

Western University
Faculty of Engineering
Department of Electrical and Computer Engineering

ECE 3380B: Advanced Digital Systems

Course Outline 2021-22

Description: The coverage of this course bridges advanced theoretical concepts in digital systems with design and implementation issues. Three themes are prevalent: the representation of digital processes using algorithms, a modular approach to design by partitioning complex systems into subsystem hierarchies, and implementation using available hardware and programmable devices. The course material provides exposure to the design and engineering of digital systems. The student will be exposed to fundamental principles in both hardware engineering and implications for computer engineering and programming.

Instructor: Dr. Anestis Dounavis, P. Eng., PhD.
TEB 254, adounavis@eng.uwo.ca
Consultation hours: TBA

Academic Calendar Copy: Memory units, coders, decoders, adders, multipliers, clocks, synchronous and asynchronous sequential circuits, algorithmic state machines, microprogrammed synthesis of ASM designs, advanced microprocessor organization.

Contact Hours: 3 lecture hours, 1.5 laboratory hours, 0.5 course.

Antirequisite: The former ECE4434 A/B

Prerequisites: ECE2277 A/B

Co-requisite: ECE3375 A/B

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

CEAB Academic Units: Engineering Science 34%, Engineering Design 66%.

Required Textbook: C.H. Roth and L.K. John, *Digital Systems Design using VHDL*, 3rd Ed. Nelson, ISBN: 9781305635142

Recommended References: links published on OWL site as needed

General Learning Objectives (CEAB Graduate Attributes)

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|------------------|---|--------------------------|---|---------------------------------------|--|
| Knowledge Base | D | Use of Engineering Tools | D | Impact on Society and the Environment | |
| Problem Analysis | D | Individual and Team Work | | Ethics and Equity | |
| Investigation | | Communication Skills | A | Economics and Project Management | |
| Design | A | Professionalism | | Life-Long Learning | |

Notation: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e.g. no review).

| Topics and Specific Learning Objectives | CEAB Graduate Attributes Indicators |
|---|-------------------------------------|
| <p>1. Review of Combinational Logic: At the end of this section, students will be able to: a. Analysis and design of combinational circuits, b. Use of Boolean algebra to verify/prove complex Boolean expression, c. Design a circuit that is free of static and dynamic hazards</p> | KB3 , PA2, PA3 |
| <p>2. Review of Synchronous Sequential Design Fundamentals: At the end of this section, students will be able to: a. Perform Mealy and Moore state machine design, b. Understand the concept of equivalent states and apply it to state reduction, c. Calculate timing conditions for proper operation of sequential circuits.</p> | KB3, PA2, PA3, D4 |
| <p>3. VHDL: VHSIC (Very High Speed Integrated Circuit) Hardware Description Language: At the end of this section, students will be able to: a. Use VHDL for modeling basic combinational and sequential blocks in digital systems, b. Verify circuit/system design via simulation using VHDL, c. Synthesize circuits from VHDL models</p> | KB3, PA2, PA3 |
| <p>4. Transistor Level Logic Gates and Programmable Logic Devices (PLDs): At the end of this section, students will be able to: a. Viewing Transistors as Imperfect Switches and Creating Logic Gates, b. Be familiar with Read-Only Memory (ROM), Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), and Field Programmable Gate Arrays (FPGA), Design digital circuits using PLDs</p> | KB3, PA2, PA3, D4 |
| <p>5. Several Design Examples: At the end of this section, students will be able to: a. Use VHDL to describe a digital system at the behavioral level for testing the system, b. Know how designs should be coded structurally if specific hardware structures are to be generated, c. Understand the concept of dividing a design into a controller and data path sections, and apply it to several design examples.</p> | KB3, PA2, PA3, D4 |
| <p>6. Algorithmic State Machine (ASM) Charts: At the end of this section, students will be able to: a. Convert state diagrams to ASM Charts b. Use ASM charts to design sequential state machines</p> | KB3, PA2, PA3 |

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| 7. Arithmetic Units: At the end of this section, students will be able to: a. Hardware Adders, Multipliers and Dividers, b. Hardware Floating-Point Arithmetic | KB3, PA2, PA3 |
| 8. Hardware Testing and Design for Testability: At the end of this section, students will be able to: a: Digital system testing for combinational and sequential circuits, b: Design for testability and employ different testing methods that make digital systems easier to test. | KB3, PA2, PA3 |
| 9. Labs | D4, ET2, CS1, CS3 |

Evaluation

| Course Component | Weight |
|-------------------|--------|
| Laboratory | 25 % |
| Midterm Test | 25 % |
| Final Examination | 50 % |

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination as well as on the laboratory. A final examination or laboratory mark < 50% will result in a final course grade of 48% or less.

Laboratory: The laboratory component consists of three design lab exercises posted on OWL. A student's mark is determined by the teaching assistant's evaluation of (1) the written report and (2) a demonstration by the student of a properly functioning implementation of the circuit design required by the laboratory.

Assignments: Practice problems sets are assigned which are to be completed outside of the scheduled time. These homework problems are not graded but should be completed to prepare for the midterm and final exam.

Midterm Test: TBA

If a student misses a midterm examination, she or he must follow the Instructions for Students Unable to Write Tests and provide documentation to Undergraduate Services Office within 24 hours of the missed test. If accommodation is granted, the instructor will decide whether to provide a make-up test or allow reweighting of the test, where reweighting means the marks normally allotted for the midterm will be added to the final exam. If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

Final Examination: The final examination will be take place during the regular examination period.

Late Submission Policy: Late submissions will not be accepted without prior approval from the instructor.

Use of English: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned

without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance: Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Absence Due to Illness or Other Circumstances: Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Missed Midterm Examinations: If a student misses a midterm examination, the exam will **not** be rescheduled. The student must follow the Instructions for Students Unable to Write Tests and provide documentation to their department within 24 hours of the missed test. The department will decide whether to allow the reweighting of the test, where reweighting means the marks normally allotted for the midterm will be added to the final exam. If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

Course Delivery with Respect to the COVID-19 Pandemic: Although the intent is for this course to be delivered in-person, the changing COVID-19 landscape may necessitate some or all of the course to be delivered online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any assessments affected will be conducted online as determined by the course instructor.

When deemed necessary, tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you

to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at: <https://remoteproctoring.uwo.ca>.

Cheating and Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Use of Electronic Devices: Students may use laptops, tablets, or smart phones to access the OWL site during lectures. However, no electronics devices are to be used during quizzes, the midterm exam, or final exam.

Use of Personal Response Devices (“Clickers”): None

Policy on Repeating All Components of a Course: Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

Internet and Electronic Mail: Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course.

Accessibility: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services: Office of the Registrar, <http://www.registrar.uwo.ca/>
Student Development Centre, <http://www.sdc.uwo.ca/>

Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>
USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.