Quality of Service and resource management. Scheduling issues for real-time MM transport. Multimedia synchronization. Multimedia and the Internet. Multimedia conferencing. Multimedia to the home. Satellites and multimedia. Multimedia applications. This course is equivalent to EACJ 5201 at Carleton University.
Course Component: Lecture

ELG 5124 Virtual Environments (3 units)
Basic concepts. Virtual worlds. Hardware and software support. World modeling. Geometric modeling. Light modeling. Kinematic and dynamic models. Other physical modeling modalities. Multisensor data fusion, anthropomorphic avatars. Animation: modeling languages, scripts, real-time computer architectures. VE interfaces. Case studies. This course is equivalent to EACJ 5204 at Carleton University.
Course Component: Lecture

ELG 5126 Source Coding and Data Compression (3 units)
Lossless coding: discrete sources, entropy rate, Huffman coding, arithmetic coding, dictionary methods. Lossy coding: continuous sources, rate-distortion functions. Waveform coding methods: scalar and vector quantization, predictive coding, transform coding, subband and wavelet coding. Applications to telecommunications and storage: text, speech, audio, facsimile, image, video.
Course Component: Lecture
Courses ELG 5126 and ELG 6167 cannot be combined for units.

ELG 5127 Medical Image 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 SYSC 5304 at Carleton University.
Course Component: Lecture
The course ELG 5127 cannot be combined for units with BMG 5105 (BIOM 5200 at Carleton University).

ELG 5128 Wireless Ad Hoc Networking (3 units)
Self-organized, mobile, and hybrid ad hoc networks. Physical, medium access, networks, transport and application layers, and cross-layering issues. Power management. Security in ad hoc networks. Topology control and maintenance. Date communication protocols, routing and broadcasting. Location service for efficient routing. Courses CSI 5148 (COMP 5103), ELG 5128 cannot be combined for units.
Course Component: Lecture
Exclusion: CSI 5148 (COMP 5103)

ELG 5131 Graphical Models (3 units)
Bayesian networks, factor graphs, Markov random fields, maximum a posteriori probability (MAP) and maximum likelihood (ML) principles, elimination algorithm, sum-product algorithm, decomposable and non-decomposable models, junction tree algorithm, completely observed models, iterative proportional fitting algorithm, expectation-maximization (EM) algorithm, iterative conditional modes algorithm, variational methods, applications. Courses ELG 5131, ELG 7177 (EACJ 5605) cannot be combined for units. This course is equivalent to EACJ 5131 at Carleton University.
Course Component: Lecture

ELG 5132 Smart Antennas (3 units)
Wireless systems and their imitations. Introduction to propagation and antenna arrays. Concept of smart antenna; spatial processing; space-division multiple access. Types of smart antennas. Range and capacity improvement. Beamforming networks and algorithms. Direction-of-arrival estimation. Multiple-input multiple- output (MIMO) architecture: basic principles; capacity issues; performance analysis. Bell Lab Layered Space-Time (BLAST) algorithm. Space-time coding. Alamouti scheme. Spatio-temporal radio channels. Impact of correlation. Courses ELG 5132, ELG 7178 (EACJ 5606) cannot be combined for units.
Course Component: Lecture

ELG 5133 Introduction to Mobile Communications (3 units)
Introduction to mobile and cellular systems. Radio channel characterization: signal strength prediction techniques and coverage; indoor/outdoor models; fading; delay spread; interference models and outage probabilities. Digital modulation and transmission system performance. Signal processing techniques, diversity and beamforming.Multiple-input multiple-output (MIMO) systems. New directions and recent results.
Course Component: Lecture

ELG 5137 Planning and Design of Computer Networks (3 units)
Planning process of computer networks; needs and technical requirements; modeling of different network planning problems; exact and approximate algorithms; topological planning and expansion problems; equipment (switch, router) location problem; approximate and optimal routing algorithms; presentation of various case studies. This course is equivalent to SYSC 5407 at Carleton University.
Course Component: Lecture

ELG 5142 Ubiquitous Sensing for Smart Cities (3 units)
This course is an introduction to ubiquitous sensing systems for intelligently coordinated and efficient cities and spaces. Three primary foci will be on smart cities sensing, reliable sensory data acquisition, and security and privacy in smart city sensing systems. Topics will include: a thorough presentation of sensor and actuator networks for smart cities, software-defined Internet of Things, vehicular sensing, social sensing, detailed investigation of opportunistic and participatory sensing solutions, sensing as a service, and security and privacy assurance in smart city services by using artificial intelligence methods. An emphasis will be given on the design and analysis of multi-purposed, non-dedicated and large-scale sensing systems along with the trustworthiness, reliability, security and efficiency requirements of smart city services.
Course Component: Lecture

ELG 5143 AI-Enabled Wireless Networks (3 units)
Communication fundamentals. Wireless communications. Device-to-device communications. Cyber physical systems (CPS). Self-organization. Supervised and unsupervised learning. Reinforcement learning. Deep learning.
Course Component: Lecture

ELG 5161 Robotics: Control, Sensing and Intelligence (3 units)
Robotics as the intelligent connection of perception to action. Advanced robotics technologies. Robot arm kinematics and dynamics. Planning of manipulator trajectories. Control of robot manipulators. Robot-level programming. Sensors and sensory perception. Control problems for sensory controlled robotic-based flexible manufacturing systems. Task-level programming. Knowledge-based control for mobile robots. This course is equivalent to EACJ 5207 at Carleton University.
Course Component: Lecture

ELG 5163 Machine Vision (3 units)
Image acquisition. Structured light and stereo ranging. Grey-scale and binary images: geometric and topological properties. Image segmentation, preprocessing, edge finding, processing. Image recognition. Mathematical models for image representation. Morphology. Representation of 3-D objects, scene understanding, motion detection. Massively parallel computers architectures. Machine vision for manufacturing. This course is equivalent to EACJ 5100 at Carleton University.
Course Component: Lecture

ELG 5164 Cloud Infrastructure and Technologies (3 units)
Theory and hands-on experience of virtualization technology and infrastructure to support cloud computing systems and services starting from Metal-As-A-Service and building up to a full, open, standards compliant Software-As-A-Service stack. Full explanation of the processes, methodologies, and tools needed for DevOps support. Topics covered include: Linux Fundamentals, Container Orchestration with Docker and Kubernetics, Networking Fundamentals, Cloud Computing using OpenStack, Network Functions Virtualization as well as special topics related to emerging applications and research.
Course Component: Lecture

ELG 5166 Cloud Analytics (3 units)
Fundamentals of complex and large-scale data processing in the cloud (evolution, characteristics, application). Distributed data processing approaches: master/slave, vertical vs. horizontal scalability, batch and streaming, transactions management, CAP Theorem. Batch processing. In-memory processing. Data processing clusters and pipelines. Hands-on experience developing and managing complex and large-scale data pipeline applications in a cloud. NoSQL databases (characteristics, types, architectures). Data lakes and cloud computing infrastructure.
Course Component: Lecture

ELG 5170 Information Theory (3 units)
Measure of information: entropy, relative entropy, mutual information, asymptotic equipartition property, entropy rates for stochastic processes; Data compression: Huffman code, arithmetic coding; Channel capacity: random coding bound, reliability function, Blahut-Arimoto algorithm, Gaussian channels, colored Gaussian noise and "water-filling"; Rate distortion theory; Network information theory. This course is equivalent to EACJ 5501 at Carleton University.
Course Component: Lecture

ELG 5179 Detection and Estimation (3 units)
Binary, M-ary and composite hypothesis testing. Bayes risk and Neyman-Pearson criteria. Parameter estimation: Cramer-Rao bounds; maximum-likelihood estimation. Detection in additive white Gaussian noise and coloured noise. Noise in noise problems. Classical estimation problems. The linear filtering problem. Wiener/Kalman filtering. Sequential and non-parametric detection. This course is equivalent to EACJ 5503 at Carleton University.
Course Component: Lecture

ELG 5180 Advanced Digital Communication (3 units)
Techniques and performance of digital signalling and equalization over linear bandlimited channels with additive Gaussian noise. Fading multipath channels: diversity concepts, modelling and error probability performance evaluation. Synchronization in digital communications. Spread spectrum in digital transmission over multipath fading channels. Courses ELG 5180, ELG 6165 (SYSC 5605) cannot be combined for units. This course is equivalent to EACJ 5704 at Carleton University.
Course Component: Lecture
Prerequisite: SYSC 5504 or ELG 5375 or the equivalent.

ELG 5191 Design of Distributed System Software (3 units)
Distributed systems design and programming issues; distributed computing. Basics of object oriented technology for distributed computing. Distributed objects technologies. Object oriented models for distributed programming. Distributed computing architecture design. Component based distributed software design. Scalability, interoperability, portability and distributed services. Distributed applications design. This course is equivalent to EACJ 5203 at Carleton University.
Course Component: Lecture

ELG 5195 Digital Logic Design: Principles and Practices (3 units)
Switching algebra. Combinational circuit design including PLA and MSI techniques. Special properties-symmetric functions, unate functions, threshold functions, functional decomposition. Sequential circuits-state reduction, incompletely specified machines, state assignments and series-parallel decomposition. Fundamental mode sequential circuits-race, hazards, and state assignment. Semicustom and MSI design. Special sequential circuits. This course is equivalent to EACJ 5705 at Carleton University.
Course Component: Lecture

ELG 5199 Design of Multimedia Distributed Database Systems (3 units)
Database concepts and architectures. Data modelling. Relational technology and distributed databases. Examples of the new generation of databases for advanced multimedia applications such as multimedia information retrieval, VOD and the limitations of the conventional models for managing multimedia information (graphics, text, image, audio and video). This course is equivalent to EACJ 5104 at Carleton University.
Course Component: Lecture

ELG 5214 Deep Learning and Reinforcement Learning (3 units)
Advanced course in the theory, techniques, tools and applications of deep learning and reinforcement learning to Applied Machine Learning.
Course Component: Lecture

ELG 5218 Uncertainty Evaluation in Engineering Measurements and Machine Learning (3 units)
Bayesian analysis, Uncertainty quantification, Probabilistic programming, Data analysis, Modeling, Monte Carlo simulations, Bayesian machine learning, Measurement, Errors, Time series analysis.
Course Component: Lecture

ELG 5228 Mobile Robotics (3 units)
Locomotion and kinematics, wheeled and mobile robotics. Robot autonomy and perception. Localization: simultaneous localization and mapping (SLAM), map-based localization, Markov-based localization, Kalman filter-based localization. Path planning: configuration space, cell decomposition, artificial potential fields, collision avoidance. Motion control: trajectory tracking, regulation. Robotic Operating System (ROS).
Course Component: Lecture

ELG 5255 Applied Machine Learning (3 units)
Machine learning is an effective tool to design systems that learn from experience and adapt to an environment. Theory and applications of machine learning to the design of electrical and computer systems, devices and networks by using techniques that utilize statistics, neural computation and information theory. Fundamentals of supervised learning, Bayesian estimation, clustering and unsupervised learning, multivariate, parametric and non-parametric methods, kernel machines, hidden Markov models, multilayer perceptron networks and deep neural networks, ensemble learning and reinforcement learning. Design and testing of machine learning techniques integrated into real-world systems, devices and networks. Guidelines for machine learning experiments, methods for cross-validation and resampling, classifier performance analysis and tools for comparing classification algorithms and analysis of variance to compare multiple algorithms.
Course Component: Lecture
Courses ELG 5255, CSI 5155, DTO 5100, DTO 5101, IAI 5100, IAI 5101, MIA 5100, SYS 5185 cannot be combined for units.

ELG 5271 Topics in Applied Artificial Intelligence (3 units)
Recent and advanced topics in the field of Applied Artificial Intelligence. Topics vary from year to year.
Course Component: Lecture

ELG 5295 Ethics for Design, AI, and Robotics (3 units)
Artificial Intelligence technologies are becoming ever more present in applications like: automated vehicles and mobility-as-a-service (e.g. driving and system-level control algorithms); consumer electronics (e.g. social robots and smart speakers); healthcare (e.g. image classification in medical imaging); and weapons systems (e.g. targeting and kill decision-making). Many of these applications are raising significant ethical concerns. A range of topics in applied technology ethics are examined through the lens of contemporary philosophy and applied ethics texts and popular media articles. Practical frameworks, methodologies and tools for anticipating, and addressing, ethical issues are introduced through hands-on, group-based design thinking workshops and projects.
Course Component: Lecture
Courses CSI 5195, DTI 5310, DTO 5310, ELG 5295, IAI 5130, SYS 5295 cannot be combined for units. This course is reserved for students registered in an Electrical and Computer Engineering Program with a Concentration Applied Artificial Intelligence.

ELG 5301 Professional Skills and Responsibility (3 units)
Students work in teams (peer groups) to complete hands-on projects and online learning modules to build their professional network and develop their careers; understand their responsibilities as professionals; and develop professional skills with a focus on communication, team leadership, and project management. Fundamentals of technical team-based projects including problem definition, research, planning and how to write a technical project proposal. Required modules on academic writing, plagiarism and conducting a literature review.
Course Component: Lecture, Tutorial

ELG 5360 Digital Watermarking (3 units)
Overview of recent advances in watermarking of image, video, audio, and other media. Spatial, spectral, and temporal watermarking algorithms. Perceptual models. Use of cryptography in steganography and watermarking. Robustness, security, imperceptibility, and capacity of watermarking. Content authentication, copy control, intellectual property, and other applications. This course is equivalent to EACJ 5360 at Carleton University.
Course Component: Lecture

ELG 5369 Internetworking Technologies (3 units)
IP Based Internet Technologies: Internet architecture and its protocols. Software/hardware requirements for quality of service (QoS), Integrated services. Scheduling. Fair queueing. Traffic and admission control algorithms. Differentiated services. Multiprotocol label switching (MPLS) and associated software/hardware design issues. Fast internet protocol (IP), asynchronous transfer mode (ATM), internet protocol (IP) over synchronous optical network (SONET), wavelength division multiplexing (WDM), satellite implementations. This course is equivalent to EACJ 5369 at Carleton University.
Course Component: Lecture
Courses ELG 5369, ELG 7187 (EACJ 5808) cannot be combined for units.

ELG 5370 Wavelets and Multiresolution Signal Analysis (3 units)
Multirate signal processing: sampling rate conversion, polyphase representation. Bases, filter banks: series expansion of discrete-time signals, series expansion of continuous-time signals, multiresolution concept and analysis, construction of wavelet, wavelet series. Complexity of multirate discrete-time processing, filter banks, and wavelet series computation. This course is equivalent to SYSC 5370 at Carleton University.
Course Component: Lecture

ELG 5372 Error Control Coding (3 units)
General introduction. Algebraic concepts. Linear block codes. Cyclic codes, BCH and Reed-Solomon codes. Convolutional codes. Maximum likelihood decoding, and sequential decoding of convolutional codes. Burst-error correcting convolutional and block codes. Automatic repeat request. Trellis Coded Modulation. Turbo codes and iterative decoding. This course is equivalent to EACJ 5504 at Carleton University.
Course Component: Lecture

ELG 5373 Data Encryption (3 units)
Secure communications: encryption and decryption. Entropy, equivocation and unicity distance. Cryptanalysis and computational complexity. Substitution, transposition and product ciphers. Data Encryption Standard (DES): block and stream cipher modes. Modular arithmetics. Public key cryptosystems: RSA, knapsack. Factorization methods. Elliptic curve cryptography. Authentication methods and cryptographic protocols. This course is equivalent to EACJ 5105 at Carleton University.
Course Component: Lecture

ELG 5374 Computer Communication Network (3 units)
Network applications, structures and their design issues. Resource sharing/access methods. Network transmission and switching techniques. OSI model. Error control, flow control and various issues related to the physical, data link and network layers. Local area networks. Performance issues of delay-throughput in various protocols. Courses ELG 5374, ELG 6121 (SYSC 5201) cannot be combined for units. This course is equivalent to EACJ 5607 at Carleton University.
Course Component: Lecture

ELG 5375 Digital Communications (3 units)
Elements of communication theory and information theory applied to digital communications systems. Characterization of noise and channel models. Analysis of digital data transmission techniques for additive Gaussian noise channels. Efficient modulation and coding for relable transmission. Spread spectrum and line coding techniques. This course is equivalent to EACJ 5506 at Carleton University.
Course Component: Lecture

ELG 5376 Digital Signal Processing (3 units)
Review of discrete time signals and systems, A/D and D/A conversions, representation in time, frequency, and Z domain, DFT/FFT transforms, FIR/IIR filter design, quantization effects. Correlation functions. Cepstrum analysis. Multi-rate signal processing. Power spectrum estimation. Introduction to joint time-frequency analysis. DSP architecture: implementation approaches. Applications. Courses ELG 5376, ELG 6162 (SYSC 5602) cannot be combined for units. This course is equivalent to EACJ 5507 at Carleton University.
Course Component: Lecture

ELG 5377 Adaptive Signal Processing (3 units)
Theory and techniques of adaptive filtering, including Wiener filters, gradient and LMS methods; adaptive transversal and lattice filters; recursive and fast recursive least squares; convergence and tracking performance; implementation. Applications, such as adaptive prediction; channel equalization; echo cancellation; source coding; antenna beamforming; spectral estimation. This course is equivalent to EACJ 5800 at Carleton University.
Course Component: Lecture

ELG 5378 Image Processing and Image Communications (3 units)
Image acquisition, display and perception: sampling and reconstruction, quantization, human vision. Discrete image representations: color spaces, block, subband and wavelet representations. Image transformations, enhancement and restoration. Image analysis: edge detection, motion estimation. Image and video compression: lossless coding, predictive and transform coding, motion compensation.
Course Component: Lecture

ELG 5379 Numerical Methods in Electromagnetic Engineering (3 units)
Review of electromagnetic and potential theory. Formulation of static and electrodynamic problems. Introduction to numerical and field-theoretical modelling techniques. Numerical methods considered: FD, MoL, SDA, TLM and BPM. Examples of commonly encountered electromagnetic problems at microwave, millimeterwave and optical frequencies. This course is equivalent to EACJ 5402 at Carleton University.
Course Component: Lecture

ELG 5381 Photonics Networks (3 units)
Optical communication networks. Network layers. Optical signal formats. Clients to the optical layer (SONET, Optical Transport Network, IP). Optical fiber. Transmitter and receiver components. Multilevel modulation of optical signals. Coherent detection. Optical bypass technology. Routing. Wavelength assignment. Grooming. Optical protection schemes. Dynamic networking. Flexible optical networks. Gridless network architecture. This course is equivalent to EACJ 5004 at Carleton University.
Course Component: Lecture

ELG 5383 Survivable Optical Networks (3 units)
Optical networks design with emphasis on network survivability. Wavelength division multiplexing (WDM), wavelength conversion, optical switch architectures, routing and wavelength assignment algorithms, IP over WDM, optical network protocols, optical network control architectures, protection and restoration, spare capacity allocation, survivable routing, design and performance evaluation.
Course Component: Lecture

ELG 5385 Matrix Methods and Algorithms for Signal Processing (3 units)
Representation and approximation in vector spaces, matrix factorization, pseudoinverses, application of eigen decomposition methods, Singular Values Decomposition, least squares problems, applications of special matrices, iterative algorithms, expectation maximization algorithm. This course is equivalent to EACJ 5385 at Carleton University.
Course Component: Lecture

ELG 5386 Neural Networks and Fuzzy Systems (3 units)
Neuro-fuzzy and soft computing. Fuzzy set theory: rules, reasoning and inference systems. Regression and optimization; derivative-based optimization - genetic algorithms, simulated annealing, downhill simplex search. Neural Networks: adaptive networks; bidirectional associative memories; supervised and unsupervised learning; learning from enforcement. Applications: neuro-fuzzy modelling and control, pattern recognition. Courses ELG 5386, MCG 5356 (MECH 5506) cannot be combined for units. This course is equivalent to EACJ 5386 at Carleton University.
Course Component: Lecture
Exclusion: MCG 5356 (MECH5506).

ELG 5901 Projet en génie électrique / Electrical Engineering Project (6 crédits / 6 units)
Projet en génie électrique. Nécessite un rapport écrit approfondi et une présentation orale. Classé S (satisfaisant) ou NS (non satisfaisant). / Project in electrical engineering. Requires an in-depth written report and an oral presentation. Graded S (Satisfactory) or NS (Not satisfactory).
Volet / Course Component: Recherche / Research
Préalable : ELG 5301. Les cours DTI 5902, ELG 5901, ELG 5902 et GNG 5902 ne peuvent être combinés pour l'obtention de crédits. / Prerequisite: ELG 5301. The courses DTI 5902, ELG 5901, ELG 5902, and GNG 5902 cannot be combined for units.

ELG 5902 Projet en entreprise / Industry Project (6 crédits / 6 units)
Les étudiants participent à des lectures hebdomadaires sur des sujets tels que le travail en équipe, la gestion de projet et le processus de conception. Travaillant en équipe, ils entreprennent un projet basé sur un client et reçoivent les conseils d'un conseiller technique. / Students participate in weekly lectures covering topics such as teamwork, project management, and the design process. Working in teams, they undertake a client-based project and receiving guidance from a technical advisor.
Volet / Course Component: Recherche / Research
Préalable : ELG 5301. Les cours DTI 5902, ELG 5901, ELG 5902 et GNG 5902 ne peuvent être combinés pour l'obtention de crédits. / Prerequisite: ELG 5301. The courses DTI 5902, ELG 5901, ELG 5902, and GNG 5902 cannot be combined for units.

ELG 6101 Simulation and Modelling (3 units)
Simulation as a problem solving tool. Random variable generation, general discrete simulation procedure: event table and statistical gathering. Analyses of simulation data: point and interval estimation. Confidence intervals. Overview of modelling, simulation and problem solving using simscript, modism and other languages. This course is equivalent to SYSC 5001 at Carleton University.
Course Component: Lecture

ELG 6102 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 SYSC 5405 and BIOM 5405 at Carleton University.
Course Component: Lecture

ELG 6104 Optimization for Engineering Applications (3 units)
Introduction to algorithms and computer methods for optimizing complex engineering systems. Includes linear programming, networks, nonlinear programming, integer and mixed-integer programming, genetic algorithms and search methods, and dynamic programming. Emphasizes practical algorithms and computer methods for engineering applications. This course is equivalent to SYSC 5004 at Carleton University.
Course Component: Lecture

ELG 6108 Introduction to Convex Optimization (3 units)
Mathematics of optimization: linear, nonlinear and convex problems. Convex and affine sets. Convex, quasiconvex and log-convex functions. Operations preserving convexity. Recognizing and formulating convex optimization problems. The Lagrange function, optimality conditions, duality, geometric and saddle-point interpretations. Least-norm, regularized and robust approximations. Statistical estimation, detector design. Adaptive antennas. Geometric problems (networks). Algorithms.
Course Component: Lecture

ELG 6110 Information Theory (3 units)
Measure of information: entropy, relative entropy, mutual information, asymptotic equipartition property, entropy rates for stochastic processes; Data compression: Huffman code, arithmetic coding; Channel capacity: random coding bound, reliability function, Blahut-Arimoto algorithm, Gaussian channels, coloured Gaussian noise and "water-filling"; Rate distortion theory; Network information theory. This course is equivalent to SYSC 5506 at Carleton University.
Course Component: Lecture

ELG 6111 Design of High Performance Software (3 units)
Designing software to demanding performance specifications. Design analysis using models of computation, workload, and performance. Principles to govern design improvement for sequential, concurrent and parallel execution, based on resource architecteure and quantitative analysis. This course is equivalent to SYSC 5101 at Carleton University.
Course Component: Lecture

ELG 6113 Software Agents (3 units)
Agent-based programming; elements of Distributed Artificial Intelligence; beliefs, desires and intentions; component-based technology; languages for agent implementations; interface agents; information sharing and coordination; KIF; collaboration; communication; ontologies; KQML; autonomy; adaptability; security issues; mobility; standards; agent design issues and frameworks, applications in telecommunications. This course is equivalent to SYSC 5103 at Carleton University.
Course Component: Lecture

ELG 6114 Methodologies for Discrete-Event Modeling and Simulation (3 units)
Methodological aspects of simulation. Modelling discrete events systems. Modelling formalisms: FSA, FSM, Petri Nets, DEVS, others. Verification and validation. Cellular models: cellular automata, cell-DEVS. Continuous and hybrid models. Parallel and distributed simulation (PADS) techniques. PADS middleware: HLA, parallel-DEVS, Time-warp. This course is equivalent to SYSC 5104 at Carleton University.
Course Component: Lecture

ELG 6115 Software Quality Engineering and Management (3 units)
All aspects of software quality engineering. Software testing, at all stages of the software development and maintenance life cycle. Software reviews and inspections. Use of software measurement and quantitative modelling for the purpose of software quality control and improvement. Courses ELG 6115, CSI 5111 (COMP 5501) cannot be combined for units. This course is equivalent to SYSC 5105 at Carleton University.
Course Component: Lecture

ELG 6118 Topics in Information Systems (3 units)
Recent and advanced topics in the field of Information Systems and its related areas. This course is equivalent to SYSC 5108 at Carleton University.
Course Component: Lecture

ELG 6120 Algebraic Coding Theory (3 units)
Review of Algebra, Finite Fields, Linear Block Codes and their Properties, Hamming Codes, Cyclic codes; Hadamard Matrices and Hadamard Codes, Golay Codes, Reed-Muller Codes, BCH and Reed-Solomon Codes, Decoding Algorithms, Coding Bounds. This course is equivalent to SYSC 5200 at Carleton University.
Course Component: Lecture

ELG 6121 Computer Communication (3 units)
Computer network types, introductory queueing theory and performance analysis. OSI layering and BISDN layering modifications. Data link layer. Local area networks and random access (CSMA - CD, switched ethernet, token ring, wireless LAN). Public Networks. IP networks, addressing, routing. Transport layer, flow control. Introduction to ISDN. Courses ELG 6121, ELG 5374 (EACJ 5607) or ELG 4181 (SYSC 4602) cannot be combined for units. This course is equivalent to SYSC 5201 at Carleton University.
Course Component: Lecture

ELG 6127 Distributed Systems Engineering (3 units)
Techniques for representing distributed systems: graphical and textual models. Processes, threads, synchronization and inter-process communication techniques, RPC. Middleware: client-server (CORBA), grids, Web services. Resource management: processor allocation, load sharing, Grid scheduling, real-time issues. Protocol: OSI model, application and presentation layers. This course is equivalent to SYSC 5207 at Carleton University.
Course Component: Lecture

ELG 6131 Advanced Topics in Biomedical Engineering (3 units)
Topics vary from year to year. This course is equivalent to SYSC 5301 at Carleton University.
Course Component: Lecture

ELG 6136 Mobile Computing Systems (3 units)
Systems to build mobile applications. Covers data link layer to application layer. Emphasis on existing wireless infrastructure and IETF protocols. Focuses on view of mobile application developer; communication systems, middleware and application frameworks, de facto standards proposed/developed by industry consortia. This course is equivalent to SYSC 5306 at Carleton University.
Course Component: Lecture

ELG 6141 Adaptive and Learning Systems (3 units)
System identification. Least squares and recursive identification techniques. Asymptotic and theoretical properties. Model structure selection. Prediction and estimation. Model reference adaptive control and self tuning regulators. Nonlinear adaptive systems. Stability. Neural networks and neuro-control. Applications to robotics, control and pattern recognition. This course is equivalent to SYSC 5401 at Carleton University.
Course Component: Lecture

ELG 6143 Network Access Techniques (3 units)
A range of access technologies with emphasis on broadband access. Physical channels and the state-of-the-art of coding, modulation, multiplexing strategies to overcome physical impairments, including high-speed transmission over twisted pair, wireless, fibre and co-axial media.This course is equivalent to SYSC 5403 at Carleton University.
Course Component: Lecture

ELG 6152 Advanced Linear Systems (3 units)
Modelling and state space realization. Review of signals and systems. Solution to the matrix DE. Discrete time systems and the Z transform. Canonical representations and transformations. Controllability, observability and controller and observer design. LQR design and the Kalman filter. Numerous examples and applications. This course is equivalent to SYSC 5502 at Carleton University.
Course Component: Lecture

ELG 6153 Stochastic Processes (3 units)
Basic concepts of randomness, as applied to communications, signal processing, and queueing systems; probability theory, random variables, stochastic processes; random signals in linear systems; introduction to decision and estimation; Markov chains and elements of queueing theory. Courses ELG 6153, ELG 5119 (EACJ 5109) cannot be combined for units. This course is equivalent to SYSC 5503 at Carleton University.
Course Component: Lecture
Exclusion: ELG 5119.

ELG 6154 Principles of Digital Communication (3 units)
Elements of communication theory and information theory applied to digital communications systems. Characterization of noise and channel models. Optimum Receiver Theory. Modulation and coding for reliable transmission: MPSK, MQAM, M-ary orthogonal modulation. Channel coding, trellis coded modulation. Spread spectrum and CDMA communications. Courses ELG 6154, ELG 5375 cannot be combined for units. This course is equivalent to SYSC 5504 at Carleton University.
Course Component: Lecture

ELG 6160 Adaptive Signal Processing (3 units)
Theory and techniques of adaptive filtering, including Wiener filters, gradient and LMS methods; adaptive transversal and lattice filters; recursive and fast recursive least squares; convergence and tracking performance; implementation. Applications, such as adaptive prediction; channel equalization; echo cancellation; source coding; antenna beamforming, spectral estimation. This course is equivalent to SYSC 5600 at Carleton University.
Course Component: Lecture

ELG 6162 Digital Signal Processing (3 units)
Review of discrete time signals and systems, A/D and D/A conversions, representation in time, frequency, and Z domain, DFT/FFT transforms, FIR/IIR filter design, quantization effects. Correlation functions. Cepstrum analysis. Multi-rate signal processing. Power spectrum estimation. Introduction to joint time-frequency analysis. DSP architecture: implementation approaches. Applications. This course is equivalent to SYSC 5602 at Carleton University.
Course Component: Lecture

ELG 6165 Advanced Digital Communication (3 units)
Techniques and performance of digital signalling and equalization over linear bandlimited channels with additive Gaussian noise. Fading multipath channels: diversity concepts, modelling and error probability performance evaluation. Synchronization in digital communications. Spread spectrum in digital transmission over multipath fading channels. This course is equivalent to SYSC 5605 at Carleton University.
Course Component: Lecture
Courses ELG 6165 (SYSC 5605 at Carleton) and ELG 5180 (EACJ 5704 at Carleton) cannot be combined for units.

ELG 6166 Introduction to Mobile Communications (3 units)
Mobile radio channel characterization: signal strength prediction techniques and statistical coverage; fading; delay spread; interference models and outage probabilities. Digital modulation and transmission system performance. Signal processing techniques: diversity and beamforming, adaptive equalization, coding. Applications to TDMA and CDMA cellular systems. This course is equivalent to SYSC 5606 at Carleton University.
Course Component: Lecture

ELG 6167 Source Coding and Data Compression (3 units)
Discrete and continuous sources. Discrete sources: Huffman coding and run length encoding. Continuous sources: waveform construction coding; PCM, DPCM, delta modulation; speech compression by parameter extraction; predictive encoding; image coding by transformation and block quantization. Fourier and Walsh transform coding. Applications to speech, television, facsimile. This course is equivalent to SYSC 5607 at Carleton University.
Course Component: Lecture

ELG 6168 Wireless Communication Systems Engineering (3 units)
Fundamentals of antenna systems and radio propagation, wireless channel characterization, link budget, spectrum, cellular and personal wireless communication systems, channel reuse, system capacity, mobility and location management, channel resource allocation, radio access network (RAN), multiple access principles, security and authentication, satellite networks, wireless LANs. This course is equivalent to SYSC 5608 at Carleton University.
Course Component: Lecture

ELG 6171 Operating System Methods for Real-Time Applications (3 units)
Principles and methods for operating system design with application to real-time, embedded systems. Concurrent programming: mechanisms and languages; design approaches and issues; run-time support (kernel). Methods for hard real-time applications. Methods for distributed systems; Programming assignments in a suitable programming language. This course is equivalent to SYSC 5701 at Carleton University.
Course Component: Lecture

ELG 6173 Integrated Database and Cloud Systems (3 units)
Database definitions, applications, and architectures. Conceptual design based on the entity-relationship and object-oriented models. Relational data model: relational algebra and calculus, normal forms, data definition and manipulation languages. Database management systems: transaction management, recovery and concurrency control. Current trends: object-oriented, knowledge-based, multimedia and distributed databases. This course is equivalent to SYSC 5703 at Carleton University.
Course Component: Lecture

ELG 6174 Elements of Computer Systems (3 units)
Concepts in basic computer architecture, assembly languages, high level languages including object orientation, compilers and operating system concepts (including concurrency mechanisms such as processes and threads and computer communication). Designed for graduate students without extensive undergraduate preparation in computer system engineering (or the equivalent experience). This course is equivalent to SYSC 5704 at Carleton University.
Course Component: Lecture

ELG 6178 Model-Driven Development of Real-Time and Distributed Software (3 units)
Advanced object-oriented design and programming of real-time and distributed systems using C++ and/or Java. Object-oriented features; inheritance, polymorphism, templates, exception handling. Concurrency issues. Design patterns and frameworks for distributed systems, with examples from communication applications. Design issues for reusable software. This course is equivalent to SYSC 5708 at Carleton University.
Course Component: Lecture

ELG 6179 Advanced Topics in Software Engineering (3 units)
Recent and advanced topics in the field of software engineering and related areas. Primary references are recent publications in the field. This course is equivalent to SYSC 5709 at Carleton University.
Course Component: Lecture

ELG 6181 Advanced Topics in Computer Communications (3 units)
Recent and advanced topics in computer-communication networks intended as a preparation for research. Students are expected to contribute to seminars or present lectures on selected topics. This course is equivalent to SYSC 5801 at Carleton University.
Course Component: Lecture

ELG 6184 Advanced Topics in Communication Systems (3 units)
Recent and advanced topics in communications systems. This course is equivalent to SYSC 5804 at Carleton University.
Course Component: Lecture

ELG 6187 Advanced Topics in Computer Systems (3 units)
Recent and advanced topics in computer systems. The course will generally focus on one or more of the following areas: specification, design, implementation, and modeling/analysis. Students may be expected to contribute to lectures or seminars on selected topics. This course is equivalent to SYSC 5807 at Carleton University.
Course Component: Lecture

ELG 6189 Designing Secure Networking and Computer Systems (3 units)
Network security with coverage of computer security in support of networking concepts. Covers various security issues in data networks at different protocol layers. Routing security, worm attacks, and botnets. Security of new mobile networks and emerging networked paradigms such as social networks and cloud computing. This course is equivalent to SYSC 5500 at Carleton University.
Course Component: Lecture

ELG 6196 Directed Studies (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 SYSC 5906 at Carleton University.
Course Component: Lecture

ELG 6301 Silicon Photonics (3 units)
Fundamentals of silicon photonics, advanced electromagnetic theory, guided wave optics, interferometry, silicon-on- insulator (SOI) photonics, silicon based waveguide devices (planar, rib, strip), fabrication of photonic devices, passive and active silicon photonic devices such as modulators, lasers, detectors, silicon opto-electronic integration. This course is equivalent to ELEC 5301 at Carleton University.
Course Component: Lecture

ELG 6302 Renewable and Distributed Energy Resource Technologies (3 units)
Topics covered include renewable energy resources, photovoltaic systems, wind generation systems, energy storage units, electric vehicles, grid integration, distributed generation, microgrid, active distribution network, modeling and analysis of power system components, state-of-the-art power system simulation tools. This course is equivalent to ELEC 5302 at Carleton University.
Course Component: Lecture

ELG 6303 Advanced Power Systems Analysis (3 units)
Power system sustainability and control, transmission lines, transformers, synchronous generators, induction motor, power flow, small-signal stability, transient stability, voltage stability, state of the art power system simulation tools. This course is equivalent to ELEC 5303 at Carleton University.
Course Component: Lecture

ELG 6304 Multimedia Compression, Scalability, and Adaptation (3 units)
A range of access technologies with emphasis on broadband access. Physical channels and the state-of-the-art of coding, modulation, multiplexing strategies to overcome physical impairments. including high-speed transmission over twisted pair, wireless, fibre and co-axial media. This course is equivalent to SYSC 5404 at Carleton University.
Course Component: Lecture
Prerequisites: ELG 6153 (SYSC 5503 at Carleton), (ELG 6154 (SYSC 5504 at Carleton) or ELG 5375 (EACJ 5506 at Carleton)).

ELG 6305 Electric Motor Drives (3 units)
DC and AC motors, speed and torque control, efficiency, maximum torque per ampere, power converters, rectifiers, inverters, field-oriented vector control, direct torque control, and sensorless control. This course is equivalent to ELEC 5305 at Carleton University.
Course Component: Lecture

ELG 6306 Resource Management on Distributed Systems (3 units)
Principles and techniques for resource management on distributed systems including clouds, grids and data analytics platforms; management of computing and storage resources; service level agreements; performance and energy aware techniques for scheduling, allocation, dynamic resource provisioning; cyber-physical systems and BigData; resource management for BigData analytics. This course is equivalent to SYSC 5206 at Carleton University.
Course Component: Lecture

ELG 6307 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 SYSC5307 at Carleton University.
Course Component: Lecture

ELG 6308 Wireless Power Transfer and Energy Harvesting (3 units)
Principles and design guidelines for efficient wireless power transfer and harvesting, short and long range power transfer, RF energy scavenging, and contactless communication. System and subsystem circuit design and analysis is expected and commercial software will be used for all course deliverables. This course is equivalent to ELEC 5408 at Carleton University.
Course Component: Lecture

ELG 6309 The Internet of Things (3 units)
Main concepts of the Internet of Things (IoT) ranging from the physical devices and sensor networks to the applications and standards. This course is equivalent to SYSC 5809 at Carleton University.
Course Component: Lecture

ELG 6312 Sensor Fusion for Autonomous Systems (3 units)
Sensor fusion for autonomous navigation systems. Topics include reference frames, maps representation, state estimation, error modelling, localization and mapping, sensors for autonomous navigation, sensor fusion algorithms. The course is for students with background in signals/systems, linear-algebra, and probability. Programming in Matlab or Python is essential. This course is equivalent to SYSC 5702 at Carleton University.
Course Component: Lecture

ELG 6315 Model-Driven Security Engineering (3 units)
Fundamentals of security engineering and its activities, with emphasis on model-driven approaches for asset identification, threat and risk assessment, security requirements elicitation, security controls selection, security evaluation, and security assurance for software intensive-systems. Examination of challenges for engineering secure software. This course is equivalent to SYSC 5805 at Carleton University.
Course Component: Lecture

ELG 6317 RF System Design (3 units)
System level design of a typical integrated radio. System architectures for radio front ends. Detailed design procedures going from a radio specification to determine block level specifications: determining NF, EVM, phase noise, linearity from BER and radio range requirements. This course is equivalent to ELEC 5807 at Carleton University.
Course Component: Lecture

ELG 6318 Cross Layer Design for Wireless Networks (3 units)
Quality of service measures at different layers. Parameter adaptation, tradeoffs, and optimization at physical, data-link, network, transport, and application layers. Examples of cross-layer design in cellular, ad hoc, sensor, local area, green, and cognitive radio networks. This course is equivalent to SYSC 5406 at Carleton University.
Course Component: Lecture

ELG 6320 Advanced Topics in Integrated Circuits and Devices (3 units)
Recent and advanced topics in the field of Integrated Circuits and Devices and its related areas. This course is equivalent to EACJ 5208/ELEC 5200 at Carleton University.
Course Component: Lecture

ELG 6321 Biomedical Instrumentation (3 units)
Instrumentation designed to measure physiological variables related to the function of the heart, lungs, kidney, nervous and musculo-skeletal system; emergency, critical care, surgery and anaesthesia equipment. This course is equivalent to SYSC 5302 at Carleton University.
Course Component: Lecture

ELG 6322 Research Methods for Engineers (3 units)
Topics required to perform engineering research including literature surveys, identifying issues, objectives, and methodology. Technical writing, documenting and presenting engineering ideas and a review of statistics, simulation, optimization and data analysis. This course is equivalent to SYSC 5902 at Carleton University.
Course Component: Lecture

ELG 6340 Advanced Linear and Nonlinear Circuit Theory and Application (3 units)
Graph theory, incidence matrices, cutset matrices, generalized KCL, topological formulation, state-space equations, Tellegen's theorem, state-transition matrix, multi-port representation, stability, passivity, causality, synthesis of passive circuits, active networks, nonlinear dynamic circuits. This course is equivalent to ELEC 6340 at Carleton University.
Course Component: Lecture

ELG 6341 Signal Integrity in High-Speed Designs: Modeling and Analysis (3 units)
Crosstalk, distortion, ground bounce, skin effect. Interconnect modeling/ simulation, packages, ground/power planes, Elmore delay, lossy-coupled, frequency-dependent transmission lines, telegraphers equations, extraction, measured parameters, macromodeling: passivity/causality, MoC/MRA, vector fit, model reduction, electromagnetic compatibility/ interference, mixed-domain systems, concurrent analysis. This course is equivalent to ELEC 5401 at Carleton University.
Course Component: Lecture

ELG 6342 Introduction to Electronic Design Automation Algorithms and Techniques (3 units)
Digital design process; Overview of design automation tools/ methodologies; Theory of computational complexity; Layout compaction; Placement and Partitioning; Floorplanning; Routing; Digital simulation; Switch-level simulation; Logic synthesis; Verification; Analog and RF simulation. Area: Computer-Aided Design for Electronic Circuits. This course is equivalent to ELEC 5402 at Carleton University.
Course Component: Lecture

ELG 6344 Neural Networks for High-Speed /High Frequency Circuit Design (3 units)
Neural network methodologies for computer-aided design of high-speed/ high-frequency circuits, including modeling of passive and active devices/circuits, and their applications in high-level design and optimization in wired and wireless electronic systems. This course is equivalent to ELEC 5404 at Carleton University.
Course Component: Lecture

ELG 6349 Microwave and Millimeterwave Integrated Circuits (3 units)
Design of communications electronics components with emphasis on GaAs MMIC implementation. Overview of MESFET, HEMT, HBT device modeling. Integrated lumped/ distributed passive element modeling. Broadband impedance matching. Design of direct-coupled amplifiers, distributed amplifiers, power devices and amplifiers, phase shifters, switches, attenuators, mixers, oscillators. This course is equivalent to ELEC 5409 at Carleton University.
Course Component: Lecture

ELG 6351 Passive Microware Circuits (3 units)
Characteristics of homogeneous and inhomogeneous transmission lines and waveguides. Planar transmission lines: stripline, microstrip, coplanar lines, slotline. Coupled transmission lines. Modelling of discontinuities. Ferrite components. Microwave network analysis: parameters, CAD models. Design of impedance-matching networks, directional couplers, power splitters, filters. Applications in MICs and MMICs. This course is equivalent to ELEC 5501 at Carleton University.
Course Component: Lecture

ELG 6352 Analog Integrated Filters (3 units)
The fundamentals and details of analog continuous-time and SAW filters. Comparison to switched-capacitor filters. Review of filter concepts, types of filters, approximations, transformations. Building blocks such as op amps, transconductance amplifiers, and gyrators. Design using cascaded second-order sections, multiple loop feedback and LC ladder simulations. This course is equivalent to ELEC 5502 at Carleton University.
Course Component: Lecture

ELG 6353 Radio Frequency Integrated Circuit Design (3 units)
IIntegrated radio front-end component design. Overview of radio systems, frequency response, gain, noise, linearity, intermodulation, image rejection, impedance matching, stability, and power dissipation. Detailed design of low-noise amplifiers, mixers, oscillators and power amplifiers. Use of on-chip inductors and baluns. Process variations, parasitics, and packaging. This course is equivalent to ELEC 5503 at Carleton University.
Course Component: Lecture

ELG 6354 Analysis of High-Speed Electronic Packages and Interconnects (3 units)
Introduction to modeling, simulation and optimization of high-speed VLSI packages; models for packages, interconnects and ground/power planes; lumped, distributed and EM models for interconnects; delay, crosstalk and switching noise; moment matching techniques; concurrent thermal/electrical analysis of IC packages and boards. This course is equivalent to ELEC 5504 at Carleton University.
Course Component: Lecture

ELG 6356 Simulation and Optimization of Electronic Circuits (3 units)
Introduction to computer simulation and optimization of electrical circuits. Time- and frequency-domain formulations for sensitivity analysis and optimization. Optimization techniques for performance-, cost- and yield-driven design of electronic circuits. Optimization approaches to modeling and parameter extraction of active and passive elements. This course is equivalent to ELEC 5506 at Carleton University.
Course Component: Lecture

ELG 6358 Advanced Methods for Simulation of Large-Scale Circuits and Systems (3 units)
Formulation of circuit equations. Sparse matrix techniques. Frequency and time-domain solutions. Relaxation techniques and timing analysis. Noise and distortion analysis. Transmission line effects. Interconnect analysis and crosstalk simulation. Numerical inversion techniques. Asymptotic waveform estimation. Mixed frequency/time domain techniques. Sensitivity analysis. This course is equivalent to ELEC 5508 at Carleton University.
Course Component: Lecture

ELG 6359 Integrated Circuit Technology (3 units)
Survey of technology used in silicon VLSI integrated circuit fabrication. Crystal growth and crystal defects, oxidation, diffusion, ion implantation and annealing, gettering, CVD, etching, materials for metallization and contacting, and photolithography. Structures and fabrication techniques required for submicron MOSFETs. Applications in advanced CMOS processes. This course is equivalent to ELEC 5509 at Carleton University.
Course Component: Lecture

ELG 6360 Digital Integrated Circuit Testing (3 units)
Production testing of digital integrated circuits. Outline of methods of testing used in production. Testing schemes and design for testability. Faults and fault models, yield estimates, testability measures, fault simulation, test generation methods, sequential testing, scan design, boundary scan, built-in self test, CMOS testing. This course is equivalent to ELEC 5600 at Carleton University.
Course Component: Lecture

ELG 6362 Microwave Semiconductor Devices and Applications (3 units)
Theory of operation for microwave diodes (varactor, p-i-n, Gunn, IMPATT) and transistors (BJT, MESFET, HBT, HEMT). Small-signal, large-signal, and noise models for CAD. Diode oscillators and reflection amplifiers. Design of transitor oscillators and amplifiers. Discussion of technology/fabrication issues and MMIC applications. This course is equivalent to ELEC 5602 at Carleton University.
Course Component: Lecture

ELG 6364 Radar Systems (3 units)
Fundamentals; range equation, minimum detectable signal, radar cross-section, pulse repetition frequency, range ambiguities. Radar classes: CW, FM-CW, MTI, tracking, air surveillance, SSR, PAR, MLS, SAR, SLAR, OTH, 3D and bistatic radars. Radar subsystems; transmitters, antennas, receivers, processors, displays, detection criteria; CFAR receivers, noise, clutter precipitation. This course is equivalent to ELEC 5604 at Carleton University.
Course Component: Lecture

ELG 6365 Optical Fibre Communication (3 units)
Transmission characteristics of and design considerations for multi-mode and single-mode optical fibre waveguides; materials, structures, and device properties of laser light sources; properties and performance of p-i-n and avalanche photodiodes; types of optical fibre signal formats, preamplifier topologies and noise, receiver sensitivity, transmitter design; link design for digital sytems. This course is equivalent to ELEC 5605 at Carleton University.
Course Component: Lecture

ELG 6366 Phase-Locked Loops and Receiver Synchronizers (3 units)
Phase-locked loops; components, fundamentals, stability, transient response, sinusoidal operation, noise performance, tracking, acquisition and optimization. Receiver synchronizers: carrier synchronizers including squaring loop, Costas loop, and remodulator for BPSK, QPSK BER performance; clock synchronizers including early-late gate, in-phase/midphase, and delay line multiplier. This course is equivalent to ELEC 5606 at Carleton University.
Course Component: Lecture

ELG 6367 Fundamentals of Antenna Engineering (3 units)
Basic properties of antennas (gain, radiation patterns, polarization, antenna temperature). Analysis of common antennas (dipoles, loops, helices, aperture antennas, microstrip, dielectric resonator antennas, reflectors). Analysis and design of linear and planar arrays (array factors, beam scanning, amplitude weighting, feed networks). This course is equivalent to ELEC 5607 at Carleton University.
Course Component: Lecture

ELG 6368 Fourier Optics (3 units)
The theory and applications of diffractive and non-diffractive coherent optics, with emphasis on holograms, tomography and high-speed optical computing. Mathematical basis: generalized 2-D Fourier transforms, transfer function of an optical system, 2-D sampling theory, Helmholtz equation, Green's theorem, and the classical diffraction theories. This course is equivalent to ELEC 5608 at Carleton University.
Course Component: Lecture

ELG 6369 Nonlinear Microwaves Devices and Effects (3 units)
The physical basis and mathematical modeling of a variety of microwave/millimeter-wave devices, (some of which exhibit the most extreme nonlinear behaviour known), how they can be exploited in practical circuits and systems, and how the resulting device/circuit interactions can be analyzed. This course is equivalent to ELEC 5609 at Carleton University.
Course Component: Lecture

ELG 6371 Fibre and Waveguide Components for Communications and Sensors (3 units)
Optical wave propagation in dielectric waveguides. Theory and practice for passive photonic devices used for routing, filtering, and signal processing, including structural and biochemical sensors. Directional couplers and splitters, filters (gratings and etalons), Mach-Zehnder interferometers, Arrayed waveguide gratings, and dispersion compensators. This course is equivalent to ELEC 5701 at Carleton University.
Course Component: Lecture

ELG 6372 Principles of Photonics (3 units)
Electromagnetic wave propagation in crystals; review of geometric optics; Gaussian beam propagation; optical fibres; dielectric waveguides for optical integrated circuits; optical resonators; optical properties of materials; theory of laser oscillation; specific laser systems; electro-optic modulators; photorefractive materials and applications; holography; optical interconnects. This course is equivalent to ELEC 5702 at Carleton University.
Course Component: Lecture

ELG 6373 Advanced Topics in Solid State Devices and Ic Technology (3 units)
Recent and advanced topics in semiconductor device physics, modeling, and integrated circuit fabrication technology. Topic varies from year to year according to departmental research interests. Students may be expected to contribute lectures or seminars on selected topics. This course is equivalent to ELEC 5703 at Carleton University.
Course Component: Lecture

ELG 6374 Advanced Topics in Cad (3 units)
Recent and advanced topics in computer-aided techniques for the design of VLSI and telecommunications circuits. Topics will vary from year to year according to the departmental research interests. Students may be expected to contribute lectures or seminars on selected topics. This course is equivalent to ELEC 5704 at Carleton University.
Course Component: Lecture

ELG 6375 Advanced Topics in Vlsi (3 units)
Recent and advanced topics in the design of very large scale integrated circuits, with emphasis on mixed analog/digital circuits for telecommunications applications. Topic varies from year to year according to departmental research interests. Students may be expected to contribute lectures or seminars on selected topics. This course is equivalent to ELEC 5705 at Carleton University.
Course Component: Lecture

ELG 6376 Submicron Cmos and Bicmos Circuits for Sampled Data Applications (3 units)
The analog aspects of digital CMOS and BiCMOS circuit design in submicron technologies including reliability; sampled analog circuits, including amplifier nonidealities and switch charge injection; CMOS/BiCMOS amplifier design considerations, leading up to standard folded-cascode and two-stage circuits. This course is equivalent to ELEC 5706 at Carleton University.
Course Component: Lecture

ELG 6377 Microsensors and Mems (3 units)
Physical design of microelectromechanical systems (MEMS) and microfabricated sensors and actuators. An overview of thin and thick film processes and micromachining techniques will provide fabrication background. Design of a variety of devices including piezoresistive, piezoelectric, electromagnetic, thermal, optical, and chemical sensors and actuators. This course is equivalent to ELEC 5707 at Carleton University.
Course Component: Lecture

ELG 6378 Asic's in Telecommunications (3 units)
Introduction to modern ASIC technologies for Telecom. Review of circuit-level building blocks for typical wireline and wireless applications, including power/performance tradeoffs. Corresponding FPGA analog and digital IO circuits are discussed. A topical literature study and circuit level design exercises. This course is equivalent to ELEC 5708 at Carleton University.
Course Component: Lecture

ELG 6379 Advanced Topics in Electromagnetics (3 units)
Recent and advanced topics in electro-magnetics, antennas, radar systems, microwave devices and circuits, or optoelectronics. The subject material will vary from year to year according to research interests in the department and/or expertise provided by visiting scholars or sessional lecturers. This course is equivalent to ELEC 5709 at Carleton University.
Course Component: Lecture

ELG 6380 Theory Semiconductor Devices (3 units)
Equilibrium and non-equilibrium conditions in a semiconductor. Carrier transport theory. Physical theory of basic semiconductor device structures and aspects of design: PN junctions and bipolar transistors, field effect devices. Current transport relationships for transistors. Charge control theory. Modeling of device mechanisms. Performance limitations of transistors. This course is equivalent to ELEC 5800 at Carleton University.
Course Component: Lecture
Prerequisites: ELG 6384.

ELG 6381 High-Speed and Low-Power Vlsi (3 units)
High-Speed and Low-Power CMOS VLSI circuit techniques. Low and high levels of abstraction; transistor, switch, logic-gate, module, system levels. State-of-the-art techniques to optimize the performance and energy consumption of a circuit. One or more of these techniques are used in a design project. This course is equivalent to ELEC 5801 at Carleton University.
Course Component: Lecture
Prerequisites: ELG 6384.

ELG 6382 Surface Controlled Semiconductor Devices (3 units)
Fundamentals of the MOS system: MOS capacitors. Long channel behaviour. theory, limitations and performance of the SPICE level 1 and 2 models. Small geometry effects: theory, limitations and performance of the SPICE level 3 model. Subthreshold operation and modelling. Hot electron effects and reliability. Advanced analysis: the MISNAN model. This course is equivalent to ELEC 5802 at Carleton University.
Course Component: Lecture

ELG 6383 Behavioural Synthesis of ICs (3 units)
Various topics related to computer analysis and synthesis of VLSI circuits including: logic synthesis, finite state machine synthesis, design methodologies, design for reuse, testing, common VLSI functions, a review of Verilog. This course is equivalent to ELEC 5803 at Carleton University.
Course Component: Lecture

ELG 6384 VLSI Design (3 units)
IC design course with strong emphasis on design methodology, to be followed by ELEC 5805 (ELG 6385) in the second term. Design philosophies considered will include Full Custom design, standard cells, gate-arrays and sea-of-gates using CMOS and BiCMOS technology. State-of-the-art computer-aided design tools are used.
Course Component: Lecture

ELG 6385 VLSI Design Project (3 units)
Using state-of-the-art CMOS and BiCMOS technologies, students will initiate their own design of an integrated circuit using tools in the CAD lab and submit it for fabrication where the design warrants. This course is equivalent to ELEC 5805 at Carleton University.
Course Component: Lecture

ELG 6388 Signal Processing Electronics (3 units)
Integrated radio front-end component design. Overview of radio systems, frequency response, gain, noise, linearity, intermodulation, image rejection, impedance matching, stability, and power dissipation. Detailed design of low-noise amplifiers, mixers, oscillators and power amplifiers. Use of on-chip inductors and baluns. Process variations, parasitics, and packaging. This course is equivalent to ELEC 5503 at Carleton University.
Course Component: Lecture

ELG 6389 Nonlinear Electronic Circuits (3 units)
Introduction to non-linear circuits used in today's telecommunications ICs; CMOS non-linear circuits such as direct-RF-sampling mixers, phase-detectors; digital loop-filters, DCOs, frequency synthesizers and clock-and-data-recovery are introduced. Modeling of these non-linear circuits and existing options for simulations and closed form circuit analysis is presented. This course is equivalent to ELEC 5809 at Carleton University.
Course Component: Lecture
Courses ELG 6389 (ELEC 5809 at Carleton), ELG 6375 (ELEC 5705 at Carleton) cannot be combined for units if taken as a special topic in ELG 6375.

ELG 6393 Interactive Networked Systems & Telemedicine (3 units)
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 SYSC 5303 at Carleton University.
Course Component: Lecture
Courses ELG 6383 (SYSC 5303 at Carleton) and BMG 5304 (BIOM 5402 at Carleton) cannot be combined for units.

ELG 6396 Directed Studies (3 units)
Various possibilities exist for pursuing directed studies on topics approved by a course supervisor. This course is equivalent to ELEC 5906 at Carleton University.
Course Component: Lecture

ELG 6397 Solar Cells - Principles, Materials, Systems and Operation (3 units)
Solar radiation. Solar cells: crystalline silicon, thin film technologies, space and concentrator cells, organic and dye sensitized. Photovoltaic systems: introduction, balance of system components, grid-connected systems, space and concentrator systems. Testing, monitoring, and calibration standards. Economics, environment and business strategy. This course is equivalent to ELEC 5304 at Carleton University.
Course Component: Lecture

ELG 7100 Topics in Electromagnetics I (3 units)
This course is equivalent to EACJ 5404 at Carleton University.
Course Component: Lecture

ELG 7113 Topics in Systems and Control I (3 units)
Current topics in the field, including linear semigroup theory and optimal feedback control. This course is equivalent to EACJ 5209 at Carleton University.
Course Component: Lecture

ELG 7114 Topics in Systems and Control II (3 units)
Current topics in the field, including linear and nonlinear filtering and optimal control of stochastic systems. This course is equivalent to EACJ 5300 at Carleton University.
Course Component: Lecture

ELG 7132 Topics in Electronics I (3 units)
Current topics in the field. This course is equivalent to EACJ 5006 at Carleton University.
Course Component: Lecture

ELG 7172 Topics in Signal Processing I (3 units)
This course is equivalent to EACJ 5600 at Carleton University.
Course Component: Lecture

ELG 7173 Topics in Signal Processing II (3 units)
This course is equivalent to EACJ 5601 at Carleton University.
Course Component: Lecture

ELG 7177 Topics in Communications I (3 units)
Current topics in the field. This course is equivalent to EACJ 5605 at Carleton University.
Course Component: Lecture

ELG 7178 Topics in Communication II (3 units)
This course is equivalent to EACJ 5606 at Carleton University.
Course Component: Lecture

ELG 7179 Topics in Signal Processing III (3 units)
This course is equivalent to EACJ 5603 at Carleton University.
Course Component: Lecture

ELG 7186 Topics in Computers I (3 units)
This course is equivalent to EACJ 5807 at Carleton University.
Course Component: Lecture

ELG 7187 Topics in Computers II (3 units)
This course is equivalent to EACJ 5808 at Carleton University.
Course Component: Lecture

ELG 7199 Directed Studies (3 units)
Various possibilities exist for pursuing directed studies on topics approved by the Department and which a full-time faculty member has agreed to direct, including any of the courses listed in the Graduate Calendar that are not being offered on a formal basis in the current academic year. This course is equivalent to EACJ 5101 at Carleton University.
Course Component: Research
Permission of the Department is required.

ELG 7500 Sujets choisis en électromagnétique (3 crédits)
Ce cours est équivalent à EACJ 5308 à la Carleton University.
Volet : Cours magistral

ELG 7572 Sujets choisis en télécommunications et traitement de signaux (3 crédits)
Ce cours est équivalent à EACJ 5702 à la Carleton University.
Volet : Cours magistral

ELG 7573 Sujets choisis sur les ordinateurs (3 crédits)
Ce cours est équivalent à EACJ 5900 à la Carleton University.
Volet : Cours magistral

ELG 7574 Sujets choisis en systèmes et réglage automatique (3 crédits)
Sujets d'intérêt courant dans le domaine. Ce cours est équivalent à EACJ 5301 à la Carleton University.
Volet : Cours magistral

ELG 7575 Sujets choisis en électronique (3 crédits)
Ce cours est équivalent à EACJ 5008 à la Carleton University.
Volet : Cours magistral

ELG 8000 Co-Op Work Term I / Co-Op Work Term I
Pour les étudiants et les étudiantes d'un programme coopératif de maîtrise qui font leur première session de travail. / For students in a co-operative master's program who are on their first work session.
Volet / Course Component: Stage / Work Term

ELG 8001 Co-Op Work Term II / Co-Op Work Term II
Pour les candidats et les candidates à un programme coopératif de maîtrise qui font leur deuxième session de travail. / For students in a co-operative master's program who are on their second work session.
Volet / Course Component: Stage / Work Term

ELG 9997 Proposition de thèse de doctorat / Ph.D. Thesis Proposal
Volet / Course Component: Recherche / Research

ELG 9998 Examen de synthèse (doctorat) / Ph.D. Comprehensive Examination
Volet / Course Component: Recherche / Research