CISC-340 Digital Systems
Course Syllabus

Revised July 27, 2019

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Quick Reference

Course title: Digital Systems

Course number: CISC_340

Course dates: Monday, September 5, 2019 through Friday, November 29, 2019

Lecture Location: Dupuis Hall Room 217

Meeting day(s): Tuesday: 6:30 p.m. – 8:00 p.m.; Thursday: 6:30 p.m. – 8:00 p.m. (90-minute classes)

Prerequisite(s): CISC-221 or equivalent

Instructor Information

- **Name:** Dave Dove
- **Email:** dove@cs.queensu.ca
- **Office location:** Goodwin Hall Room 661
- **Office hours:** Tuesday, Thursday 4 p.m.. – 5:30 p.m.
- **Phone:** 533-6053

Teaching assistants: TBA

Lab Assignment/TA hours : Location: Goodwin 248

TA contact information and TA times to be determined.

Textbook: Digital Design. An Embedded System Approach Using VHDL.
Peter J. Ashenden
Morgan Kaufmann ISBN 978-0-12-369528-4

There is also extensive online material (OnQ.queensu.ca).

Intended Student Learning Outcomes

As a result of this course, I hope that a year later, students will still be able to ...

Foundation Knowledge

- use their knowledge of the concepts and relationships between basic electrical properties (voltage, current, resistance, capacitance) to implement or analyze simple electronic circuits.
- explain the functions, implementations, and common applications of the basic building blocks of digital circuits (multiplexors, decoders, registers, etc) and their collective use in more complex arithmetic and logical functions.

Application

- evaluate partial or complete digital system designs, identifying appropriate trade-offs, and with an awareness of theoretical and practical implications.

Integration

- explain the relationships and interactions among logic circuits, computer hardware, operating systems, system software and applications.

Communication Skills

- Demonstrate your ability to articulate a technical position and support it with scholarly arguments.
- Demonstrate interpersonal and team interaction skills.

It is also hoped that students will...

Human Dimension

- embrace difficulty and be persistent in solving problems.
- share their own ideas and understandings with others and recognize the value of alternative and conflicting ideas.

Caring

- develop an appreciation of self-reflection and self-learning and the part they play in enhancing their own self-confidence and personal growth.
- be excited about the possibilities that embedded systems can bring to everyday life, now and in the future.

Learning How to Learn

- develop a systematic, inquiry-based approach to learning that involves formulating good questions and using them as a path to resolve complex problems.
- understand the critical importance of and practice frequent and regular reflection on their learning.

I will make an extra effort to make these six learning goals visible to students in every component readings, lab assignments, in-class activities, projects, and quizzes) of the course. In order for significant learning to occur, students need to reflect on their learning in every activity that they undertake relating to the course.

* reference: Creating Significant Learning Experiences, *L. Dee Fink 2013*

Student Assessment: (see the Appendix for Grading Scales)

There is no Mid-Term or Final Exam in this course.

*Note: The portion of your final course mark allotted to each of Individual Assessment, Team Assessment and Peer Assessment will be as follows:

Individual Work Assessment: 60%
Team Work Assessment : 40%

Individual Work Assessment (by Instructor)

- Quiz 1: 10%
- Quiz 2: 10%
- Quiz 3: 10%
- Quiz4: 15%
- Weekly Lab Assignments : 15%

Total Individual Work Assessment: 60%

Consult the course web site for specific date information. Quizzes are 60 minutes in length and take place in the normally scheduled class period. All Quizzes are closed book.

Team Assessment

- Team Readiness Assessment Tests (tRATs) :15%
- Assessment of Term Team Project : 25% *
- In-Class Activities: not assessed for marks

*There are two peer assessments (mid-term and end-of-term) There are no marks allotted to them but may affect your Term Team Project mark.

The term project is a team project, done with teams typically of 4 members. This project will be evaluated as a single entity with all team members getting the same mark. The instructor however reserves the right to reduce the mark of any team member that demonstrates a significant and problematic reluctance to fulfill their obligations to the project. The two peer assessments will be used to assess individual team member performance.

Student Peer Assessment

Assessment of your own team performance and the performance of your team members on the term project will be done at mid-term, and again at the end of the term. Failure to submit a peer assessment by the due dates will reduce your team project mark (and subsequently your course mark) by 5 marks for each assessment missed.

The assessment is submitted via a web form. The form will require you to include comments that will be collated and sent to team members anonymously. Peer assessments have a rigid due date and time and submissions are not allowed after that.

Course Topics

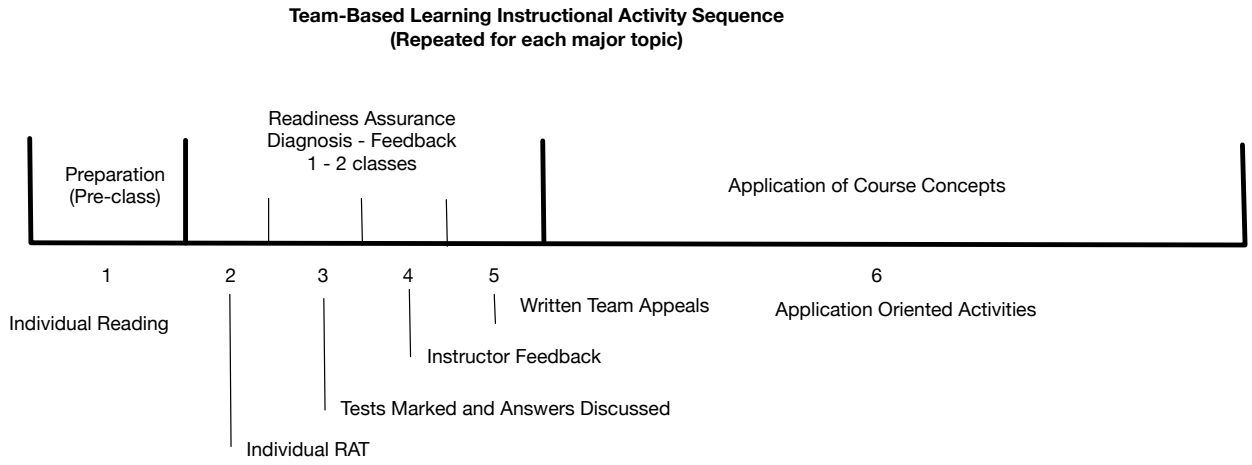
1. Digital Circuit Basics
    - Basic electronics
    - Introduction to combinational logic
    - Boolean algebra theorems, truth tables, switching expressions
    - Implementation, simplification and customization
2. Programmable Logic: Tools and Technologies
    - EDA(Electronic Design Automation) tools for design entry, simulation, synthesis, design management
    - Approaches to design verification
    - Implementations: PALs, CPLDs, ASICs, FPGAs
3. Combinational Systems
    - VHDL - A Hardware Description Language
        - VHDL Basics
    - Standard Combinational Modules
        - Gates, multiplexors, decoders, encoders, adders, ALUs
        - Example circuits relating to computer applications
4. Sequential Systems:
    - flip-flops, registers, state machines
    - State machine design, data vs control section design
    - Register Transfer Level (RTL) design of complex sequential systems
5. Communications
    - communications between chips, between chip and device, network communications
    - Interfacing common input and output devices.

Why Study Digital Logic in Computing Science?

1. A course on digital logic will include topics relating to performance and power consumption (important for mobile devices) not covered in courses about Computer Architecture.
2. A course on digital logic extends the study of abstraction layers of computers studied in Computer Architecture down into the lower layers of hardware implementation.
3. A course on digital logic helps explores the relationship between software and hardware.
4. A course on digital logic gives programmers more options in system design by making it feasible to include hardware design as part of the solution to system design problems. Programming language extensions are becoming available that allow the programmer to specify that code segments be implemented in hardware in embedded systems implemented with an FPGA (Field Programmable Gate Array). Sophistication of hardware design tools for FPGAs extends the ability to design hardware solutions beyond the exclusive domain of electrical engineers.
5. Use of FPGAs to implement real hardware designs remains relevant as a means of exploring computer theory and practice.
6. Concepts covered in digital logic design are compatible with recurring concepts in computing science such as dealing with complexity, the use of models, consistency and correctness, levels of abstraction, re-use of design elements, dealing with tradeoffs in time and space.

Course Delivery

This course will use an active learning, partially team-based approach for course delivery. In this approach, the focus is on what the learner learns rather than on what the instructor teaches. Course content is acquired by the learner under the guidance of the instructor. The instructor will give a brief overview of the topic. Students will be given a reading/research assignment that covers the topic and includes basic questions and possibly sample problems with solutions. Students will then be individually tested on basic comprehension of what they have read. Solutions will be discussed, and problem areas addressed, possibly with a short lecture from the instructor. The remainder of class time for the topic will be used to present problems and have students develop, present, and discuss solutions. In preparation for in-class work, students may be required to complete homework assignments. This approach to learning involves active participation of the students as most of the class time is spent discussing course concepts and receiving immediate feedback on the student's level of understanding. During the first class of the term, permanent teams of about 6 – 8 students will be formed of students with diverse qualifications. These teams will sit together in class and team membership remains static for the duration of the course. The teams will be sub-divided into teams of at 3 or 4 students for the purposes of the term project.



For each Major Topic:

A multiple choice, Readiness Assurance Test (iRAT) will be given individually. Then each team has a discussion and answers the same questions once more and submits a team tRAT answer form. The instructor will review answers to the RAT and concurrently, the individual iRATs will be marked within each team. The marked RATs are submitted to the instructor. By default, students will get their team's mark for their RAT. Students are allowed to miss or fail 2 RATs without penalty. After that, students will receive their individual iRAT mark instead of tRAT mark for any RAT that they miss or fail (<50%).

The purpose of the RATs is to ensure that students are adequately prepared for the subsequent class activities on the current topic and to identify common areas of difficulty relating to the topic which are then discussed and clarified.

Following the RAT there may be homework between classes in preparation for the subsequent in-class activities. All teams work on the same problems.

Each activity includes a debrief session where solutions are compared and discussed. Any remaining questions about the material are resolved.

Students are expected to bring in their own copy of the activity to class and supplement it with their own notes for review before quizzes. Each team will submit one copy of their team's completed activity for review (not marked) by the instructor. Solutions to the activities are not posted online.

Appendix A: Policy Statements

Grading Scale

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale:

Queen's Official Grade Conversion Scale

Grade	Numerical Course Average (Range)
A+	90-100
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72
C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F	49 and below

Late Policy

- Late labs, activity and project submissions will not be accepted without prior arrangement with the course instructor. Approved late submissions must be made to the course instructor or the general office in order to be accepted. Anything slipped under my door (Goodwin 753) will be disposed of.

Academic Integrity

Academic Integrity is constituted by the six core fundamental values of honesty, trust, fairness, respect, responsibility and courage (see www.academicintegrity.org). These values are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities http://www.queensu.ca/secretariat/policies/senate/report-principles-and-priorities).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see Academic Regulation 1 http://www.queensu.ca/artsci/academic-calendars/regulations/academic- regulations/regulation-1), on the Arts and Science website (see http://www.queensu.ca/artsci/academics/undergraduate/academic-integrity), and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

The instructor reserves the right to give the student a failing course grade as a result of breaches of academic integrity deemed serious, including plagiarism of lab assignments.

Calculator Policy

As noted in Academic Regulation 9.2, Calculators acceptable for use during quizzes, tests and examinations are intended to support the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the **Casio 991** series calculator is permitted and is the **only approved calculator for Arts and Science students**. This calculator sells for around $25 at the Queen's Campus Bookstore, Staples and other popular suppliers of school and office supplies.

Copyright of Course Materials

The material on this website is copyrighted and is for the sole use of students registered in the course. The material on this website may be downloaded for a registered student's personal use but shall not be distributed or disseminated to anyone other than students registered in the course during the current term. Failure to abide by these conditions is a breach of copyright and may also constitute a breach of academic integrity under the University Senate's Academic Integrity Policy Statement.

Accessibility Statement

Queen's is committed to an inclusive campus community with accessible goods, services, and facilities that respect the dignity and independence of persons with disabilities. If any material in this course is not adequately accessible to you, please contact the course instructor so that remedial action can be taken.

Accommodation Statement

Queen's University is committed to achieving full accessibility for persons with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. If you are a student with a disability and think you may need accommodations, you are strongly encouraged to contact Student Wellness Services (SWS) and register as early as possible. For more information, including important deadlines, please visit the Student Wellness website at: http://www.queensu.ca/studentwellness/accessibility-services/

Academic Considerations for Students in Extenuating Circumstances

The Senate Policy on Academic Consideration for Students in Extenuating Circumstances (http://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/ExtenuatingCircumstancesPolicyFinal.pdf) was approved in April, 2017. Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances that are beyond their control and which have a direct and substantial impact on their ability to meet essential academic requirements. The Faculty of Arts and Science is developing a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances, which will be posted on the Faculty of Arts and Science website in Fall, 2017.

Absenteeism

In a team-based, active learning environment, it is vitally important for you to attend every class.

Individual attendance may be recorded during classes involving in-class activities. If the team and instructor was not given prior notice of an impending absence and the valid a reason for it, the absent student may not get credit for the team activity. If a student is absent a significant number of times without giving the team notice or team members have doubts about the validity of reasons for absenteeism, it may affect their peer evaluation of that student. If you will be missing a significant number of classes, you need to discuss this with an instructor to make appropriate assessment modifications.

Students who miss a Quiz must inform the instructor before or on the day of the Quiz of the reason for the absence and may be given a single opportunity to write a makeup Quiz.

Any absence that is the result of illness (up to 48 hours) will require the student to visit the self-declaration form on the Arts and Science Academic Consideration Request Portal that is here:

https://webapp.queensu.ca/artsci/acrp/

The course instructor must receive official notification before any accommodation for any missed work affecting academic performance assessment is considered.

If you are the student who is responsible for bringing in a laptop and/or parts kit for in-class activities, it is crucial that arrangements be made with another student to bring in the parts kit and an alternate laptop for in-class activities and inform the instructor of your impending absence. Otherwise your team will not be able to do any work that day and will not get any credit for it.

Other Policies and Information

- Teams will be provided microcontroller boards and associated electronic parts that will be used in team projects and some class activities.
- Lab/TA hours are held in Goodwin Hall Room 248.
- Marking of RATs, Quizzes, or Assignments may be contested by writing a scholarly appeal and submitting it to the instructors (printed or by email) in a timely manner.
- Solutions to RATs, Quizzes, Lab Assignments, and In-Class activities are not electronically published but the instructor will always be happy to review your answers and make sure that any misconceptions are resolved.
- Lab work can be done on any PCs in the CASLAB domain. Login to the CASLAB domain and create files on your personal "Z:" drive.
- Students can download the required FPGA software from the Xilinx web site. You will find download links on the Extras page of the course web site. Students may do the all of the project work on their own PCs if they wish, subject to how and where teams decide to meet to work on the projects. Other software resources will be made available as required.
- Note that there is no Mid-Term or Final Exam in this course.

Team Projects (details currently under review)

Team projects will use Xilinx Vivado software. It is installed in Goodwin 248, and Walter Light 310. This software is free and available online. Download the Xilinx Vivado Web Edition software at http://www.xilinx.com.

- Phase #1 Embedded system (Digilent Basys 3 platform) with I/O interfaces. Investigation of switches, sensors, motors, and displays.
- Phase #2 Embedded system focusing on the IOT (Internet of Things) and including a Raspberry Pi Zero W as well as the Basys 3.