



ENGG*4560 Embedded System Design

01

Winter 2020

Section(s): C01

School of Engineering

Credit Weight: 0.75

Version 1.00 - January 05, 2020

1 Course Details

1.1 Calendar Description

This course introduces the basic principles of embedded system design. It utilizes advanced hardware/software abstractions to help design complex systems. Topics include: design of embedded CUPs; embedded architecture cores; system-on-chip designs and integration using processor cores and dedicated core modules; embedded computing platforms; embedded programming design and analysis; processes and operating systems; networks for embedded systems; distributed embedded architectures; design examples that target robotics, automobile, and communication systems.

Pre-Requisites: ENGG*3380 or ENGG*3640

1.2 Course Description

This course is a senior level course in electrical and computer engineering and introduces basic principles of embedded systems design. Topics include: hardware description language for design and simulation; system-on-chip design and integration using processor cores and dedicated core modules; on-chip busses; hardware/software interfaces; coprocessor design; embedded computing platforms; security for embedded systems; design examples.

1.3 Timetable

Lectures

Monday Sec 01 8:30 am – 9:50 am RICH 2531

Wednesday Sec 01 8:30 am – 9:50 am RICH 2531

Laboratory

Wednesday Sec 01 3:30 pm – 6:20 pm RICH 2531/RICH 1532

1.4 Final Exam

Final Exam: 40%

April 17th, 2020: 7:00 pm – 9:00 pm, Room TBA

2 Instructional Support

2.1 Instructional Support Team

Instructor: Radu Muresan Ph.D., P.Eng.
Email: rmuresan@uoguelph.ca
Telephone: +1-519-824-4120 x56730
Office: RICH 2509
Office Hours: Friday: 3 pm - 5 pm
 Students can come for consultations during my office hours or can make an appointment as necessary

Lab Technician: Kevin Dong
Email: kdong@uoguelph.ca
Office: RICH 2506

3 Learning Resources

3.1 Required Resources

Course Website (Website)

Course material, news, announcements, and grades will be regularly posted to the ENGG*4560 CourseLink site. You are responsible for checking the sites regularly.

[1] ENGG4560 Lecture E-Notes (Notes)

Radu Muresan, University of Guelph

[2] A Practical Introduction to Hardware/Software Codesign (Textbook)

P. R. Schaumont, Springer, 2010.

[3] The Block Cipher Companion (Textbook)

L. R. Knudsen, M. J. B Robshaw, Springer 2011

[4] Verilog for Digital Design (Textbook)

F. Vahid, R. Lysecky, Wiley, 2007.

[5] GEZEL (Website)

<http://www.islab.soe.uoguelph.ca/rijndael.ece.vt.edu/gezel2/index.html>

[6] ENGG4560 Lab Manual, W19 Version (Lab Manual)

University of Guelph, CourseLink Resource

3.2 Additional Resources

Design through Verilog HDL (Textbook)

T. Padmanabhan, B. Sundari, Wiley, 2004.

Computer System Design, System-on-Chip (Textbook)

M. J. Flynn, W. Luk, Wiley, 2011

Additional Resources (Other)

Lecture Information: All lecture notes are posted on the ENGG*4560 CourseLink system (Week #1 to Week #12) under LECTURES module.

Lab Information: The ENGG*4560 Embedded Systems Design Lab Manual is posted on the ENGG*4560 CourseLink system under the LABORATORY module.

Assignments: Course material assignments are introduced throughout the lecture notes.

Exams: Some example solutions of previous final exams will be posted on the ENGG*4560 CourseLink system under the EXAM SOLUTIONS section.

Miscellaneous Information: Other information related to embedded systems design will be posted on the web page.

4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Use of mainstream HDL such as Verilog, VHDL, or SystemC
2. Use of open source cycle-based HDL GEZEL
3. Design simple system-on-chip components using HDL
4. Design complex system-on-chip applications with hardware processor and FPGA cores (DE1-SOC Architecture)
5. System-on-chip design concepts
6. On-chip busses
7. Design Hardware/Software Interfaces
8. Coprocessor design concepts and example applications
9. Design security components for embedded systems
10. Explore and present new research results in the field of embedded systems design through reports and presentations

11. Use of embedded systems design tools

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	5, 6, 7, 8, 9
1.4	Recall, describe and apply program-specific engineering principles and concepts	5, 6, 7, 8, 9
2	Problem Analysis	1, 2, 3, 4, 5, 6, 7, 8, 9, 11
2.3	Construct a conceptual framework and select an appropriate solution approach	1, 11
2.4	Execute an engineering solution	1, 2, 3, 4, 5, 6, 7, 8, 9, 11
4	Design	1, 3, 4, 5, 6, 7, 8, 9, 11
4.3	Create a variety of engineering design solutions	1, 3, 4, 5, 6, 7, 8, 9, 11
5	Use of Engineering Tools	1, 2, 3, 4, 11
5.2	Demonstrate proficiency in the application of selected engineering tools	1, 2, 3, 4, 11
7	Communication Skills	10
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	10
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	10
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	10
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	10
7.5	Demonstrate ability to process oral and written communication by	10

#	Outcome	Learning Outcome
	following instructions, actively listening, incorporating feedback, and formulating meaningful questions	

5 Teaching and Learning Activities

5.1 Lecture

Week 1-2

Topics: HDL Basics, Verilog

References: [1], [4]

Learning Outcome: 1, 3

Week 3

Topics: DE1-SOC Architecture

References: [1], [6]

Learning Outcome: 5

Week 4

Topics: GEZEL Basics

References: [1], [5]

Learning Outcome: 2, 3

Week 5-8

Topics: Embedded systems design, system-on-chip design concepts:

1. Introduction

2. On-Chip Busses

3. Design Hardware/Software Interfaces

4. Coprocessor Control Shell Design

5. Applications: Trivium Crypto-Coprocessor; CORDIC Coprocessor

References: [1], [2]

Learning Outcome: 5, 6, 7, 8, 9

Week 9-11

Topics: Embedded systems design, security concepts:

1. Block ciphers
2. 3-DES, AES ciphers
3. Using block ciphers
4. Security attacks

References: [1], [3]

Learning Outcome: 9

Week 12

Topics: Research presentations and discussions

Learning Outcome: 10

5.2 Lab

Topics: 1. Lab1/Tutorial 1: Quartus Software Tools

References: [6]

Learning Outcome: 3, 4, 11
SOC design tutorial plus FPGA component implementation

Week 2: Demo Due

Topics: Lab2: Digital Design with Verilog HDL

References: [6]

Learning Outcome: 3, 4, 11
Week 4: Demo Due

Topics: Lab3/Tutorial3: SOC Design with HPS and FPGA

References: [6]

Learning Outcome: 3, 4, 11
Week 6: Demo Due

Topics: Project: Embedded system design implementation using
FPGA coprocessor

References: [6]

Learning Outcome: 4, 7, 8, 9, 11
The project component includes a demo of the implementation and a final complete report

Week 8: Progress Design Demo Due

Week 11: Final Project Demo Due

Week 12: Project Report Due

5.3 Other Important Dates

Monday, January 6: Classes commence

Monday, February 17 – Friday, February 21: WINTER BREAK

Friday, April 3: Last day of classes.

You can refer the student undergraduate calendars for the semester scheduled dates.

6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Labs + Project	50
Research Report + Presentation	20
Final Exam	30
Total	100

6.2 Assessment Details

Labs (50%)

Learning Outcome: 1, 3, 4, 7, 8, 9, 11

Lab 1, Lab 2, and Lab 3 have only a demo that is worth 4%, 8%, and 8%, respectively

Project has a progress design demo, a final project demo plus a report (progress demo is worth 5%, final project demo is worth 10%, and project report is worth 15%)

Research Report and Presentation (20%)

Learning Outcome: 10

Research report and the presentation are each worth 10%

Final Exam (30%)

Learning Outcome: 1, 2, 3, 4, 5, 6, 7, 8, 9

7 Course Statements

7.1 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor at the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

Passing grade: In order to pass the course the students must obtain passing marks in all labs and the research presentation and write the final exam and obtain a passing mark of 50% or greater in the final exam. If the mark in the final exam is under 50% the final course mark will be 47%.

Lab/Project Work: You must attend all lab demos and complete all lab reports. If you miss a laboratory demo due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the instructor to complete a makeup lab demo.

Late Lab/Project Reports: Late submissions of lab reports will be accepted only with the approval of the course instructor. However, penalties on late submissions will be applied. Applied penalties will be posted on ENGG*4560 CourseLink system.

7.2 Relationships with other Courses & Labs

Previous Courses:

ENGG*3640 (Microcomputer Interfacing): instruction set architecture, microcontroller architecture and design, interfacing principles and components.

ENGG*3380 (Computer Organization and Design): CPU design, instruction set design, microprocessor architectures and design, interfacing principles and components.

8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on CourseLink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>
