Anja Kroon's McGill University Coursework
B. Eng. Honours Electrical Engineering

Discrete Time Signal Processing (Graduate Course)

Discrete-time signals and systems; Fourier and Z-transform analysis techniques, the discrete Fourier transform; elements of FIR and IIR filter design, filter structures; FFT techniques for high speed convolution; quantization effects.

Numerical Methods (Graduate Course)

DC resistor networks and sparse matrix methods. Nonlinear electric and magnetic circuits: curve-fitting; the Newton-Raphson method. Finite elements for electrostatics. Transient analysis of circuits: systems of Ordinary differential equations; stiff equations. Transient analysis of induced currents. Solution of algebraic eigenvalue problems. Scattering of electromagnetic waves: the boundary element method; numerical integration.

Optimization and Optimal Control (Graduate Course)

General introduction to optimization methods including steepest descent, conjugate gradient, Newton algorithms. Generalized matrix inverses and the least squared error problem. Introduction to constrained optimality; convexity and duality; interior point methods.

Machine Learning for Engineers (Graduate Course)

Introduction to machine learning: challenges and fundamental concepts. Supervised learning: Regression and Classification. Unsupervised learning. Curse of dimensionality: dimension reduction and feature selection. Error estimation and empirical validation. Emphasis on good methods and practices for deployment of real systems.

Probability and Random Signals 2 (Graduate Course)

Multivariate Gaussian distributions; finite-dimensional mean-square estimation (multivariate case); principal components; introduction to random processes; weak stationarity: correlation functions, spectra, linear processing and estimation; Poisson processes and Markov chains: state processes, invariant distributions; stochastic simulation.

Speech Communications (Graduate Course)

Articulatory and acoustic descriptions of speech production, speech production models, speech perception, digital processing of speech signals, vocodors using formant, linear predictive and cepstral techniques, overview of automatic speech recognition systems, speech synthesis systems and speaker verification systems.

Electrical Engineering Honours Thesis (2 Semesters)

A research project undertaken with close mentorship by a staff member and under the supervision of the course instructor. The thesis consists of defining an engineering problem, reviewing relevant background, acquiring/analyzing data, and seeking design solutions using appropriate simulation/analysis tools and experimental investigations.

Honours Research Lab Rotation (4 Semesters)

A series of four research laboratory rotations selected among research groups in the Department of Electrical and Computer Engineering meant to expose students to research as preparation for graduate school.

Honours Applied Linear Algebra

Matrix algebra, determinants, systems of linear equations. Abstract vector spaces, inner product spaces, Fourier series. Linear transformations and their matrix representations. Eigenvalues and eigenvectors, diagonalizable and defective matrices, positive definite and semidefinite matrices. Quadratic and Hermitian forms, generalized eigenvalue problems, simultaneous reduction of quadratic forms. Applications.

Microprocessors

Course focused on design techniques for developing modern microprocessor-based systems, multiple state-of-art instructions set architectures (ISAs) and associated assembly languages, use of tools for compiling, linking, memory overlay; debug techniques for start-stop and real-time debugging, together with debug infrastructure and interfaces: flash patching, variable watching and instruction stream tracing.

Telecommunication Networks

Architecture and protocols of contemporary networks; wired and wireless access systems; flow and congestion control; network optimization; randomized multiple access protocols; queueing disciplines; low-power wireless networks.

Electromagnetic Wave Propagation

Transient and steady state wave propagation in transmission lines; telephone and radio frequency lines; Smith's chart and impedance matching; Maxwell's equations, Helmholtz's equations, Poynting's theorem; plane waves, polarization, Snell's law, critical and Brewster's angle; rectangular waveguides, optical fibres, dispersion; radiation and antennas; S-parameters; lab work involving the Smith chart, communication transmission lines, reflection and refraction, and optical waveguides.

Linear Systems and Control

Modelling and simulation of control systems, review of LTI systems, time response of first and second order systems, state space modeling, controllability, state feedback and pole placement, observability, observer design, and output feedback, block diagrams and their

simplification, Routh-Hurwitz stability criterion, system type and steady state errors, Bode plots, Nyquist plots, Nyquist stability criterion, gain and phase margins, lead-lag compensators.

Communication Systems and Networks

Information and bandwidth, signals, modulation and noise, transmission and switching. Principles of layered design and the OSI model, measures of performance. Information sources and services. Application, Presentation and Session layers. Transport and Network layers. Data link layer and multi-user communication. Physical layer and transmission techniques. Wireline and wireless transmission media. Core (Backbone), and Access Communication Networks. Communication network classification.

Electronics

Introduction to electronic circuits using operational amplifiers, PN junction diodes, bipolar junction transistors (BJTs), and MOS field-effect transistors (MOSFETs), including: terminal characteristics, large- and small-signal models; configuration and frequency response of amplifiers with discrete biasing. Introduction to SPICE.

Power Engineering

Characteristics and components of power systems. Generation, transmission and utilization of electric power. 3-phase ac and dc systems. Fundamentals of electromechanical energy conversion. Ampere and Faraday's law. Magnetic circuits. Mutual inductance and transformers. Torque and force. Rotating magnetic fields. Basic rotating machines. Lab work involving techniques of electric power, efficiency, torque, and speed measurements.

Design Principles and Methods

Engineering process: design specifications, parameters, optimization, implementation, troubleshooting and refinement; project management: scheduling, risk analysis, project control; case studies; design examples and project.

Electric and Magnetic Fields

Divergence, gradient and curl. The divergence theorem and Stokes’ theorem. Maxwell's equations, electrostatics, magnetostatics and induction for power-frequency electrical engineering problems.

Signals and Systems

Review of complex functions. Discrete-and continuous-time signals, basic system properties. Linear time-invariant systems, convolution. Fourier series and Fourier transforms, frequency-domain analysis, filtering, sampling. Laplace transforms and inversion, transfer functions, poles and zeros, solutions of linear constant-coefficient differential equations, transient and steady-state response. Z-transforms.

Computer Organization

Basic computer structures; instruction set architecture; assembly language; input/output; memory; software; processor implementation; computer arithmetic. Lab work involving assembly language level programming of single-board computers.

Properties of Materials in Electrical Engineering

Materials Engineering: Properties of a material continuum and crystalline state; properties of atoms in materials; conduction electrons in materials; electronic properties of semiconductors and metals; magnetic and thermal properties of materials; applications of electronic materials in semiconductor technology, recording media and transducers.

Digital Logic

An introduction to digital logic, binary numbers and Boolean algebra, combinational circuits, optimized implementation of combinational circuits, arithmetic circuits, combinational circuit building blocks, flip-flops, registers, counters, design of digital circuits with VHDL, and synchronous sequential circuits.

Probability and Statistics for Engineers

Probability: basic probability model, conditional probability, Bayes rule, random variables and vectors, distribution and density functions, common distributions in engineering, expectation, moments, independence, laws of large numbers, central limit theorem. Statistics: descriptive measures of engineering data, sampling distributions, estimation of mean and variance, confidence intervals, hypothesis testing, linear regression.

Electric Circuits 2

Circuit variables. Analysis of resistive circuits, network theorems (Kirchhoff’s laws, Ohm’s law, Norton and Thevenin equivalent). Ammeters, Voltmeters, and Ohmmeters. Analysis methods (nodal and mesh analysis, linearity, superposition). Dependent sources and Op-Amps. Energy storage elements. First and second order circuits.

Electrical Circuits 1

Circuit variables. Analysis of resistive circuits, network theorems (Kirchhoff’s laws, Ohm’s law, Norton and Thevenin equivalent). Ammeters, Voltmeters, and Ohmmeters. Analysis methods (nodal and mesh analysis, linearity, superposition). Dependent sources and Op-Amps. Energy storage elements. First and second order circuits.

Analytical Mechanics

Civil Engineering: Kinematics of particles, dynamics of particles. Work, conservative forces, potential energy. Relative motion and general moving frames of reference. Central force fields and orbits. Dynamics of a system of particles. General motion of rigid bodies, angular momentum and kinetic energy of rigid bodies. Generalized coordinates and forces, Lagrange's equations.

Ordinary Differential Equations for Engineers

Mathematics & Statistics (Sci): First order ODEs. Second and higher order linear ODEs. Series solutions at ordinary and regular singular points. Laplace transforms. Linear systems of differential equations with a short review of linear algebra.

Intermediate Calculus

Mathematics & Statistics (Sci): Series and power series, including Taylor's theorem. Brief review of vector geometry. Vector functions and curves. Partial differentiation and differential calculus for vector valued functions. Unconstrained and constrained extremal problems. Multiple integrals including surface area and change of variables.

Electromagnetism & Optics

Physics: The basic laws of electricity and magnetism; geometrical optics.

Mechanics and Waves

Physics: The basic laws and principles of Newtonian mechanics; oscillations, waves, and wave optics.

Intro to Computer Science

Computer Science (Sci): Mathematical tools (binary numbers, induction, recurrence relations, asymptotic complexity, establishing correctness of programs), Data structures (arrays, stacks, queues, linked lists, trees, binary trees, binary search trees, heaps, hash tables), Recursive and non-recursive algorithms (searching and sorting, tree and graph traversal). Abstract data types, inheritance. Selected topics.

Intro to Software Development

Software development practices in the context of structured and object-oriented programming. Introduces the formalisms inherent in medium-to-large scale object-oriented programming. Introduction to tools and practices employed in commercial software development.

Linear Algebra and Geometry

Mathematics & Statistics (Sci): Systems of linear equations, matrices, inverses, determinants; geometric vectors in three dimensions, dot product, cross product, lines and planes; introduction to vector spaces, linear dependence and independence, bases. Linear transformations. Eigenvalues and diagonalization.

Calculus 1

Review of functions and graphs. Limits, continuity, derivative. Differentiation of elementary functions. Antidifferentiation. Applications.

Calculus 2

The definite integral. Techniques of integration. Applications. Introduction to sequences and series.

Communication in Engineering

Written and oral communication in Engineering (in English): strategies for generating, developing, organizing, and presenting ideas in a technical setting; problem-solving; communicating to different audiences; editing and revising; and public speaking. Course work based on academic, technical, and professional writing in engineering.

Engineering Economy

Faculty Course: Introduction to the basic concepts required for the economic assessment of engineering projects. Topics include: accounting methods, marginal analysis, cash flow and time value of money, taxation and depreciation, discounted cash flow analysis techniques, cost of capital, inflation, sensitivity and risk analysis, analysis of R and D, ongoing as well as new investment opportunities.

Engineering Professional Practice

Faculty Course: Laws, regulations and codes governing engineering professional practice. Responsibility and liability. Environmental legislation. Project and organization management. Relations between engineer and client. Technical practice - analysis, design, execution and operation.

Responsibilities of the Professional Engineer

Faculty Course: A course designed to provide all Engineering students with further training regarding their responsibilities as future Professional Engineers. Particular focus will be placed on three professional characteristics that future engineers must demonstrate: i) professionalism, ii) ethical and equitable behaviour, and iii) consideration of the impact of engineering on society and the environment.

Introduction to the Engineering Profession

Faculty Course: Introduction to engineering practice; rights and code of conduct for students; professional conduct and ethics; engineer's duty to society and the environment; sustainable development; occupational health and safety; overview of the engineering disciplines taught at McGill.