Course: EE685
Title: Digital Computer Struct(ure)

Term: Fall 2022
Credit hours: 3
Meeting days/time/location: Tuesday & Thursday, @ 3:30-4:45PM, in 265 FPAT

Instructor Information
Name: Professor Henry (Hank) Dietz
Email: hankd@engr.uky.edu
Office building and room number: 203 Davis Marksbury Building
Office phone: (859) 257 4701
Office hours: schedule and live office camera are posted at http://aggregate.org/hankd

Email is the preferred contact method; please place "EE685" in the Subject line.
Office meetings can be physically in the Davis Marksbury Building, or can be arranged to be online via Zoom. **Course students and staff must abide by all relevant pandemic safety guidelines; wearing a mask is encouraged for in-person meetings in which social distancing is not practical.**

Course Description (significantly upgraded from the previous catalog description)
Study of fundamental concepts in digital computer system design. This course course involves developing a deep and broad understanding of how computer system hardware is structured. The material is not limited to design of a pipelined RISC processor, but includes various other system aspects ranging from interrupt handling and multithreading to memory heirarchy and various forms of parallel processing. Detailed design of multiple subsystems will be explored using Verilog and simulation tools.

Course Prerequisites
CPE 380 or a comparable introduction to computer organization and architecture with some exposure to digital logic design and/or hardware description languages. This course could be considered to be a more detailed and advanced look at issues similar to those discussed in CPE 480, which even uses the same textbook, but CPE 480 is not required as a prerequisite.

Required Materials
Various materials for the course will be provided, primarily via canvas or the course website, http://aggregate.org/EE685 . The textbook is *Computer Architecture, Sixth Edition: A Quantitative Approach*, Hennessy & Patterson, Morgan Kaufmann publisher, 2019. Although the course generally follows the structure and topics of this text, it is not directly used, and is thus *optional*.

Associated Expenses
Rather than requiring software to be installed on personal computers or in-person use physical lab facilities, Verilog and simulation software are provided in forms that allow work to be done using a web browser interface that gives access to software running on machines in 108 Marksbury (Dietz's research lab). Students are expected to have personal systems able to use this web browser interface.

Activities Outside of Regular Class Meetings

The class will be making fairly heavy use of computing facilities in the 108A Marksbury supercomputer machine room. We might or might not physically meeting there at some point during the semester. If any regular class meeting is not held in person, the plan is that the material will be made available online via a recorded presentation, perhaps with the option of live Zoom attendance, rather than by scheduling in-person make-up sessions. Online "virtual flipped classroom" meetings also may be substituted for some in-person class meetings.

Skill and Technology Requirements

Students are expected to have some C/C++ programming experience, exposure to digital logic design as discussed under prerequisites, and generally be computer literate.

For technical/account help, students can contact Information Technology Services by phone 859-218-HELP (4357) and via the ITS Customer Services page. (https://www.uky.edu/its/customer-support-student-it-enablement/customer-services)

Student Learning Outcomes

After completing this course, a student will be able to:

- Describe the levels of software and hardware in a computer system and the meaning and purpose of an Instruction Set Architecture (ISA) [1]
- Analyze, evaluate, and compare the performance of computers [2,4,6]
- Describe how specific high-level-language program constructs are implemented in assembly and machine language for various computers [1]
- Write and run programs on a simulator for a designed computer [1,6]
- Describe how computers perform integer and floating-point (IEEE 754 format) addition, subtraction, multiplication, and division/reciprocal [1]
- Organize, and design at the gate and register level, the datapath, control, and memory of a simple computer[1]
- Describe pipelining, speculation, and various other modern architectural features [1]
- Describe how Verilog HDL implementations of various computer subsystems work [1]
- Understand the historical and continuing evolution of computing systems and the effects of technological changes on computer design [7]

The 1-7 Computer Engineering Program Student Outcomes are listed at http://www.engr.uky.edu/research-faculty/departments/electrical-computer-engineering/about/educational-objectives-and – each of the above course outcomes is marked with the most relevant program outcome number(s) in [].

Course Details
Tentative Course Schedule

Topic	Lectures
Introduction and Verilog	4
Walk through a complete RISC design: system software and Verilog hardware	6
Advanced processor internals (floating point, interrupts, etc.)	4
Review for Midterm	
Memory hierarchy and protection (caches, virtualization support, etc.)	5
Instruction-level parallelism (out-of-order execution, multithreading, etc.)	5
Scalable parallel architectures, networking, etc.	4
Review for Final Exam	

The above schedule roughly follows the flow of the various versions of the (optional) text listed above. The main difference is that there is more introductory material here, which may be review for those who have taken CPE 380 and CPE 480 here, but ensures that all students are up to speed for the more advanced material.

Course Activities and Exams
There are two exams planned. The midterm exam will each cover approximately 1/2 of the material and may be administered either in-class or online using software that allows each student to take the exam at a time of their choosing within a window of several days. The final exam will be comprehensive, and is planned to be given in person in the timeslot designated by the registrar: **1:00-3:00PM on Tuesday, December 13, 2022**. In Fall 2021, the final was given online in order to better accommodate those affected by pandemic-related issues. It would be appropriate to think of the final as being comprehensive, but weighting the material since the midterm more heavily. The midterm will count for approximately 20% of your grade and the final approximately 30%.

The remaining 50% will be divided between the homework assignments/projects. There are expected to be about five such assignments, some of which will be individual and some done as teams. Some projects will involve Verilog implementation and/or simulation of advanced constructs. All homeworks/projects are submitted online, but projects may also require an in-class presentation.

To ensure students do well in both theory (exams) and practice (assignments/projects), the maximum course grade a student can get is one letter grade above the lower of the letter grade for exams or the letter grade for assignments/projects.

Of course, especially in these pandemic times, we reserve the right to adjust the course activities and grading scheme should any unanticipated issues make it appropriate to do so. Students would be notified of any significant changes via canvas and/or the course web site.

Grading Scale
Nominally, the grading scale is:

90 – 100% = A
80 – 89% = B
70 – 79% = C
60 – 69% = D
Below 60% = E

Adjustments may be made to scores of specific graded materials (e.g., adjusting everyone's score for exam 1 if there was an issue with a question)

Midterm Grades
For undergraduates, midterm grades will be posted in myUK by the deadline established by the University Senate and published in the [Academic Calendar](http://www.uky.edu/registrar/content/academic-calendar). (http://www.uky.edu/registrar/content/academic-calendar) . Note that midterm grades will be based on the work completed and graded up to that point, which do not necessarily have the same exam vs. homework ratio as the course overall. For this reason, the midterm grade may be computed by a different weighting formula than your course grade in order to better estimate your likely performance in the course as a whole based on the work done to that point.

Attendance Policy/Acceptable Documentation
The University of Kentucky generally expects appropriate documentation for an excused absence: e.g. a letter from a healthcare provider. In general, notification beforehand via email to hankd@engr.uky.edu, with "CPE380" in the subject line, will be accepted as a valid reason for an excused absence. Students missing class meetings generally are responsible for catching-up on the material missed even if the absence is excused. However, an excused absence will avert being penalized if a quiz is missed, and class presentation recordings may be made available to help those with an excused absence.

Assignment Policies
Assignment Submissions
All assignments will be collected electronically using software to be discussed in class and via canvas.

Returning Assignments to Students
The system we created for online exams will immediately let the student know their grade, but will not allow access to the graded exam until after the window for taking the exam has closed. The graded final exams are kept on file and can be accessed by meeting with the course instructor. Assignments and quizzes may be handled in different ways. You are welcome to ask the instructor for more information about your grades and help identifying potential problem areas in your understanding.

Late Assignments
Online exams and assignments are expected to be submitted no later than the specified deadline, but the server will accept late submissions. Except where University Senate Rules about excused absences

apply, it is entirely at the discretion of the instructor as to how much, if any, credit will be awarded for a late submission. Late assignments that are submitted after the assignment answers are posted or discussed in class are given zero credit, but ones submitted before any answers have been made available are more likely to be given some credit. It is also useful to note that any assignment can be submitted multiple times without penalty, and all such submissions are typically logged, but generally only the last one submitted before the deadline is considered for grading.

Assignments Due during Prep Week
No assignments will be due during Prep Week (which isn't really a week long). However, it is possible that activities making-up for an absence would be scheduled during that time.

Academic Policy Statements
Whatever is stated in the current Senate's Academic Policy Statements document applies.

Academic Offenses (Cheating, Plagiarism, and Falsification or Misuse of Academic Records)
Whatever is stated in the current Senate's Rules Regarding Academic Offenses document applies.

In the classroom, students should not take any actions that would disrupt the classroom environment (e.g., talking on a cell phone during class). In general, students are expected to behave in a respectful way towards their fellow students, the TA, and the instructor. **Failure to follow University of Kentucky guidelines involving appropriate precautions against spread of the pandemic will be treated as very serious offenses and dealt with as specified by the University.**

Students are expected to generally behave in an ethical manner, but violations will be treated as serious offenses. Altering graded exams and then submitting them for regrade is obviously unethical, but you do not need to be trying to enhance your grade in order for your behavior to be inappropriate. For example, attempts to break into computer accounts associated with this course or to falsely identify yourself are serious ethical violations even if there was no intent to "cheat" per se.

There are lots of study materials for this course, including old exams, widely available; using them as study aids is perfectly acceptable, but be warned that an apparent reuse of an old question usually has the question slightly reworded so that repeating the old answer will get no credit. Although students are encouraged to discuss course material with one another, everything you submit must be entirely your own original work. Similarly, for in-class exams that specify no textbooks, no calculators, etc., use of the banned resources is a serious offense. Online exams will specify what is and is not permitted, but the general rule is that referencing your notes, looking at online materials at the course web site, etc. is OK – however, getting help from another human while working on an online exam is not OK. Neither is it permissible for you to offer such help to a classmate.

Resources
There are a wide range of resources available to help you with this course, the most relevant of which will be cited at either canvas or the course web site. Arguably the most important resources are the instructor, TA, and your classmates – and you are strongly encouraged to interact.

In addition, the University of Kentucky offers facilities/services such as Distance Learning Library Services and Tutoring and Coaching Resources.

Diversity, Equity, and Inclusion

The Senate Syllabus Statement on Diversity, Equity, and Inclusion (DEI) applies. Basically, I expect that we will all be open and nice to each other – that's what makes the best academic environment.

Student Resources

The University offers a variety of resources to students. Visit the University Senate's Resources Available to Students to access that list .

Course Recordings

The University of Kentucky Code of Student Conduct defines Invasion of Privacy as using electronic or other devices to make a photographic, audio, or video record of any person without their prior knowledge or consent when such a recording is likely to cause injury or distress.

Meetings of this course may be recorded. All video and audio recordings of lecturers and class meetings, provided by the instructors, are for educational use by students in this class only. They are available only through the Canvas shell or website for this course and are not to be copied, shared, or redistributed.

As addressed in the Code of Student Conduct, students are expected to follow appropriate university policies and maintain the security of linkblue accounts used to access recorded class materials. Recordings may not be reproduced, shared with those not enrolled in the class, or uploaded to other online environments.

If the instructor or a University of Kentucky office plans any other uses for the recordings, beyond this class, students identifiable in the recordings will be notified to request consent prior to such use. In anticipation of such cases, students may be asked to complete an "authorization of use" form by a faculty member.

Video and audio recordings by students are not permitted during the class unless the student has received prior permission from the instructor. Any sharing, distribution, and or uploading of these recordings outside of the parameters of the class is prohibited. Students with specific recording accommodations approved by the Disability Resource Center should present their official documentation to the instructor.

Course Copyright

All original instructor-provided content for this course, which may include handouts, assignments, and lectures, is the intellectual property of the instructor. Students enrolled in the course this academic term may use the original instructor-provided content for their learning and completion of course requirements this term, but such content must not be reproduced or sold. Students enrolled in the course this academic term are hereby granted permission to use original instructor-provided content for reasonable educational and professional purposes extending beyond this course and term, such as studying for a comprehensive or qualifying examination in a degree program, preparing for a professional or certification examination, or to assist in fulfilling responsibilities at a job or internship; other uses of original instructor-provided content require written permission from the instructor in advance.