CPTS 260 Introduction to Computer Architecture, Spring 2022

Carpenter 102 ◇ Monday/Wednesday/Friday 4:10 pm – 5:00 pm

Instructor: Ganapati Bhat, EME 506
Email: ganapati.bhat@wsu.edu (Include "CPTS260" in the subject)
Office hours: Monday, 3 pm – 4pm; Thursday, 3 pm – 4pm
TA Office hours: TBD
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Catalog description: Computer systems architecture; logic, data representation, assembly language, memory organization and trends.

Pre-requisites: CPT S 223 Advanced Data Structures C/C++

Course Material:

1. **Textbook:** Computer Organization and Design (Fifth/Sixth Edition): The Hardware/Software Interface by David A. Patterson and John L. Hennessy.

2. **Reference Textbook:** Computer System Architecture (3rd Edition) M. Morris R. Mano

3. **Required Software:** We will be using the SPIMS simulator (qtspim 9.1.20) please download and install that onto your respective OS/machines through this link.

Tutoring: VECA offers tutoring for CPTS260 and CPTS/EE classes. Please visit tutoring services website to see the schedule. I encourage you to use these resources in addition to the lectures, office hours, and the textbook.

Course objectives: This course is to delve into structure and implementation of computer architecture. Though the lectures and the textbook will continue to get more acquainted with the MIPS architecture and how it relates to decoding and implementing high level languages such as C++ and JAVA.

By the end of the course, students will be able to:

- Represent numbers in various bases, convert numbers from one basis to another, and perform arithmetic operations on the numbers

- Apply floating point standard representations to convert floating point numbers from decimal to binary and vice versa

- Apply the knowledge of computer performance to compute response time of a computer on a given program

- Write MIPS assembly code for a given problem description

- Write assembly code equivalence of a high level problem given for example in C

- Assess performance of two computers on a given program workload
- Identify how computers execute instructions and how register and memory contents are modified as a result of this execution
- Simplify a given boolean function, draw its equivalent gate-level circuit, and compare the simplified circuit with the original one in terms of delay and area complexity
- Identify values of various control signals in a computer as a program is being executed by CPU
- Identify what hardware blocks are active during execution of various instructions
- Apply the knowledge of pipelining to compute the amount of time that it takes to execute a program on a pipelined architecture
- Assess performance of a pipelined architecture versus an architecture without pipelining
- Understand and apply strategies to deal with hazards in an architecture with pipelining
- Compare performance of a computer with cache memory versus one without cache memory
- Apply the knowledge of sequential circuits to identify how output of a sequential circuit changes during each clock cycle
- Identify content of a cache memory for various cache designs including direct mapped, set associative, and fully associative designs
- Apply the knowledge of memory hierarchy to compute hit rate, miss rate, and miss penalty for various memory hierarchy designs

Brief list of topics covered:

1. Instruction Sets
2. Computer Performance
3. Integer Representation and Arithmetic
4. Coding in MIPS: loops and function calls;
5. Basics of Digital Design
6. Single Cycle Simple MIPS Architecture
7. Pipelining and Pipelined MIPS Architecture
8. Memory Hierarchy and Cache Memory Design
9. Virtual Memory
10. Input/Output

Quizzes and Homework

We will have weekly/biweekly homework and quizzes. Quizzes will be administered via Canvas usually at the end of the week to test what was covered throughout that given week. Homework can either be typeset of handwritten. If turning in handwritten work please make sure that everything is clean and legible. All programming codes should be well documented.

Late work

Assignments are due by the established due dates and times. You have a total of 4 days for late submission that can be used to submit an assignment late. However, you cannot use more than 2 days of late submission for a single assignment. You need to inform the instructor of your intent to use the late days before the assignment is due. Any late submissions after you exhaust your 4 days of late submission will incur a penalty of 5% per 24 hours late (weekend counts as one day). If an emergency occurs, the instructor will accommodate the student as much as possible. Make-up exams will not be possible unless the student speaks with the instructor at least two days in advance. I understand emergencies do occur and rescheduling of exams because of these is to be determined by the instructor.

Exams

The course will have two midterms and one final exam to evaluate student learning. The mid term exams will be conducted in class during the regular class hours. The final exam will be held during the university scheduled exam time.

Tentative exam dates:

1. Exam 1 - Friday, February 25, 2022

2. Exam 2 - Friday, April 1, 2022

3. Final Exam (*Comprehensive*) - TBD

Grading Policy

The grade distribution of each component is as follows:

Assignments	35%
Quizzes	10%
Class participation	5%
Two mid-term exams	20%
Final exam	30%

Letter and numerical grade equivalence for this course is shown in the table below. The numerical grade will be rounded up to the closest decimal point; for instance, 90.752 will be rounded to 90.8.

Letter	Range	Letter	Range
A	95–100	C	73-76.9
A-	90–94.9	C-	70–72.9
B+	87–89.9	D+	65–69.9
B	83–86.9	D	60–64.9
B-	80–82.9	F	0–59.9
C+	77–79.9		

Course Schedule (tentative, subject to change)

- Concept of instruction set

- Formulas and Gates; Unsigned numbers and Signed numbers; Characters in bits

- MIPS basics: memory and registers; Conversion from C to MIPS;

- Coding in MIPS: loops and function calls

- Instruction types, Multiplier and Floating numbers; Newton's Method

- Single cycle processor; Data path and control;

- Pipeline, control and data hazards;

- Memory and cache; Direct map and set associative caches;

- Virtual Memory and Paging;

- Coding in Interrupt;

- Multiprocessor basics: cache coherence and synchronization;

Posting to the Web

Course materials, including homework, lecture slides and videos, exam questions, programming assignments **may not** be posted to any website other than the official course website (Canvas) provided by WSU.

Academic Effort Statement

For each hour of lecture equivalent, students should expect to have a minimum of two hours of work outside class. Quizzes and assignments are designed to help student master the concepts as well as spend time studying the material of the course.

COVID-19 Policy

Students are expected to abide by all current COVID-19 related university policies and public health directives, which could include wearing a cloth face covering, physically distancing, self-attestations, and sanitizing common use spaces. All current COVID-19 related university policies and public health directives are located at **https://wsu.edu/covid-19/**. Students who do not comply with these directives may be required to leave the classroom; in egregious or repetitive cases, students may be referred to the Center for Community Standards for university disciplinary action.

Attendance and Make-up Policy

Due to the complexity of the topics in this class, it is highly recommended that students attend all the lectures. If student misses a lecture, it is student's responsibility to study the topic covered in the lecture on his/her own.

Academic Integrity

Academic integrity is the cornerstone of higher education. As such, all members of the university community share responsibility for maintaining and promoting the principles of integrity in all activities, including academic integrity and honest scholarship. Academic integrity will be strongly enforced in this course. Students who violate WSU's Academic Integrity Policy (identified in Washington Administrative Code (WAC) 504-26-010(4) will receive [insert academic sanction (e.g., fail the course, fail the assignment, etc.)], will not have the option to withdraw from the course pending an appeal, and will be reported to the Center for Community Standards.

Cheating includes, but is not limited to, plagiarism and unauthorized collaboration as defined in the Standards of Conduct for Students, WAC 504-26-010(3). You need to read and understand all of **the definitions of cheating**. If you have any questions about what is and is not allowed in this course, you should ask course instructors before proceeding.

If you wish to appeal a faculty member's decision relating to academic integrity, please use the form available at **communitystandards.wsu.edu**. Make sure you submit your appeal within 21 calendar days of the faculty member's decision.

Graduate students may also refer to **https://gradschool.wsu.edu/rights-and-responsibilities/**

Students with Disabilities

Reasonable accommodations are available for students with documented disabilities or chronic medical or psychological conditions. If you have a disability and need accommodations to fully participate in this class, please visit your campus' Access Center/Services website to follow published procedures to request accommodations. Students may also contact their campus offices to schedule an appointment with a Disability Specialist. All disability related accommodations are to be approved through the Access Center/Services on your campus. It is a university expectation that students visit with instructors (via email, Zoom, or in person) to discuss logistics within two weeks after they have officially requested their accommodations.

For more information contact a Disability Specialist on your home campus:

- Pullman, WSU Global Campus, Everett, Bremerton, and Puyallup: 509-335-3417 **Access Center** (`https://www.accesscenter.wsu.edu`) or email at access.center@wsu.edu

- Spokane: 509-358-7816 **Access Services** (`https://spokane.wsu.edu/studentaffairs/access-resources/`) or email j.schneider@wsu.edu

- Tri-Cities: Access Services (`http://www.tricity.wsu.edu/disability/`) or email g.hormel@wsu.edu

- Vancouver: 360-546-9238 **Access Center** (`https://studentaffairs.vancouver.wsu.edu/student-wellness/access-center`) or email van.access.center@wsu.edu

Accommodation for Religious Observances or Activities

Washington State University reasonably accommodates absences allowing for students to take holidays for reasons of faith or conscience or organized activities conducted under the auspices of a religious denomination,

church, or religious organization. Reasonable accommodation requires the student to coordinate with the instructor on scheduling examinations or other activities necessary for course completion. Students requesting accommodation must provide written notification within the first two weeks of the beginning of the course and include specific dates for absences. Approved accommodations for absences will not adversely impact student grades. Absence from classes or examinations for religious reasons does not relieve students from responsibility for any part of the course work required during the period of absence. Students who feel they have been treated unfairly in terms of this accommodation may refer to Academic Regulation 104 – Academic Complaint Procedures.

Safety and Emergency Notification

Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the "Alert, Assess, Act," protocol for all types of emergencies and the **"Run, Hide, Fight"** response for an active shooter incident. Remain ALERT (through direct observation or emergency notification), ASSESS your specific situation, and ACT in the most appropriate way to assure your own safety (and the safety of others if you are able).

Please sign up for emergency alerts on your account at MyWSU. For more information on this subject, campus safety, and related topics, please view the FBI's **Run, Hide, Fight** video and visit the **WSU safety portal**.

Full details can be found at **https://provost.wsu.edu/classroom-safety/**