McGill
Faculty of Engineering

Course Outline

ECSE 316

Course Title:	**Signals and Networks**
Credits:	**3**
Contact Hours:	**(3-2-4)**
Course Prerequisite(s):	**COMP 251, ECSE 200, and MATH 263**
Course Corequisite(s):	**N/A**
Course Description:	**Introduction to the physical and software architecture of networks and the analysis and representation of signals; client-server and peer-to-peer architectures; layered design principles; network applications and socket programming; multimedia streaming, web transfer, and voice-over-IP; continuous-time and discrete-time signals; Fourier transforms and frequency domain analysis and representation of signals; filtering and sampling; flow and congestion control; solutions of linear constant-coefficient differential equations, transient and steady state response; Laplace transforms; addressing and routing for unicast, multicast, and broadcast transmission; wired and wireless access systems; multiple access protocols. Examples: Ethernet, http, TCP/IP, 802.11, OSPF, BGP.**

Canadian Engineering Accreditation Board (CEAB) Curriculum Content

CEAB curriculum category content	Number of AU's	Description
Math	**0**	Mathematics include appropriate elements of linear algebra, differential and integral calculus, differential equations, probability, statistics, numerical analysis, and discrete mathematics.
Natural science	**0**	Natural science includes elements of physics and chemistry, as well as life sciences and earth sciences. The subjects are intended to impart an understanding of natural phenomena and relationships through the use of analytical and/or experimental techniques.
Complementary studies	**0**	Complementary studies include the following areas of study to complement the technical content of the curriculum: engineering economics and project management; the impact of technology on society; subject matter that deals with the arts, humanities and social sciences; management; oral and written communications; health and safety; professionalism, ethics, equity and law; and sustainable development and environmental stewardship.
Engineering science	**39**	Engineering science involves the application of mathematics and natural science to practical problems. They may involve the development of mathematical or numerical techniques, modeling, simulation, and experimental procedures. Such subjects include, among others, applied aspects of strength of materials, fluid mechanics, thermodynamics, electrical and electronic circuits, soil mechanics, automatic control, aerodynamics, transport phenomena, elements of materials science, geoscience, computer science, and environmental science.
Engineering design	**13**	Engineering design integrates mathematics, natural sciences, engineering sciences, and complementary studies in order to develop elements, systems, and processes to meet specific needs. It is a creative, iterative, and open-ended process, subject to constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may also relate to economic, health, safety, environmental, societal or other interdisciplinary factors.

Accreditation units (AU's) are defined on an hourly basis for an activity which is granted academic credit and for which the associated number of hours corresponds to the actual contact time: one hour of lecture (corresponding to 50 minutes of activity) = 1 AU; one hour of laboratory or scheduled tutorial = 0.5 AU. Classes of other than the nominal 50-minute duration are treated proportionally. In assessing the

time assigned to determine the AU's of various components of the curriculum, the actual instruction time exclusive of final examinations is used.

Graduate Attributes

This course contributes to the acquisition of graduate attributes as follows:

Graduate attribute	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
Level descriptor	D	D			D							

I = Introduced; D = Developed; A = Applied

KB *- Knowledge Base for Engineering: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.*

PA *- Problem Analysis: An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.*

IN *- Investigation: An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.*

DE *- Design: An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.*

ET *- Use of Engineering Tools: An ability to create, select, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.*

IT *- Individual and Team Work: An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.*

CS *- Communication Skills: An ability to communicate complex engineering concepts within the profession and with society at large. Such abilities include reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.*

PR *- Professionalism: An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.*

IE *- Impact of Engineering on Society and the Environment: An ability to analyse social and environmental aspects of engineering activities. Such abilities include an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society; the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.*

EE *- Ethics and Equity: An ability to apply professional ethics, accountability, and equity.*

EP *- Economics and Project Management: An ability to appropriately incorporate economics and business practices including project, risk and change management into the practice of engineering, and to understand their limitations.*

LL *- Life-Long Learning: An ability to identify and to address their own educational needs in a changing world, sufficiently to maintain their competence and contribute to the advancement of knowledge.*

Policies

Academic Integrity

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures.
(see www.mcgill.ca/students/srr/honest/ for more information).
(approved by Senate on 29 January 2003)

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.
(approved by Senate on 21 January 2009)

Grading Policy

In the Faculty of Engineering, letter grades are assigned according to the grading scheme adopted by the professor in charge of a particular course. This may not correspond to practices in other Faculty and Schools in the University.

In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.

Course Outline – ECSE 316 Signals and Networks

General Information

Course #	ECSE 316
Term	Winter
Year	2023
Course pre-requisite(s)	COMP 251, ECSE 200, and MATH 263
Course schedule (day and time of class)	Monday, Wednesday: 8:35am – 9:55am
Number of credits	3 (3 Lecture - 2 Tutorial – 4 Study)
Course location	Lectures: TR 100; Tutorials: (M W 3:35pm – 5:25pm) ENGTR 1100

Instructor Information

Name and Title	Prof. Mark Coates
E-mail	Mark.coates@mcgill.ca
Telephone number	514-398-7137 (email is MUCH more reliable)
Office hours for students	By appointment
Office location	MC 759

TA Information

Names	Muberra Ozmen, Antonios Valkanas, Pavel Rumiantsev
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Course Overview

Electrical Engineering : Introduction to the physical and software architecture of networks and the analysis and representation of signals; client-server and peer-to-peer architectures; layered design principles; network applications and socket programming; multimedia streaming, web transfer, and voice-over-IP; continuous-time and discrete-time signals; Fourier transforms and frequency domain analysis and representation of signals; filtering and sampling; flow and congestion control; solutions of linear constant-coefficient differential equations, transient and steady state response; Laplace transforms; addressing and routing for unicast, multicast, and broadcast transmission; wired and wireless access systems; multiple access protocols. Examples: Ethernet, http, TCP/IP, 802.11, OSPF, BGP.

Learning Outcomes

By the end of this course, students should be able to:

- Explain core principles of the architecture and design of computer networks and the internet;
- Conduct analysis of application layer, transport layer, network layer and link layer protocols;
- Perform basic monitoring of networks and diagnose problems;
- Implement networked applications via socket programming;

- Identify the different types of signals and specify their characteristics;
- Calculate the frequency representation of signals;
- Determine the transfer functions of systems;
- Understand Fourier analysis and Laplace transforms and solve problems using them;
- Perform sampling of signals and understand the implications of the sampling process

Instructional Method

The course includes three 1 hour lectures each week presenting the course material.

There is a 2-hour tutorial session each week. Problems will be distributed during the course. There is no associated assessment, but solving the problems will provide you with a much better understanding of the course material. Part of each tutorial will be dedicated to allowing you to solve some of the problems in a collaborative environment. In the other part of the tutorial, the teaching assistant will demonstrate how to solve problems.

Students will conduct a project in a group of 4 during the semester in which they will conduct research into a topic of their choice. The project concludes with preparation of a video and a brief report.

Course Materials

Primary Textbooks

- **(KR)** J.F. Kurose and K.W. Ross, Computer Networking: A Top-Down Approach, 8th edition, Pearson, 2020.
- **(R)** K.D. Rao, Signals and Systems, Birkhäuser, 2018.

Secondary Reference

- **(L)** B. P. Lathi, Linear Systems and Signals, 2nd edition, Oxford University Press, 2004.

Kurose and Ross is available online from Pearson (subscription cost is $9.99 per month). Rao is available in electronic form from the McGill library.
In the course outline below, I identify readings from Kurose-Ross and Lathi. I will substitute the Lathi readings for equivalent readings from Rao during the semester.

Course Content

- The course covers two topics: (i) computer networks and (ii) signals and systems.

- For the computer networks portion of the course, we will proceed by motivating the layered network design architecture, and then study principles, protocols and applications from the top-layer (application

layer) down to the link layer. The physical layer is addressed in courses on digital communication. We adopt this approach because network applications are familiar to students and provide a good motivation. By analyzing the requirements of common applications (web browsers, peer-to-peer file exchange, Internet telephony, video streaming), we can see what services need to be provided by the next layer (transport layer). In turn, we can then examine what the transport layer requires in order to provide these services. This follows the top-down presentation of material in the textbook. I will present the principles of network operation, design and analysis, and provide practical examples of protocols and implementation.

- The signals and systems portion of the course provides a brief introduction to the fundamentals of the analysis and processing of signals and the design and analysis of (linear) systems that operate on those signals. We first address continuous time signals and review key analysis tools for such signals (Fourier series and Fourier transforms). Subsequently, we will examine discrete time signals and sampling. In the final portion of the course, we will explore linear systems and pole-zero analysis.

Week	Date	Description	Assignments and/or Readings Due
1+2	4/1 + 9/1	Motivation; Networks: Introduction + Architecture; Application Layer	KR 1.1-1.5, 2.1-2.6
3	16/1	Python Tutorial; Networks: Transport Layer	KR 3.1-3.7
4	23/1	Signals: Continuous Time + Fourier Series	L 1.1-1.5, 2.4, L 6.1-6.3
5	30/1	Signals: Fourier Transforms, Discrete Time	L 7.1-7.3, 3.1-3.3, 3.8, 5.5 Programming Exercise 1 due
6	6/2	Signals: Sampling, Problem Review	L 9.1, 8.1-8.2
7	13/2	Networks: Network Layer	KR 4.1-4.4
8	20/2	Networks: Network Layer, Link Layer	KR 5.1-5.5; Midterm
9	27/2	READING WEEK	
10	6/3	Networks: Wireless Networks	KR 6.1-6.3
11	13/3	Signals: Introduction to Systems Signals: Discrete Time Systems	L 1.6 – 1.7, 2.6 L 3.4-3.5
12	20/3	Signals: Discrete Time Systems Signals: Zeros and Poles	L 3.7-3.8, 3.10 L 4.1, 4.3, 7.2, 7.4
13	27/3	Signals: Discrete Fourier Transform	L 8.4, 8.5
14	3/4	Signals: Review and Problems	Programming Exercise 2 due
15	10/4	Course Review	Project video and report submission

Evaluation

- Project (15%): More in-depth research into a topic of your choice; video and written report; conducted in groups of 4.
    - Grading criteria: Video – clarity of presentation, use of visuals (e.g. slides), content (depth of research into topic); Report – grammatical correctness, presentation quality, clarity, correct citations, coverage of topic, depth of research, clear summary and report.

- Programming Exercises (15%): Submitted code and very brief reports; conducted in groups of 2.
    - Grading criteria: Code correctness – does it correctly operate on test cases and border conditions, does it handle errors correctly. Code structure – modularity, clarity, documentation and commenting. Design process – clear requirements analysis, clear structure plan, diagram to indicate operation.

- Midterm Exam (20%): In class (22nd February); numerical problems and short answers. Closed book.

- Final Exam (50%): Exam period; numerical problems and short answers. Closed book.

The midterm exam will be held on 22nd February, in place of the usual lecture.

Late Assignments: Without pre-arranged extension (i.e., communication with the instructor before the due date) or a valid excuse, late assignments are subject to a penalty of 5% of the maximum available marks per day late. Weekends count as one day.

Midterm Exam Policy: Individuals who miss a midterm exam for health reasons are required to provide a doctor's note as soon as possible to the instructor (and within one week). The marks associated with the midterm exam will be moved to the final exam.

Course completion: At least 65 percent of the course assignments must be submitted for a passing grade to be obtained.

Name of Assignment	**Due Date**	Grading Scheme **% of final grade**
Programming Exercise 1 (code and brief report)	7th Feb.	7.5
Midterm Exam	22nd Feb.	20
Programming Exercise 2 (code and brief report)	5th April	7.5
Project (10-minute video and report)	12th April	15
Final Exam	>16th Apr.	50

McGill Policy Statements

Required Course Outline Statements [in keeping with Senate resolutions]

Language of Submission:

"In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded. This does not apply to courses in which acquiring proficiency in a language is one of the objectives."

« Conformément à la Charte des droits de l'étudiant de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté (sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue). »

Academic Integrity:

"McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures" (see McGill's guide to academic honesty for more information).

« L'université McGill attache une haute importance à l'honnêteté académique. Il incombe par conséquent à tous les étudiants de comprendre ce que l'on entend par tricherie, plagiat et autres infractions académiques, ainsi que les conséquences que peuvent avoir de telles actions, selon le Code de conduite de l'étudiant et des procédures disciplinaires (pour de plus amples renseignements, veuillez consulter le guide pour l'honnêteté académique de McGill). »

Additional Statements

- "The University Student Assessment Policy exists to ensure fair and equitable academic assessment for all students and to protect students from excessive workloads. All students and instructors are encouraged to review this Policy, which addresses multiple aspects and methods of student assessment, e.g. the timing of evaluation due dates and weighting of final examinations."

- "Note that to support academic integrity, your assignments may be submitted to text-matching or other appropriate software (e.g., formula-, equation-, and graph-matching)."

- "As the instructor of this course I endeavor to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me and the Office for Students with Disabilities, 514-398-6009."

- "McGill University is on land which has long served as a site of meeting and exchange amongst Indigenous peoples, including the Haudenosaunee and Anishinabeg nations. We acknowledge and thank the diverse Indigenous people whose footsteps have marked this territory on which peoples of the world now gather."

  « L'Université McGill est sur un emplacement qui a longtemps servi de lieu de rencontre et d'échange entre les peuples autochtones, y compris les nations Haudenosaunee et Anishinabeg. Nous reconnaissons et remercions les divers peuples autochtones dont les pas ont marqué ce territoire sur lequel les peuples du monde entier se réunissent maintenant. »

- "End-of-course evaluations are one of the ways that McGill works towards maintaining and improving the quality of courses and the student's learning experience. You will be notified by e-mail when the evaluations are available. Please note that a minimum number of responses must be received for results to be available to students."

- "In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change."