Department of Electrical Engineering

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The Department

Chair of the Department:
G.I. Costache
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P.A. Galko

The Department of Electrical Engineering is one constituent of the Ottawa-Carleton Institute for Electrical Engineering. Consult the Institute entry on page 121 of this calendar for a faculty list, graduate program descriptions and admission requirements.

Department Facilities

Computing Facilities

1) A VMS Cluster consisting of:
   (a) VAX 3500 server with 8 MB of RAM, and a 800 MB disk
   (b) Eight VAX Station II systems each with 5 MB of RAM, a 200 MB disk and a 19" monitor
2) A Unix network consisting of:
   (a) Two RISC DecServer 3100s each with 24 MB of RAM and a 1 GB disk
   (b) Four RISC DecStation 3100s each with 16 MB of RAM and a 100 MB disk and a 19" colour monitor
   (c) Five RISC DecStation 3100s each with 16 MB of RAM, a 100 MB disk and a 19" monochrome monitor
3) Several other Unix-based workstations in various research laboratories (SUN workstations, Compaq 386, HP386, etc.)

In addition to this, the Department operates dozens of IBM compatible and Apple Macintosh family computers. Essentially all of the Department's computers are linked together in a network using Ethernet and LocalTalk networks. The Department's networks connect the University of Ottawa's IBM mainframe and the Internet network.

In addition to these facilities, students in the Department have access to a computer-aided design laboratory operated by the Faculty of Engineering (University of Ottawa). This facility includes a VAX 3500 and nine VAX Stations connected in a cluster.

Digital Communications Research Laboratory

This laboratory is equipped with a variety of communication system and signal analysis equipment. This includes some of the latest equipment for data source simulation, data error rate monitoring, spectrum analysis, cross and autocorrelation function measurement, probability density function measurement, noise simulation, filtering, etc. It also includes prototype digital modulation and demodulation equipment, and various digital signal processing hardware and software systems based on the TMS320C25 digital signal processor. The laboratory also features a 14/12 GHz satellite earth station and associated terminal equipment for testing prototype equipment on an actual satellite link.

Lightwave Communications Research Laboratory

This laboratory is equipped with modern optical communications instruments covering the wavelengths from 600 nanometres to 1.5 microns. The laboratory also features several SUN workstations with software for the computer simulation of various aspects of optical communication systems and networks. Current experimental work in the laboratory includes holographic coupler designs, coherent optical networks and indoor infrared multicasting.

Computer Communications Research Laboratory

This laboratory is equipped with several HP RS/20 and SUN computer systems connected together on an Ethernet network linked to the rest of the Department's computing facilities. Recent activities in the laboratory include the development of gateways to interconnect LANs using Satellite Wide Area networks and ISDN, and design and implementation of a test-bed facility for multimedia communication applications. The laboratory is also equipped with simulation programs such as QNAP2, RESQ OPNET, NETWORKS, GSPNA, and GreatSPN.

Electromagnetic Research Laboratory

This laboratory is equipped with modern co-axial line and waveguide instruments covering frequencies from 10 MHz to 60 GHz. A computer-controlled frequency domain network analyzer with error correcting capabilities allows reflection and transmission measurements from 5 Hz to 60 GHz. The laboratory is also equipped with a computer-controlled

time domain network analyzer and a modern scalar network analyzer (transmission, reflection test set) as well as various frequency counters and spectrum analyzers. A computer controlled three-dimensional scanning system located in an anechoic chamber and used for near-field antenna measurement in both frequency and time domains over the frequency range from 100 MHz to 3GHz. TEM cells at 100 MHz and 3 GHZ are available for field probe calibration and EMC/I testing of electronic equipment.

Graduate Courses

- Engineering 92.504 (ELG5337)

Electronics Design Techniques with Integrated Circuits
Review of basic operational amplifier techniques. Design of specialty circuits: wideband low noise video amplifiers, chopper amplifiers, isolation amplifiers, and switched capacitor filters. Review of phase locked loops. Filter design using phase locked loops. Operation and use of surface acoustic wave devices and charge coupled devices.
Prerequisite: ELG4131 or the equivalent.
D.T. Gibbons.

- Engineering 92.505 (ELG5162)

Knowledge-Based Systems: Principles and Design
Basic concepts and terminology. Introduction to mathematical logic and to reasoning. Introduction to Lisp and Objective C. Knowledge representation using rules, semantic nets and frames. Case study. Representation in state space. Case study. Use of knowledge. Procedural and declarative knowledge. Demons. Production systems. Case study. Solution searching algorithms. Expert system components. Inference engine principle. Basic schemes for inference engine representation. Knowledge-based system design. Using an expert system shell for the design of knowledge-based systems. Case study and expert system for process control.
Dan Ionescu.

- Engineering 92.506 (ELG7132)

Topics in Electronics I
Current topics in the field.

- Engineering 92.507 (ELG7133)

Topics in Electronics II
Current topics in the field.

- Engineering 92.508 (ELG7575)

Sujets choisis en électronique
Sujets d'intérêt courant dans la matière.

- Engineering 92.510 (ELG5163)

Machine Vision
Image acquisition. Lighting considerations. Structured light and stereo ranging. Gray-scale and binary images: geometric and topological properties. Regions and image segmentation. Image preprocessing. Edge finding. Image processing. Image recognition techniques. Mathematical models for image representation. Mathematical morphology. Model building. Representation of 3-D objects. Three dimensional scene understanding. Motion detection. Special vision architectures, massively parallel computers, AIS series. Machine vision for manufacturing.
Prerequisite: ELG4153.
Dan Ionescu.

- Engineering 92.511 (ELG5192)

Microprocessor-Based Systems Design
The purpose of this course is to present the hardware design alternatives of microprocessor-based systems. The course covers the following main topics: overview of microprocessors; CISC, microprogramable and RISC machines. The memory subsystem: main memory and virtual memory systems. The input/output subsystem: I/O schemes, digital and analog I/O ports, and bussing schemes. Multiple processor systems overview; taxonomy of multiprocessor systems and when to use multi-microprocessor systems. As part of the course the students will write a major project on an agreed on topic and present it to the class if time permits.
Moshe Kreiger.

- Engineering 92.512 (ELG5197)

Introduction to Embedded Systems
The purpose of this course is to present the design alternatives of embedded systems. The course covers the following main topics: overview of embedded systems, where they fit and their general characteristics. Simple embedded systems: sequential event response systems and cyclic executives. Design overview: prototype-based designs, multitasking and multiactivity paradigms. Multitasking systems design: elements of real-time operating systems and harmony. Multiactivity systems design: process activity language (PAL) and PAL-based design tools. As part of the course the students will write a major project on an agreed topic and present it to the class if time permits.
Prerequisite: ELG4161 or the equivalent.
Moshe Kreiger.

- Engineering 92.513 (ELG5198)

Parallel Processing with VLSI
Overview of parallel processing. Architectures for parallel processing: array processors, associate processors, vector processors, orthogonal processors, switch lattice architecture, hypercubes, systolic arrays, wavefront arrays, pyramid structures, data flow architectures, and reduction machines. Memory organization, buses, I/O and interconnection networks for parallel processing systems. Connection machine processing hardware, RISC processors, and some VLSI processors. Impact of GaAs technology on parallel processing. Future parallel processing systems

implementations. Some representative parallel processing systems. Examples of parallel processing architectures for various applications.
Sethuraman Panchanathan.

- Engineering 92.514 (ELG5199)

Design of Multimedia Distributed Database Systems
The purpose of the course is to provide the students with the basic concepts of the conventional database technology: technology trends and databases, database concepts and architecture, data modelling. Emphasis will be on the relational technology and distributed databases: relational concepts, relational algebra, distributed database architecture, horizontal and vertical fragmentations, distribution design, distributed transparency, distributed concurrency control. The course will also examine the new generation of databases for advanced applications such as multimedia information retrieval and the limitations of the conventional models for managing multimedia information such as graphics, text, image, audio/video and voice. Extended relational databases and object-oriented database approaches will be discussed. As part of the course the students will write a major project on topics related to both traditional and advanced database technologies and present it to the class.
Ahmed Karmouch.

- Engineering 92.515 (ELG5373)

Secure Communications and Data Encryption
Introduction to secure communications. Data encryption and encipherment. Source entropy and average mutual information. Cryptanalysis of encrypted data. Classic encipherment methods: substitution, transposition and product ciphers. Symmetric cryptosystems: shift register sequences, stream ciphers and Data Encryption Standard DES. Public key encipherment concept, RSA cipher, knapsack cipher, computational complexity, Diffie-Helman public key distribution scheme. Message authentication and identity verification. Applications: electronic funds transfer, secure speech communications.
Prerequisite: ELG5119 or 94.553 or the equivalent.
J.-Y. Chouinard.

- Engineering 92.516 (ELG5113)

Stochastic Systems
Wiener processes. Poisson random measures. Stochastic Wiener-Ito integrals. Stochastic integrals with respect to Poisson measures. Stochastic differentials. Diffusion processes. Itostochastic differential equations: existence and uniqueness of solutions, continuous dependence of solutions with respect to parameters. Semigroup theory and generation of semigroups as applied to stochastic differential equations. Applications to engineering systems modelling (computer communications networks, power system networks, etc.).
Prerequisite: Permission of the instructor.
N.U. Ahmed.

- Engineering 92.519 (ELG5119)

Stochastic Processes
Probability spaces. Random variables. Distribution and density functions. Expectation. Functions of random variables. Moments and characteristic functions. Random vectors. Functions of random vectors. Sequences of random variables. Convergence notions. The central limit theorem. The law of large numbers. Stochastic processes: basic notions, characterizations and examples. Stationarity notions. Poisson processes. Gaussian processes. Transformations of stochastic processes. Ergodicity. Second order random processes. Representation theorems. Markov processes. Homogeneous Markov chains. Applications.
Exclusion: 94.553
P.A. Galko.

- Engineering 92.520 (ELG5120)

Queuing Systems
Stochastic processes: Markov chains, discrete birth-death, etc. Queuing systems: M/G/1, G/M/m, M/M/m/k/n queues, etc. Priority queues. Networks of queues: local/global balance equations, product form solutions for open and closed networks. Mean value analysis, diffusion approximation, non-product form networks. Related models (e.g., Petri nets). Numerical solutions. Examples include throughput analysis from multiprocessors and computer-communication networks.
Prerequisite: ELG5119 or 94.553 or the equivalent.
Exclusion: 94.517
O.W. Yang.

- Engineering 92.526 (ELG5353)

Distributed Parameter Systems
First and second order evolution equations on Banach spaces. Controllability and stability of hyperbolic systems. Identification of system parameters. Application to flexible spacecraft.
Prerequisite: Permission of the instructor.
N.U. Ahmed.

- Engineering 92.527 (ELG5161)

Robotics: Control, Sensing and Intelligence
Robotics as the intelligent connection of perception to action. Robotics in the CIM context. 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. Mobile robots. Knowledge-based control for mobile robots: environment perception, robot's world model, navigation and motion control.
Prerequisite: ELG4161 or the equivalent.

E.M. Petriu.

- Engineering 92.528 (ELG5160)
Introduction to Robotics
Introduction to robots and their applications. Types of robots. Power sources: hydraulic, pneumatic and electric systems. Representation of robot kinematics and dynamics. Planning and execution of manipulator trajectory. Feedback from the environment: the use of sensors and artificial vision. Real-time computer control. Programming languages and programming aspects. Application case studies.
Prerequisites: ELG4151 and ELG4161 or the equivalents.

- Engineering 92.529 (ELG7113)
Topics in Systems and Control I
Current topics in the field, including linear semigroup theory and optimal feedback control.

- Engineering 92.530 (ELG7114)
Topics in Systems and Control II
Current topics in the field, including linear and nonlinear filtering and optimal control of stochastic systems.

- Engineering 92.531 (ELG7574)
Sujets choisis en systèmes et reglage automatique.
Sujets d'intérêt courant dans la matière.

- Engineering 92.534 (ELG5101)
Millimeter-Wave Engineering and Applications
Techniques for generating, transmitting and receiving millimeter waves. Propagation characteristics of millimeter-waves in the atmosphere and other media. Tube and solid state sources: antennas; transmission media; waveguide circuits and components. Millimeter-wave systems and applications for radar, communications, radiometry, remote sensing and radio astronomy.
Prerequisites: ELG4101 and ELG4102 or the equivalents.
G.I.Costache and Prakash Bhartia (DREO).

- Engineering 92.535 (ELG5108)
Electromagnetic Compatibility and Interference
Interference phenomena. Shielding of conductors. Grounding. Other noise reduction techniques. EMI filters. Noise sources: narrowband and broadband. Electromagnetic pulse as an interference source. Modelling EMI/C circuit boards and backplanes.
Prerequisite: ELG4101 or the equivalent.
G.I. Costache and Prakash Bhartia (DREO).

- Engineering 92.538 (ELG7500)
Sujets choisis en électromagnétisme.
Sujets d'intérêt courant dans la matière.

- Engineering 92.540 (ELG5109)
Radio-, Micro- and Millimeter Wave Measurements and Instrumentation
Fundamentals of electronic measurements, uncertainty analysis. Measurements from 10 kHz to 300 GHz: voltage, current, power, frequency, attenuation, phase and Q-factor. Fundamentals of electronic instrumentation: digital voltmeters, power meters, frequency counters, impedance analyzers, network analyzers and spectrum analyzers. Application of computers for measurements: IEEE 488 interface, automatic test equipment. New trends in electronic instrumentation.
Prerequisite: ELG5104 or the equivalent.

- Engineering 92.541 (ELG5104)
Electromagnetic Waves: Theory and Applications
The homogeneous wave equation. Uniform and non-uniform plane waves. Inhomogeneous wave equations. Green's functions. Theory of potentials. Scattering problems. Numerical methods. Boundary value problems. Perturbation and variational techniques.
Prerequisite: ELG4101 or the equivalent.
M.M. Ney.

- Engineering 92.542 (ELG5379)
Numerical Methods in Electromagnetic Engineering
An introduction into modern numerical methods for solving electromagnetic field problems. Deterministic as well as eigenvalue problems will be treated using the following techniques: finite difference and finite element techniques, moment methods, sparse matrix techniques, spectral domain techniques, hybrid mode analysis, transmission line matrix simulations. Applications include wire antennas, waveguides of arbitrary cross-section, micro-strip and quasiplanar transmission lines, transmission line discontinuities and computer-aided design and optimization of microwave components.
Prerequisite: ELG4101 or the equivalent.
G.I. Costache.

- Engineering 92.543 (ELG5504)
Ondes électromagnétiques: théorie et applications
Equation homogène d'onde. Ondes planes uniformes et non uniformes. Equation non homogène d'onde. Fonctions de Green. Théorie des potentiels. Problèmes de diffraction. Methodes numériques. Problèmes avec frontières limitées. Méthode des perturbations et variationnelles.
Préalable: ELG4101 ou équivalent.
M.M. Ney.

- Engineering 92.544 (ELG7100)
Topics in Electromagnetics I
Current topics in the field.

- Engineering 92.545 (ELG7101)
Topics in Electromagnetics II
Current topics in the field.

- Engineering 92.546 (ELG5779)
Méthodes numériques en génie électromagnétique

Une introduction aux méthodes modernes de résolution numérique de problèmes électromagnétiques. Le cours couvre des problèmes déterministes et aux valeurs propres. Les méthodes suivantes seront présentées: différences finies, éléments finis, analyse dans le domaine spectral, analyse par modes hybrides, méthode t.l.m. Les méthodes seront appliquées aux problèmes suivants: antennes, guides d'onde de section arbitraire, lignes microrubans et lignes quasi-planaires, discontinuités dans les lignes de transmission, conception par ordinateur de composants hyperfréquences.
Préalable: ELG4101 ou équivalent.
G.I. Costache.

- Engineering 92.549 (ELG5714)

Satellite Communications
Basic up-link and down-link equations. System noise temperature. Power flux density and energy dispersal. Analog frequency modulation techniques. Signal-to-noise ratios for telephony and television. Time division multiple access systems and digital system capacity under bandwidth and power limitations. Single channel per carrier frequency division multiple access schemes and system capacity. Pre-assigned and demand assigned satellite networks. Geometry relating to satellite and earth stations. Earth station figure of merit (G/T) measurement using radio stars. Rain attenuation. System fade margins for linear and saturated transponders. Dual polarization frequency re-use. Interference between terrestrial microwave and satellite systems.

- Engineering 92.550 (ELG5371)

Digital Communications by Satellite
Overview of satellite communications. Channel characterization and link budget calculations. Transponders: a transponder model, channelization, frequency plans, processing transponders. Earth station technology: modems (BPSK, QPSK, MSK, etc., coherent versus differential detection), low noise amplifiers, high power amplifiers. Forward error correction for satellite links. Propagation and interference considerations. Satellite access techniques: FDMA, TDMA, CDMA, random multiple access. Satellite switching and on-board processing. Networking and Services. Integrated services digital satellite network. VSAT, MSAT, Intelsat and Inmarsat.
Prerequisite: ELG4171 or the equivalent.
Abbas Yongaçoglu.

- Engineering 92.551 (ELG5170)

Introduction to Information Theory
Introduction to information theory and communication systems: source coding, channel coding and data encryption. The measure of information: entropy, mutual information and average mutual information. Discrete-source coding: fixed-length and variable-length codes, stationary sources, ergodic sources, Markovian sources, the Source-Coding Theorem. Data compression. The rate-distortion function. Information estimation: the Neyman-Pearson Theorem, maximum-likelihood detection, elementary and asymptotic bounds on performance, the Chebyshev inequality and the Chernoff bound. Channel coding: data transmission over discrete noisy channels, the capacity of discrete memory-less channels, discrete channels with memory, the Channel Coding Theorem, block codes and tree codes. Continuous channels and sources: entropy and mutual information of continuous-amplitude discrete-time signals, discrete-time Gaussian sources and channels with and without memory, the rate-distortion function of a Gaussian signal, continuous-time Gaussian sources and channels, transmission with a band-width constraint.
Prerequisite: ELG5119 or 94.553 or the equivalent.
J.-Y. Chouinard.

- Engineering 92.552 (ELG5331)

Transmission Systems for Communications
This course is for engineers involved with the design, application and specification of transmission systems for communications, including voice, data and video information. Topics to be covered include: network fundamentals, signal properties, noise, transmission media, system impairments, performance objectives, message channels, cable transmission and treatment, analog carrier systems, multichannel system load and testing, nonlinear channels and intermodulation noise, microwave radio systems, FM radio, SSB-FM, satellite systems, digital transmission fundamentals, digital terminals, multiplexers, baseband digital systems, digital cable systems, digital microwave radio systems, digital satellite systems, optical-fibre systems, local area transport, digital signal processing applications, system maintenance.
Prerequisite: ELG4171 or the equivalent.
W.F. McGee.

- Engineering 92.553 (ELG5179)

Detection and Estimation
An introduction to the optimal processing of communication signals. The binary hypothesis testing problem. Bayes risk and Neyman-Pearson criteria based receivers. M-ary hypothesis detection problems. Composite hypothesis problems. Parameter estimation criteria; Cramer-Rao bounds; maximum likelihood estimation. Function space concepts. Integral equations; the Karhunen-Loeve Expansion Theorem. Detection problems of signals in additive white Gaussian noise. Detection problems in coloured noise; the whitening filter; singular detection. The noise-in noise problem. Classical signal estimation problems. The liner filtering problem. The Wiener filter. The Kalman filter. Sequential detection (Wald's test). Introduction to non-parametric detection.

Prerequisites: ELG5119 or 94.553; and ELG5375 or 94.554; or the equivalents.
P.A. Galko.

- Engineering 92.554 (ELG5372)
Error Control Coding
General introduction. Algebraic concepts. Linear block codes. Cyclic codes, error trapping, decoding of cyclic codes, BCH codes, majority-logic decoding of cyclic codes, finite geometry codes, burst-error correcting codes. Convolutional codes. Maximum-likelihood decoding, sequential decoding, and majority-logic decoding of convolutional codes. Burst-error correcting convolutional codes. Automatic repeat request strategies. Applications of block coding to data storage systems. Applications of convolutional codes.
Co-requisite: ELG4171 or the equivalent.
Abbas Yongaçoglu.

- Engineering 92.556 (ELG5375)
Principles of Digital Communication
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 reliable transmission. Spread spectrum and line coding techniques.
Prerequisite: 94.553 or ELG5119 or the equivalent (may be taken concurrently).
Exclusion: 94.554.
P.A. Galko.

- Engineering 92.557 (ELG5376)
Digital Signal Processing
Discrete-time signals, system functions, convolution, correlation, transforms. Frequency domain and Z-domain representations. FIR and IIR filters. Filter design in frequency and time domains. The Discrete Fourier Transform. Fast Fourier Transform algorithms. Realizations: finite word-length effects, quantization of analog signals and filter coefficients; quantization of multiplier and adder outputs, overflow and limit cycles. Decimation and interpolation and their applications. Anti-aliasing filter design. A/D and D/A impairments and specifications. Echo cancellers. The extent to which the above topics are covered will be determined at the beginning of the course based on the student's background.
Prerequisite: ELG5119 or 94.553 or the equivalent.
Exclusion: 94.562
T.A. Aboulnasr.

- Engineering 92.558 (ELG5776)
Traitement numérique des signaux
Méthodes de traitement numérique des signaux dans le domaine fréquentiel et temporel; effets d'arrondissement sur les coefficients et accumulation des erreurs. Réalisations directes très hautes vitesses. Réseaux systoliques. Réalisations utilisant des micro-ordinateurs. Techniques d'adaptation. Applications aux systèmes de télécommunications.
Préalable: ELG4172 ou équivalent.

- Engineering 92.559 (ELG5378)
Image Processing and Image Communications
Linear systems approach to image processing. Two-dimensional transforms for image processing. Image analysis, segmentation, and classification. Applications to inspection, remote sensing, and medicine. Image coding: spatial domain, transform domain. Properties of the human visual system and image displays. Image processing hardware.
Prerequisite: ELG5376 or 94.562 or the equivalent.

- Engineering 92.560 (ELG7172)
Topics in Signal Processing I
Current topics in the field.

- Engineering 92.561 (ELG7173)
Topics in Signal Processing II
Current topics in the field.

- Engineering 92.562 (ELG5778)
Traitement et transmission d'images
Applications des systèmes linéaires en traitement d'images. Transformées bi-dimensionnelles et leurs emplois pour le traitement d'images; analyse d'images par segmentation et classification; exemples d'applications en inspection, télédetection et médecine; codage d'images, dans le domaine spatial, des transformées, méthodes hybrides, caractéristiques du système visuel humain et écrans de visualisation; hardware pour le traitement d'images.
Préalable: ELG5376 ou 94.562 ou équivalent.

- Engineering 92.563 (ELG7179)
Topics in Signal Processing III
Current topics in the field.

- Engineering 92.565 (ELG7177)
Topics in Communications I
Current topics in the field.

- Engineering 92.566 (ELG7178)
Topics in Communications II
Current topics in the field.

- Engineering 92.567 (ELG5374)
Computer-Communication Networks
Introduction. Network goals. Applications of networks. Network structure. Network architectures. The ISO reference model. Introduction to queuing theory. Delay analysis. The physical layer. The

data link layer. The network layer: point to point networks, satellite and packet-radio networks, local area networks. The transport and session layers: interconnection of packet switching networks. The presentation layer: network security and privacy, file transfer protocols. The application layer: distributed data base systems.
Co-requisite: ELG4171 or the equivalent.
Exclusion: 94.521
O.W. Yang.

- Engineering 92.570 (ELG5380)
Digital Telephony
The communication process. The telephone network: constituents and principles governing its evolution. Speech processing and applications. VLSI codes and line circuits. Digital transmission principles. Time-division multiplexing, channel banks and transmission systems. Principles of digital switching and exchanges: circuit and packet switching. Architecture alternatives. Stored program control and distributed systems. Switching office service circuits. Reliability, maintainability and evaluation criteria. Comparative analysis of commercial systems. Office communications. Communication workstations. ISDN. Network evolution and network control issues. (Students will be expected to do extensive reading of the current literature and a report and class presentation of an assigned topic.)
Prerequisite: ELG4171 or the equivalent.

- Engineering 92.571 (ELG5381)
Office Communication Systems
The communication process and office automation quandary. Office models. Office communication system design. Key systems. PBX design principles and comparative analysis. Local area networks. Fibre optics in the office. Open system interconnect. Internetwork communications. Requirements and architectural alternatives for integrated voice and data communications. LANs and computer to PBX interfaces. Integrated office systems: examples and critical analysis. New communication services: messaging, teleconferencing, document and image communication, directories, etc. Access. Voice terminals. Data terminals. The PC invasion and local services. Portability. Integrated work stations. Man-machine interfaces. The impact of ISDN. Private networks. (Students will be expected to do extensive reading of the current literature and a report and class presentation of an assigned topic.)
Prerequisite: ELG5380 or the equivalent.

- Engineering 92.572 (ELG7572)
Sujets choisis en télécommunications et traitement de signaux.
Sujets d'intérêt courant dans la matière.

- Engineering 92.573 (ELG5194)
Design and Testing of Reliable Digital Systems
Introduction. Test generation for combinatorial circuits. Fault detection in sequential circuits. Memory testing. LSI/VLSI circuit testing. Deterministic and random testing of digital circuits. Design for testability. Self-checking circuits. Design of fault-tolerant systems. Case studies.
Prerequisite: ELG5195 or the equivalent.
S.R. Das.

- Engineering 92.574 (ELG5180)
Advanced Digital Communication
Digital signalling over channels with intersymbol interference (ISI) and additive Gaussian noise. Error probability analysis. Fading multipath channels as arise in terrestrial line-of-sight (LOS) and mobile/portable communications, diversity concepts: modelling and error probability performance evaluation. Synchronization in digital communications. Spread spectrum in digital transmission over multipath fading channels. Optical communications and networking over fibre and atmosphere. Shot noise, laser intensity noise and Gaussian noise performance limits.
Prerequisite: 94.554 or ELG5375 or the equivalent.
Exclusion: 94.565
Mohsen Kavehrad.

- Engineering 92.575 (ELG5195)
Digital Logic Design: Principles and Practices
Combinational circuit analysis including hazard detection. Number systems and codes. Switching algebra. Combinational circuit design including PLA and MSI techniques. IC logic families. Flip-flop properties. Switching algebra: special properties; symmetric functions, unate functions, threshold functions, Boolean difference, and functional decomposition. Introduction to sequential circuits; state reduction, incompletely specified machines, state assignment, and series-parallel decomposition. Fundamental mode sequential circuits; race, hazards, and state assignment. Testing aspects of digital systems; failure and fault models, deterministic test generation for combinational circuits, testing sequential circuits, state identification, and testing memories and complex LSI/VLSI circuits. Design for testability techniques: scan techniques, built-in self test (BIST), and easily testable network structures. Semicustom and MSI design. Special sequential circuits including sequential integrated circuits.
S.R. Das.

- Engineering 92.577 (ELG5192)
Microprocessor-Based Systems
The course considers the various design alternatives of microprocessor-based systems. Review of current microprocessor trends. Design alternatives of microprocessor-based system executives. LSI memories

and memory system design. Input/output options and the design of various input/output ports. Busing schemes. Design of bit-sliced systems.
Prerequisite: ELG4391 or the equivalent.
Moshe Krieger.

- Engineering 92.578 (ELG5193)
Multi-Microprocessor Systems
Multiprocessor systems: definitions, characteristics, objectives and applications. Multi-microprocessor systems: what, where and why. Task-driven systems. Examples of multi-microprocessor systems. (Students will be expected to do extensive reading of the current literature, a project and class presentation of an assigned topic.)
Prerequisite: ELG5192 or the equivalent.
Moshe Krieger.

- Engineering 92.579 (ELG5196)
Automata and Neural Networks: Applications in Machine Perception
This course is intended to provide a general introduction to the field of automata networks, giving special attention to "artificial neural networks" and their application in modelling perception mechanisms. Introduction: a historical overview of the area and a look at examples of automata network applications in cellular computer architectures, modelling of physical and biological phenomena, and the modelling of cognition and perception mechanisms. Mathematical tools: Boolean networks, discrete iterative automata, random automata networks, and dynamic automata network behaviour (threshold networks and the behaviour of iterative automata). Neural networks: models for motor control, perception and information retrieval; representation and learning, basic components (the "formal neuron", the perceptron), linear learning, feature discovery by competitive learning, retrieval, multi-layered networks, the "gradient back propagation" learning algorithm for multi-layered networks, and VLSI implementation of a neural network model. Applications in machine perception: self-organization in a perceptual network, the "Adaptive Resonance Theory" of adaptive pattern recognition by a self-organizing neural network, neural networks for adaptive pattern recognition, neural networks for visual pattern recognition, a silicon model of early visual processing and its application to optical flow computing, and a "neural" phonetic typewriter.
E.M. Petriu.

- Engineering 92.587 (ELG7186)
Topics in Computers I
Current topics in the field.

- Engineering 92.588 (ELG7187)
Topics in Computers II
Current topics in the field.

- Engineering 92.590 (ELG7573)
Sujets choisis sur les ordinateurs.
Sujets d'intérêt courant dans la matière.

- ELG6000
Engineering Report/Rapport technique
For students in the course work master's program working on the Engineering Report. Pour les candidats à la maîtrise qui préparent un rapport technique.

- ELG7999
M.A.Sc. Thesis/Thèse de M.Sc.A.
For students working towards their master's thesis.
Pour les étudiants qui travaillent à leur thèse de maîtrise.

- ELG8000
CoOp Work Term I/Travail coopératif Ier trimestre
For students in a cooperative master's program who are on their first work term.
Pour les candidats à un programme coopératif de maîtrise qui font leur première session de travail.

- ELG8001
CoOp Work Term II/Travail coopératif IIe trimestre
For students in a cooperative master's program who are on their second work term.
Pour les candidats à un programme coopératif de maîtrise qui font leur deuxième session de travail.

- ELG9998
Ph.D. Comprehensive Exam/Examen de synthèse du doctorat
For students undergoing the Ph.D. comprehensive examination.
Pour les étudiants qui doivent passer l'examen de synthèse du doctorat.

- ELG9999
Ph.D. Thesis/Thèse de doctorat
For students working towards their Ph.D. thesis.
Pour les étudiants qui travaillent à leur thèse de doctorat.