

ENGPYHS 2E04
Analog and Digital Circuits
Undergraduate Studies
Fall/Winter 2020/21
Course Outline

Current as of Thu 2020-12-17 13:15:06; 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

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Ext. 22657

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

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8. Ahmed Hassanen hassanea@mcmaster.ca

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 ENGPHYS 2A04, 2E04, 3BA4, 3BB4, and 3L04, and potentially a big help (if not mandatory) in ENGPHYS 4A06, and 4US2, among other courses. However, you only need to buy it once, then buy specific circuit supplements for following courses.

2. ENGPHYS 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 ENGPHYS 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 (online)
- The forum, where you can get help from me, the TAs, and each other

ENGPYHS 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 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
- 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.

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.*

→ If your student number requires more than one breadboard you can either buy a breadboard or show why it requires 2 breadboards and then eliminate digits from the start of your student number until you can do it on one breadboard and do that instead.

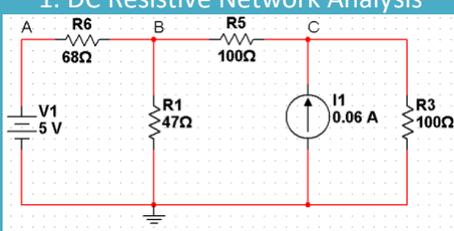
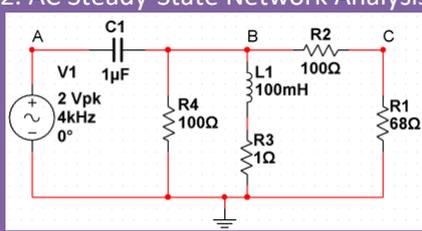
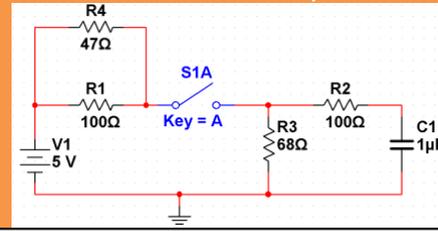
At the start, middle, and end of the course students also submit a self-reflection survey to aid in their experiential learning. These surveys are required and due on certain dates. Surveys ask students to rate their current achievement level towards GA indicators and form one measurement of student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

Supplementary files for 2E04 contain all course content: all course notes, sample practice problems, the outline, explanations of deliverables (including the survey questions), and even **forum posts giving questions and answers for student questions**. All videos are available via links to allow visitors to watch them.

COURSE SCHEDULE

1. Monday 1030: Lecture
2. Wednesday 1030: Lecture
3. Thursday 1030: Lecture → TA Live Help Time

People have "labs" scheduled from 1430-1720 each day, but this is self-study; 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.

Date	Topic	Due	Daily Activity
Mon 11 Jan	<p>1. DC Resistive Network Analysis</p> 		Live Lecture
Wed 13 Jan			Live Lecture
Thu 14 Jan			TA Workshop
Fri 15 Jan			S1
Mon 18 Jan			Live Lecture
Wed 20 Jan			Live Lecture
Thu 21 Jan			TA Workshop
Fri 22 Jan			H1
Mon 25 Jan	<p>2. AC Steady-State Network Analysis</p> 		Live Lecture
Wed 27 Jan			Live Lecture
Thu 28 Jan			TA Workshop
Fri 29 Jan			
Mon 1 Feb			Live Lecture
Wed 3 Feb			Live Lecture
Thu 4 Feb			TA Workshop
Fri 5 Feb		H2	
Mon 8 Feb	<p>3. Transient Analysis</p> 		Live Lecture
Wed 10 Feb			Live Lecture
Thu 11 Feb			TA Workshop
Fri 12 Feb			H3
Mon 15 Feb			
Wed 17 Feb	Mid-term Recess		
Thu 18 Feb			
Fri 19 Feb			
Mon 22 Feb		4. Frequency Response & Filters	

Date	Topic	Due	Daily Activity
Wed 24 Feb			Live Lecture
Thu 25 Feb			TA Workshop
Fri 26 Feb		H4	
Mon 1 Mar	5. AC Power		Live Lecture
Wed 3 Mar			Live Lecture
Thu 4 Mar			TA Workshop
Fri 5 Mar		H5	
Mon 8 Mar	6. Digital Logic Analysis & Design		Live Lecture
Wed 10 Mar			Live Lecture
Thu 11 Mar			TA Workshop
Fri 12 Mar			
Mon 15 Mar			Live Lecture
Wed 17 Mar			Live Lecture
Thu 18 Mar			TA Workshop
Fri 19 Mar		H6	
Mon 22 Mar	7. Sequential Logic Analysis & Finite State Machines		Live Lecture
Wed 24 Mar			Live Lecture
Thu 25 Mar			TA Workshop
Fri 26 Mar			
Mon 29 Mar			Live Lecture
Wed 31 Mar			Live Lecture
Thu 1 Apr			TA Workshop
Fri 2 Apr		Good Friday - no lab	
Mon 5 Apr	Design Project: Sequential Logic Design		Live Lecture
Wed 7 Apr			Live Lecture
Thu 8 Apr			TA Workshop
Fri 9 Apr			
Mon 12 Apr			Live Lecture
Wed 14 Apr			Live Lecture

<u>Date</u>	<u>Topic</u>	<u>Due</u>	<u>Daily Activity</u>
Fri 23 Apr	Design Project "Due"	DP&S3	

ASSESSMENT

Component	Weight
Content Week Deliverables	70% (10% each * 7)
Self-Reflection Surveys	3% (1% each * 3)
Design Project	27%
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.