Teaching Dossier

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Submitted for Tenure Track Teaching Stream Review

The Edward S. Rogers Sr. Department of Electrical & Computer Engineering
Faculty of Applied Science & Engineering
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Table of Contents

1. BIOGRAPHICAL INFORMATION

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II. Education

Sept. 2001 – Nov. 2005

Doctor of Philosophy, Electrical Engineering, University of Toronto

Sept. 1996 – Jan. 1998

Master of Applied Science, Electrical Engineering, University of Toronto

Sept. 1992 – Apr. 1996

Bachelor of Applied Science, Electrical Engineering, University of Toronto

2. OVERVIEW

This document encapsulates my teaching related activities for the periods that I worked as an Assistant Professor Teaching Stream at the Edward S. Rogers Sr. Department of Electrical & Computer Engineering and previously as a sessional instructor. My teaching encompasses different subjects in the areas of computer software/hardware, electronics/power electronics, internetworking/computer networks, communication and design process, design project, robotics, control systems, energy systems, kinematics and dynamics, signal and systems, electromagnetism, and mathematics. This comprises 26 courses taught over the last five years as an Assistant Professor and over 110 courses prior to my appointment. Overall, I have taught over 36 different subjects (from first year to graduate) during my teaching career. The experience gained from the time as a Sessional Instructor prepared me to quickly adapt to my new appointment and commence teaching with a full load.

My experience in industry as a test, design, and project engineer has also been an asset in bringing practical ideas into my teaching specifically in conducting labs and project-oriented subjects. During the last five years, I have supervised 19 undergraduate projects comprising of 61students where 8 design teams received Certificate of Distinction that is awarded to top projects in the Electrical & Computer Engineering. I have contributed six publications subsequent to my appointment and one prior to my appointment in the area of engineering education. I have created new labs and modified existing labs for ***a)*** ECE314 (Fundamental of Electrical Energy System), ***b)*** ECE361 (Computer Networks), and ***c)*** APS105 (Computer Fundamentals).

My current research is mainly focused on two projects. One project is to develop a remote lab platform for computer networks and determine potential applications of remote labs to other courses. This research is funded under the Dean's Emerging Innovation award for Teaching

Professorship. And the other project is to design and implement a software application that allows students' remote access to the university's computers.

I also developed two courses for the professional engineering program as offered by the School of Continuing Studies at the University of Toronto. My awards include the Year's Best Online Learning Experience Award, the Departmental Teaching Award, and the Gordon R. Slemon Award in 2021, 2018, and 2015 respectively.

This dossier, for the convenience, is structured to separate the duties carried out as an Assistant Professor in the Teaching Stream and as a Sessional Instructor. Section 3 of this document provides my teaching approach and philosophy. Section 4 presents the teaching experience and the courses taught until September 2021. A summary of students' evaluations follows in Section 5. The innovations and related activities to improve courses such as new labs, modified labs, and new courses are included in Section 6. Section 7 presents the research conducted in the area of engineering education. Section 8 explains any mentorships that I have done. My contributions to the department, colleagues, and other courses is explained in Section 9. My activities regarding professional development are presented in Section 10. Finally, appendices provide samples of supporting documents.

3. TEACHING APPROACH

I. Prologue

My teaching approach arises from my own experience as a student at the Department of the Electrical & Computer Engineering at the University of Toronto. During my undergraduate studies and at the start of many of my courses, I was often puzzled by the goal and objectives of the course. I did not know why we were studying a certain topic and what the course intended to achieve. My performance was severely impacted as connection between topics studied and the final goal of the course was missing. This made me to perform poorly in the midterm tests as the course did not make any sense. However, as the course approached the end, I could connect the dots and the rationale behind studying certain topics became evident. Consequently, I did very well by the end of the course. For instance, in my fourth year of undergraduate studies, I took an analog filters course. My performance for both midterms was at the bottom of the class. Failure was on the horizon. However, as the final exam approached, I did figure out what the course was all about and became so good that, for instance, I wrote a complicated transfer function for an 8^{th} order Chebyshev filter in one line. This made the teaching assistant (TA) to give me a zero for one of the quizzes as no steps were provided. The TA, upon my request, asked me to go to the blackboard and solve problems in his presence. I clearly demonstrated my approach in solving problems in one step. The TA assigned me full mark and warned me of losing marks if not showing partial steps in the solution.

My personal experience as a student led me, as an instructor, to structure my own courses by determining the goal of the course and then breaking it into smaller modules and finally dividing each module into manageable topics that could fit into one or two lectures. Hence throughout the course, I repeatedly explain and remind students of:

a. The final goal of the course in relation to other courses, and its significance in the students' future career options as an engineer. Further, the rationale behind studying the course is stressed.
b. The objectives and milestones of each module of the course and how they, as a whole, relate to achieving the final goal of the course.
c. The goal from each lecture at the beginning and at the end of each lecture, i.e. each lecture needs to be a stand-alone unit while making a connection to the overarching goal of the course.

I try not to follow the same style, methodologies, or approach in my teaching for every course. The endeavor is to maintain flexibility in teaching style to match the course type, content, level of difficulty, classroom environment, and more importantly student needs. It is clear that not all courses are of the same nature; some include more mathematical and/or physical concepts and some do not. The former requires a slower pace in teaching to demonstrate step-by-step derivations and to allow students to catch up. This category is better suited for a chalkboard. Students may find the latter type of course boring if the same chalkboard approach is pursued. In such cases, one can employ tools like laptops, or tablets accompanied with software programs that facilitate and speed up delivery of the course. Classrooms are not all the same; some have great blackboards, great A/V equipment, and offer a more square-shape footprint that allows better interaction with students. My attempt is to keep my teaching style versatile to adapt to the course requirements and environment. This approach can contribute to a better student experience. For instance,

a) ECE361 (Computer Networks) includes concepts that can be better taught with a much faster pace with numerous diagrams. This type of subject is more suited to be taught using PowerPoint slides and animations,

b) ECE314 (Fundamental of Electrical Energy System) discusses more of physical phenomenon enriched with mathematical concepts. I teach this course with a slower pace and employ a chalkboard, and

c) APS105 (Computer Fundamentals) teaches the notion of programming and what a software program entails using the C language. APS105 is offered to the first year students and is considered as the first programming course that students take. Over the time, I adjusted my teaching style so that for the first 5-10 minutes to explain the idea behind the lecture on chalkboards. Students are more able to concentrate during the first few minutes of the lecture. During this time, I explain the entire idea of the lecture without entangling with details, or complex examples. Then using a tablet and Microsoft OneNote software, I write all the details and provide examples for students.

My teaching career, as a sessional instructor, allowed me to teach a variety of courses. With each position, I examined, in multiple classroom environments, the effectiveness of my teaching and gained valuable insights in the total progression of student learning. I had to learn quickly and on my own and, in the process, developed the following three fundamental questions that consumed me after each lecture:

- Why did students lose interest in the lecture?
- What part of the lecture did not have clarity and why?
- What could I do to resolve the problem(s)?

Finally, teaching, to me, resembles a boxing match. The match is lost if I drop my guard, forget to prepare, or underestimate the task at hand.

II. Statement of Teaching Philosophy

I ask myself, when commencing to prepare for a course, "How deep is my own knowledge and understanding of the subject matter?", and "Can I describe the concept in a few words?". I put my best effort forth to learn the state of the art and refresh my understanding of topics. I do not limit to reading scientific articles or textbooks but also to discuss key concepts and emerging research with my colleagues. I implement all the labs on my own and attend TAs' lab training. This becomes useful in connecting the lecture materials to the labs. For instance, in teaching ECE243 (Computer Organization) I did implement all the labs and most of the assembly code examples presented in the lectures on an FPGA platform to gain a better understanding and ensure the correctness of the examples.

One good source of information is the notes from previous instructors. Another source is comments or notes from students who have taken the course. I check the notes and speak to former students to include their feedback. I often check students' notes from my own class. This allows to identify any potential miscommunication. For instance, in one occasion, one student could not understand my shorthand writing for "+ve" representing the word "positive" and instead wrote down "the" which was wrong and made no sense within the context. I stopped writing shorthand forms and made an effort to ensure a clear communication.

My emphasis is on guiding students to learn on their own and become more independent as individuals. At the same time, students need to become active learners, work as a team, and develop a sense of interdependence. For example, students sometimes ask questions during the exam that may exhibit their lack of self-confidence in decision-making and not lack of knowledge. Student, while pointing to a completely correct solution, may ask, "Sir is this correct?". In order to strengthen students' confidence and sense of independence/interdependence throughout the

lectures, I often solve an example right after discussing a new concept. Then asking students to close their notes and solve a new problem or repeat the same problem just discussed. Typically students are asked ***a)*** to work individually for 3 minutes then, ***b)*** check their notes for 2 minutes, and finally ***c)*** work in a group with other students around them for 3 minutes to solve a given problem. This ***a)*** forces students to focus and learn course material gradually while in lecture, ***b)*** provides students with an environment to solve problems by themselves, hence, develop a sense of independence and confidence, and ***c)*** allows students to build a sense of interdependence and actively participate in teaching each other. More importantly, students realize the value of teamwork in engineering. I have been applying this method in almost all my courses. The followings comments provide the student's feedback with regards to in-lecture active participation.

- "Lectures were extremely useful. Concepts were taught clearly and questions were always answered. Learning of the concepts was greatly reinforced through the use of examples and participation during lecture. "
- "Very good. Professor makes a good attempt to involve students in the lecture through active learning."

We all had to experience the COVID-19 pandemic and experience the switch to online-teaching. My teaching philosophy for online-teaching remained the same as in-person. However, the online environment imposes challenges for both students and instructors. With the lack of physical contact comes a greater challenge of keeping students focused. This is a natural consequence of both students and instructors being in a more relaxed environment. Not having access to multiple blackboards that would allow writing the entire lecture material or an example on several blackboards and then moving back and forth to relate the details is another challenge. I tried to address this by drawing lines that would allow students to relate my talk to the material written

down on my tablet using OneNote software. For instance, I drew a line between a programming instruction within an example that would declare a pointer and then relating it to a block diagram showing a computer memory by drawing a line. I did this in an interactive way by drawing and then erasing. This changed the material written on the computer screen from being still to more of a motion picture that was accompanied by my explanations. In turn, students had to focus and stay tuned with the lecture as if they were watching a movie. This approach turned to be effective as reflected in a sample of the students' course feedback provided below.

- "Hamid has been an extremely helpful prof, he always finds good analogies to help better explain new concepts. The way he draws out and traces each piece of code has been really helpful to my understanding as well. As a new programmer, this course has been amazing and I couldn't have hoped for anything better."

4. TEACHING EXPERIENCE

I. Courses Taught:

This section provides a summary of the courses taught.

a. The Edward S. Rogers Sr. Department of Electrical & Computer Engineering, University of Toronto

i. Table 1 summarizes the courses taught at the Faculty of Applied Science & Engineering of the University of Toronto after my appointment as an Assistant Professor in July 2016.

Table 1: A summary of courses taught at the University of Toronto after my appointment. The Table shows the type of course and the total number sessions that a course was taught.

Course		Years	Times taught (#)
Code	**Name**		
APS105F/S	Computer Fundamentals	2018-2021	5
ECE159S	Electric Circuit Fundamentals	2019	1
ECE243S	Computer Organization	2017-2019	3
ECE314F	Fundamental of Electrical Energy Systems	2016-2019	4
ECE361F/S	Computer Networking	2016-2021	8
ECE496Y1	Design Project	2016-2021	5
	Total		**26**

ii. Table 2 summarizes the courses taught at the Faculty of Applied Science & Engineering of the University of Toronto as a Sessional Instructor.

Table 2: A summary of courses taught at the University of Toronto prior to my appointment. The Table shows the type of course and the total number sessions that a course was taught.

Course		**Years**	**Times taught (#)**
Code	**Name**		
ECE532S	Computer Systems	2013	1
ECE533F	Advanced Power Electronics	2002-2005	Few lectures
AER525S	Robotics	2014	1
ECE410F	Control Systems	2011-2014	3
ECE461F	Internetworking	2015	1
ESC472S	Electrical and Computer Capstone Design	2012-2015	4
ECE496H	Design Project	2006-2020	13
ECE342S	Computer Hardware	2014-2015	2
ECE361F/S	Computer Networking	2016-2019	7
MIE346S	Analog and Digital Elecronics for Mechatronics	2010	1
MIE301S	Kinematics and Dynamics of Machines	2013-2014	2
CSC372F	Microprocessor Software	2014	1
ECE315S	Switch-Mode Energy Conversion	2002-2005	Few lectures
ECE216S	Signals and Systems	2012	1
ECE221S	Electric and Magnetic Circuits	2015	1
ECE243S	Computer Organization	2007-2016	4
ECE244F	Programming Fundamentals	2013-2015	3
ECE298F	Communication and Design I	2007	1
MAT290F	Advanced Engineering Mathematics	2008-2009	2
MAT298F	Linear Algebra and Differential Equations	2007	1
CSC258H	Computer Organization	2001-2005	5
ECE253S	Digital and Computer Systems	2013-2015	3
APS105F/S	Computer Fundamentals	2014-2016	2
ECE110S	Electrical Fundamental	2011-2013	4
MAT196F	Calculus A	2013	1
MAT186F	Calculus I	2014	1
CHE113S	Concepts in Chemical Engineering	2010-2013	4
APS11F	Engineering Strategies & Practice I	2009-2011	2
APS112S	Engineering Strategies & Practice II	2006-2013	5
	Total		**76**

iii. Tables 3 and 4 present summaries of ECE496 (Design Project) as an Assistant Professor and a Sessional Instructor respectively. ECE496 is a one-year capstone design project that provides an environment for the fourth year ECE students to work on their thesis projects. I have been part of ECE496 since 2006 as both an administrator and supervisor, serving for more than sixteen sessions. In the following tables, the column called C*ertificate of Distinction* indicates the number of projects that were among top projects in that year. Also the column called *Awards* shows the number of projects that received award.

Table 3: Provides a summary of activities in ECE496 as an assistant Professor.

Academic Year	***Role***	***Teams (#)***	***Students (#)***	***Certificate of Distinction (#)***	***Awards***
2020 - 2021	***Supervisor***	*3*	*12*	*2*	*One team received The Administrators' Award*
2019 - 2020		*4*	*12*	*1*	*One team received CNIB award* (Hochhausen Prize)
2018-2019		*5*	*14*	*1*	
2017-2018		*4*	*13*	*2*	
2016-2017		*3*	*10*	*2*	*One team received CNIB award* (Hochhausen Prize)
	Total	**19**	**61**	**8**	
2020-2021	***Administrator***	**11**	**40**	**4**	
2019-2020		**11**	**35**	**1**	
2017-2018		**8**	**27**	**2**	
	Total	**30**	**102**	**7**	

Table 4: Provides a summary of activities in ECE496 as a Sessional Instructor.

Academic Year	***Role***	***Teams (#)***	***Students (#)***	***Certificate of Distinction (#)***
2011-2012	***Supervisor***	*3*	*11*	*0*
2010-2011		*2*	*7*	*1*
2009-2010		*3*	*11*	*1*
	Total	**8**	**29**	**2**
2015-2016	***Administrator***	*11*	*34*	*1*
2014-2015		*12*	*37*	*2*
2013-2014		*12*	*36*	*0*
2012-2013		*13*	*37*	*1*
2011-2012		*13*	*35*	*1*
2010-2011		*13*	*38*	*0*
2009-2010		*15*	*47*	*2*
2008-2009		*26*	*64*	*1*
2007-2008		*14*	*38*	*0*
2006-2007		*14*	*37*	*0*
	Total	**143**	**403**	**8**

iv. Engineering Strategies and Practice (APS112) course offers students with a systematic approach to engineering design. APS112 encourages students to apply design methodologies to practical projects. The course is in continuous need of practical projects with actual clients. Table 5 summarizes the projects that I provided for APS112. My responsibilities were to be available to meet students, read documents, attend students' presentations, and provide guidance and clarification on the projects.

Table 5: Provides a summary of projects provided for APS112.

Year	**Projects (#)**	**Teams (#)**	**Students (#)**	**Titles**
2020	2	2	6	Hybrid Gate
			6	The West Wall
2019	1	1	6	A Green Townhouse
2018	3	3	6	Design of an Entrance Gate for a Community Complex
			6	Design of a heating and cooling system for a townhouse
			6	The interior design of a 3-storey townhouse.
2011	3	3	7	Re-design of the Energy Systems Lab located at the ECE Department of the University of Toronto.
			7	Design of a practical Heavy/Punching Bag Stand.
			7	Crutch Holders.
Total	**9**	**9**	**57**	

b. Department of Computer Science at Ryerson University

Table 6 summarizes courses taught at the Computer Science Department at Ryerson University, prior to my appointment in the Teaching Stream at the University of Toronto.

Table 6: A summary of courses that I taught at Ryerson University prior to my appointment.

Course		**Years**	**Times taught (#)**
Code	**Name**		
CPS607	Autonomous Mobile Robotics	2011-2015	5
CPS310	Computer Organization II	2011-2016	6
CPS213	Computer Organization I	2011-2015	3
CPS125	Digital Computation and Programming	2006-2013	6
CPS118	Introductory Programming for Scientists	2007-2013	4
Total			**24**

5. STUDENTS' EVALUATIONS

This section summaries available students' evaluations.

i. Table 7 presents evaluations for the courses taught as an Assistant Professor. The responses for a select sample of questions are considered as follows.

Q15: *What is your overall rating of the instructor as a teacher?*
Q3: *The instructor created a course atmosphere that was conducive to my learning.*
ICM: *Institutional Composite Mean*

Table 7 is based on a 5-Point Scale assessment where:

1 - Not At All, 2 – Somewhat, 3 – Moderately, 4 – Mostly, 5 - A Great Deal.

Table 7: Evaluation results as an Assistant Professor based on a 5-Point Scale.

Course	Year	Calss Size	Q15	Q3	ICM	Coordinator?
ECE314	2019	44	4.6	4.8	4.5	Yes
	2018	59	4.5	4.6	4.3	Yes
	2017	62	4.8	4.8	4.5	Yes
	2016	96	4	4	3.8	Yes
ECE361F/S	2021	135	4.2	4.3	4.2	Yes
	2020	127	4.3	4.5	4.1	Yes
	2019	78	3.6	3.6	3.1	No
	2019	106	4	4.1	4	Yes
	2018	80	4	4.2	4	Yes
	2017	110	3.8	4	3.9	Yes
	2017	92	4	4	3.9	Yes
	2017	79	4	4.1	4	Yes
ECE243S	2019	107	3.9	4	4.1	No
	2018	109	4.6	4.6	4.2	No
	2017	117	4.3	4.5	4.3	No
APS105F/S	2021	119	4.2	4.4	3.9	No
	2020	108	3.8	4	4	Yes
	2019	24	4.8	4.9	4.7	Yes
	2018	95	4.6	4.7	4.4	No
ECE159S	2019	120	4.5	4.5	4.1	No
Average		93	4.23	4.33	4.10	
Max		135	4.80	4.90	4.70	
Min		24	3.60	3.60	3.10	

* The coordinator and I presented the course in a format that proved to be not very effective.

ii. This section represents the evaluation results as a Sessional Instructor.

Table 8 is based on a 5-Point Scale assessment where:

1 - Not At All, 2 – Somewhat, 3 – Moderately, 4 – Mostly, 5 - A Great Deal.

In addition, it shows the responses to the following three selected questions:

Q15: *What is your overall rating of the instructor as a teacher?*

Q3: *The instructor created a course atmosphere that was conducive to my learning.*

ICM: *Institutional Composite Mean*

Table 8: Evaluation results as a Sessional Instructor based on a 5-Point Scale.

Course	Year	Class Size	Q15	Q3	ICM	Coordinator?
AER525	2014	15	4.6	4.6	4.4	Yes
ECE461F	2015	95	3.8	4	3.8	Yes
ESC472S	2014	30	4	4.2	3.9	Yes
ECE410H1	2014	13	4	4.4	4.1	Yes
	2013	32	4.9	5	4.6	Yes
ECE342S	2015	76	4.1	4.3	3.9	No
	2014	79	3.9	4.3	4	No
CSC372F	2014	50	N/A	4.1	3.9	Yes
MIE301H1	2014	18	4.6	4.8	4.4	Yes
ECE221S	2015	111	4.3	4.4	4.2	No
ECE243S	2016	119	3.9	3.9	3.9	No
		118	3.9	4	4.3	No
	2015	119	4.3	4.3	4.2	No
	2014	95	4	4.1	3.9	No
	2012	98	4	4	4.3	No
ECE244F	2015	124	4.3	4.5	4.1	No
		122	4.3	4.4	4	No
	2013	96	4.1	4.3	4	No
ECE253H1	2014	17	4.7	4.6	4.1	Yes
APS105F	2014	80	4.7	4.7	4.4	No
MAT196F	2013	105	4.4	4.4	4.1	No
MAT186F	2014	104	4.3	4.5	4.1	No
ECE110H1	2016	77	4.1	4.1	3.8	No
	2015	57	4.6	4.5	4.1	Yes
Average		77	4.25	4.35	4.10	
Max		124	4.90	5.00	4.60	
Min		13	3.80	3.90	3.80	

Table 9, on the other hand, provides the evaluation results as a Sessional Instructor based on a 7-Point Scale where:

1 is "Inadequate" and 7 is "Outstanding".

Note: Evaluation results are presented based on question number 16 as indicated below.

"What is your overall rating of the instructor as a teacher?"

Table 9: Evaluation results as a Sessional Instructor based on a 7-Point Scale.

Course	Evaluation	Year
ECE532	5.23	2013
ECE410	6.77	2012
MIE346	6.16	2010
MAT298	5.66	2007
MAT290	6.25	2008
	6.11	2009
CSC258	6.5	2005
	6.1	2004
ECE253	6.52	2013
ECE243	5.89	2007
ECE216	6.41	2012
CHE113	6.04	2011
	5.8	2010
APS112	5.68	2006
ECE110	6.53	2012
	6.21	
	6.69	2011
Average	**6.15**	
Max	**6.77**	
Min	**5.23**	

6. TEACHING INNOVATIONS AND RELATED SCHOLARSHIPS

This section describes the teaching ideas implemented and their outcomes as well as other works carried out to introduce or improve the laboratories and experiments.

I. Teaching Activities

a. Reversi Project: 2021

APS105 (Programming Fundamental) includes a project that runs within 3 weeks of the labs. It is called "*reversi*". Teaching staff in APS105 has always been the advocators of *reversi* as it provides a project for students in the format of a game. I worked on this project along with Mr. Afshin Poraria and two TAs to revamp the *reversi's* infrastructure and code. The *reversi* is one of the most challenging project-lab for students in the winter semester. The old version of the game did not allow students to start the project early on to familiarize themselves with the game and the rules. It did not allow students to compete with each other, at their will, in order to verify or improve their implementations. The code that managed the competition was only available in the form of an executable file and hence, the instructors could not modify or update this code. The new implementation provides the possibility of any future enhancements and modifications.

Important changes include:

- Completely rewriting the "match" module, the core of the competition. There was no source code available previously.
- The competition and ranking of students on the leaderboard are now based on the "Elo rating system", a widely used method in chess competitions.

- An interactive *reversi* site has been created, which students can access at any time, play the game, and even test their code against the benchmarks, or even play against each other. This encourages students and increase the enthusiasm levels amongst them.
- A solution library is built for the first part of the project, with the idea that even if the student fails to come up with his/her own solution for this stage, he/she still can continue by using this solution library.
- An independent website and file system under ECE servers is created. The site is conveniently accessible to the course teaching staff.
- A secure and confidential PIN assignment system is created and used during the competition. This PIN is assigned automatically via Quercus. Students can use this PIN to determine their current ranking while maintaining anonymity, hence, there is no need for publishing names or student numbers.
- The newly created website can hold the ranking of the current year's top scorers but also can keep track of previous years' top ranked players. This was done to imitate the old Arcade machines, in an effort to keep former students connected to the ECE department.
- This site also facilitates the process for directing students to a known location for various handouts and files required for the course.
- Updating various supporting scripts and readme documents.
- Creating a permanent home for APS105 web access.
- A new Virtual Machine is also created based on the most resent Ubuntu, which includes gcc, g++, and both codeLite and VSCode. This is ongoing work that needs to be fully tested.

Links:

The APS105 Reversi Interactive Platform: http://142.150.239.187:8090/

APS105 Leaderboard: http://142.150.239.187:8090/leaderboard

Impacts:

The impact of the work is:

1. Increase in the students' level of engagement.
2. Decreased time consumed for teaching staff in managing the *reversi* project for any modifications.
3. Possibility of expanding the platform to support similar student projects, even for other courses offered in the department.

b. ***Revamping Capstone Design Project:*** 2020-2021

ECE496 - Design Capstone

Coordinated ECE496 for 2020-2021 academic year. The following summarizes the changes implemented in order to improve the quality and hence learning experience of students. The course is a two-semester course and has been significantly restructured for 2020-2021. During the past few years, it has become evident to the teaching ECE496 staff that the course did not provide adequate guidance or a structure allowing students to kick-off their project in terms of implementation in the fall semester. In fact, students spent their fall semester almost entirely on project proposal realization. It could be also observed from the oral presentations, mid-February, that students were still struggling with the project proposal and had not made a significant progress in their implementations. Another shortcoming was the disconnect among project supervisor,

administrator, and students in terms of the scope of the project. This caused confusions for students about the project's expectations or requirements.

There existed several course websites that made it difficult to track or maintain these sites for both students and the teaching staff. Further, the online nature imposed by the pandemic had to be addressed and accommodated. The pandemic could cause PEY cancellations increasing the enrollment in ECE496 that had to be accounted for as well. The work started during the first week of April 2020 and changes were implemented. These changes were decided and finalized after consultations with the following teaching staff of ECE496.

- Professor Phang, coordinator for 2019-2020, who has ample knowledge of the ECE496 setup and its multiple websites as well as understanding of ECE496 regulatory requirements.
- ECE496 Administrators who provided feedback during many hours spent to discuss the changes.

Summary of changes implemented:

- Introduced a proposal meeting in September among supervisor, administrator, and students. The purpose is to allow an early discussion among stakeholders to clearly define the expectations and scope of the project. As a result, misunderstandings about the project specifications were resolved at the early stages.
- Introduced an Interim Demonstration during the first week of December where supervisor, administrator, and students had to attend. The purpose of this demo was to encourage students to start the implementation phase as early as possible. The outcome of the Interim Demonstration was that almost all the projects had some parts of the project working during the fall semester. This was a significant achievement as often when students establish a

good understanding of the project specifications followed by a partial implementation then they can become independent and continue on the remaining of the project with minimal supervision.

- Deferred the Implementation Plan document delivery from September to late November. The purpose was to give students adequate time to consider different implementations strategies and determine the best suited approach then follow with the documentation.
- Design Fair where the projects and their outcomes were presented to the ECE community was restructured to allow online demonstrations. This posed a few challenges in terms of students' accommodation to upload video files as well as students' consents for public viewing. A few teams expressed discomfort with being viewed or heard by people other than their administrator but, at the same time, requested to be included for awards or better projects. This group of students had also to be accommodated, hence:
    a) We supplied students with guidelines and instructions on how to use their MyMedia accounts.
    b) We Launched a MyMedia account for ECE496 in order to store all the students' video files for any future use.
- Combined and migrated multiple course websites and resources into Quercus and kept the Internal ece496 website as this site is currently the most convenient platform for management of the marks and submission of the documents.
- Provided timetables comprising of the course deliverables, submissions' due-dates, feedback/marks' due-dates, purpose of each deliverable for supervisors, administrators, and students at the start of the course.
- Updated/Modified all the guidelines and documents for the course.

- Launched Piazza discussion board as a trial in the course for the first time. Piazza allowed students to share questions and ideas with each other and the course coordinator. Further questions and responses could be viewed and shared by all students thus adding to their learning.

Future work:

The current internal ece496 website provides many good features that are custom designed for ECE496. Further improvements can be made as follows:

- Merge ece496 internal website with Quercus so as to bring all the resources for ECE496 under one common umbrella.
- Merge the project listing website which is different from the ece496 internal website into Quercus.
- Improve internal ece496 website to allow all kinds of file formatting for uploads to the site. The current website only allows pdf files to be uploaded.
- Reflect students' questions, comments, and/or feedback gathered in Piazza on the course guidelines and documents.

c. An Ancillary Simulation Environment: 2018-2020

Simulation software is one of the requirements in some courses that can greatly enhance understanding of the course material. One particular area is modern switch-mode power conversion as taught in ECE314 (Fundamental of Electrical Energy Systems). Students are initially introduced to fundamental concepts of the switch-mode converters in the lectures. They then put these concepts into practice in the hands-on labs, which are limited to three-hour-long experiments conducted in a strictly controlled environment due to safety concerns especially in working with

high voltages and currents. This leaves little room for exploration and independent trial-and-error. Therefore, an out-of-the-box functional software design of the switch-mode converters studied in lectures (*LabSim*) was implemented. *LabSim* reduces the time required by students to master and simulate switch-mode converters.

A pilot run of *LabSim* was conducted over the course of one semester, with students being provided the models in parallel with the relevant lecture and lab material. *LabSim* presents an implementation that aims to address the shortcomings within our introductory power electronics course. *LabSim* received a positive reception and the feedback from students demonstrated the software's impact in improving students' understanding of the course material.

LabSim was initially introduced as a Work In Progress (WIP). The pedagogical approach was to offer *LabSim* as a completely voluntary ancillary tool with the idea of not increasing the course load. Students' survey showed that *LabSim* accomplished its main goal of bridging the gap between lectures and labs. One common theme in the provided feedback was that students would benefit more if *LabSim* were incorporated more directly into their assignments. The pedagogical approach was updated in the fall 2019 offering of the course to involve ***a)*** developing simulation-centred questions in pre-lab preparation assignments, ***b)*** dedicating office hours for simulation-related questions, ***c)*** developing additional simulators for crucial converter circuits as discussed in lectures, and ***d)*** providing dedicated simulation workstations on campus for students' usage. Surveys were conducted to determine the educational, technical, and workload impacts on students. The results revealed that the new pedagogical approach significantly improved students' receptions across all assessment categories as opposed to the initial implementation. The most common suggestion in student feedback, however, is that they would benefit from an even larger *LabSim* presence in their course material. In particular, *LabSim* can be used as a demonstration

tool in lectures and can be incorporated in mandatory simulation-based problems in their assignments. The improved survey results suggest that *LabSim* is currently moving in the right direction. Further, *LabSim* was also used by ECE349 (Energy Conversion) during winter 2019 semester. The following summary represents two of the students' responses. Appendix C provides more responses.

- "I would suggest to include *LabSim* in the prelab or may be even as a bonus question on prelab, this will ensure students will actually do the simulations and have a CLEAR understanding of what will be expected in the lab. e.g students can draw waveforms on prelab for marks. Having this experience working with Simulink will be beneficial for the students in the long term when they apply for jobs etc. most jobs require the use of CAD tools and simulation software"
- "Make the prelab simulations mandatory. "

Publications:

- M. Elshazly, and H.S. Timorabadi, "Work in Progress: LabSim: An Ancillary Simulation Environment for Teaching Power Electronics Fundamentals", Proceedings of the American Society for Engineering Education (ASEE), Tampa Convention Center, Tampa, Florida, June 15 - 19, 2019.
- M. Elshazly, and H.S. Timorabadi, "WIP: Exploring Pedagogical Alternatives for Incorporating Simulations in an Introductory Power Electronics Course", Proceedings of the American Society for Engineering Education (ASEE) – ASEE's Virtual Conference, June 22 - 26, 2020.

d. Reduced Complexity Processor 2017-2018

A single-cycle processor has been used in teaching computer functionalities in the Computer Organization course (ECE243) for over a decade. The design of this processor was limited to only

paper and pencil. There was no implementation of the single-cycle processor available. An implementation of this processor was considered. The implementation allows students to further investigate the functionalities and architecture of a single-cycle processor and hence develop a better realization of the course material. The implementation provides an open-source of the Verilog coding as well as an open-source C program for the compiler to be used by students for any modifications or extension to processor functionalities.

Publication:

- H.S. Timorabadi, "Reduced Complexity Processor for Teaching Computer Architecture", Proceedings of the Canadian Engineering Education Association (CEEA) Conference, University of British Columbia, Vancouver, British Columbia, June 3-6, 2018.

II. New Labs

a. New Measurement Lab 2018

It was found, based on students' and teaching assistants' feedback as well as discussions with the lab manager that students can benefit from a measurement lab in ECE314 (Fundamental of Electrical Energy System). The purpose for introducing this lab is to teach the proper usage of equipment and components. The importance and effects of this lab are multifold, as this lab:

a. Allows students to refresh their knowledge of any equipment they learned previously such as an oscilloscope.
b. Teaches the proper usage of any new equipment such as a spectrum analyzer.
c. Introduces new power components to students such as a Voltage Source Inverter (VSI).

Lab Manager: Jack Goldstein *Email: jack.goldstein@utoronto.ca*

III. Modified Labs

a. Computer Networks (ECE361) Labs 2017

The initial labs used during the setting of 2016 were based on the labs provided by the textbook author. These labs employed Java as the programming language. The labs were tedious and did not reflect the course format and needed to be revamped. Students did not have any knowledge of Java which was the programming language of choice. In addition, finding Teaching Assistants who knew Java and had at the same time knowledge of computer networks was very difficult. The labs were changed and modified to fit the course format.

Labs were altered into two large projects that each encapsulates a more realistic computer network scenario. For instance, the File Transfer lab (Appendix A, Part b) allows students to capture the overall functionality of how a file is sent and received on the Internet. Each of the projects is then divided into sections. In each lab students implement a few sections and gradually learn and build the entire project.

Further, the C language was chosen for coding the labs as students learn C during their first year of studies and this provides a good application of C language. There is also an abundance of TAs who are proficient in the C programming language. Therefore, with this change, the course could concentrate on the teaching/learning of the computer networks concepts and not focus on the learning of Java, a non-essential component of the course topic.

b. Fundamental of Electrical Energy Systems (ECE314) Labs 2016

The Energy Systems Laboratory has undergone significant renewal and changes. In addition, the labs in ECE314 included many typos. Many unnecessary redundancies existed that did not add to

the students' learning experience and made the three-hour lab sessions even longer and at times confusing. As a remedy, the following steps were taken:

- Modified the existing labs while keeping in view the intended goals of the labs to address the typos, and/or redundancies.
- Supplied a report template so as to provide a framework for students in writing reports with the intention of reducing the already excessive student workload.

c. Computer Fundamentals (APS105) Labs 2014-2019

Every semester, new labs are designed in APS105 based on the previous labs' framework. The following labs were designed or introduced for APS105, over the course of three semesters:

a. All the labs for spring 2019 were designed.
b. Three new labs for winter 2018 were revised.
c. Three new labs for fall 2014 were revamped.

IV. Lab Safety

a. Lab Safety Manual for Fundamentals of Electrical Energy Systems (ECE314) 2016

The electrical safety where students work with high voltages/currents is of paramount importance. I became concerned about the electrical safety when initially assigned to teach the Fundamental of Electrical Energy Systems (ECE314) in the summer of 2016. As such and in planning for the course, I discussed safety protocols with the lab manager who also had concerns. Then based on the lab manager's previous work, and inputs from other faculty members, and teaching assistants, a document was assembled. After revisions, this document is being used in ECE314 for all courses using labs in the Energy Systems group. Students are required to study this safety document and

answer a multiple-choice questionnaire prior to the first lab. TAs are also instructed to ask questions from students during the first lab to test students' understanding of the safety related hazards.

Lab Manager: Afshin Poraria *Email:* afshin.poraria@utoronto.ca

V. Lab Training 2019

In all the courses with a lab component that I teach, I have scheduled lab-training sessions for Teaching Assistants (TAs). A senior TA is in charge of lab-training sessions. I attend the sessions and alongside, TAs do the experiment. My understanding is that TAs become more serious when the instructor is present. Starting in the fall of 2019, I have also arranged for TAs to answer a few short questions at the end of each lab-training session to verify their readiness to conduct the labs. In particular, I have assigned a three-hour lab training for each experiment in ECE314 (Fundamental of Electrical Energy System). In these training sessions, TAs are required to go through each experiment and implement them step-by-step. The lab training in ECE314 is of paramount importance due to safety concerns for both TAs and students who are exposed to high voltages and currents. I have already set a requirement for all the TAs to take the safety course and read the safety document. TAs are required to answer a multiple-choice questionnaire to ensure their safety preparedness. TAs are also evaluated at the end of each training session to verify their readiness and understanding of the lab experiment. I also attend both the training sessions and the actual lab sessions to closely monitor them.

VI. Course Guest Speakers/Field Trips

Guest speakers can contribute to the educational experience of students. They can better relate our work at the university to the practices at the industry. Hence, students can develop a higher appreciation for concepts covered in the course when they actually find the application of these concepts in industry and everyday life. As a coordinator of ECE361, I have arranged for a guest speaker from industry to speak with students since my appointment. ECE361 is a fundamental course in the area of computer networks and only offers programming labs. Hence, a guest speaker could provide a different perspective and link textbook materials to the state-of-art practices in industry and instill enthusiasm in students.

Guest Speaker Name: Dr. Ali Tizghadam *Email:* ali.tizghadam@gmail.com

Field trips can give students the chance to experience and discuss the material learned in class, particularly, in courses like ECE314 (Fundamental of Electrical Energy System). In the past, field trips to visit the University of Toronto's Power Plant were arranged for ECE314. Furthermore, recent students' surveys reminded me of the importance of the field trips. There were two field trips arranged for the winter of 2019 setting of ECE314: one to the University of Toronto Power Plant and the other to the GE affiliate in Markham.

The following remarks are from the students' surveys.

- "I think it would be pretty cool to actually go out and see the systems in motion, maybe like a field type sort of thing. After learning about three-phase power, I came home and looked at the transmission lines outside my house and I thought it was so cool that I knew how it worked. This would be a good experience for students in this class to have. "
- "It would be more interesting to see how everything we learn fits into the big picture and how people are using it every day. With all the circuits we work with, we put them to test

in the lab but never actually get to see where it is used in the real world. By seeing this, it would spark interest for students."

VII. Courses Developed

The province of Ontario requires a Professional Engineering (P. Eng.) license for those who want to practice as an engineer. The Licensing International Engineers into the Profession (**LIEP**) is a program designed for internationally educated engineering graduates who seek a P.Eng. License. The School of Continuing Studies at the University of Toronto offers refresher courses for its LIEP program. I designed the following two courses for this program.

SCS 3147-001 (Power Systems and Machines), 2015

This course intends to teach **LIEP** student's theories and principles of power systems and machines, electrical actuators and energy converters, case studies, reviews of past exams, extensive problem-solving exercises, and assignments. As requested by the School of Continuing Studies, the entire set of PowerPoint slides for all the lectures were developed. These slides along with homework assignments, tests, and exams are to be used by the course instructors who will be teaching the course. A sample of slides is provided in Appendix F, Part a.

SCS 3146-001 (Digital Systems and Computers), 2015.

This course intends to teach **LIEP** students the fundamentals of digital systems and computer architecture, case studies, reviews of past exams, and extensive problem-solving exercises. As requested by the School of Continuing Studies, the entire set

of PowerPoint slides for all the lectures were developed. The slides and the homework assignments, tests, and exams are supposed to be used by the course instructors who will be in future teaching the course. These were going to be available for any instructor who would teach the course. Appendix F, Part b shows a sample of slides.

7. RESEARCH ACTIVITIES

I. Scholarship

a. EngageAI: Video Analytics for Online Teaching 2020-2021

One of the difficulties for teaching online is having real-time information about the level of engagement from the audience. *EngageAI* is a system that provides real-time feedback from the viewing audience during online lectures or any other online events. This project started in May 2020 with a group of 4 undergraduate students. *EngageAI* employs video-based machine learning models to detect drowsiness and other emotions like happiness and neutrality and then aggregates them in a dashboard environment such instructor can view during the lecture. This provides real-time feedback and hence an opportunity to adjust the teaching to keep students engaged. An important aspect of *EngageAI* is that no video data or personal information is transmitted outside of the students' web browsers, and individual students remain anonymous to the instructor. This work has been fully accepted for presentation at the American Society for Engineering Education (ASEE).

Impacts of the work:

- *EngageAI* is promising as it provides real-time data to the instructor and allows the instructor to decide how to implement any plausible improvements in the lecture delivery.
- This project also encouraged and provided a platform for undergraduate students to conduct research, publish, and attend a conference.

Publication:

- J. Stairs, M. Chaudhery, R. Mangla, J. Chandhok, and H.S. Timorabadi, "Engage AI: Leveraging video analytics for instructor-class awareness in virtual classroom settings", Proceedings of the American Society For Engineering Education (ASEE), ASEE Annual Conference – Virtual, July 26-29, 2021.

b. Flipping the Script on Project Management in Education 2017

The modern education system predominantly employs a waterfall model: a highly structured linear approach with well-defined deliverables in the implementation of projects throughout university courses. The waterfall model comes at a cost:

I. Students are not provided with an opportunity to play any major role in the management of the projects since deliverables are often predefined;

II. Feedback is ineffective and does not positively impact the learning process since it is typically provided only after project completion; and

III. The short timelines do not provide students with the opportunity to face challenges that get compounded into more complex issues as the project proceeds.

In addition, the waterfall model is not the model primarily employed by industry. Hence, graduating students lack the state of the art as utilized by industry. As a remedy, research was conducted to determine the effectiveness of Agile Development Methodologies (ADM) to university project-oriented courses. One of the outcomes of the application of ADM to a design capstone project provided the project supervisor the opportunity to stay up to date with the project progress in a more detailed granular manner. This, in turn, contributed to the success of the project.

Publication:

- S. Abid, M. Antipin, and H.S. Timorabadi, "Flipping the script on project management practices in education: the outcomes of applying Agile Development Methodologies in a classroom setting", Proceedings of the Canadian Engineering Education Association (CEEA) Conference, University of British Columbia, Vancouver, British Columbia, June 3-6, 2018.

c. Structural Impediments to Learning 2016

The learning process of students depends on many factors including the physical factors in classrooms. An investigation was conducted to determine the effectiveness of the Bahen Centre for Information Technology at the University of Toronto. This building was selected since it was built as a learning environment for university students. The study intended to:

i. Provide an opportunity for the first-year students to put their learning from the design courses such as APS11 and APS112 into practice by addressing a practical problem.

ii. Determine the shortcomings of a learning environment (Bahen Building) from both students' and instructors' perspectives as well as providing recommendations.

iii. Provide recommendations that could be used for future designers so that they can consider and include human factors in their designs.

Publication:

- S. Abid, D. Almond, and H. S. Timorabadi, "Structural impediments to learning: Investigating learning environments inside the Bahen Centre ", Proceedings of the Canadian Engineering Education Association (CEEA) Conference, University of Toronto, June 4-7, 2017.

d. An Effective Teaching Method 2006

This inquiry explores a tandem method for teaching procedural problem-solving concepts to students. The goal was to improve the quality of students' learning by enabling instructors to apply and relate course concepts to solving problems while engaged in the process of solving them.

The study considers how to teach procedural problem solving. An instructor needs to discuss lengthy steps in solving procedural problems for students. The procedure can be followed by solving an application/numerical problem for a better understanding. By this time, students have

already become distant from the steps explained for the procedure and its rationale. It is difficult to show the importance of each step in the procedure while describing it. It is also hard to relate to the procedure, to the example that is being solved. As a result, students become bored and inattentive during the lecture and cannot follow the relation between the procedure and the example. This research explores the effectiveness of an alternative method where the example is introduced side by side, in tandem, with the procedure. The study was conducted prior to my appointment as an Assistant Professor.

Publication:

- H. Shokrollah Timorabadi, "An Effective Teaching Method for Problem Solving in Engineering", Engineering teaching and learning practices (ETLP) St. Lawrence Section conference, The Munk Centre for International Studies, University of Toronto, Toronto, ON, Canada, Oct. 19-20, 2007.

II. Current Teaching Scholarship

a. Experimental Lab Platform for Distant Learning 2017

Laboratory experiments are an integral part of engineering education. Labs are primarily designed to develop proficiency in technical skills, provide an opportunity to place theory in the context of practice, and allow a deeper realization of concepts developed in lectures. The following challenges exist in conducting successful labs.

- *Limited access time to lab location:* Labs are only available for a short, fixed period due to space, scheduling, or resource constraints. This does not allow students to ***(a)*** repeat an experiment and investigate potential questions that arise during the experiment, ***(b)*** to clear up misunderstandings, or ***(c)*** to make up a missed lab. In addition, lab accessibility is limited to working hours which makes costly lab equipment unproductive.

- *Time required to construct an experiment:* Many experiments require a lengthy setup time and time for allowing a TA to verify the circuit or assisting in trouble shooting a problem in the case of a faulty setup.
- *Limited number of topics are explored by labs:* The current labs are limited in scope and cover only major concepts in the course. It would be beneficial to conduct more labs addressing more of the important theoretical concepts in the course.
- *Restrictions on individual lab conduct:* Labs are often conducted in groups of students due to space and scheduling constraints. Group-work does not promote students to independently conduct experiments and thus prevent the student from leaning independently.
- *Safety concerns:* Labs in engineering often pose a safety concern that prevents a student from conducting an experiment without supervision.

This research is motivated by the aforementioned shortcomings and lead to the design and implementation of a platform called *LABLynx*.

LABLynx outcomes would primarily include:

- *Flexible scheduling:* Allowing students to decide the time and the pace to perform lab experiments.
- *Location independence:* Separating students' geographical locations from the actual lab location.
- *Improved economics:* Sharing labs allows better utilization of facilities without human supervision.

- *Better realization of theoretical concepts:* Allowing experiments to be repeated for clarification purposes and experimenting with concepts that are not part of the assigned labs.
- *Increased efficiency:* Reducing setup time thus allowing students to utilize their time primarily on the actual experiment.
- *Improved safety:* Avoiding direct contact with lab components.

The initial design considers an application to the Computer Networks course (ECE361). *LABLynx* points in the direction of an extensible and open platform that could in future include other engineering courses. It provides a teaching tool that is adaptive to the students' demands. This project has the potential of contributing to engineering education and methodology by which students conduct practical experiments.

LABLynx presents an opportunity for students to experience and on-demand scheduling with an increased opportunity to engage in in-depth independent learning. It is of significant interest to determine the practicality of on-demand learning tools such they can be made applicable to other courses.

Work In Progress:

The work on *LABLynx* is ongoing despite the delays in the lab setup, server purchase/installation, and COVID-19 pandemic. The project is on its way and the plan is to have a working version by fall 2021 for Beta testing in ECE361. The itemized implementation progress is summarized below.

- *Architectural Topology:* The project topology has been decided and the architectural design is completed.
- *Programming:* The design topology has been coded and simulated on a laptop.

- *Primary Testing:* The architectural program developed has been tested and passes the primary test sets developed.
- *Server:* The specifications for a server have been determined and the server has been purchased. In addition, the server configuration is being completed.
    - It should be noted that at this time just the master server has been purchased. This will allow us to further investigate the design and hence the resource requirements. There will be 1-2 slave servers and a file server that will be sized, purchased, and installed during upcoming months.

b. Students' Remote Access 2021

Amid the COVID-19 pandemic, studying and working remotely has become a regular routine for students and professors. The need for a user-friendly remote connection software has dramatically increased since March 2020, and it is anticipated to continue in the future, as the working styles have evolved. The available Virtual Network Computing (VNC) products are relatively complicated and Secure Shell (SSH) connections do not provide any visualization for students. This is rather problematic for those students who have little experience with modern computing. For instance, students in APS105 typically have a difficult time to configure and set up their computers for doing their labs. Thus, with a team of undergraduate students the design and implementation of an application was considered. This app, UG_Remote, is a combination of VNC and SSH connections with both Windows and Mac OS compatibility. UG_Remote facilitates remote access to the university's computing network.

The plan is to have two versions for the UG_Remote, a desktop software version and a web application. Both versions will provide a terminal interface for shell interactions, VNC remote for

graphical interactions, and file transferring between the user and the remote servers. We have already built the desktop version with a client software using the Electron.js framework as the front-end, and a Python server as the backend. This version is being used by students in APS105 in the spring of 2021 and was used by students in APS105 and ECE361 during the winter of 2021. UG_Remote will also be valuable to students after the end of the COVID-19 pandemic. It can assist with limited physical lab spaces and facilitate students' remote access and work.

III. Summer Research Students

This section provides the list of students who were provided with an opportunity to conduct research during their undergraduate studies.

a. May - August 2019

i. One student (3rd year) helped with the development of in lecture demonstration equipment.

Student Name: Roshan Reginold *Email:* roshan.reginold@mail.utoronto.ca

ii. A two-student group (both 1st year) is working on the effectiveness of the Myhal Centre as an educational environment and suggesting any potential improvements.

Studnet Name: Kate Ni *Email:* kate.ni@mail.utoronto.ca

Student Name: Tyler McLeod *Email:* tyler.mcleod@mail.utoronto.ca

b. May - August 2018

i. One student (2nd year) implemented a software package for Agile software development with Scrum that was tested during the 2018-2019 ECE496 (Design Project) course. The effectiveness outcomes are still under investigation.

Student Name: Hao Wang *Email:* ternal.wang@mail.utoronto.ca

8. MENTORSHIP

I. Sessional Instructor Mentorship

I have had the pleasure of knowing Afshin Poraria of the Energy Systems at the University of Toronto and observing his impeccable knowledge and hands-on skills in the Energy Systems Lab. As Afshin works behind the scenes, he is not very visible and not many of our students take advantage of his vast engineering knowledge. I always wondered how to make use of Afshin's knowledge in educating our students. In the 2017-2018 academic year, there was a need for an instructor to teach APS105 (Computer Fundamentals). I recommended Afshin to the Undergraduate Chair upon which Afshin was assigned to teach APS105. Afshin has high sense of responsibility and asked me to provide feedback and some assistance with his teaching APS105. We met and discussed the faculties' policies concerning exams, students, resources, and in general the course. I made my course notes, past exams, and labs available to Afshin in case he needed them. Afshin has been an asset in teaching courses since 2017. He has already taught several sessions of APS105 including the online version of the course. I have been providing him with my counsel, in particular, assisting him in adapting to the online teaching.

Name: Afshin Poraria *Email:* afshin.poraria@utoronto.ca

II. Student Mentorship

I first came to know Saif Abid during the winter of 2014 while teaching APS112 as a Project Manager (PM). Then Saif took ECE110 during the summer of 2014 with me. Following completion of ECE110, Saif along with two other students expressed interest in pursuing some volunteer research for the months of July and August 2014. I mentioned a few of the shortcomings with the Bahen Center for Information Technology. If possible, they could conduct research to

determine the pros and cons of this building as an educational environment. The outcome of the study was an almost complete study that could be published. Nevertheless, we did not publish this work due mainly to a lack of funds. Subsequent to my appointment, I reached out to Saif and we found out that there was still a niche for our old research. We managed to incorporate many new findings and recommendations to better suit the Bahen Center for students' learning. This research was published in 2017.

In the following years, Saif kept in contact with me and sought advice on a variety of matters including course selections, building a career in software, performing better during PEY, and eventually becoming successful in creating a startup company. Furthermore, I acted as Saif's Capstone Design project supervisor. Saif and a group of students executed a project with practical applications. This project was among the top projects in 2017 and won the CNIB Hochhausen Prize for excellence in accessible design in engineering for people who are blind or partially sighted.

Student Name: Saif Abid *Email:* saif282@gmail.com

9. DEPARTMENTAL ACTIVITIES

I was a graduate, post-doctoral fellow, and sessional lecturer and am presently an Assistant Professor at the Edward S. Rogers Sr. Department of Electrical & Computer Engineering. I have a good knowledge of structure, management, resources, teaching and research approaches of the department and the continuous evolution that we experience. During this time, I have observed and worked with various researchers, and lecturers in the department and, am familiar with their visions, and concerns. In fact, because of this experience and knowledge, I am motivated to bring in the best possible teaching techniques to my students and update these based on the most validated research results, and the new social norms and understanding. This, of course, requires contentious learning and change. I made major changes to the labs in ECE314 and participated in developing a safety document in order to keep up with the extensive revitalization in our Energy System Laboratory.

The wide range of subjects that I taught during the past few years provides me with an opportunity to bridge the gap and convey best teaching and interaction methods to different parts of the department. Moreover, it allows me to connect different subjects and provide our students with an overall view/understanding of engineering as a whole.

I know that some of my applied techniques have not been successful, but I believe in learning and that a failure is an opportunity to do better. I endeavor to remain impartial to all comments and feedback from my students, colleagues, or peers. In one survey I asked, "*What are your general suggestions to improve the course?*". Student responded, "*Nothing really other than maybe having a cross section of each type of motor introduced to further visualize the concept but the Prof did an amazing job at selecting the right videos to replace this suggestion and correctly demo each*

motor.". I have already developed a few 3D-prints of electric machines and am developing an In-Lecture demo kit that can be used by any instructor who teaches electric machines.

I have high interest in serving the department at any capacity. When the call for serving in work-load committee came, I took it seriously. I spoke to Teaching Stream faculties and made sure to reflect their views in the meeting. I have recently been asked to be part of Student Staff Committee. This is a great opportunity for me to not only serve the department but find out about students' needs and feedback and address them in my teaching.

I was also actively pursuing the potential of Teaching Stream faculty to serve as part of a Thesis Defense Committee. This appeared to be permitted in other departments and our department was following rules that were made prior to the time lecturers were recognized as Professors. Fortunately, I was appointed as Associate (Restricted) Graduate Faculty member from July 1, 2021 to June 30, 2022. This is really great and allows me to be more involved with the department and our graduate program.

10. PROFESSIONAL DEVELOPMENT

There has been significant research in the area of teaching over the past few years. In particular, many scientific principles and techniques have been developed for teaching engineering students. I realize the importance of these techniques and continuously struggle to acquire them by attending conferences, workshops, and seminars. My belief is that these techniques act as a toolbox available to me that, depending on the situation and if need arises, could be applied and achieve a more effective teaching outcome. This section lists the courses, conferences, workshops, and seminars that I have attended since my hiring.

I. Teaching-Focused Course

a. Teaching in Higher Education (THE500H)

The purpose of the course is to train and educate participants for an academic career by introducing the effective teaching strategies at the university level. Candidates are introduced to teaching practices and take part in different lecture scenarios.

II. Disciplinary Conferences Attended

a. The American Society for Engineering Education (ASEE) 2020 Annual Conference, ASEE's Virtual Conference, June 22 -26, 2020., Florida, June 15 - 19, 2019.

b. The 126th Annual Conference & Exposition, the American Society for Engineering Education (ASEE) 2019 Annual Conference, Tampa Convention Center, Tampa, Florida, June 15 - 19, 2019.

c. CEEA/ACEG 2018 Conference, University of British Columbia, Vancouver, British Columbia, June 3, 2018 - June 6, 2018.

III. Workshops Attended

a. Tri-Campus Probationary & Continuing Status Review Workshop, 10AM Eastern Time, February 23, 2021, Virtual.

b. Promotion Workshop for the Teaching Stream, 3-5PM, May 6, 2020, by Video Conference.

c. The Teaching Stream Promotion Workshop, Presented by UTFA, Faculty Club, 41 Willcocks Street, Toronto, ON, Thursday April 25, 2019.

d. Tenure Workshop on the interim review and the tenure review presented by UTFA, Claude T. Bissell Building, Room 205, 140 St. George, Wednesday, May 15, 2019, 10:00 – Noon.

e. The Teaching Stream Promotion Workshop and Reception, the Faculty Club, 41 Willcocks Street, April 25, 2019, 3-7 p.m.

f. One-day workshops at the Canadian Engineering Education Association (CEEA) Conference, University of British Columbia, Vancouver, British Columbia, June 2, 2018.

g. Strategies for Writing an Effective Teaching & Learning Grant., Provided by Centre for Teaching Support & Innovation, at the University of Toronto, 130 St. George Street, Robarts Library, 4th floor, August 23, 2018.

h. 2-day professional development event CTSI Course Design/Re-Design., Course Design/Redesign Institute, Centre for Teaching Support & Innovation at University of Toronto, Blackburn Room, 4th floor Robarts, Toronto, ON, Wednesday May 23 & Thursday May 24, 2018.

i. UTFA Teaching Stream workshop, Upper Dining Room Faculty Club, 41 Willcocks Street, Toronto, ON, Thursday April 19, 2018.

j. Quantum Machine Learning Symposium, hosted by The Creative Destruction Lab (CDL), Rotman School of Management (Room LL1035), Saint George Street, Toronto, ON, Canada, Monday, 14 May 2018 from 12:15 PM to 4:30 PM (EDT)

k. Teaching for Effective Learning in Engineering Workshop, offered by "Canadian Engineering Education Association" and received certificate on June 03, 2017.

l. The Fundamentals of University Teaching, offered by "Centre for Teaching Support & Innovation" and received certificate on March 22, 2018.

m. UTFA Mid-term Review and Promotion to Continuing Status for the Teaching Stream workshop, Rotman School of Management, Room L1010, 105 St. George Street, Toronto, ON, Friday May 05, 2017.

n. Instructor Summer School: Workshop, Centre for Teaching Support & Innovation, University of Toronto, Toronto, ON, August 17, 2017.

o. Strategies for Writing an Effective Teaching & Learning Grant, S. McCahan, C. Rolheiser, and A. Hyman, Centre for Teaching Support & Innovation, University of Toronto, Toronto, ON, June 09, 2017.

p. UTFA Teaching Stream workshop, Upper Dining Room Faculty Club, 41 Willcocks Street, Toronto, ON, Thursday April 19, 2018.

IV. Seminars Attended

i. University of Toronto's 13th Annual Teaching and Learning Symposium, Desautels Hall, Rotman School of Management, University of Toronto, 95 St. George Street, Toronto, ON M5A 2N4, May 28, 2019, 8:00AM-16:30PM.

ii. The 2019 Learning & Teaching Conference, Ryerson learning and teaching office, George Vari Engineering and Computing Centre, ENG103, Ryerson University, Toronto, ON M5B 2K3, May 16, 2019, 8:30am – 7PM.

iii. The Ryerson Learning and Teaching Conference, hosted by Ryerson University, May 17, 8:15-6:30pm, Engineering building, Gould Street, Toronto, ON.

iv. 13th annual Teaching & Learning Symposium, Learning Spaces + Places, offered by CTSI, the Desautels Hall, the Rotman School of Management, 95 St. George Street, Toronto, ON, May 28, 2019, 8am-4:30pm..

Appendix A: SAMPLES OF LABS DEVELOPED OR MODIFIED

This appendix provides samples of labs that I created or modified after my appointment.

Part a: The following samples are the labs, preparation skeleton, and lab report skeleton developed for ECE314 (Fundamental of Electrical Energy System).

University of Toronto
Department of Electrical and Computer Engineering

Laboratory ECE 314	Experiment: # 1

SAFETY TRAINING, SAFE STARTUP, AND LABSIM INTRODUCTION

Part I – Laboratory Introduction

Purpose of the Experiment:

- To become familiar with the lab safety and emergency procedures of the lab.
- To be become familiar with using the streetcar resistor for safe startup of converter circuits.
- To become familiar with using the power electronics circuit simulator.

Background:

This is the first experiment in the power electronics laboratory. Its purpose is to study and understand the safety aspects of these labs. The safety training will introduce proper handling of instruments and lab setup.

In addition to general safety instructions, this lab also introduces a key component of safe power electronic circuit operation: the streetcar resistor. The streetcar resistor is a variable resistor used to manually start up power electronic circuits in order to avoid damage to their switching components.

Additionally, this lab contains an introductory demonstration of the PLECS software and how it can be used with Simulink to design and test realistic power electronics circuits.

Equipment and Circuits:

Power:

1	30 Ohm variable resistor, 'streetcar resistor'
1	10 A DC-breaker
1	60 W Incandescent Light Bulb

Meters:

1	150 V DC
1	10 A DC

Part II - Preparation

Please read the safety manual carefully and submit the attached safety quiz at the beginning of the lab. Please note that you would be asked questions similar to the quiz during the lab.

Part III – Voltage Divider and Safe Startup

Throughout this course, you will be using the voltage source converter (VSC) in the blue box to conduct various experiment. The blue box contains a large capacitor that can draw large currents when a voltage is applied, risking damage to diodes and switching components. In order to limit this current, we switch on the circuit in a manner that allows the input voltage to *slowly* ramp up to the required input voltage. This is done with the help of the variable "streetcar" resistor shown in Figure 1.

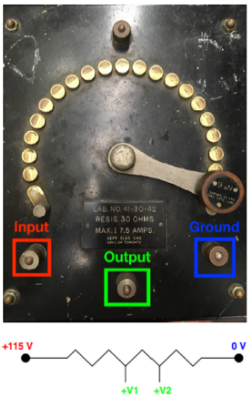


Figure 1: Top view and schematic of the streetcar resistor. The streetcar resistor has 3 terminals: input (red), output (green) and ground (blue). The slider controls the voltage at the output terminal ($0 < V2 < V1 < 115V$).

As shown in Figure 1 the streetcar resistor allows the application of a variable voltage ranging from 0V to the value of the panel's input voltage (in this case 115V). To understand the resistor's operation better, you are asked to connect the simple circuit shown in Figure 2.

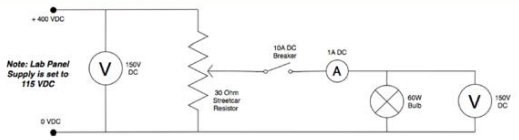


Figure 2: Schematic of the streetcar resistor test circuit

1. Have your circuit checked by a TA. Make sure you have used black wires for every current branch connected to the ground (0 V) terminals and red wires otherwise.
2. Adjust the streetcar resistor's slider until it is closest to the ground terminal.
3. Turn on DC power. Keep in mind that the streetcar resistor is always energized when the power is on, so do not touch any of the exposed contacts.
4. Record and compare the readings between the voltmeters across the resistor and the lightbulb. Are they different? What is the reading on the ammeter? What is the state of the light bulb?
5. Turn off DC power. Adjust the streetcar resistor's slider until it is closes to the input terminal.
6. Turn on DC power. Record and compare the readings between the voltmeters across the resistor and the lightbulb. Are they different? What is the reading on the ammeter? What is the state of the light bulb?
7. While power is on, adjust the streetcar resistor back and forth between minimum and maximum values. What is the relationship between the voltage across the light bulb, the position of the slider, and the input voltage?
8. You are asked to develop a start-up procedure for this circuit such that the light bulb operates at 115V in steady state but is never subjected to an instantaneous change in voltage. How can you accomplish that? Please list the steps.
9. Turn off the power, ensure both voltmeters are reading 0V and no current is flowing through the circuit, disassemble the circuit.

Part III – LabSim Introduction

In addition to the lecture, tutorial, and lab material, you will also have access to a simulator called LabSim. LabSim is a set of simulation files for the common types of switch-mode power converters you will see throughout the course. LabSim is incredibly useful as it helps bridge the gap between theory and experiment. LabSim allows you to design circuits, size components, and test a variety of parameters and control schemes before the prototyping stage, resulting in a faster and more efficient design process. It can also provide valuable insight into the underlying physics of systems that are too difficult to probe experimentally and/or too complex to solve in closed form.

Throughout this course, we will be using the PLECS Simulink blockset to simulate open-loop power electronics circuits in switching mode converters. The purpose of this introduction is to assist you with installing the software and running simulations. You are encouraged to explore each converter model after learning its theory in class and before doing its lab experiment. This should give you the opportunity to clarify some of the more abstract concepts and familiarize yourself with the circuit at your own pace before conducting experiments that are limited by lab hours and strict safety measures.

Software Access & Installation

You will need a computer running Windows, macOS, or Linux with MATLAB/Simulink and PLECS installed in order to run the simulations. To get access to a MATLAB license, please refer to the UofT Libraries Information Commons Webpage:

http://sites.utoronto.ca/ic/software/detail/matlabStudent.html

A PLECS student license code will be provided to each student during the first lab session. Please note that these license codes are **individually unique** and should not be shared with other students. The PLECS student license is valid for one year from the date of activation.

After you receive your license code, you need to follow the installation instructions found on this webpage:

https://www.plexim.com/store/students

Make sure you enter your real UofT email as the license file will be emailed to you.

Once the standalone installation and licensing is complete, you must download and install the PLECS blockset from

https://www.plexim.com/download/blockset

Do not forget to run the 'plecslib' command upon launching MATLAB right after installing the blockset.

If you do not have access to a personal computer, you can use the workstations in labs where MATLAB and PLECS are installed. You can find information regarding the availability of software in labs here:

https://www.ece.utoronto.ca/lab-support/software/

Model Overview

All models consist of three main components that simulate the equipment you see in the lab, as shown in Figure 1:

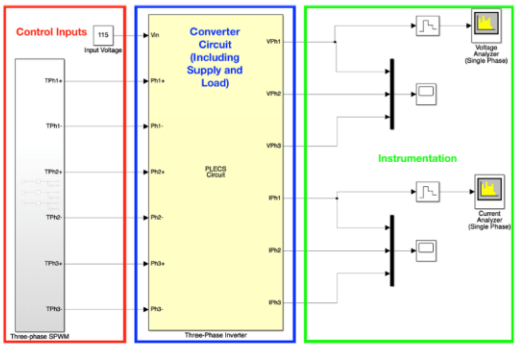


Figure 3: Main components of the LabSim models

Control Inputs: These typically include the input DC voltage setting and the gating signal sent to the switches. These blocks would be analogous to the voltage setting in the yellow power panel and the RT-Linux system, respectively.

Converter Circuit: This is the PLECS circuit model containing all the power components. This includes the DC power supply, switches, filters, sensors, and a resistive load. These blocks would be analogous to the combination of the DC power supply in the yellow panel, the converter in the blue box, the inductor and/or capacitor, the voltage and current sensors, and the barrel resistor, respectively.

Instrumentation: These blocks simulate the equipment we use to analyze the measurements fed by the sensors in the power circuit and understand the waveforms we are sending to the load. We typically use an oscilloscope, a power (harmonic) analyzer, or a combination of the two.

The circuit elements and sub-blocks comprising each of these components depend on the type of converter. In ECE314, you will be working with DC-DC converters (buck, boost, buck-boost), a single-phase DC-AC converter, and a three-phase DC-AC converter.

Model Limitations

All of the models you will be using simulate the full switching operation of power electronics circuits. This enables you to very closely replicate the performance of real circuits. You can investigate the influence of switching frequencies, filter sizes, control algorithms, load impedances, and a variety of other parameters on the performance of your circuit.

Computer models, however, are still idealized mathematical formulations for a complex physical reality. You should be always be aware of the physical limitations of any computational model you use throughout your career. You may design a perfect circuit in Simulink and realize it fails in the lab due to overheating components, start-up transients, electromagnetic interference, power disruptions, or a host of other non-idealities that these models do not typically account for.

In addition to physical limitations, there are also computational limitations on what you can do with these models. In our case here, this limitation becomes very clear at high switching frequencies. Remember that Simulink is an elegant interface for solving systems of differential equations numerically. This means that the higher your switching frequency, the smaller the time steps Simulink solver has to use to reach the correct solution.

If you think your simulation is taking too long to run, you can try reducing your switching frequency or total simulation time. You can set the simulation time in the toolbar at the top of your Simulink window, as shown in Figure 2.

Part b: The following provides one the project labs developed for ECE361 (Computer Networks).

ECE361 COMPUTER NETWORKS

File Transfer

H. TIMORABADI

Objective

The following practical labs provide you with some hands-on experience with socket programming. You will use UNIX sockets to implement simple client and server programs which interact with each other to accomplish a file transfer in a connectionless manner.

Lab Assignment

In this assignment, you need to implement a server that opens a socket and listens for incoming data transfer at a specific port number. You also need to implement a client that reads a binary file from the file system and transfers the file to the server. When the server receives the client's data, it writes the data to a file.

References

- Section 2.4 and related sections on Berkeley API from Chapter 2 of the *Communication Networks* by Alberto Leon-Garcia and Indra Widjaja, McGraw Hill, 2nd Edition, 2004.
- The network socket programming "Beej's Guide to Network Programming" available on the course website under the course section.

Section 1

In this section, you will implement simple client/server programs. The client and server will use a UDP socket for sending and receiving.

Server Program (server.c)

You should implement a server program, called "`server.c`" in C on a UNIX system. Its execution command should have the following structure:

```
server <UDP listen port>
```

Upon execution, the server should:

1. Open a UDP socket and listen at the specified port number
2. Receive a message from the client
   a. if the message is "ftp", reply with a message "yes" to the client.
   b. else, reply with a message "no" to the client.

Client Program (deliver.c)

You should implement a client program, called "`deliver.c`", in C on a UNIX system. The client program will send a message to the server. Its execution command should have the following structure:

```
deliver <server address> <server port number>
```

After executing the server, the client should:

1. Ask the user to input a message as follows:

```
ftp <file name>
```

2. Check the existence of the file:
   a. if exist, send a message "ftp" to the server
   b. else, exit
3. Receive a message from the server:
   a. if the message is "yes", print out "A file transfer can start."
   b. else, exit

Question: Can we use string functions on messages?

Section 2

Based on the client and server in section 1, you need to measure the round-trip time from the client to the server.

Question: How long is the measured round-trip time?

Section 3

In this section, you will implement a client and a server to transfer a file. Unlike simply receiving a message and sending it back, you are required to have a specific **packet format** and implement **acknowledge** for the simple file transfer using UDP socket.

Packet Format: all packets sent between the client and server must have the following structure:

```
struct packet {
     unsigned int total_frag;
     unsigned int frag_no;
     unsigned int size;
     char* filename;
     char filedata[1000];
}
```

The `total_frag` field indicates the total number of *fragments* of the file. Each packet contains one fragment. The `frag_no` field indicates the sequence number of the fragment, starting from 1. The `size` field should be set to the size of the data. Therefore, it should be in the range of 0 to 1000. All members of the packet should be sent as a **single string**, each field separated by a colon. For instance:

```
total_frag = 3
frag_no = 2
size = 10
filename = "foobar.txt"
filddata = "lo World!\n"
```

Your packet should look like this:

```
packet = "3:2:10:foobar.txt:lo World!\n"
```

Please remember that while the beginning of the packet is in fact just plain text, the data portion of the packet may in fact contain *binary* data. **This means that you should not use**

string manipulation functions available in C for the data field or for the whole packet. Only the first part of the packet before data is really a string.

The reason you cannot use string functions is because string functions assume that the data ends with the null character. This character however, may appear *within* the data of the packet. If you were to use `strcpy` on a packet with binary data, some of your data may get lost and your program will not function correctly. You should test your program on both binary data (an image file for instance) as well as a text file. In general, if your program works for binary data, it will work for a text file.

Acknowledgement: **You should implement some sort of acknowledgement to guarantee correct receipt of the file.** For this assignment, you may use a simple stop-and-wait style acknowledgement.

The server may use ACK and NACK packets to control data flow from the sender. The client should open a UDP socket to listen for acknowledgements from the server. You will have to carefully coordinate between the client and the server to guarantee correct file transfer.

Client Program (deliver.c):

The execution command should have the following structure:

```
deliver <server address> <server port number>
```

Upon execution, the client program should read data from a file specified by user and send it to the server using a UDP socket. If a file is larger than 1000 bytes, the file needs to be fragmented into smaller packets with maximum size 1000 before transmission.

Server Program (server.c):

```
server <UDP listen port>
```

Upon receiving the first packet in a sequence (i.e. `frag_no = 1`), the program should read the file name from the packet and create a corresponding file stream on the local file system. Data read from packets should then be written to this file stream. If the EOF packet is received, the file stream should be closed.

Page 4

Section 4

One file is segmented into packets for transfer, and acknowledgement guarantees correct receipt of the file. If one packet from the client is lost, what will happen? If an ACK/NACK packet is lost, what will happen?

Timeout: You should implement a timer for ACK/NACK packet at the client. After sending a packet, the client should wait for an ACK in a time period of t1. If the ACK packet didn't come within t1, the client assumed a packet loss happened and resend it.

Question: For a timeout, how do we select the value of t1?

Makefile

You should also prepare a `makefile` that generates the executable file `deliver` from `deliver.c` and the executable file `server` from `server.c`.

Execution Example

Assuming you have a file named `source.jpg` on `ug201` which you wish to send to `ug202` (In this server, port 5000 is used.):

On the host `ug202`:

```
Server 5000
```

On the host `ug201`:

```
deliver ug202.eecg.utoronto.ca
5000 ftp <filename>
```

Remember that your two programs need to be in separate folders as the file cannot be copied onto itself. You can verify correct operation of your code by performing a binary `diff` on the source and destination file.

Page 5

Deliverables:

The following should be available for the lab evaluation:

- The client program (deliver.c)
- The server program (server.c)
- Makefile to compile your program
- Any extra header files or source code necessary for correct operation of your code.

Submission Procedure:

For electronic submission, one submission per group is required. You have to create a tar ball (a1.tar.gz) with all the files needed to compile and run your programs.

The following command can be used to tar your files:

```
tar -czvf a1.tar.gz <project directory>
```

where the project directory contains your source code, headers, and Makefiles.

Use the following command on the eecg UNIX system to submit your code:

```
submitece361f 1 a1.tar.gz
```

You can perform the electronic submission any number of times before the actual deadline. A resubmission of a file with the same name simply overwrites the old version. To see a list of what you have submitted, use the command:

```
submitece361f -l 1
```

Page 6

Part c: The following presents one of the documents provided to TAs in APS105 (Computer Fundamentals). This documents tents to provide a consistent marking scheme across all sections in the course.

APS 105 — Computer Fundamentals

Lab 1: More Complex Calculations

Marking Scheme

TA Marking guide with suggested questions

Marking the style

Total mark is 4. Out of the 4 marks, 1 mark should be allocated to the style of the student's solution. The mark should be given to the student if the student's solution:

- Has at least one line of comments in each part of the solution;
- Uses indentation reasonably well (i.e. a few problematic areas are allowed);
- Uses variable names in the style of "applePayRate".

There will be no fractional marks on style. If the student's solution does not satisfy any of the requirements above, give a style mark of zero.

Suggested questions

2 out of 4 marks will be allocated to questions. One question will be asked in each part. Again, there will be no fractional marks such as 0.5 for each part. As a TA, you may feel free to ask any question with approximately the same difficulty level as the suggested ones below:

Part 1

- How do you convert percentage expressed as an integer to a fractional? (say from 10 percent to 0.10)?
- How do you print floating point numbers rounded to two decimal places?

Part 2

- How do you obtain the most significant digit out of the 3-digit code that a user enters?
- What's 9's complement?

Part 3

- How do you compute x^y?
- What should be done to use the math library in the standard C library?

Code Functionality

1 out of 4 marks is allocated for functionality. Test the code give different inputs and based on results assign marks.

Appendix B: COURSE NOTES AND SLIDES

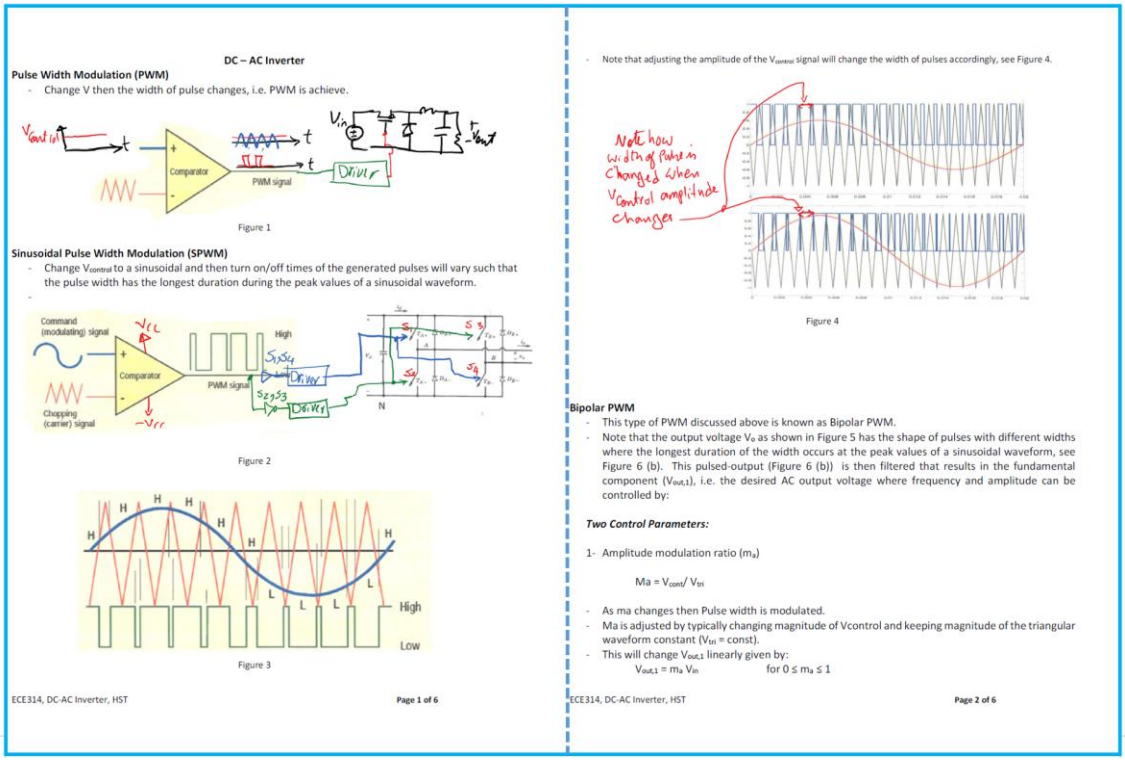
This appendix provides samples of course notes and slides developed after my appointment.

Part a: I have noticed that students pay a lot of attentions in making neat notes. This can be one of the sources of distraction, particularly, when drawings become complicated. Providing the notes similar the following sample allows students to focus on concept being taught rather than making neat notes. The following sample is for ECE314 where the actual handout does not include the hand-written parts and students write those during the lecture.

Students' Comments:

"*It was helpful when materials were printed beforehand so we could focus more on following along rather than taking notes*"

"*I have found that the handouts given out during lecture were VERY effective, because I could focus on learning and absorbing the material in lecture vs. just rushing to write down notes and not understand anything... The handouts are very useful for taking side notes as well during and after lecture. Also to improve lectures you can use more real life examples and explain problems faced by today's power industry, this will ensure that students stay focused during lecture and inspire students to think of capstone projects.* "



DC – AC Inverter

Pulse Width Modulation (PWM)

- Change V then the width of pulse changes, i.e. PWM is achieve.

Figure 1

Sinusoidal Pulse Width Modulation (SPWM)

- Change $V_{control}$ to a sinusoidal and then turn on/off times of the generated pulses will vary such that the pulse width has the longest duration during the peak values of a sinusoidal waveform.

Figure 2

Figure 3

- Note that adjusting the amplitude of the $V_{control}$ signal will change the width of pulses accordingly, see Figure 4.

Figure 4

Bipolar PWM

- This type of PWM discussed above is known as Bipolar PWM.
- Note that the output voltage V_o as shown in Figure 5 has the shape of pulses with different widths where the longest duration of the width occurs at the peak values of a sinusoidal waveform, see Figure 6 (b). This pulsed-output (Figure 6 (b)) is then filtered that results in the fundamental component ($V_{out,1}$), i.e. the desired AC output voltage where frequency and amplitude can be controlled by:

Two Control Parameters:

1- Amplitude modulation ratio (m_a)

$$Ma = V_{cont} / V_{tri}$$

- As ma changes then Pulse width is modulated.
- Ma is adjusted by typically changing magnitude of Vcontrol and keeping magnitude of the triangular waveform constant (V_{tri} = const).
- This will change $V_{out,1}$ linearly given by:

$$V_{out,1} = m_a V_{in} \qquad \text{for } 0 \le m_a \le 1$$

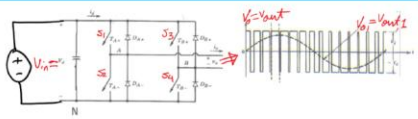


Figure 5

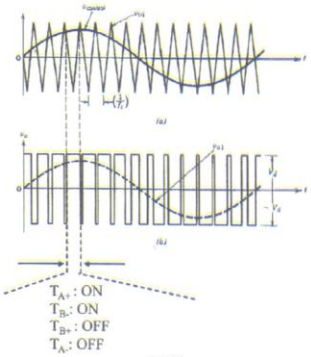


Figure 6

2- Frequency modulation ration (m_f)

$m_f = f_s / f_{cont}$ where f_s is the switching frequency and f_{cont} is the frequency of the control signal (i.e. $V_{control}$).

- m_f determines number of pulses in a cycle.
- Harmonics at the output appear as sidebands centered around f_s and multiples as:

For a **Bipolar PWM** => $f_h = (J.m_f \pm k).f1$ Equation (1)
where even k exist if j is odd
odd k exist if j is even
for J=1, 2, 3, ... and k=0, 1, 2,...

For a **Unipolar PWM** => $f_h = (J.2.m_f \pm k).f1$ Equation (2)
where J=1, 2, 3,... and only odd k exist

Choice of m_f

- Select f_s such to avoid 9-20 kHz. (acoustic noise).
- The higher f_s then the higher is the switching losses. This sets the upper bound on mf. Typically is chosen as m_f=21.
- Observe in Figure 8 as the higher the switching frequency (f_s) or mf then the more harmonics are shifted to the higher frequencies, hence, it is easier to filter.

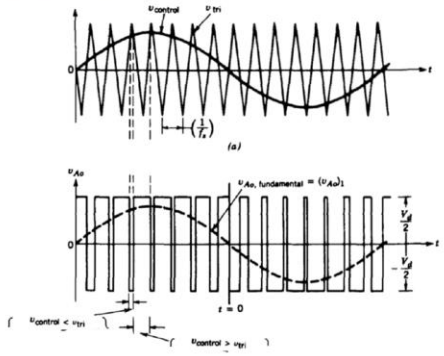


Figure 7

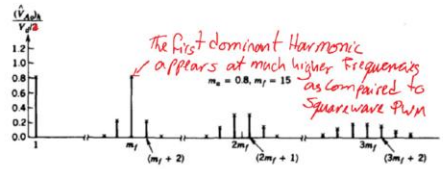


Figure 8

Unipolar PWM

- For this approach the switching pattern is different from Bipoar PWM and is controlled as shown in Figure 9.
- As a result, the harmonics are pushed to higher frequencies based on Equation 2. These harmonics are shown in Figure 10.

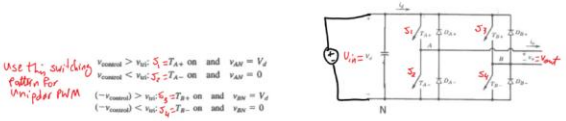


Figure 9

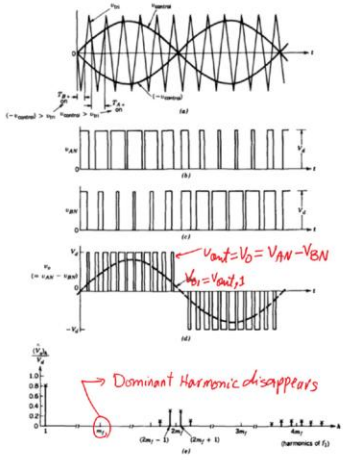


Figure 10

Over-Modulation

- Is avoided since it causes undesired harmonics.
- Increases V_0 amplitude but not linearly, see Figure 12.
- Causes many harmonics to reappear (see Figure 13) and at one point V_0 appears as square wave.

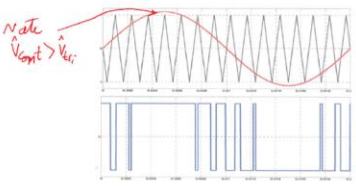


Figure 11

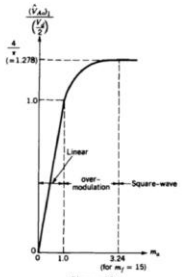


Figure 12

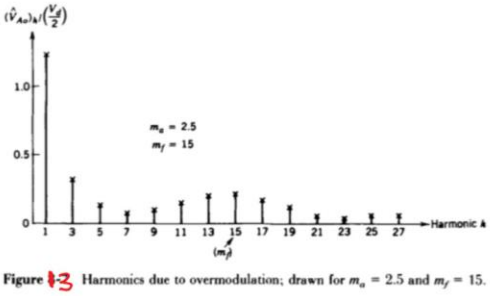
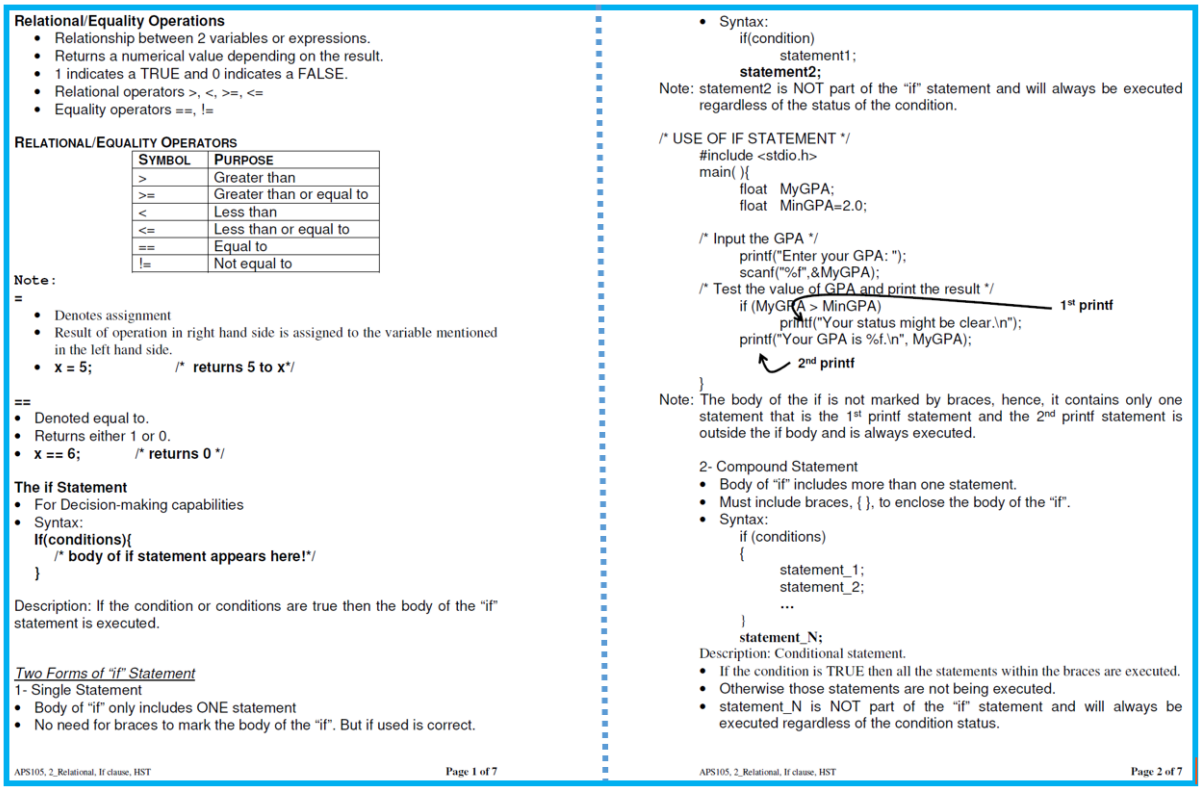


Figure 13 Harmonics due to overmodulation; drawn for $m_a = 2.5$ and $m_f = 15$.

Part b: The following is one sample of the lecture materials developed and distributed in class for the APS105 (Computer Fundamentals).



Relational/Equality Operations

- Relationship between 2 variables or expressions.
- Returns a numerical value depending on the result.
- 1 indicates a TRUE and 0 indicates a FALSE.
- Relational operators >, <, >=, <=
- Equality operators ==, !=

RELATIONAL/EQUALITY OPERATORS

SYMBOL	PURPOSE
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
==	Equal to
!=	Not equal to

Note:

=

- Denotes assignment
- Result of operation in right hand side is assigned to the variable mentioned in the left hand side.
- **x = 5;** **/* returns 5 to x*/**

==

- Denoted equal to.
- Returns either 1 or 0.
- **x == 6;** **/* returns 0 */**

The if Statement

- For Decision-making capabilities
- Syntax:

```
If(conditions){
    /* body of if statement appears here!*/
}
```

Description: If the condition or conditions are true then the body of the "if" statement is executed.

Two Forms of "if" Statement

1- Single Statement

- Body of "if" only includes ONE statement
- No need for braces to mark the body of the "if". But if used is correct.

APS105, 2_Relational, If clause, HST Page 1 of 7

- Syntax:

```
if(condition)
        statement1;
    statement2;
```

Note: statement2 is NOT part of the "if" statement and will always be executed regardless of the status of the condition.

```
/* USE OF IF STATEMENT */
#include <stdio.h>
main( ){
    float   MyGPA;
    float   MinGPA=2.0;

/* Input the GPA */
    printf("Enter your GPA: ");
    scanf("%f",&MyGPA);
/* Test the value of GPA and print the result */
    if (MyGPA > MinGPA)                    1st printf
        printf("Your status might be clear.\n");
    printf("Your GPA is %f.\n", MyGPA);
                2nd printf
}
```

Note: The body of the if is not marked by braces, hence, it contains only one statement that is the 1st printf statement and the 2nd printf statement is outside the if body and is always executed.

2- Compound Statement

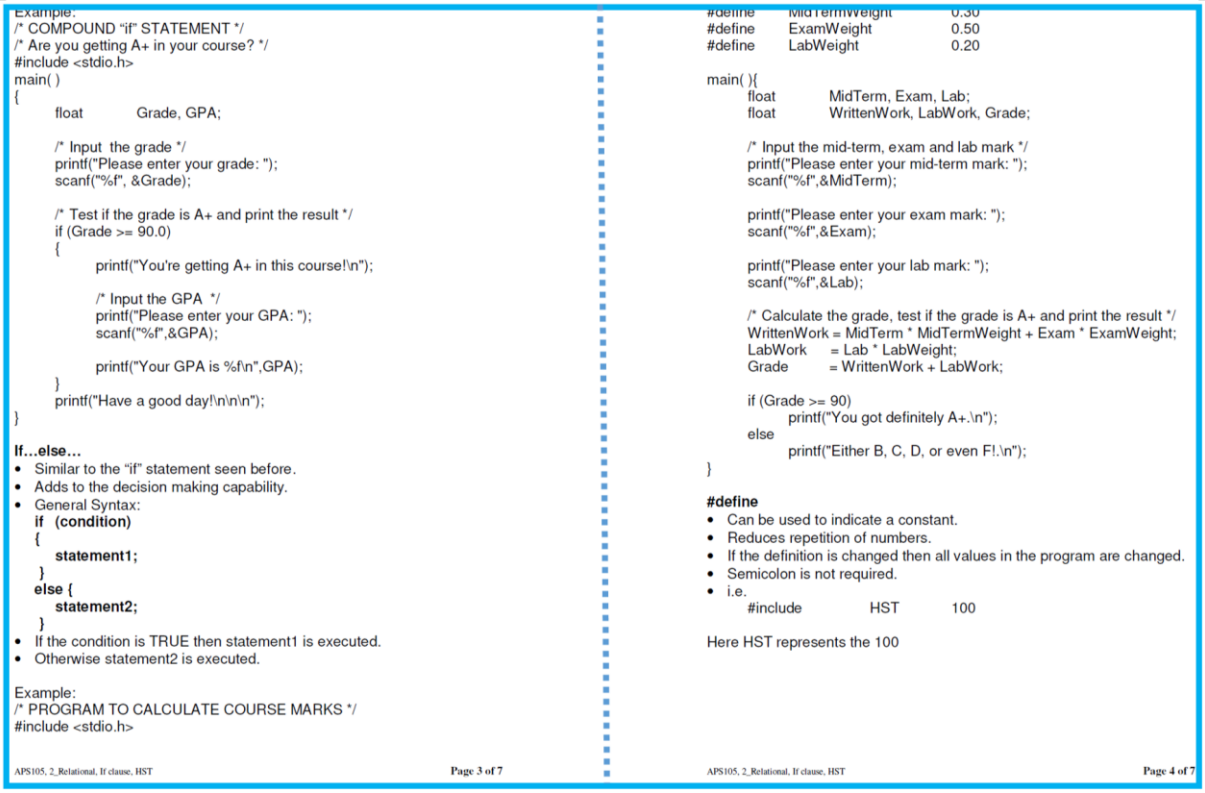
- Body of "if" includes more than one statement.
- Must include braces, { }, to enclose the body of the "if".
- Syntax:

```
if (conditions)
{
    statement_1;
    statement_2;
    …
}
statement_N;
```

Description: Conditional statement.

- If the condition is TRUE then all the statements within the braces are executed.
- Otherwise those statements are not being executed.
- statement_N is NOT part of the "if" statement and will always be executed regardless of the condition status.

APS105, 2_Relational, If clause, HST Page 2 of 7



Example:

```
/* COMPOUND "if" STATEMENT */
/* Are you getting A+ in your course? */
#include <stdio.h>
main( )
{
    float       Grade, GPA;

    /* Input  the grade */
    printf("Please enter your grade: ");
    scanf("%f", &Grade);

    /* Test if the grade is A+ and print the result */
    if (Grade >= 90.0)
    {
        printf("You're getting A+ in this course!\n");

        /* Input the GPA  */
        printf("Please enter your GPA: ");
        scanf("%f",&GPA);

        printf("Your GPA is %f\n",GPA);
    }
    printf("Have a good day!\n\n\n");
}
```

If…else…

- Similar to the "if" statement seen before.
- Adds to the decision making capability.
- General Syntax:

```
if  (condition)
{
    statement1;
}
else {
    statement2;
}
```

- If the condition is TRUE then statement1 is executed.
- Otherwise statement2 is executed.

Example:

```
/* PROGRAM TO CALCULATE COURSE MARKS */
#include <stdio.h>
```

APS105, 2_Relational, If clause, HST Page 3 of 7

```
#define     MidTermWeight       0.30
#define     ExamWeight          0.50
#define     LabWeight           0.20

main( ){
    float       MidTerm, Exam, Lab;
    float       WrittenWork, LabWork, Grade;

    /* Input the mid-term, exam and lab mark */
    printf("Please enter your mid-term mark: ");
    scanf("%f",&MidTerm);

    printf("Please enter your exam mark: ");
    scanf("%f",&Exam);

    printf("Please enter your lab mark: ");
    scanf("%f",&Lab);

    /* Calculate the grade, test if the grade is A+ and print the result */
    WrittenWork = MidTerm * MidTermWeight + Exam * ExamWeight;
    LabWork     = Lab * LabWeight;
    Grade       = WrittenWork + LabWork;

    if (Grade >= 90)
        printf("You got definitely A+.\n");
    else
        printf("Either B, C, D, or even F!.\n");
}
```

#define

- Can be used to indicate a constant.
- Reduces repetition of numbers.
- If the definition is changed then all values in the program are changed.
- Semicolon is not required.
- i.e.

```
#include      HST       100
```

Here HST represents the 100

APS105, 2_Relational, If clause, HST Page 4 of 7

Nested if…else

- Very similar to if … else … statement seen before
- Syntax:

```
if      (condition_1)
        DoThis_1;
else
        if (condition _2)
                DoThis _2;
        else
                DoThis _3;
```

Description:
If condition _1 is TRUE then DoThis _1
If condition _1 is FLASE and condition _2 is TRUE then DoThis _2
If condition _1 is FLASE and condition _2 is FALSE then DoThis _3

Example:

```
/*************************************************************
** PROGRAM TO CALCULATE GST AND PST
** SHOWS HOW NESTED "if…else" FUNCTION.
*************************************************************/
#include <stdio.h>
#include <stdlib.h>        /* Adding <stdlib.h> library to include exit( )*/
#define     GST         0.07
#define     PST         0.08
main( ){
        char        choice;
        float       Ptax, Gtax;
        float       BTprice, ATprice;
        /* Get the selected letter by user */
        printf("Use the menu - Select a Letter indicating which tax calculation
you want:\n");
        printf("P represents Provincial Tax and G represents Goods &
Services Tax.\n");
        puts("Now enter your choice (P or G):");
        scanf("%c",&choice);

        /* Get the price before tax, calculate GST and PST print the result*/
        printf("Please enter the Before Tax price\n");
        scanf("%f",&BTprice);

        if (choice == 'G'){
                ATprice =  GST * BTprice + BTprice;
```



```
                printf("The Before Tax Price is %f.\n",BTprice);
                printf("The After Tax Price is %f.\n", ATprice);
        }
        else
                if (choice == 'P'){
                        ATprice =  PST * BTprice + BTprice;
                        printf("The Before Tax Price is %f.\n",BTprice);
                        printf("The After Tax Price is %f.\n", ATprice);
                }
           else{
                        printf("That was not one of the choices.\n");
                        printf("Sorry!\n");
                }
}
```

Logical Operations – AND, OR, NOT

- Logical AND is represented by "&&"
- i.e.
  (expression1) && (expression2)

Description: This operation is TRUE only if expression1 is TRUE and expression2 is TRUE.
Works based on the AND truth table as follows:

LOGICAL AND TRUTH TABLE

EXPRESSION 1	EXPRESSION 2	AND
0	0	0
0	1	0
1	0	0
1	1	1

Note: "1" means TRUE and "0" means FALSE.
Note: Any nonzero value is treated as TRUE

Logical OR Operation

- Logical OR is represented by "||"
- i.e. (expression1) || (expression2)

Description: This operation is FALSE only if both expression1 and expression2 are FALSE.
Works based on the OR truth table as follows:

LOGICAL OR TRUTH TABLE

EXPRESSION 1	EXPRESSION 2	OR
0	0	0
0	1	1
1	0	1
1	1	1

Logical NOT Operation

- Logical NOT is represented by "!"
- i.e. ! (expression1)

Description: This operation negates the logical value of the expression.
Works based on the NOT truth table as follows:

LOGICAL NOT TRUTH TABLE

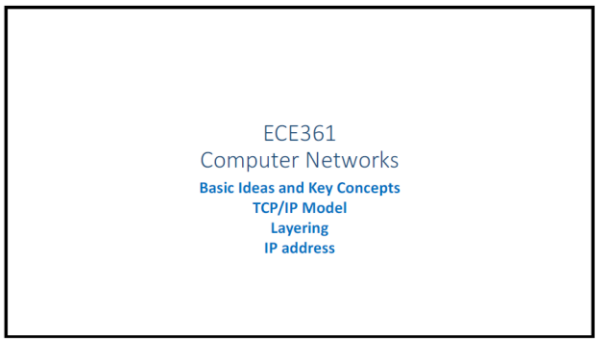
EXPRESSION 1	NOT
0	1
1	0

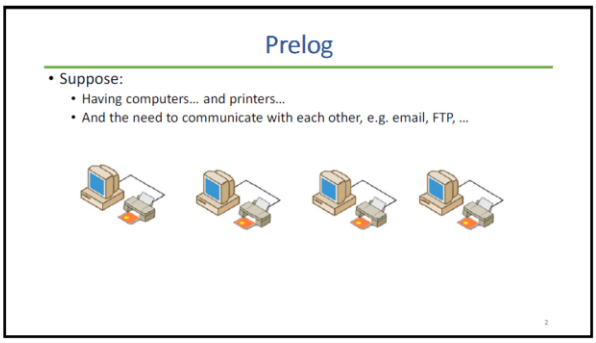
Precedence C Operators/Mathematical/Relational, Logical

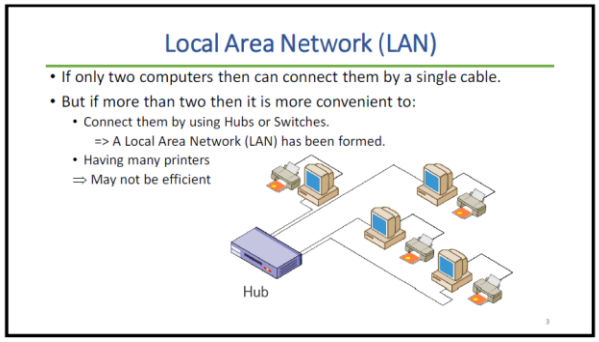
PRECEDENCE FOR C OPERATORS

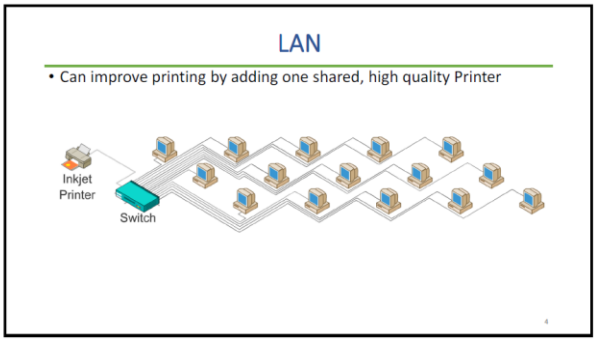
HIGH ↓ LOW	OPERATION	PURPOSE
	!	Logical Not
	*, /	Multiplication and Division
	+, -	Addition and Subtraction
	<, <=, >=, >	Less, Less or Equal, Greater or Equal, Greater
	==, !=	Equal, Not Equal
	&&	Logical AND
	||	Logical OR

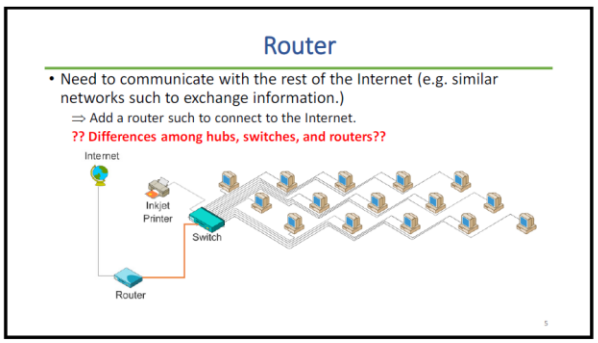
Part c: The lecture material for the ECE361 (Computer Networks) are typically presented in the form of PowerPoint slides and are sometimes with the use of tablet, or chalkboard. The PowerPoint comprise over 1000 slides that some are exactly the original slides came with the course textbook or other sources, are modified slides, or completely developed by me. The following slides represents part of a set of 48 slide-set developed for ECE361.

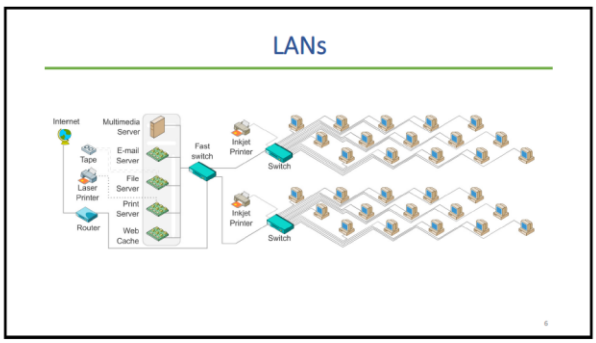












The Internet

- Is represented by bunch of clouds that shows different networks.
- Router:
  - Interconnects the networks.
  - Sets the borders between networks.
- Need to have networks separated for:
  - Security purposes.
  - Billing purposes.
  - Ownership.
- Users:
  - View all of the interconnected networks as one single network.
  - Do not know how the hosts on each side of the Internet are connected to the Internet.
  - Do not know how many routers or how many networks there are between them.

  ⇒Despite all of these: the connection appears seamless to both end users.

7

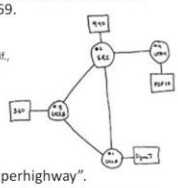
The Internet

- Permits heterogeneous computers to communicate with a common set of applications, independent of their physical network connections.
  - Heterogeneous since:
    - There can be different operating systems, different platforms, different hardware, etc.
- Notes:
  - There exist all kinds of different networks on the Internet.
  - Need standards that allow all kinds of networks to talk to each other using varieties of computer hardware.
  - These standards are commonly known as Protocols.
    - e.g. TCP (Transmission Control Protocol) is commonly used for transport over the Internet.

8

History of Internet

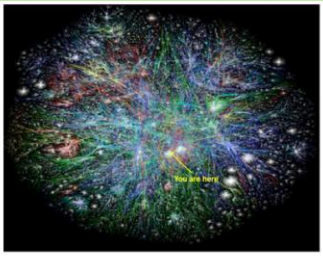
- Started with the Arpanet that was developed by the Defence Advanced Research Project Agency (DARPA) on Dec. 05, 1969.
  - Four computer network nodes at:
    - The University of California, Los Angeles, (U.C.L.A.),
    - The Stanford Research Institute (S.R.I.) in Menlo Park, Calif.,
    - The U.C. Santa Barbara (UCSB), and
    - The University of Utah.



- Has grown to become the global "Information Superhighway".
- Although has spread around the world; it could still be considered as US-Centric.

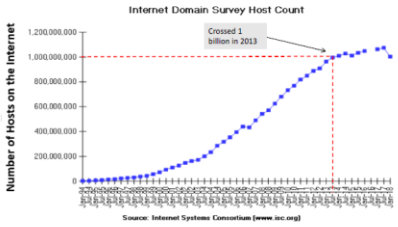
9

The Internet



Source: Slides from textbook: Computer Networking: A Top Down Approach, 6th edition Jim Kurose, Keith Ross Addison-Wesley March 2012

The number of hosts connected to the Internet passed One Billion



Source: Internet Systems Consortium, https://www.isc.org/network/survey/

11

The number Internet users continues to grow

- Globally:
  - In 2016: Over **3.4 Billion** people used the Internet.
  - In 2018: exceeded 4 Billion
  - In 2019: 4.39 Billion internet users; and increase of 9% over 2018.

Note: Most of the Internet users live in the developing countries.

- Canada in 2018:
  - Total Internet connections: **32,120,519**
    - Total Internet users: 36.95 million
  - Total Population : **36,286,378**
  - Share of Canadian Internet connections: **88.5 %**
  - Share of Canadian users relative to World Internet users: **0.9 %**

Internet Challenge

- The challenge is how to maintain a seamless communication among billions of hosts connected to the Internet

⇒ Need standards, i.e. Protocols.

- **Protocol:**
  - Is a set of rules that govern the communication between two parties,

    e.g. two layers

Protocol Layering

- Is required since communications in internet are complex.
- Divides communications into intellectually manageable pieces.
- Provides a conceptual framework that can assist in realization of the protocols.
- Becomes invisible when protocols interact with each other.

- Notes:
  - Layering gives a guideline, not a rigid framework.
  - Optimizations may violate strict layering.

14

Layering Models

- Two models to consider:
  - TCP/IP model
    - Main subject of this course and the Labs.
  - ISO model (a.k.a 7-layer model)
    - Will be briefly discussed.

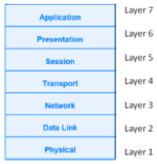
15

OSI Model (ISO 7498)

- Was developed under ISO (International Organization for Standardization, founded in 1947).
- Open Systems Interconnection model (OSI) was created such to be compatible with all the networks and systems.
  - It describes how data is transmitted over a network.
- Is divided into 7 layers

Layering:

- Makes the functionality as discrete and independent as possible
- Any changes to one layer does not require any changes to other layers of the model



16

TCP/IP Protocol Suite

- Is also known as TCP/IP
- Indicates that there are more than two protocols; it is a suite of varieties of protocols.
- Was designed to provide effective and reliable communication between heterogeneous host computers.
- Has become a de-facto industry standard for heterogeneous networking.
- Is adaptable to the new technologies that keep appearing every now and then.

17

History of TCP/IP Protocol

- Before TCP/IP: Had only single-vendors, Examples:
  - IBM wanted everybody to be using IBM system (SNA) => User needed to buy more IBM equipment.
    - ***Side note:*** *SNA (Systems Network Architecture)* is a complete protocol stack and is the proprietary networking architecture created by IBM in 1974.
  - Same with Apple Macintosh that offered a smaller scale system (AppleTalk).
    - ***Side note:*** AppleTalk is the proprietary suite of networking protocols developed for Macintosh computers by the Apple Inc.
- Clearly users wanted to have the option of choosing from different vendors.
- This was the drive to have a protocol that worked between heterogeneous hosts

  => TCP/IP

18

Appendix C: SURVEY RESULTS AND FEEDBACK

LabSim was introduced in teaching ECE314 (Fundamental of Electrical Energy System) as a supplementary tool for simulating power electronics circuits. In order to determine the effectiveness and pros/cons of the *LabSim* two surveys were conducted. The followings represent some of the questions and answers from those surveys.

Question:

Do you have any suggestions or ideas related to the use of simulations, practical models, or other demonstration tools to improve ECE314?

Responses:

- "Somehow, make us use the tools."
- "Make the prelab simulations mandatory. "
- "Add *labsim* in prelab assignment."
- "I would suggest to include *LabSim* in the prelab or may be even as a bonus question on prelab, this will ensure students will actually do the simulations and have a CLEAR understanding of what will be expected in the lab..e.g students can draw waveforms on prelab for marks. Having this experience working with Simulink will be beneficial for the students in the long term when they apply for jobs etc.. most jobs require the use of CAD tools and simulations softwares... There should be a lab regarding the use of electric motors or generators, that would be interesting. Overall TA's did a very good jobs of helping students, I also found the pre-lab office hours very useful!"
- "*LabSim* is very useful for labs because during the lab session i often do not have enough time to grasp the concepts without asking the TA's for help."

- "I believe adding a bonus *LabSim* part to every prelab would be a good way of having students experiment with this tool and use it more effectively."

Question:

Do you have any comments or suggestions related to the impact of *LabSim* on the course workload?

Responses:

- "Somehow, make us use the tools."
- "It's not really an impact on the workload, but as mentioned earlier, the installation process is lengthy and cumbersome. I had to wait a few days for the license to be emailed to me in order to use it. Maybe for Lab 1 or Lab 2, you can make it mandatory for students to use *LabSim* in some way or the other (in their personal computers or in ECF machines) so that they're comfortable or at least familiar with using it if they feel they really need to when the course content gets more complex."
- "As students were primarily required to teach themselves how to use the software I would say that it did impact the workload. I think the first few tutorials should be dedicated to walk-throughs for basic simulation techniques."
- "It had zero impact."

Question:

Do you have any general comments or suggestions regarding *LabSim* or your experience with it?

Responses:

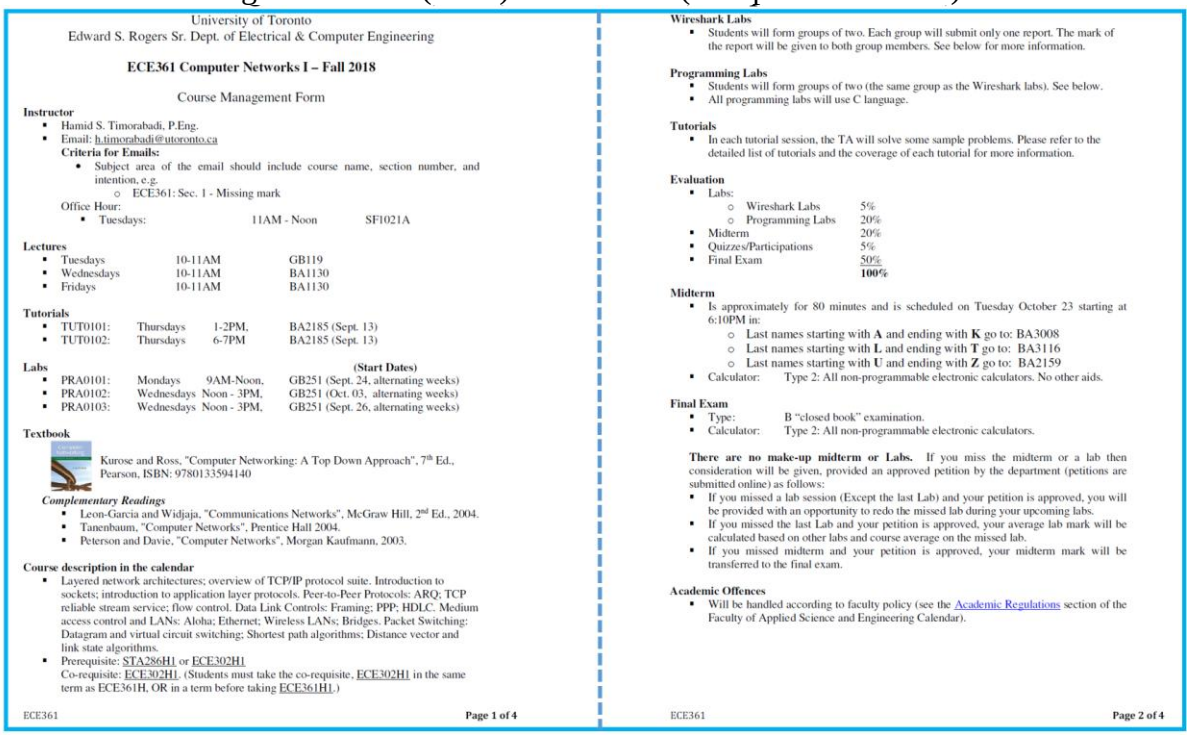
- "It is good to have something extra to help us understand materials and are not counted for marks, so I can have more choices on how to study but I am not forced to do it."

- “I thought it was an interesting and different way to get familiar with course material that was slightly different from the normal curriculum.”
- “Overall, *LabSim* is great and other than the smaller issues I mentioned, I think the biggest improvement would be made if you could encourage its use a lot more and explain to students that "hey, if you're having trouble understanding how this circuit operates, then use *LabSim*. We have the circuit already set-up for you and all you need to do is see how it operates when you change values and stuff. It'll only take you about 15 minutes and you'll hopefully end up understanding what would happen if you increase/decrease capacitance or inductance, etc."
- “I like *LabSim* and I think it is a great addition to the curriculum. Using it made my experience on this course better.”
- “Hard to install and configure”
- “Probably the best tool I've come across for circuit and model simulation”

Appendix D: COURSE MANAGEMENT FORMS

This appendix presents course management forms that includes information about two of the courses I have taught after my appointment.

Part a: Course Management Form (CMF) for ECE361 (Computer Networks) for fall 2018.



University of Toronto
Edward S. Rogers Sr. Dept. of Electrical & Computer Engineering

ECE361 Computer Networks I – Fall 2018

Course Management Form

Instructor
- Hamid S. Timorabadi, P.Eng.
- Email: h.timorabadi@utoronto.ca

Criteria for Emails:
- Subject area of the email should include course name, section number, and intention, e.g.
  - ECE361: Sec. 1 - Missing mark

Office Hour:
- Tuesdays: 11AM - Noon SF1021A

Lectures
- Tuesdays 10-11AM GB119
- Wednesdays 10-11AM BA1130
- Fridays 10-11AM BA1130

Tutorials
- TUT0101: Thursdays 1-2PM, BA2185 (Sept. 13)
- TUT0102: Thursdays 6-7PM BA2185 (Sept. 13)

Labs (Start Dates)
- PRA0101: Mondays 9AM-Noon, GB251 (Sept. 24, alternating weeks)
- PRA0102: Wednesdays Noon - 3PM, GB251 (Oct. 03, alternating weeks)
- PRA0103: Wednesdays Noon - 3PM, GB251 (Sept. 26, alternating weeks)

Textbook

Kurose and Ross, "Computer Networking: A Top Down Approach", 7th Ed., Pearson, ISBN: 9780133594140

Complementary Readings
- Leon-Garcia and Widjaja, "Communications Networks", McGraw Hill, 2nd Ed., 2004.
- Tanenbaum, "Computer Networks", Prentice Hall 2004.
- Peterson and Davie, "Computer Networks", Morgan Kaufmann, 2003.

Course description in the calendar
- Layered network architectures; overview of TCP/IP protocol suite. Introduction to sockets; introduction to application layer protocols. Peer-to-Peer Protocols: ARQ; TCP reliable stream service; flow control. Data Link Controls: Framing; PPP; HDLC. Medium access control and LANs: Aloha; Ethernet; Wireless LANs; Bridges. Packet Switching: Datagram and virtual circuit switching; Shortest path algorithms; Distance vector and link state algorithms.
- Prerequisite: STA286H1 or ECE302H1
  Co-requisite: ECE302H1. (Students must take the co-requisite, ECE302H1 in the same term as ECE361H, OR in a term before taking ECE361H1.)

ECE361 Page 1 of 4

Wireshark Labs
- Students will form groups of two. Each group will submit only one report. The mark of the report will be given to both group members. See below for more information.

Programming Labs
- Students will form groups of two (the same group as the Wireshark labs). See below.
- All programming labs will use C language.

Tutorials
- In each tutorial session, the TA will solve some sample problems. Please refer to the detailed list of tutorials and the coverage of each tutorial for more information.

Evaluation
- Labs:
  - Wireshark Labs 5%
  - Programming Labs 20%
- Midterm 20%
- Quizzes/Participations 5%
- Final Exam 50%
  100%

Midterm
- Is approximately for 80 minutes and is scheduled on Tuesday October 23 starting at 6:10PM in:
  - Last names starting with **A** and ending with **K** go to: BA3008
  - Last names starting with **L** and ending with **T** go to: BA3116
  - Last names starting with **U** and ending with **Z** go to: BA2159
- Calculator: Type 2: All non-programmable electronic calculators. No other aids.

Final Exam
- Type: B "closed book" examination.
- Calculator: Type 2: All non-programmable electronic calculators.

There are no make-up midterm or Labs. If you miss the midterm or a lab then consideration will be given, provided an approved petition by the department (petitions are submitted online) as follows:
- If you missed a lab session (Except the last Lab) and your petition is approved, you will be provided with an opportunity to redo the missed lab during your upcoming labs.
- If you missed the last Lab and your petition is approved, your average lab mark will be calculated based on other labs and course average on the missed lab.
- If you missed midterm and your petition is approved, your midterm mark will be transferred to the final exam.

Academic Offences
- Will be handled according to faculty policy (see the Academic Regulations section of the Faculty of Applied Science and Engineering Calendar).

ECE361 Page 2 of 4

ECE361 - Fall 2018
Course Schedule and Reading

Note: this is a tentative list and based on the course progress may change in terms of content and the order the sections are covered. Note Oct. 8 is Thanksgiving.

Week	Date	Lecture	Topic	Reading
1	Sept. 7-13	1	Course Introduction	-
		2	Introduction to Computer Networks	1.1-1.2
		3	Circuit Switching and Packet Switching	1.3
2	Sept 14-20	4	Layered Architecture	1.4, 1.5
		5	Applications	2.1 - 2.2
		6	HyperText Transfer Protocol (HTTP)	2.2
3	Sept 21-27	7	Cookies, Caching, Conditional Get, FTP	2.3
		8	Simple Mail Transfer Protocol (SMTP)	2.4
		9	Domain Name System	2.5
4	Sept 28- Oct. 4	10	P2P File Sharing	2.6
		11	Transport layer, UDP	3.1, 3.2, 3.3
		12	Stop-and-Wait ARQ	3.4
5	Oct. 5-11	13	Selective Repeat ARQ/Go-Back-N ARQ	3.4
		14	Transport Control Protocol (TCP)	3.5
		15	Congestion Control	3.6, 3.7
6	Oct. 12-18	16	Virtual Circuits and Datagram	4.1, 4.2
		17	Inside a router, Internet Protocol	4.3, 4.4.1
		18	IP Addressing	4.4
7	Oct. 19-25	19	CIDR, DHCP	4.4
		20	**Midterm, Tuesday Oct. 23 between 6:10-8PM**	
		21	NAT	4.4
8	Oct. 26 - Nov. 1	22	ICMP	4.4
		23	IPv6	4.4.4, 4.5.1
		24	Routing- Distance Vector	4.5.2
9	Nov. 2-8	25	Routing- Distance Vector - Hierarchical	4.5.2, 4.5.3
		26	Routing in the Internet, RIP, OSPF	4.6.1, 4.6.2
		27	BGP - Flooding	4.6.3, 4.7
10	Nov. 9-15	28	Broadcast and Multicast	4.7
		29	Link layer, Error Detection	5.1
		30	Cyclic Redundancy Check (CRC)	5.2
11	Nov. 16-22	31	Multiple Access - ALOHA - Slotted ALOHA	5.3.1, 5.3.2
		32	Carrier Sense Multiple Access, Ethernet	5.3.2, 5.4.2
		33	MAC Addressing - ARP	5.4.1
12	Nov. 23 -29	34	Link Layer Switches, VLAN	5.4.3, 5.4.4
		35	Cellular Networks	6.1, 6.2, 6.4
		36	CSMA/CA	6.3
13	Nov. 30 - Dec. 6	37	WiFi Networks	6.3
		38	Review	-
		39	Review	-

ECE361 Page 3 of 4

Labs schedule

ECE361 Programming Labs Schedule (Fall 2018)

Section	Date	Time	Location	Programming Lab	Material Due	Marks
PRA0101	24-Sep-18	9AM -Noon	GB251	1	Section 1 of File Transfer Lab	2 1 works; 1 questions
PRA0102	3-Oct-18	Noon - 3PM				
PRA0103	26-Sep-18	Noon - 3PM				
PRA0101	22-Oct-18	9AM -Noon		2	Section 2 and 3 of File Transfer Lab	4 2 works; 2 questions
PRA0102	17-Oct-18	Noon - 3PM				
PRA0103	24-Oct-18	Noon - 3PM				
PRA0101	5-Nov-18	9AM -Noon		3	Section 4/Overall File Transfer Lab	4 2 works; 2 questions
PRA0102	31-Oct-18	Noon - 3PM				
PRA0103	7-Nov-18	Noon - 3PM				
PRA0101	19-Nov-18	9AM -Noon		4	Section 1 of Text Conferencing Lab	6 4 works; 2 questions
PRA0102	14-Nov-18	Noon - 3PM				
PRA0103	21-Nov-18	Noon - 3PM				
PRA0101	3-Dec-18	9AM -Noon		5	Section 2 of Text Conferencing Lab	4 2 works; 2 questions
PRA0102	28-Nov-18	Noon - 3PM				
PRA0103	5-Dec-18	Noon - 3PM				

Wireshark Labs
Each group will submit five Wireshark assignments throughout the semester. Each report has a total of 1 mark, which adds up to 5 marks for the whole set of Wireshark assignments.

An introduction to Wireshark is given during the first week of Lab #1 session. Students are required to measure the traffic on the Internet and write a report about the experiment. The questionnaire for each Wireshark assignment will be posted on the course website. Students can print the questionnaire and fill out the blanks and submit a hard copy of their report along with a print out of their Wireshark trace.

Marking: The TAs use the submitted trace to mark the reports. If the traces are not submitted, ½ mark will be deducted even if the questionnaire is answered correctly. Please print only the relevant traces and **do not** print the packet-contents window that displays content in ASCII and hexadecimal format.

The following table lists a tentative set of the protocols that will be studied.

Assignment	Wireshark	Data	Deadline
1	HTTP	05-Oct.-2018	5:00 pm
2	UDP	19-Oct.-2018	5:00 pm
3	TCP	02-Nov.-2018	5:00 pm
4	IP	16-Nov.-2018	5:00 pm
5	Ethernet and ARP	30-Nov.-2018	5:00 pm

- All reports should be dropped by the deadline in box #37 on the fourth floor (on the way to BA4000) of Bahen Centre for Information Technology.
- Each lab group consist of two students per group and will submit one report.

ECE361 Page 4 of 4

Part b: Course Management Form (CMF) for ECE314 (Fundamental of Electrical Energy System).

University of Toronto
Edward S. Rogers Sr. Dept. of Electrical & Computer Engineering

ECE314: Fundamental of Electrical Energy System
Fall 2018
Course Management Form

Instructor
- Hamid S. Timorabadi, P. Eng.
- Email: h.timorabadi@utoronto.ca

Criteria for Emails:
- Subject area of the email should include "ECE314" and an intention, e.g.
  - ECE314: Missing mark

- Office Hours: Tuesdays 11AM-Noon SF1021A

Lectures
- Mondays: 1-2PM GB248
- Tuesdays: 2-3PM GB248
- Thursdays: 1-2PM GB248

Tutorials (Starts September 10 then every week after)
- TUT0101: Mondays 6-7PM, MY380

Labs (Location is GB40)
- PRA0101: Wed. 3-6PM, Starts on Sept. 12, then alternating weeks
- PRA0102: Wed. 3-6PM, Starts on Sept. 19, then alternating weeks
- PRA0103: Thu. 3-6PM, Starts on Sept. 13, then alternating weeks

Lab Topics:
- Lab #1: Safety and Introduction to LabSim
- Lab #2: Circuit Setup & Hands-on with Lab Equipment
- Lab #3: Buck Converter
- Lab #4: DC-AC Converter
- Lab #5: Grid Connected DC-AC Converter
- Lab #6: Transformer

Important: A hand out for each lab will be posted in advance on the course website. All labs (except for the first Lab) include a graded lab prep. In the interest of fairness, all lab preps for all students must be turned in before the deadlines that will be posted on the course website.

Textbook
1. Course packet for ECE314, will be available after September 06 from ***Carlton Printers*** (27 Carlton Street, Toronto, On M5B 1L2), consisting of the following:
   - R.W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, 2nd Edition, Kluwer Academic Publishers, 2001, Chapters 1-5 and 16.
   - N. Mohan, T.M. Undeland, W.P. Robins, "Power Electronics - Converters, Applications, and Design", 3rd Edition, John Wiley & Sons, Inc., 2003, Chapter 8.
2. Custom textbook available at the bookstore: excerpt from A.E. Fitzgerald, C. Kingsley, and S.D. Umans, Electric Machinery, 6th Edition, McGraw-Hill.

Course description in the calendar
- Introduction to 3-phase systems, single line diagrams and complex power flow. Energy conversion via switch-mode power electronic circuits: DC/DC converters, DC/AC converters. Energy conversions via magnetic devices: Faraday's law for time varying fields, characterization of hysteresis and eddy current losses in magnetic materials, modelling of magnetic circuits, transformer and inductor modelling and design. Introduction to electromechanical energy conversion: Lorentz Force, concepts of energy, co-energy, forces between ferromagnetic materials carrying flux, simple magnetic actuators.
- Prerequisite: ECE212H1 and ECE221H1 and ECE231H1
  Exclusion: ECE315H1

Learning Objectives
- Demonstrate the ability to identify, characterize, and model DC-DC converters
- Formulate and model DC-AC inverters.
- Demonstrate the ability to execute and implement formulation and modelled developed in the lab environment.
- Demonstrate and analyze implementation results from labs and compare against those theoretical outcomes from formulation and models.
- Develop skills and capabilities in working as part of a larger team.

Outline
- Note that the following outline is tentative.

Topic	Lecture(s)	Text Chapters
Introduction and Logistics	1	
Analysis of DC/DC converters	2-6	Erickson: 2.1-2.5
Steady-state equivalent models of DC/DC converters	7-9	Erickson: 3.1-3.5
Switch realization and switching losses	10-12	Erickson: 4.1, 4.3.1
Continuous/Discontinuous conduction mode boundary	13	Erickson: 5.1
Analysis of periodic signals (Fourier series, RMS, power factor, distortion)	14-16	Erickson: 16.1-16.3
DC/AC conversion (square wave, PWM)	17-21	Mohan: 8
Magnetic circuits, inductance, magnetic materials	22-24	Fitzgerald: 1.1-1.5
Transformers (ideal & non-ideal)	25-29	Fitzgerald: 2.1-2.6
Electromechanical energy conversion	30-37	Fitzgerald: 3.1-3.6, 4.1-4.2, 4.4, 5.1-5.2

Evaluation
- Labs 25%
- Midterm 25%
- Final Exam 50%
  100%

Midterm
- No aids allowed except any kind of non-programmable electronic calculators.
- Midterm is scheduled for Thursday Oct. 25 starting at 6:10 with a duration of approximately 80 minutes.
- Location:
  - Last names starting with **A** and ending with **L** go to: **BA3008**
  - Last names starting with **M** and ending with **Z** go to: **BA3116**

Final Exam
- Exam Type: C (Single aid sheet allowed).
- Calculator Type: 2 (All non-programmable electronic calculators)

Notes
There are no make-up midterm or Labs. If you miss the midterm or a lab then consideration will be given, provided a petition with supporting documentation as follows:
- If you missed a lab session and your petition is approved, your average lab mark will be calculated based on the other labs and the class average.
- If you missed midterm and your petition is approved, your midterm mark will be transferred to the final exam.

Academic Offences
- Will be handled according to the faculty policy (see the Academic Regulations section of the Faculty of Applied Science and Engineering Calendar).

ECE314 Lab Schedule (Fall 2018)

All labs are:
- *In GB040 (Energy Systems Lab)*
- *From Noon-3PM*

Section	Date	Lab	Marks
PRA0101	Sept. 12		
PRA0102	Sept. 19	**Lab 1:** Safety and Introduction to LabSim	2
PRA0103	Sept. 13		
PRA0101	Sept. 26		
PRA0102	Oct. 03	**Lab 2:** Circuit Setup & Instrumentation	3
PRA0103	Sept. 27		
PRA0101	Oct. 10		
PRA0102	Oct. 17	**Lab 3:** Buck Converter	5
PRA0103	Oct. 11		
PRA0101	Oct. 24		
PRA0102	Oct. 31	**Lab 4:** DC-AC Converter	5
PRA0103	Oct. 25		
PRA0101	Nov. 07		
PRA0102	Nov. 14	**Lab 5:** Connected DC-AC Converter	5
PRA0103	Nov. 08		
PRA0101	Nov. 21		
PRA0102	Nov. 28	**Lab 6:** Transformer	5
PRA0103	Nov. 22		

Appendix E: STUDENTS' EMAILS

This appendix provides a few unedited and unsolicited samples from students' emails.

Part A: Emails related to online teaching:

The first three samples are from spring 2020. This is the first time a course was taught completely online with almost no known structure from faculty to support.

Sample #1

From: Sarah John <sarahj.john@mail.utoronto.ca>
Sent: Tuesday, June 23, 2020 10:37 PM
To: Hamid Shokrollah-Timorabadi <h.timorabadi@utoronto.ca>
Subject: APS105 Semester

Hello Prof. Hamid,
I just wanted to email you and thank you for a great semester! You are one of the most dedicated profs I have had in first year. As well, thank you for being so accommodating to students, it was not unnoticed. I know for me personally, that posting the lectures and the filled notes helped me much. I was able to get things I missed in lecture and listen to the details in lecture again. Thank you for such well explained lectures.
Hope you have a great summer!
Best,
Sarah

Sample #2

From: Kareem Elmaaddawy <kareem.elmaaddawy@mail.utoronto.ca>
Sent: Sunday, June 21, 2020 11:52 PM
To: Hamid Shokrollah-Timorabadi <h.timorabadi@utoronto.ca>
Subject: Thank you

Hi professor,
Hope all is well and that you are staying safe. Since we are almost done with the course I just wanted to say thank you a lot for the efforts you've put into making this course a fun course and I can surely say that I enjoyed learning this course thanks to you. I took this course last semester but found it very difficult and the professor himself was not of any use and I absolutely despised coding, but after taking the course with you it really has changed my outlook and I am really considering pursuing this as a profession in the future. Thank you so much sir for your efforts and I hope you have a great summer ahead of you.
Best regards,
Kareem

Sample #3

From: Victoria Del Campo <victoria.delcampo@mail.utoronto.ca>
Sent: Wednesday, September 9, 2020 5:00 PM
To: Hamid Shokrollah-Timorabadi <h.timorabadi@utoronto.ca>
Subject: APS105 summer course

Hi Professor,
I am emailing you today because tomorrow I will begin my first day of class in second year ECE. I am not sure if you recall, but I was in your summer APS105 class. I was a chemical engineering student at that point. Because of that course, I acquired the knowledge and the confidence to be able to switch programs and start pursuing a future in computer engineering. I still have a long way to go and many challenges ahead of me, but I was only able to start this journey because of APS105 and your patience to teach us. Thank you so much for guiding and teaching us.
Best,
Victoria Del Campo

Sample #4

From: Tony Chung <tony.chung@mail.utoronto.ca>
Sent: Sunday, June 21, 2020 9:43 AM
To: Hamid Shokrollah-Timorabadi <h.timorabadi@utoronto.ca>
Subject: To professor Hamid: Appreciation Email (APS105)

Hello professor, this is Tony from your Aps105 summer course. I hope you are not finding the weather too hot there in Canada☺
First of all, I would like to thank you from the bottom of my heart, for teaching APS105. You are one of the best instructors I have had here at UofT (although there are not so many since I'm only a first year haha). You were so much more caring and kind towards the students than other professors in my first year experience.
I also would like to apologize for not being able to attend the live lectures for the remainder of the term. As you probably have noticed from my petition, I suffer from tic disorder which causes severe body convulsions when I am mentally stressed, and since I am currently in Korea with a 13-hour-time-difference, I was not able to take a good amount of rest so my condition has worsened. I had to take a break and get a good amount of sleep. My initial goal was to be present in all lectures and answer your questions, but unfortunately I could not make that come true, and I am sorry.
Part of the reason I took APS105 was to transfer to ECE in second year. I am in EngSci, and I did not find my course instructors for programming much helpful and so, I was lost. I was even considering dropping the EngSci programming course and take APS105 over the summer in order to transfer to ECE. Though I successfully finished the course, I still decided to take APS105 as a review. And I still believe that it was one of the best choices I made.
I loved the way you teach. You are different from many other professors I have had, in a way that, despite it was an online course and many of us were uncomfortable with such setting, you

consistently communicated with us and ensured that we understood a concept thoroughly. You also manually drew out diagrams, which became a huge aid in studying. Thank you, for making APS105 not just an ordinary summer course, but more of a fun learning experience. It has been a very productive month studying C, and I hope I have you as my professor again in a near future.
Enjoy the rest of the summer, and I hope the weather in Canada calms down a bit – I'm hearing it's simmering over there. I would really hope that one day we can have a coffee chat and just talk about life once things get much better.

Thank you professor, and please be safe!
All the best,
Tony Chung

Sample #5

From: Akash Mathur <akash.mathur@mail.utoronto.ca>
Sent: Tuesday, December 22, 2020 9:45 AM
To: Hamid Shokrollah-Timorabadi <h.timorabadi@utoronto.ca>
Subject: ECE361: Thank You Professor!

Hi Professor Timorabadi,
As the semester officially comes to a close, I wanted to take the time to say **thank you for an incredible semester**!

2020 has been difficult for all, but your class was inspiring, fun, and extraordinarily useful for 'the real world'. I believe you and the TA's did an amazing job, as this class was one of my favourites! I'm extremely excited to put into practice the many networking fundamentals you've empowered us with!
I believe I speak for many students when I say your teaching style was phenomenal, and the course was organized and executed very well. I also don't have enough words of praise for the TA's! They were extraordinarily useful, thoughtful, and often went 'above and beyond' to help us with problems.
Once again, thank you for an incredible semester, and have a very happy holiday season!
Best Regards,
Akash Mathur

Akash Mathur
Email || akash.mathur@mail.utoronto.ca
Web. || akashmathur.com
Computer Engineering
University of Toronto, 2021

Sample #6

From: Akshat Mengi <akshat.mengi@mail.utoronto.ca>
Sent: Tuesday, December 22, 2020 2:34 PM
To: Hamid Shokrollah-Timorabadi <h.timorabadi@utoronto.ca>
Subject: RE: ECE361 marks on acorn

Thank You I really appreciate your communication. I was not able to attend lectures live due to time difference but I really enjoyed this course and really did learn a lot.
Thank You
Akshat Mengi

Sample #7

From: Manik Chaudhery <manik.chaudhery@mail.utoronto.ca>
Sent: Monday, April 19, 2021 12:52 PM
To: Hamid Shokrollah-Timorabadi <h.timorabadi@utoronto.ca>
Cc: Janpreet Chandhok <janpreet.chandhok@mail.utoronto.ca>; Raman Mangla <raman.mangla@mail.utoronto.ca>; Jeremy Stairs <jeremy.stairs@mail.utoronto.ca>
Subject: Re: Capstone Design Poster

Thanks a lot for all your guidance and support this year. We are all really grateful for all that you have helped us with, starting out last year we would have never thought we would be able to create a fully functional product and write a paper which could be published, but you helped us make it possible. Thanks again and we are looking forward to continuing to work on this and hopefully use it the next semester in class as well.
Kind Regards,
Manik

Part B: Emails related to prior to online teaching:

Sample #8

From: Armin Radan <armin.radan@mail.utoronto.ca>
Sent: Saturday, April 27, 2019 9:29 AM
To: Hamid Shokrollah-Timorabadi
Subject: ECE361: Thank You

Dear Prof. Timorabadi,

I wanted to thank you for your teachings, I really enjoyed your classes. ECE361 was my fourth course with you and for me "Hamid" was a brand of quality, passion, fun and learning. So I

selected all courses that I knew you were teaching. Thank you for making the hardest concepts to easiest ones to grasp, I will certainly miss your classes and teaching method.
Yours Sincerely,
Armin Radan

Sample #9

From: Jaden Reimer <j.reimer@mail.utoronto.ca>
Sent: Saturday, February 16, 2019 11:13:04 AM
To: Hamid Shokrollah-Timorabadi
Subject: ECE243: Thanks for Teaching so Far

Hello Professor Timorabadi,

As reading week begins it sparks a great time to reflect, refine, and catch up on (or start!) our understanding of course concepts. I want to take a moment to thank you for the effort you visibly put into your ECE241 lectures. Good teaching should always be rewarded.

Your enthusiasm for the material was evident from day one and really helps stay focused on the material. You always keep a lively atmosphere in class and it really helps keep spirits up after the long days of second semester. It's a trying time for everyone but it's comforting to have a space to focus on pure content for an hour, regardless of what else is going on. Keep up the good work! Your efforts don't go unnoticed.

Enjoy the week of rest from LEC0101,
Jaden Reimer

Sample #10

From: Zehua Li <samzehuali.li@mail.utoronto.ca>
Sent: Tuesday, April 30, 2019 10:33 AM
To: Hamid Shokrollah-Timorabadi
Subject: Thank you letter

Hi Professor Hamid,

This is Sam from this year ECE159 class. Thank you for being such a responsible teacher this year and making this course useful and fun at the same time. Your teaching style is very effective and also enjoyable. And also thank you for coming by the final exam room and waved at me. It provides me with a lot of confidence and intelligence. Unfortunately, I was unable to find you after I finish and do not get a chance to say bye to you.
Hope you have a great summer!
Sincerest gratitude,
Sam Li

Sample #11

From: Edward Liu <edwardy.liu@mail.utoronto.ca>
Sent: Tuesday, December 25, 2018 1:04:42 AM
To: Hamid Shokrollah-Timorabadi
Subject: Happy Holidays

Dear Professor Hamid,

It has been a wonderful year thanks to your amazing lectures and all the great help that you have given me.

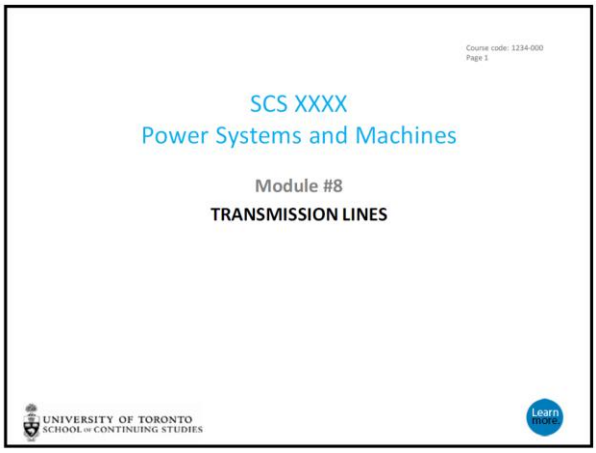
May your Christmas be filled with lots of happiness, peace, and love.. and of course lots of presents :)

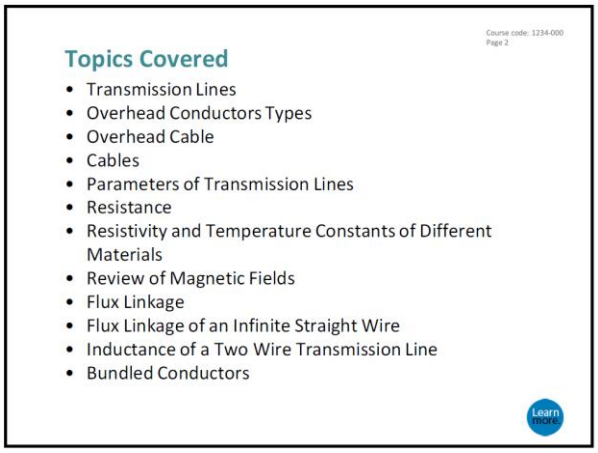
Sincerely,
Your Student,
Edward

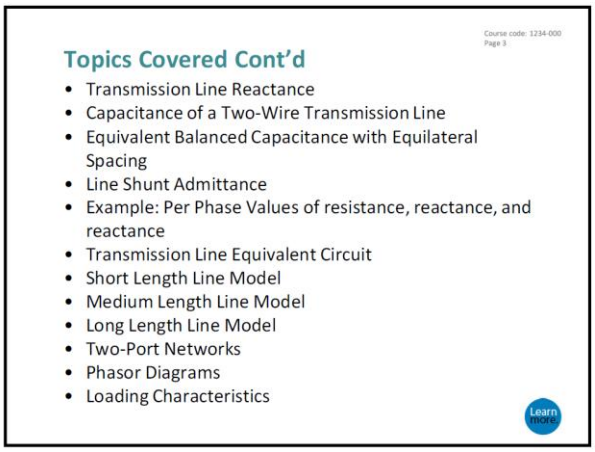
Appendix F: DEVELOPED COURSES

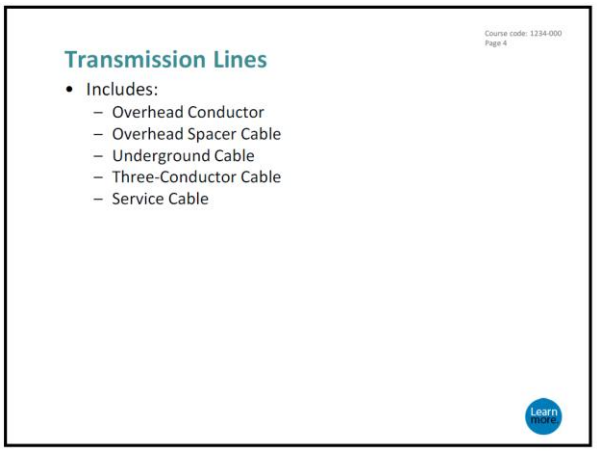
This appendix provides samples for the two courses developed for the School of Continuing Studies.

Part a: Lecture slides for SCS 3147-001 (Power Systems and Machines).









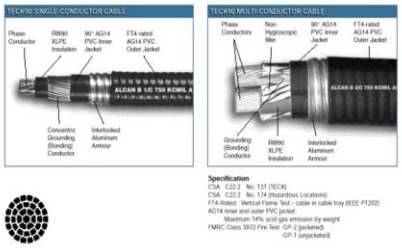
Overhead Conductors Types

- ACSR
  - Aluminum Conductor with inner Steel Reinforced strands
- ACAR
  - Aluminum Conductor with inner Al-Alloy Reinforced strands (corrosion resistant)
- Aluminum - current carrying member
- Steel - structural support

Overhead Cable

- Where conductor close proximity is required
- Insulating jacket surrounds each conductor
- Plastic spacers keep conductors from coming in contact with one another

Cables



Parameters of Transmission Lines

- Transmission lines do not provide a nameplate that allows to construct a model for analysis
- Modeling of transmission lines with:
  - Geometric data : conductor distances and diameters
  - Wire data: resistance and surface area
- Parameters derived from modeling
  - Resistance
  - Self and mutual inductances
- Capacitances between conductors and against ground

Resistance

- DC resistance for length (l), cross section area (A), and material resistivity ρ is given by:

$$R_{DC} = l\frac{\rho}{A}$$

- Resistance per length from tables can be determined for a linear temperature dependency from:

$$\rho(T) = \rho_{20°C}\left(1+\alpha\left(T-20°C\right)\right) \rightarrow M = \frac{1}{\alpha} \rightarrow \rho_{T2} = \rho_{T2}\frac{M+T_2}{M+T_1}$$

- Also need to consider skin effect

Resistivity and Temperature Constants of Different Materials

- Table 9-1

Material	Resistivity at 20 °C (Ω-m)	Temperature constant (°C)
Annealed copper	1.72×10^{-8}	234.5
Hard-drawn copper	1.77×10^{-8}	241.5
Aluminum	2.83×10^{-8}	228.1
Iron	10.00×10^{-8}	180.0
Silver	1.59×10^{-8}	243.0

Course code: 1234-000
Page 11

Review of Magnetic Fields

- Ampere's Law:
  - States that the integral of the scalar product of a closed path and the magnetic field equals the encircled current, i.e.

$$\oint_\Gamma \mathbf{H} \cdot d\mathbf{l} = i_e$$

- Magnetic Flux:
  - Integral of the flux density that is normal to a defined area

$$\mathbf{B} = \mu \mathbf{H}$$

$$\phi = \int_A \mathbf{B} \cdot d\mathbf{a}$$

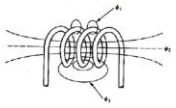
Learn more

Course code: 1234-000
Page 12

Flux Linkage

- Is the total flux linked to the current and is given by:

$$\lambda = \sum_{i=1}^{N} \phi_i$$



- Can define the inductance as:

$$\lambda = Li$$

$$L = \frac{\lambda}{i} = \frac{\sum \phi}{i} = \frac{\sum \int \mathbf{B} \cdot d\mathbf{a}}{i} = \frac{\sum \int \mu \mathbf{H} \cdot d\mathbf{a}}{i}$$

Learn more

Course code: 1234-000
Page 13

Flux Linkage of an Infinite Straight Wire

- The infinite straight wire is an approximation of a reasonably long wire transmission line
- Assumptions
  - Straight, infinitely long wire of radius *r*
  - Uniform current density in the wire. Total current is *I*
    - Valid in practice for dc or low-frequency ac
  - Flux lines form concentric circles (i.e. H is tangential)
  - Angular symmetry - it suffices to consider *H*(*x*)

Learn more

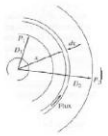
Course code: 1234-000
Page 14

Flux Linkage of Infinite Straight Wire Cont'd

- Case 1:
  - Points outside of the conductor (x > r)

$$\oint_\Gamma \mathbf{H} \cdot d\mathbf{l} = H \cdot 2\pi x = i$$

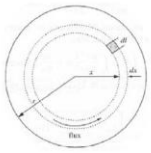
$$H = \frac{i}{2\pi x}$$



- Case 2:
  - Points inside of the conductor (x < r)

$$H \cdot 2\pi x = i_e = \frac{\pi x^2}{\pi r^2} i$$

$$H = \frac{x}{2\pi r^2} i$$



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Page 15

Flux Linkage of Infinite Straight Wire

- To find the flux density:

  $B = \mu_r \mu_0 H$
- Outside the conductor
  - Air $\mu_r \approx 1$
- Inside the conductor
  - Aluminum $\mu_r \approx 1$
  - Steel / Iron $\mu_r > 1$

    typically on the order of 1000 to 10000

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Page 16

Flux Linkage of Infinite Straight Wire Cont'd

- Case 1:
  - Points outside of the conductor (*x* > *r*)

$$\frac{\lambda_1}{l} = \frac{\phi_1}{l} = \frac{1}{l} \int_A \mathbf{B} \cdot d\mathbf{a} = \int_r^R B(x)\,dx = \mu_0 \int_r^R \frac{i}{2\pi x} dx$$

$$= \frac{\mu_0 i}{2\pi} \ln \frac{R}{r}$$

- Case 2:
  - Points inside of the conductor (x < r)

$$\frac{\lambda_2}{l} = \int_0^r \frac{\pi x^2}{\pi r^2} \underbrace{\mu_r \mu_0 H(x)\,dx}_{\frac{d\phi_2}{l}} = \mu_r \mu_0 \int_0^r \frac{\pi x^2}{\pi r^2} \frac{x}{2\pi r^2} i\,dx$$

$$= \frac{\mu_r \mu_0 i}{8\pi}$$

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Page 17

Flux Linkage of Infinite Straight Wire Cont'd

- Combine the two flux linkages (per length) together

$$\frac{\lambda}{l} = \frac{\lambda_1 + \lambda_2}{l} = \frac{\mu_0 i}{2\pi}\left(\frac{\mu_r}{4} + \ln\frac{R}{r}\right) = 2\times10^{-7} i\left(\frac{\mu_r}{4} + \ln\frac{R}{r}\right)$$

- Wire inductance per length

$$\frac{L}{l} = \frac{\lambda}{li} = 2\times10^{-7}\left(\frac{\mu_r}{4} + \ln\frac{R}{r}\right)$$

- Notes:
  - R for the area outside the conductor
  - r is the radius of the conductor

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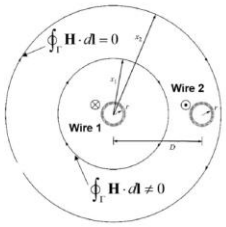
Page 18

Inductance of a Two Wire Transmission Line

$$L_1' = L_2' = \frac{\mu_0}{2\pi}\left(\frac{\mu_r}{4} + \ln\frac{D}{r}\right)$$

- Note that $\mu_r = 1$ for non ferromagnetic conductors



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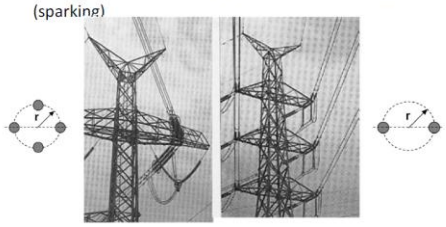
Bundled Conductors

- Bundles reduce the electric field strength in the vicinity of the conductor
  - Higher voltages possible without extensive corona losses (sparking)



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Transmission Line Reactance

- Reactance per length from L', e.g. 2 conductor transmission line

$$X_{12}' = 2\pi f L_{12}' \quad in\ \frac{\Omega}{m}$$

- Large spacing between phases increases X'
  - High voltage lines tend towards larger X'
  - A cable's reactance are small compared to that of overhead lines
- Increasing the conductor radius decreases X'
  - Bundling of conductors of HV lines
- Additional influencing parameters
  - Line sag, tower geometry, etc.
  - Very elaborate calculations → Tabulated value

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Page 21

Capacitance of a Two-Wire Transmission Line

- Capacitance between phases:

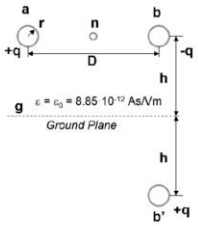
$$C_{ab} = \frac{q}{V_{ab}} = \frac{\pi\varepsilon}{\ln\frac{D}{r}}$$

- Capacitance between phase and neutral where $V_{an} = V_{ab}/2$:

$$C_{an} = \frac{q}{V_{an}} = \frac{2\pi\varepsilon}{\ln\frac{D}{r}}$$

- Capacitance between phase and ground:

$$C_{bg} = \frac{q}{V_{bg}} = \frac{2\pi\varepsilon}{\ln\frac{2h}{r}}$$



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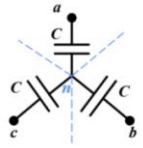
Equivalent Balanced Capacitance with Equilateral Spacing

- Is given by:

$$C_{an}' = \frac{0.0241}{\log_{10}\frac{GMD}{r}} \quad \text{nF/m}$$



- Where:
  - GMD_ϕ is the geometric mean distance between conductors given by:

$$GMD_\phi = \sqrt[3]{d_{ab}\, d_{bc}\, d_{ca}}$$

  - r_ϕ is the conductor radius

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Line Shunt Admittance

- Admittance per length from C′ (in μS/mile) is given by:

$$Y_C' = j2\pi f C' = \frac{f}{60}\frac{14.665}{\log_{10}\left(\frac{GMD_\phi}{r_\phi}\right)}$$

- Large spacing between phases decreases Y′
  - High voltage lines tend towards smaller Y′
  - Cables have much larger Y′ than overhead lines
- Increasing the conductor radius increases Y′
  - Bundling of conductors of HV lines increases charging current
- Additional influencing parameters
  - Line sag, tower geometry, etc.
  - Very elaborate calculations → tabulated values

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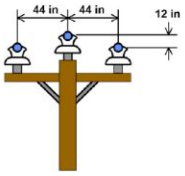
Example: Per Phase Values of resistance, reactance, and reactance

- Calculate the resistance, inductive reactance, and capacitive reactance per phase and for the overhead line shown. Assume the line operates at 60 Hz.
  - R = 0.3263 Ω/mile
  - GMR = 0.0244 feet



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Solution

$$GMD_\phi = \sqrt[3]{d_{12}\ d_{23}\ d_{13}} = \sqrt[3]{(45.6)(88)(45.6)}$$
$$= 56.8 \text{ in} = 4.73 \text{ ft}$$

$$Z_a = (0.3263) + j\,0.2794\frac{(60)}{60}\log_{10}\left(\frac{4.73}{0.0244}\right)$$
$$= 0.326 + j0.639 \quad \Omega/\text{mi}$$

$$r_\phi = \tfrac{1}{2}dia = \tfrac{1}{2}(0.720 \text{ in})\cdot\tfrac{1}{12} = 0.03 \text{ ft}$$

$$C = \frac{0.0389}{\log_{10}(4.73/0.03)} = 0.177 \ \mu\text{F/mi/phs}$$

$$X_C = 1/(2\pi\ 60 \cdot 0.177\ \mu\text{F}) = 149.9 \quad \Omega\,\text{mi}$$

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Transmission Line Equivalent Circuit

- Three general models for equivalent transmission line circuits
  - Choice influenced by the line length, type (cable or overhead line), and operating voltage level
  - Choice based on the analysis (e.g., short circuit or voltage drop)
- Models
  - Short Length Line
  - Medium Length Line
  - Long Length Line

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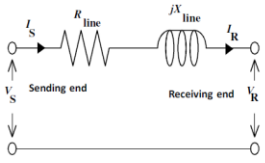
Page 27

Short Length Line Model

- Used for:
  - low- and medium-voltage overhead lines
  - high-voltage lines with lengths less than ~50 miles
- Neglects the effect of the line shunt capacitance
- Lumps the line series impedance into a resistance and inductance equivalent

$X_{line} = X' \cdot d$
$R_{line} = R' \cdot d$



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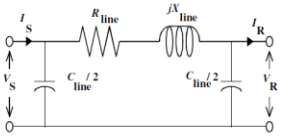
Medium Length Line Model

- Used for
  - high-voltage overhead lines longer than ~50 mi & less than ~150 mi
  - medium- and high-voltage cable circuits
- Lump parameter model using a pi-equivalent
  - Lumps the line series impedance into a resistance and inductance equivalent
  - Lumps the line shunt capacitance into two capacitors at each end of the line



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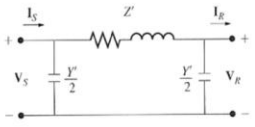
Long Length Line Model

- Used for
  - high-voltage overhead lines longer than ~150 mi
  - traveling wave calculations (e.g. lightning strike)
- Lump parameter model using a modified pi-equivalent
  - Derived from traveling wave equations for transmission lines
  - Uses propagation constant calculated from z and y (parameters per length)



$$\gamma = \sqrt{zy}$$

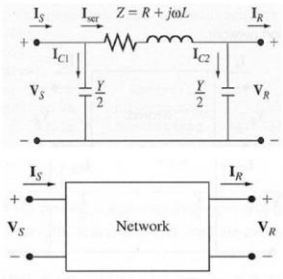
$$Z' = Z\,\frac{\sinh \gamma d}{\gamma d}$$

$$Y' = Y\,\frac{\tanh(\gamma d/2)}{\gamma d/2}$$

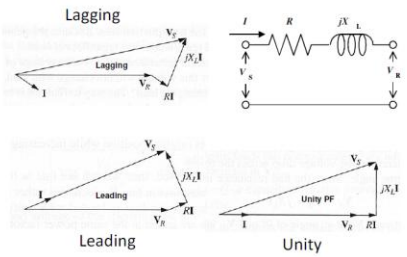
Two-Port Networks

- ABCD Model

$$\mathbf{V}_S = A\mathbf{V}_R + B\mathbf{I}_R$$
$$\mathbf{I}_S = C\mathbf{V}_R + D\mathbf{I}_R$$



Phasor Diagrams



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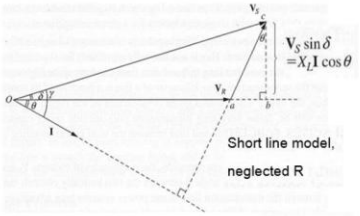

$$P = \frac{3V_S V_R \sin(\delta)}{X_L} \qquad P_{MAX} = \frac{3V_S V_R}{X_L} \text{ for } \delta = 90°$$

Typical operation: $\delta \le 25°$

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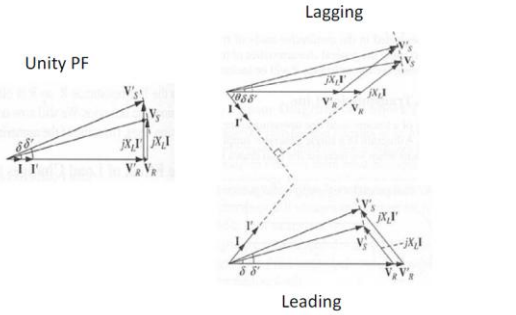

Part b: Lecture slides for SCS 3146-001 (Digital Systems and Computers).

SCS XXXX
Digital Systems and Computers

Module #8

Assembly Language

UNIVERSITY OF TORONTO
SCHOOL OF CONTINUING STUDIES

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Topics Covered

- Assembly Language
- General Purpose CPU Registers
- Program Counter (PC)
- Addressing Modes
- Direct Mode:
  - Immediate Mode
  - Register Mode
  - Absolute Mode
- Indirect Mode:
  - Register Indirect Mode
  - Autoincrement Mode
  - Autodecrement Mode.

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Topics Covered

- Useful Mnemonics: ORG, EQU, DC, DS
- Example of Adding Numbers
- Example of Finding Smallest and Largest
- Example of an Array of Integers

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Assembly Language

- Machine Language
  - Includes patterns of 0's and 1's that allows to manipulate a computer hardware.
  - It is difficult to work with a combination of 0's and 1's that computer hardware understands.
    - Hence, need a higher level language that is easier to work with.
- Assembly Language:
  - Uses symbolic names to represent patterns of 0's and 1's that machine understands and can implement
  - e.g. symbols like add, sub, move, …
    - These symbols ae called Mnemonics.

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General Purpose CPU Registers

- Faster access time (than accessing memory) since these registers are already residing inside the CPU.
- Since very few registers exists inside CPU than the size of the memory then fewer bits are required to address them in an operation.
  - Therefore,
    - Faster processing time.
    - Shorter instruction size
- M68000 has:
  - 8 data registers: D0, D1, …, D7
  - 8 address registers: a0, a1, …, a7

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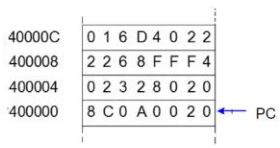
Program Counter (PC)

- Resides in CPU and holds the address of the next instruction to be executed.
- When initially a new program starts the address of the first instruction of that program is loaded into the PC
  - This address is used to fetch and execute one instruction at a time, in order of increasing addresses.
  - This is called Straight-Line Sequencing.



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Addressing Modes

- Refers to the way in which an operand of an instruction is specified.

Direct Mode:

- Gives either the operand or the address explicitly.

- Immediate Mode:
  - Operand is an immediate and is given in the instruction
  - Use notation #
  - e.g.

    add.b #99, d7

  - Use notation $ for Hex values
  - Use notation % for binary values

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Page 8

Direct Mode: Cont'd

- Register Mode:
  - Operand is in a CPU register and is given in the instruction.
  - e.g.

    add.b d5, d7

- Absolute Mode
  - Operand is a memory location
  - Address of memory location is given explicitly
  - e.g.

    add.b A, d0

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Page 9

Indirect Mode

- Instruction does not provide the operand or its address explicitly.
- Instead, it gives the effective address
  - The effective address of the operand is the contents of the register or memory location whose address appeared.

- Register Indirect Mode:
  - Effective address of operand is in and address register and is give in the instruction.
  - e.g.

    add.b (a6), d5

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Indirect Mode: Cont'd

- Autoincrement Mode:
  - The effective address of operand is the content of an address register.
  - After the operand is accessed the content of the address register is incremented.
  - e.g.

    add.w (a6)+, d5

- Autodecrement Mode:
  - First the content of the specified register is decremented.
  - Then the decremented address is the effective address of the operand.
  - e.g.

    add.w -(a6), d5

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Page 11

Useful Mnemonics

- ORG: origin
  - To indicate the start address of a block of instructions or data.
  - e.g.

    org $2000

- EQU: equal
  - To equate names with numerical values.
  - e.g.

    SRA equ $FFFFF7E3

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Page 12

Useful Mnemonics: Cont'd

- DC: Define/Declare constant
  - For declaring constant data
  - e.g.

    A dc.w 1, 2, 3, 4,5

- DS: Define Storage
  - To reserve a block of memory for storing information
  - e.g.

    B ds.w 100

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Example of Adding Numbers

- Read two numbers from memory and store the result back into the memory.
- For example, perform this high level language segment of code:

```
int     c, a, b;
a = 16;
b = 4;
c = a + b
```


Solution

```
        org     $2000
        move.w      a, d0
        move.w      b, d1
        add.w       d1, d0
        move.w      d0, c
        Trap    #15
a       dc.w    16
b       dc.w    4
c       ds.w    1
```


Example of Finding Smallest and Largest

- Write a 68k assembly language program that reads a sequence of N numbers from memory locations starting at $3000 and places the smallest and the largest values in the sequence in data registers d1 and d2 respectively.
- Write the complete program and the sequence required for a case of N = 4
- Note all data sizes and N are word-size

Solution

Example of an Array of Integers

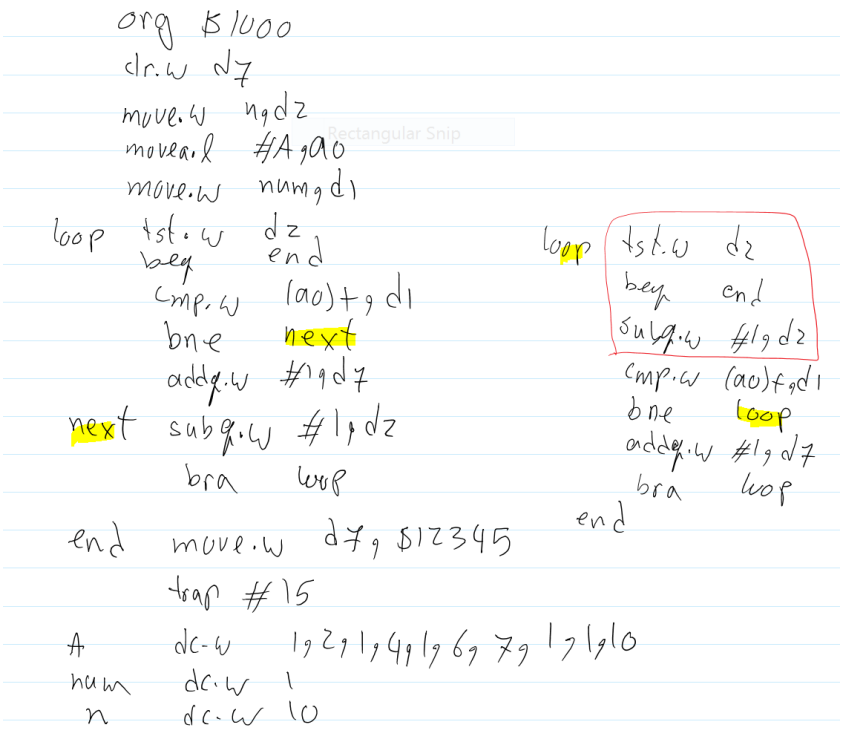
Write a M68000 assembly language program (No subroutine) that searches an array named ***A*** containing ***n*** word-sized integers for a given integer number called ***Num***. The program counts the number of times ***Num*** is repeated in array ***A*** and stores this value in memory location with address $12345.

The program also declares:

- Array ***A*** with contents of *1, 2, 1, 4, 1, 6, 7, 1, 1, 10*
- Word-sized ***n*** = 10
- ***Num*** = 1.

Solution

Solutions for each problem were also provided. The following is one of the solutions.



```
        org  $1000
        clr.w  d7
        move.w  n,d2
        movea.l  #A,a0
        move.w  num,d1
loop    tst.w  d2
        beq  end
        cmp.w  (a0)+,d1
        bne  next
        addq.w  #1,d7
next    subq.w  #1,d2
        bra  loop
end     move.w  d7,$12345
        trap  #15
A       dc.w  1,2,1,4,1,6,7,1,1,10
num     dc.w  1
n       dc.w  10
```

```
loop    tst.w  d2
        beq  end
        subq.w  #1,d2
        cmp.w  (a0)+,d1
        bne  loop
        addq.w  #1,d7
        bra  loop
end
```

Appendix G: CHALKBOARD MATERIALS

This appendix illustrates a sample of the material covered in ECE314 by employing chalkboard.