

ENGPYHS 2E04
Analog and Digital Circuits
Undergraduate Studies
Fall/Winter 2021/22
Course Outline

Current as of Thu 2021-08-19 13:29:37; see the course Forum for the most up-to-date version of this document

CALENDAR/COURSE DESCRIPTION

Design and analysis of analog and digital electrical circuits - component analysis, circuit analysis and theorems, binary numbers, Boolean analysis and digital circuit design.
Three lectures, one lab (three hours each); second term

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): PHYSICS 1E03 and registration in an Engineering program
Antirequisite(s): None

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Matt Minnick
BSB/B106
minnick@mcmaster.ca
ext. 24546

Office Hours:
All the time asynchronously via the course forum
Live via course forum during class time
Use the forum! :-)

LAB TECHNICIAN

Peter Jonasson
jonasso@mcmaster.ca
BSB/B102
Ext. 22657

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

See course forum for details.

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

Course Forum: Microsoft Teams

COURSE INTENDED LEARNING OUTCOMES

Upon successful completion of the course, you will be able to:

1. Analyze analog and digital electrical circuits;
2. Simulate analog and digital circuits using software-based tools;
3. Design, implement and test analog and digital electrical circuits using simulation software and laboratory measurement equipment.
4. Perform circuit measurements taking into account the specifications of electrical measuring equipment.

MATERIALS AND FEES

COMPUTER:

Students should have a laptop or Desktop capable of simultaneously running an equation solver (e.g., Maple, MATLAB, Python, etc.), a circuit solver (e.g., MultiSim, SPICE, etc.) and Microsoft Word (Windows machines are recommended, price point of \$300 or up should be fine). You are required to use this for the labs.

SOFTWARE:

MS Word (2007 or newer) & MS Teams (current version)
NI Multisim simulation software (ideally version 14 or newer)
Maple (Version 15 or higher) or another computer algebra system is recommended.

HARDWARE

1. Level 2 Hantek channel digital storage component kit. This includes a Hantek 3in1 scope bundled with extra probes, a breadboard, and a large number of analog and digital components. This is mandatory for ENGPYHS 2A04, 2E04, 3BA4, 3BB4, and 3L04, and potentially a big help (if not mandatory) in ENGPYHS 4A06, and 4US2, among other courses. However, you only need to buy it once, then buy specific circuit supplements for following courses.

2. ENGPYHS 2E04 circuit component supplement. This includes all the components you need (along with the Hantek kit) to complete the course deliverables. This should be included with the version that you purchased for ENGPYHS 2A04 if you took that course in fall 2020.

TEXTBOOKS:

Course notes available free online.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

Resources:

- Lecture notes & examples (online)
- Worked Example Practice Problems (online)
- Course videos explaining the notes & some practice problems each week (on [YouTube](#))
- The forum, where you can get help from me (Dr. Minnick), the lab tech (Peter Jonasson), the TAs, and most importantly each other

ENGPHYS 2E04 ("EP 2E04", "2E04") is a compulsory course taken in second semester of level 2 by all EP programs and all Mechatronics programs. The full topic list of the course is as follows:

1. Part 1: Analog circuits
 - a. DC Resistive Network Analysis (2 weeks)
 - i. Was Lab 1 in 2018 & 2019
 - b. AC Steady-State Network Analysis (2 weeks)
 - i. Was Lab 2 in 2018 & 2019
 - c. Transient Analysis (1 week)
 - i. Was Lab 3 in 2018 & 2019
 - d. Frequency Response & Filters (1 week)
 - i. Was Lab 4 in 2018 & 2019
 - e. AC Power (1 week)
 - i. Was Lab 5 in 2018 & 2019
2. Part 2: Digital circuits
 - a. Digital Logic Analysis & Design (2 weeks)
 - i. Was both Lab 6 & 7 together in 2018 & 2019
 - b. Sequential Logic Analysis & Finite State Machines (2 weeks)
 - i. Was Lab 8 in 2018 & 2019
 - c. Sequential Logic Design (Major Design Project, taking up final 1.4 weeks of term and due 1.6 weeks later)
 - i. Was the Design Project Lab in 2018 & 2019

Each topic has Course Notes, Example Practice Problems, and Video Lectures that guide you through the material. Besides that, students, the instructor, and TAs form a learning community of practice through the course forum and post many questions, answers, and tips to help work through and understand the content.

Students explore all topics using a "three-pronged" approach to electronics problem solving; students "Tri-Solve" all electronics problems by:

1. Completing an Analytical solution (with the help of computer algebra systems),
2. Simulating them (using NI Multisim software), and
3. Physically measuring them (by assembling the circuits on a breadboard, then powering them and measuring their results using a Hantek 2D42 3in1 Digital Oscilloscope Waveform Generator Multimeter).

The expectations for regular content weeks are as follows:

1. Work through all the topic's course notes, practice problems, and videos.
2. Then finally:
 - a. Create a variation of the sample lab circuit for that week which emphasizes the topics and is challenging, and Tri-Solve it.
 - b. Submit a writeup of
 - i. The circuit explaining how it works and their analytical solution method,
 1. (can use the multisim image as the circuit diagram, but should include a full analytical solution explanation including how to get the equations, even if they're solved using a CAS)
 - ii. Showing (via screen captures) and explaining a multisim solution (including any code as supplementary files),

1. We're going to support you in Multisim. If you want to use a different circuit analysis program (e.g., <http://qucs.sourceforge.net/>) you are welcome to do so as long as you still explain your solution using it. However, we will only be able to guarantee support for Multisim. Students using a Mac should plan extra time to get a Windows installation working to use Multisim:
 - a. <https://support.apple.com/en-ca/HT201468> - takes you through the process of setting up Boot Camp, the dual-booting manager for MacOS. Make sure you have enough space on your internal hard drive for the Windows partition!
 - b. To get a free copy of Windows 10, go to On the Hub: <https://mcmaster.onthehub.com/WebStore/Welcome.aspx> -Sign in with your McMaster email and password. Click the "Students" tab to find the Windows 10 license.
- iii. Showing (via photos) and explaining photos of their working circuit detailing output from their Hantek device, and the debugging approach they took to get it to its final state (if applicable), and
 1. Make sure the photo includes an image of your student card in the frame
 2. For the sequential logic topics (Topic 7 and the Design Project) also include a video of it working as part of the delivery
- iv. Analysis discussing on any agreement or disagreement between the three results.
- v. Reflection on the most important takeaways from this topic - where might you apply this in the future?

All submissions are due at 23:59 on Friday evenings. Just in case something goes wrong, everyone gets a 3-day grace period (as if they'd MSAF'd it) for every submission (without actually needing to submit an MSAF) and can hand it in as late as the following Monday evening at 23:59 without penalty (however, after that it's a 0, and support for the project will stop after Friday evening, so students should definitely treat Friday evening as the real deadline.)

If the circuit fails to work (can't be measured) due to equipment failure or otherwise, students can still get credit by documenting their attempts to debug the issue and submitting that as a detailed writeup as well. If given sufficient time, the department lab techs can also replace broken equipment.

For more marking details on the homeworks, see the EP2E04 Deliverable Rubric document on the course forum.

H5: ANALOG FINAL MINI-PROJECT

The final homework in the analog-half of the course serves as a mini-design project. This involves:

1. Completing a write-up of your circuit for the week's topic, just like you did the other homeworks H1-4. Here, you should also reflect on the circuit, task, and results in the context of all of the analog work in the course.
2. Creating a 3-5 minute video of you presenting your project and upload it to a streaming site (YouTube or equivalent). You should explain what your variation circuit is and what your task is (e.g., correct the power factor of this load network), then briefly explain the process you took to do this and confirm that it works analytically, with simulation, and with your physical build. Reflect on the meaning of this in the context of the analog work you did and beyond.

3. Having a 5-minute discussion about it with your TA. The TA will book a time with you during the week of November 1st-5th where you'll meet to answer questions and show off your mastery of the analog parts of the course.

For more marking details on H5, see the EP2E04 Deliverable Rubric document on the course forum.

FINAL DESIGN PROJECT (AKA FINAL PROJECT, AKA DIGITAL DESIGN PROJECT)

The final design project is a large digital design exercise: *use sequential logic design and a decoder chip to make a 7SD cycle through their student number.*

See the course forum for more details on the design project tasks, deliverables, and rubrics.

SELF-REFLECTION SURVEYS

At the start, middle, and end of the course students also submit a self-reflection survey to aid in their experiential learning. These surveys are required and due on certain dates. Surveys ask students to rate their current achievement level towards GA indicators and form one measurement of student achievement of those indicators (since student opinion of their abilities is highly correlated with their abilities).

PARTICIPATION BONUS

Participation in the course is key to success so to help you maximize your engagement in all aspects of the course there is an up-to-10% participation course weight replacement option. i.e., if your participation is excellent you'll get 10%; if it's good you'll get 7%, if it's OK you'll get 3%, and if it's poor you'll get 0%. Whatever % you get, it will replace that amount of your final grade with a 100% mark. e.g.,

Excellent participation: Grade = 10% + 90%*(rest of course grade)

OK participation: Grade = 3% + 97%*(rest of course grade)

Poor participation: Grade = rest of course grade (i.e., normal grading)

There are several ways to positively participate including:

1. Asking (and especially answering) meaningful honest questions in the forum to the best of your ability
2. Consistently attending classes and labs and positively participating (including having your camera on, working with groups in labs to tackle the content together, etc.)
3. Offering (and obtaining) live peer help in the class forum

You don't necessarily need to participate in all possible ways to achieve "good" or even "excellent" participation.

COURSE SCHEDULE

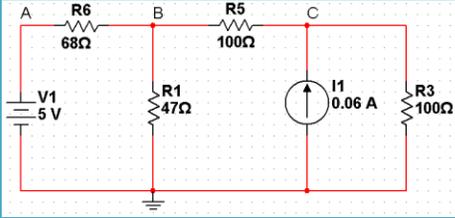
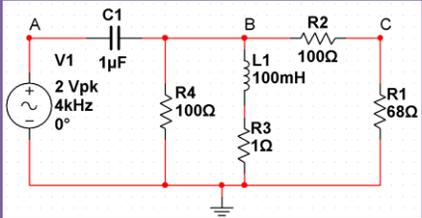
1. Monday 1330: Lecture
2. Wednesday 1330: Lecture
3. Thursday 1330: Lecture → TA Live Help Time

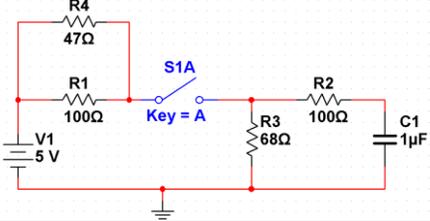
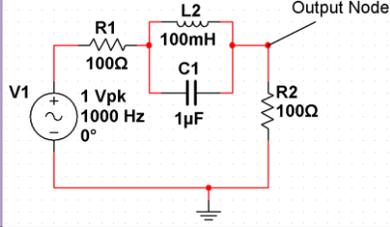
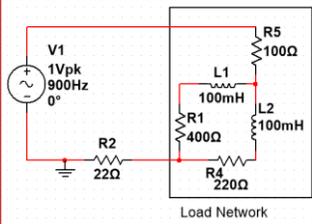
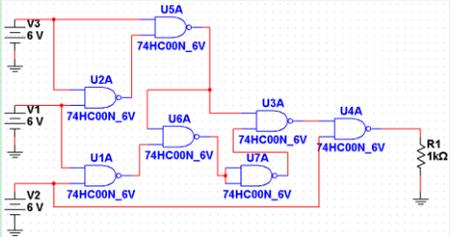
People have "labs" scheduled from 1430-1720 each day, but [after the first week] this is actually self-study time; you don't need to attend your lab day, and instead should use this time to finalize watching the asynchronous course videos and that guide you through the content for the topic and working on your topic assignment. However, every day from 1430-1720 there's a TA available via Teams for lab support and people will be there to give peer support as well.

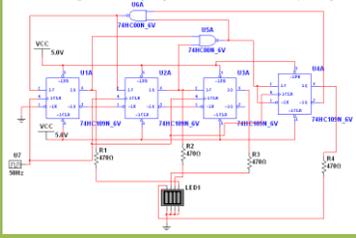
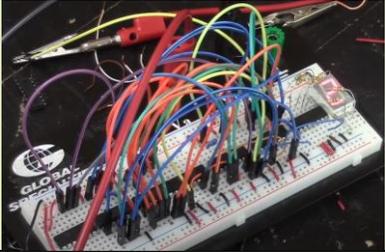
For the *first* lab you should show up in-person if possible to pick-up your lab kit and receive a brief introduction to its contents. In preparation, you must:

1. Complete the covid19 training: https://hr.mcmaster.ca/employees/health_safety_well-being/our-safety/health-and-safety-training/ (you only need to do this once)
2. Complete the covid19 screening: <https://covid19.mcmaster.ca/campus-health-safety/#tab-content-screening-process> (you need to do this before each time you return to campus)

If possible, it's also a good idea to watch as many of the topic 1 videos as possible, especially the lab kit component videos ([this one](#) and the following ones that cover the lab kit components.)

<u>Date</u>	<u>Topic</u>	<u>Due</u>	<u>Daily Activity</u>	
Mon 6 Sep	<p>1. DC Resistive Network Analysis</p> 		(Labour Day)	
Wed 8 Sep			Live Lecture	
Thu 9 Sep			TA Workshop	
Fri 10 Sep		S1		
Mon 13 Sep			Live Lecture	
Wed 15 Sep			Live Lecture	
Thu 16 Sep			TA Workshop	
Fri 17 Sep		(H1)		
Mon 20 Sep		<p>2. AC Steady-State Network Analysis</p> 		Live Lecture
Wed 22 Sep				Live Lecture
Thu 23 Sep			TA Workshop	
Fri 24 Sep				
Mon 27 Sep			Live Lecture	
Wed 29 Sep			Live Lecture	
Thu 30 Sep			TA Workshop	
Fri 1 Oct	H2			
Mon 4 Oct	<p>3. Transient Analysis</p>			Live Lecture
Wed 6 Oct				Live Lecture
Thu 7 Oct			TA Workshop	
Fri 8 Oct		H3		

Date	Topic	Due	Daily Activity
			
Mon 11 Oct	<p>Mid-term Recess</p>		
Wed 13 Oct			
Thu 14 Oct			
Fri 15 Oct			
Mon 18 Oct	<p style="text-align: center;">4. Frequency Response & Filters</p> 		Live Lecture
Wed 20 Oct			Live Lecture
Thu 21 Oct			TA Workshop
Fri 22 Oct		H4 + S2	
Mon 25 Oct	<p style="text-align: center;">5. AC Power</p> 		Live Lecture
Wed 27 Oct			Live Lecture
Thu 28 Oct			TA Workshop
Fri 29 Oct		*H5*	Analog Final H & Video due
Mon 1 Nov	<p style="text-align: center;">6. Digital Logic Analysis & Design</p> 		Live Lecture
Wed 3 Nov			Live Lecture
Thu 4 Nov			TA Workshop
Fri 5 Nov			
Mon 8 Nov			Live Lecture
Wed 10 Nov			Live Lecture
Thu 11 Nov			TA Workshop

<u>Date</u>	<u>Topic</u>	<u>Due</u>	<u>Daily Activity</u>
Fri 12 Nov		H6	
Mon 15 Nov	7. Sequential Logic Analysis & Finite State Machines 		Live Lecture
Wed 17 Nov			Live Lecture
Thu 18 Nov			TA Workshop
Fri 19 Nov			
Mon 22 Nov			Live Lecture
Wed 24 Nov			Live Lecture
Thu 25 Nov			TA Workshop
Fri 26 Nov			H7
Mon 29 Nov	Design Project: Sequential Logic Design 		Live Lecture
Wed 1 Dec			Live Lecture
Thu 2 Dec			TA Workshop
Fri 3 Dec			
Mon 6 Dec			Live Lecture
Wed 8 Dec		Live Lecture	
Fri 10 Dec	Design Project "Due"	DP&S3	

ASSESSMENT

Component	Weight
Analog	48%
H2-4	30% (10% each * 3) (H1 is optional)
H5 (Analog Final H, Vid, & Pres)	18%
Digital	49%
H6 & 7	20% (10% each *2)
Digital Design Project	29%
Self-Reflection Surveys	3% (1% each * 3)
Participation	Special Bonus
Total	100%

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's grade in the course.

Outcomes	Indicators
By learning techniques involved in Tri-Solving circuit problems, understands limits of physical measures, analytical work, and simulations	02.3 - Obtains substantiated conclusions as a result of a problem solution including recognizing the limitations of the solutions.
Uses appropriate analytical tools, simulation software, and measurement tools	03.2 - Selects appropriate model and methods and identifies assumptions and constraints.
Generates appropriate circuit extensions and solutions in design projects	04.3 - Proposes solutions to open-ended problems.

For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Engineering Physics is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

1. plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
2. improper collaboration in group work.
3. copying or using unauthorized aids in tests and examinations.

COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

This course has been universally-designed and has pre-included resources normally requiring academic accommodations into its design universally for everyone. In particular,

-All course content is delivered via both written notes and captioned videos explaining them, and
-Course assessments directly target essential requirements and allow all resources you would reasonably be expected to have in your career when doing similar tasks.

Because of this universal course design and true assessments of essential requirements, in most cases further academic accommodations are unnecessary, and students will not need to even identify to the instructor via SAS that they normally have any accommodation needs. However, it is possible that extreme circumstances could warrant additional accommodations in some regard this course design does not account for, in which case students should contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

It is the students' responsibility to regularly check the course forum for updates and announcements. Under normal circumstances, missed deadlines correspond to a reduction in grade as per the assessment section.

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

1. Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:
 - Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
 - Students may submit requests for relief using the MSAF once per term.
 - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
 - a. **Relief in this course means an extension on the due date of the deliverable(s) by 3 calendar days, and has been pre-allocated to everyone for every deliverable - no need to actually submit an MSAF.**
 - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
 - The MSAF cannot be used for academic work that has already been completed or attempted.
 - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
 - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.
2. For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:
 - Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
 - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.