Toronto Metropolitan University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Outline (W2024)

ELE404: Electronic Circuits I

Instructor(s)	Dr. Fei Yuan [Coordinator] Office: ENG433 Phone: (416) 979-5000 x 556100 Email: fyuan@torontomu.ca Office Hours: Thur. 2-3 pm via ZOOM
Calendar Description	Introduction to electronics, diodes, linear and non-linear circuit applications. Bipolar junction and field-effect transistors: physical structures and modes of operation. DC analysis of transistor circuits. The CMOS inverter. The transistor as an amplifier and as a switch. Transistor amplifiers: small signal models, biasing of discrete circuits, and single-stage amplifier circuits. Biasing of BJT integrated circuits. Multi-stage and differential amplifiers. Current sources and current mirrors. Important concepts are illustrated with structured lab experiments and through the use of Electronic workbench circuit simulations.
Prerequisites	ELE 302 and MTH 312 and PCS 224
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. A.Sedra, K.Smith, T. Carusone, and V. Gaunet, Microelectronic Circuits, 8th edition, Oxford University Press, 2020.
Reference Text(s):	
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. Use fundamental knowledge of electric circuits to predict and understand the behavior of electronic circuits and amplifiers. (**1c**) 2. Apply engineering techniques and conduct computations to analyze and solve electronic circuit problems. (**2b**) 3. Transform functional objectives and requirements defined for an electronic circuit into candidate designs for the circuit. (**4b**) 4. Propose, evaluate, and rank the candidate circuit designs. Select the most suitable design from the candidates and understand and practice iterations in the design process. (**4c**) 5. Learn to verify and validate experimental results obtained in the labs and relating them to the theoretical nature of the electronic circuits under test, by comparing the experimental results with analysis techniques introduced in the lectures as well as computer simulation results. (**5b**) **NOTE:***Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).*

Course Organization	4.0 hours of lecture per week for 13 weeks 2.0 hours of lab per week for 12 weeks 0.0 hours of tutorial per week for 12 weeks
Teaching Assistants	1. Mon 1) 4-6 pm (sec.16): Bhagawat Adhikari (b3adhika@torontomu.ca) 2. Tue 1) 8-10 am (sec.5): David Wu (wenhao.wu@torontomu.ca) 2) 10-12 noon (sec.3): Anahita Abbasnejad Seresti (aseresti@torontomu.ca) 3) 3-5 pm (sec.17): Anahita Abbasnejad Seresti (aseresti@torontomu.ca) 3. Wed. 1) 8-10 am (sec.13): Bhagawat Adhikari (b3adhika@torontomu.ca) 2) 10-12 noon (sec.12): Bhagawat Adhikari(b3adhika@torontomu.ca) 3) 10-12 noon (sec.14): Bhagawat Adhikari(b3adhika@torontomu.ca) 4) 4-6 pm (sec.15): Shirin Hosseini (shirin.hosseini@torontomu.ca) 4. Thur. 1) 8-10 am (sec.11): Hanish Ashrafirad (hanieh.ashrafirad@torontomu.ca) 2) 10-12 pm (sec.4): Hanish Ashrafirad (hanieh.ashrafirad@torontomu.ca) 3) 12-2 pm (sec.8): Md Nooruzzaman (md.nooruzzaman@torontomu.ca) 4) 2-4 pm (sec.7): Md Nooruzzaman (md.nooruzzaman@torontomu.ca) 5) 4-6 pm (sec.9): Md Nooruzzaman(md.nooruzzaman@torontomu.ca) 5. Fri 1) 8-10 am (sec.2): Mohammadreza Maleki (mohammadreza1.maleki@torontomu.ca) 2) 10-12 pm (sec.6): Mohammadreza Maleki (mohammadreza1.maleki@torontomu.ca) 3) 12-2 pm (sec.10): Hanieh Ashrafirad (hanieh.ashrafirad@torontomu.ca) 4) 2-4 pm (sec.1): Hanieh Ashrafirad (hanieh.ashrafirad@torontomu.ca)
Course Evaluation	

Theory	
Midterm Exam.	30 %
Final Exam	40 %
Laboratory	
Design Project	9 %
Labs (7 labs, 3% each).	21 %
TOTAL:	100 %

Note: In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both **"Theory and Laboratory"** components, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the **"Course Evaluation"** section above for details on the Theory and Laboratory components (if applicable).

Examinations	1. Midterm Exam will be a 2-hour closed-book examination during regular lecture time on Feb. 28 (2-4 pm). 2. Final Exam will be a 3-hour closed-book examination. Only course materials covered AFTER the midterm exam will be tested. The date and time of the final examination will be set by the university.
Other Evaluation Information	None
Teaching Methods	1) Drawboard-PDF tools from Microsoft / in-classroom multimedia teaching facilities will be used for teaching. 2) Pre-lecture notes in pdf will be distributed to students before lectures via D2L. 3) Post-lecture notes in pdf containing materials added in lectures will be distributed to students after lectures via D2L.
Other Information	None

Course Content

Week	Hours	Chapters / Section	Topic, description
1/2	8	Ch.3, Ch.4	Module 1 : Diodes and their applications 1.1 Intrinsic semiconductors 1.2 Doped semiconductors 1.3 Currents in semiconductors - Drift current - Diffusion current 1.4 pn junctions - Structure of pn junctions - Width of pn junctions - Current of pn junctions - Reverse pn junction breakdown 1.5 Ideal diodes 1.6 pn junction diodes 1.7 Applications of diodes - Half-wave rectifiers - Full-wave rectifiers - Full-wave bridge rectifiers - Voltage regulators
3/4	6	Ch.6	Module 2 - Bipolar junction transistors (BJTs) 2.1 Structure of BJT 2.2 Symbols of BJT 2.3 Operation of BJT - pn-junctions - Cut-off mode

			- Active mode - Saturation mode 2.4 Small-signal equivalent circuit of BJT

4/5/6	10	Ch.7, Ch.8, Ch.10	Module 3 - BJT voltage amplifiers
			
			3.1 Load line and maximum signal swing
			3.2 Common-emitter (CE) amplifiers
			  - CE amplifiers with a resistor load
			  - CE amplifiers with a current-source load
			3.3 Common-base (CB) amplifiers
			  - CB amplifiers with a resistor load
			  - CB amplifiers with a current-source load
			3.4 Common-collector (CC) amplifiers (emitter followers)
			  - Emitter followers with a resistor load
			  - Emitter followers with a current-source load
			3.5 Multi-stage amplifiers
			3.6 Current mirrors
			3.7 Design considerations of BJT voltage amplifiers

7/8	8	Ch.5	Module 4 - Metal-oxide-silicon field-effect transistors (MOSFETs)
			
			4.1 Structure of MOSFET
			4.2 Symbols of MOSFET
			4.3 Operation of MOSFET
			  - pn-junctions
			  - Cut-off
			  - Inversion
			  - Triode
			  - Pinch-off
			  - Saturation
			4.4 Small-signal equivalent circuit of MOSFET

9/10/11	8	Ch.7, Ch.8, Ch.10	Module 5 - MOSFET voltage amplifiers
			
			5.1 Load line and maximum signal swing
			5.2 Common-source (CS) amplifiers
			  - CS amplifiers with a resistor load
			  - CS amplifiers with a current-source load
			5.3 Common-gate (CG) amplifiers
			  - CG amplifiers with a resistor load
			  - CG amplifiers with a current-source load
			5.4 Common-drain (CD) amplifiers (source followers)
			  - CD amplifiers with a resistor load
			  - CD amplifiers with a current-source load
			5.5 Multi-stage amplifiers
			5.6 Current mirrors
			5.7 Design considerations of MOSFET voltage amplifiers

12/13	8	Ch.9	Module 6 - Differential MOSFET voltage amplifiers

6.1 Why differential ?
6.2 Single-ended signaling versus differential signaling
6.3 Differential voltage gain
6.4 Differential-input single-ended-output amplifiers
6.5 Rejection of supply and ground disturbances
6.6 Common-mode voltage gain
6.7 Slew rate
6.8 Mismatch
6.9 Common-mode input voltage range
6.0 Design considerations of differential MOSFET voltage amplifiers

Laboratory(L)/Tutorials(T)/Activity(A) Schedule

Week	L/T/A	Description
1 (1.8-1.12)	No lab	No lab in week 1.
2 (1.15-1.19)	No lab	No lab in week 2.
3 (1.22-1.26)	Lab 1	Diodes. Lab report due: 11:59 pm of Feb. 4. Submit lab report to D2L.
4 (1.29-2.2)	Lab 2	Voltage regulators. Lab report due: 11:59 pm of Feb. 11. Submit lab report to D2L.
5 (2.5-2.9)	Lab 3	Bridge rectifiers. Lab report due: 11:59 pm of Feb. 18. Submit lab report to D2L.
6 (2.12-2.16)	Lab 4	Wave-shaping circuits. Lab report due: 11:59 pm of Mar. 3. Submit lab report to D2L.
7 (2.19-2.23)	Study week	Study week. No labs.
8 (2.28-3.4)	Midterm exam	Midterm exam. (Feb. 28, 2-hr in-person closed-book exam). No lab.
9 (3.4-3.8)	Lab 5	Common-emitter amplifier. Lab report due: 11:59 pm of Mar. 17. Submit lab report to D2L.

10 (3.11-3.15)	Lab 6	Common-base amplifier. Lab report due: 11:59 pm. of Mar. 24. Submit lab report to D2L.
11 (3.18-3.22)	Lab 7	Common-collector amplifier. Lab report due: 11:59 pm of Mar. 31. Submit lab report to D2L.
12 (3.25-3.29)	Project	Design project (simulation only). TA will be available via ZOOM during your scheduled lab session.
13 (4.1-4.5)	Project	Design project (simulation only). TA will be available via ZOOM during your scheduled lab session. Project report due: 11:59 pm of April 7. Submit project report to D2L.

University Policies & Important Information

Students are reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on the Senate website

Refer to the Departmental FAQ page for furhter information on common questions.

Important Resources Available at Toronto Metropolitan University

- The Library provides research workshops and individual assistance. If the University is open, there is a Research Help desk on the second floor of the library, or students can use the Library's virtual research help service to speak with a librarian.
- Student Life and Learning Support offers group-based and individual help with writing, math, study skills, and transition support, as well as resources and checklists to support students as online learners.

- You can submit an Academic Consideration Request when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may always visit the Senate website and select the blue radio button on the top right hand side entitled: **Academic Consideration Request (ACR)** to submit this request.

  For Extenuating Circumstances, Policy 167: Academic Consideration allows for a once per semester ACR request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. Absences more than 3 days in duration and those that involve a final exam/final assessment, require documentation. Students must notify their instructor once a request for academic consideration is submitted. See Senate Policy 167: Academic Consideration.

- If a student is requesting accommodation due to a religious, Aboriginal and/or spiritual observance, they must submit their request via the online Academic Consideration Request (ACR) system **within the first two weeks of the class or, for a final examination, within two weeks of the posting of the examination schedule**. If the required absence occurs within the first two weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these requests should be submitted with as much lead time as possible in advance of the required absence.

- If taking a remote course, familiarize yourself with the tools you will need to use for remote learning. The Remote Learning Guide for students includes guides to completing quizzes or exams in D2L Brightspace, with or without Respondus LockDown Browser and Monitor, using D2L Brightspace, joining online meetings or lectures, and collaborating with the Google Suite.
- Information on Copyright for Faculty and students.

Accessibility

- Similar to an [accessibility statement,](#) use this section to describe your commitment to making this course accessible to students with disabilities. Improving the accessibility of your course helps minimize the need for accommodation.
- Outline any technologies used in this course and any known accessibility features or barriers (if applicable).
- Describe how a student should contact you if they discover an accessibility barrier with any course materials or technologies.

Academic Accommodation Support

Academic Accommodation Support (AAS) is the university's disability services office. AAS works directly with incoming and returning students looking for help with their academic accommodations. AAS works with any student who requires academic accommodation regardless of program or course load.

- Learn more about [Academic Accommodation Support](#).
- Learn [how to register with AAS](#).

Academic Accommodations (for students with disabilities) and Academic Consideration (for students faced with extenuating circumstances that can include short-term health issues) are governed by two different university policies. Learn more about [Academic Accommodations versus Academic Consideration and how to access each](#).

Wellbeing Support

At Toronto Metropolitan University, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge, especially in those times of crisis.

If you are experiencing a mental health crisis, please call 911 and go to the nearest hospital emergency room. You can also access these outside resources at anytime:

- **Distress Line:** 24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk:** 24/7-hour line for postsecondary students (phone: 1-866-925-5454)
- **Keep.meSAFE:** 24/7 access to confidential support through counsellors via [My SSP app](#) or 1-844-451-9700

If non-crisis support is needed, you can access these campus resources:

- **Centre for Student Development and Counselling:** 416-979-5195 or email csdc@torontomu.ca
- **Consent Comes First - Office of Sexual Violence Support and Education:** 416-919-5000 ext 3596 or email osvse@torontomu.ca
- **Medical Centre:** call (416) 979-5070 to book an appointment

We encourage all Toronto Metropolitan University community members to access available resources to ensure support is reachable. You can find more resources available through the [Toronto Metropolitan University Mental Health and Wellbeing](#) website.