

Department of Electrical and Computer Engineering

ECED 4260/Credit Hours: 3/IC Design and Fabrication

Fall 2022/2023

Lectures (Mon. & Wed. 11:35-12:55); **Tutorial / Lab** (Mon. 14:35-17:25)

Office Hour Wed. 13:00-15:00 C314

Course Website: mems.ece.dal.ca/eced4260.php

Instructor: Yuan Ma (Email: Yuan.Ma@Dal.Ca)

Individual meetings can be scheduled by appointment via email. In any email regarding this course, please include “ECED 4260” in the subject, and I will make every attempt to reply to your email within 24 hours except the weekends.

TA/Marker	Avinash Mishra	Email:	Av470402@dal.ca
-----------	----------------	--------	-----------------

Course Description

Design and modelling of RTL (Register Transfer Level) digital system are introduced using hardware description languages VHDL and Verilog. Subsystem design of arithmetic circuits, ROM, RAM and FSMs will be examined and implemented with Field Programmable Gate Arrays (FPGA) training board DE1-SoC. Performance analysis, optimization, faults, and testability will also be discussed. Extensive use of CAD tools will give the student hands-on experience with systems typical of those used in industry. The theory of MOS transistors is reviewed and their fabrication technologies are presented with an emphasis on CMOS circuit fabrication.

Course Pre-requisites, Co-requisites and/or other Restrictions

ECED 2200 Digital Circuits, and ECED 3201 Introduction to Electronics

Course Learning Outcomes

Upon completion of this course, you should be able to:

- Understand and apply classical sequential logic design in general digital circuits;
- Demonstrate use of hardware description language using computer aided tool such as Intel Quartus Prime and ModelSim;
- Design and test RTL (Register Transfer level) digital system;
- Apply the solution of fast addition and multiplication to binary numbers;
- Demonstrate independent learning skills.

Recommended Text(s)

Peter J. Ashenden, The Student’s Guide to VHDL, and The Designer’s Guide to VHDL

M. Morris Mano, Digital Design with an Introduction to the Verilog HDL, VHDL and SystemVerilog

Pong P. Chu, RTL Hardware Design Using VHDL

Experiment Kit (provided for in-person labs): Intel DE1-SoC board

Course Schedule

An important part of the course is to develop RTL design skills through lectures and labs. Four tutorials, three labs and one project are designed for this purpose. Please refer to the course website for tutorial/lab procedures.

	Focus Topic	Tutorial/Lab Activities	Assessments
1	Introduction	-----	-----
2	HDL and FPGA introduction	Tutorial A. Quartus Prime	Tutorial A, Assignment 1
3	HDL description & RTL design	(University closed)	
4	Logic simulation and testbench	(University closed)	
5	Arithmetic circuits – Fast Adder	Tutorial B. ModelSim simulator	Tutorial B, Assignment 2
6	Midterm review, FSM HDL	(Thanksgiving)	
7	Multiplier and Divider	Tutorial C. Testbench	Tutorial C, Quiz 1
8	Fixed vs Floating-point numbers	Lab 3. Multiplier and FSM	Lab 3, Assignment 3
9	Timing and IP cores	Tutorial D. Timing Analyzer	Tutorial D, Assignment 4
10	-----	-----	-----
11	MOSFET & microfabrication	Tutorial E. SignalTap Analyzer	Tutorial E
12	Vending Machine Example	(optional) Lab Q&A	Assignment 5
13	Digital system testing	Lab test	-----
14	Final review	-----	Quiz 2

Course Assessments

Components of your grade include assignment, tutorial and lab submissions, quizzes, an RTL design project, and a lab test. Any missed academic work without an approved *Request for Accommodation* from the Dean's office will be given a grade of 0 (zero). Please refer to <http://forms.engineering.dal.ca/> for active policy on **absence reporting**. Please note that there will be **no** supplemental exams for this course; the weight of any approved accommodation on quizzes will be put on the rest of the course work.

Assignments (17.5%): Five assignments will be set and evaluated as part of the learning process. Unless specifically indicated, every assignment is to be completed independently.

Tutorial and Labs (25%): Please refer to the course website for the schedule and requirement of tutorial/lab submissions. Students are recommended to download the Intel Quartus Prime software onto their own computers. The instruction for downloading the software and the user guides of the FPGA programming boards used in the lab can be found on the course website.

Quizzes (15% + 22.5 %): Two 80-minutes quizzes will be scheduled to evaluate the learning outcomes of the courses. The quiz with a better grade will be counted with the 22.5% weight.

Lab test (20%): There will be a 1.5-hour lab test near the end of the term, including design, simulation, and implementation of an RTL digital circuit using HDL and FPGA board.

Associate Deans Office – Undergraduate Studies

Associate Dean: Dr. Timothy Little timothy.little@dal.ca

Undergraduate Office Coordinator: Jason Lecoure Jason.lecoure@dal.ca

Student Success Coordinator: Karyn Hemsworth Karyn.hemsworth@dal.ca

General Inquires: engineering@dal.ca or (902) 494-2963

Dalhousie Engineering Student Oath

I, as one who is preparing to enter the profession of engineering, promise to conduct myself in an honorable and ethical manner, and, as such, I will not cheat, plagiarize or be involved in any other academically dishonest activities. I shall uphold the values of truth, honesty and trustworthiness. I shall study diligently so that I will be able to safeguard human life, to protect the welfare of society and the environment, and to uphold the reputation of the profession. In all this I shall be concerned for the well-being of others, and not just myself.

University Policies, Statements, Guidelines and Resources for Support

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate. <https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog>

University Statements

- Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (*The Center for Academic Integrity, Duke University, 1999*). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

http://www.dal.ca/dept/university_secretariat/academic-integrity.html

- Accessibility

The Advising and Access Centre and the Student Success Centre (Agricultural Campus) serve as Dalhousie's centres for expertise on student accessibility and accommodation. Our work is governed by Dalhousie's Student Accommodation Policy to best support the needs of Dalhousie students. Our team work with students who request accommodation as a result of: disability, religious obligation, an experienced barrier related to any other characteristic protected under Canadian Human Rights legislation.

https://www.dal.ca/campus_life/academic-support/accessibility.html

- Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/student-life-policies/code-of-student-conduct.html

- Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported.

<http://www.dal.ca/cultureofrespect.html>

- Recognition of Mi'kmaq Territory
Dalhousie University acknowledges that the University is located on Traditional Mi'kmaq Territory.

The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit the office in the McCain Building (room 3037) contact the programs at elders@dal.ca or 902-494-6803.

University Policies and Programs

- Important Dates in the Academic Year (including add/drop dates)
http://www.dal.ca/academics/important_dates.html
- University Grading Practices: Statement of Principles and Procedures
https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html
- Scent-Free Program <http://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>
- Faculty Information: Student Self-Declaration of Absence
<http://forms.engineering.dal.ca/>

Learning and Support Resources

- General Academic Support – Advising
Halifax: https://www.dal.ca/campus_life/academic-support/advising.html
Truro: <https://www.dal.ca/about-dal/agricultural-campus/student-success-centre/academic-support.html>
- Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/guidelines/fair-dealing-guidelines.html>
- Black Students https://www.dal.ca/campus_life/communities/black-student-advising.html
- International Students https://www.dal.ca/campus_life/international-centre.html
- Indigenous Students https://www.dal.ca/campus_life/communities/indigenous.html
- Library <http://libraries.dal.ca>
- Copyright Office <https://libraries.dal.ca/services/copyright-office.html>
- E-Learning website <http://www.dal.ca/dept/elearning.html>
- Writing Centre https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html
- Faculty or Departmental Advising Support: Studying for Success Program
http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html
- Student Finance page: https://www.dal.ca/admissions/money_matters.html

Student Health and Wellness Resources

- Student Health and Wellness https://www.dal.ca/campus_life/health-and-wellness/services-support.html
- Student Services @ Sexton https://www.dal.ca/campus_life/academic-support/student-services-sexton.html
- Online Resources for Students https://www.dal.ca/campus_life/health-and-wellness/online-resources.html

Safety

- Biosafety (<http://www.dal.ca/dept/safety/programs-services/biosafety.html>)
- Research Laboratory Safety Policy Manual (<http://www.dal.ca/dept/safety/documents-policies-procedures.html>)
- Laboratory Chemical Safety Manual <http://www.dal.ca/dept/safety/programs-services/chemical-safety.html>
- Radiation Safety Manual <http://www.dal.ca/dept/safety/programs-services/radiation-safety.html>