Computer Architecture

Course Description

Description
This course aims to provide a strong foundation for students to understand modern computer system architecture and to apply these insights and principles to future computer designs. While suitable for those students directly interested in computer engineering, this course can also provide a foundation for students interested in performance programming, compilers, and operating systems; and it can provide system-level context for students interested in emerging technologies and digital circuits. The course is structured around the three primary building blocks of general-purpose computing systems: processors, memories, and networks. The first half of the course focuses on the fundamentals of each building block. Topics include processor microcoding and pipelining; cache microarchitecture and optimization; and network topology, routing, and flow control. The second half of the course delves into more advanced techniques and will enable students to understand how these three building blocks can be integrated to build a modern shared-memory multicore system. Topics include superscalar execution, branch prediction, out-of-order execution, register renaming and memory disambiguation; VLIW, vector, and multithreaded processors; memory protection, translation, and virtualization; and memory synchronization, consistency, and coherence. Students will learn how to evaluate design decisions in the context of past, current, and future application requirements and technology constraints.

Learning Objectives
This course is meant to be a capstone course in computer science that draws together concepts from across the CS curriculum including digital logic design, computer organization, system-level software, computing, and engineering design. The course will prepare students for jobs in the computer engineering industry and can act as a springboard to more advanced material in graduate level courses. By the end of this course, students should be able to:

- describe computer architecture concepts and mechanisms related to the design of modern processors, memories, and networks and explain how these concepts and mechanisms interact.
- apply this understanding to new computer architecture design problems within the context of balancing application requirements against technology constraints; more specifically, quantitatively assess a design’s execution time in cycles and qualitatively assess a design’s cycle time, area, and energy.
- evaluate various design alternatives and make a compelling quantitative and/or qualitative argument for why one design is superior to the other approaches.
- demonstrate the ability to implement and verify designs of varying complexity at the register-transfer-level.
- create new designs at the register-transfer-level and the associated effective testing strategies.
write concise yet comprehensive technical reports that describe designs implemented at the register-transfer-level, explain the testing strategy used to verify functionality, and evaluate the designs to determine the superior approach.

Major Course Requirements

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Class Format: The class will have a face-to-face and online component.

(course outline)

Part I. The Beginning 1.
2. Computer Arithmetic and Digital Logic

Part II. Instruction Set Architectures
4. Instruction Set Architectures –
   Reinventing the CISC. Introduction to SIMD Processing. Streaming Extensions and the Development of SIMD Technology.

Part III. Organization and Efficiency 6. Performance –
9. Cache Memory and Virtual Memory
10. Main Memory Introduction.
    Primary Memory. DRAM. The Read-Only Memory Family. New and Emerging Nonvolatile Technologies.
12. Input/Output
13. Processor-Level Parallelism

**Academic Integrity/Plagiarism**

University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a zero in the exam or assignment.

**Dropping a Class**

I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. Please consult with me before you decide to drop to be sure it is the best thing to do. Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. June 20 is the last day to drop a class with an automatic grade of “W” this term.

**Classroom/professional behavior**

Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace.
and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

Statement of Civility (can be in place of classroom/professional behavior)
Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

Grade Appeals (College of Science and Engineering Version)
As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at [http://www.tamucc.edu/provost/university_rules/index.html](http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage ([http://sci.tamucc.edu/students/GradeAppeal.html](http://sci.tamucc.edu/students/GradeAppeal.html)). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

Disabilities Accommodations
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call or visit Disability Services at (361) 825-5816 in Corpus Christi Hall 116.

If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

Statement of Academic Continuity
In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.