

**San Jose State University - Fall 2022**  
**CS 147 Section 3: Computer Architecture**  
MW 1:30pm-2:45pm, MH422  
Course Syllabus

Description: Introduction to computer systems design. Survey various machine architectures including implementation alternatives for major processor sub-systems. Discussion includes data representation, arithmetic logic unit operations and algorithms, control processor unit instruction formats, memory addressing schemes, and hierarchical memory organization. "Non-classical" architectures such as parallel processors and RISC machines are also presented. Performance measurement and speedup techniques are studied to perform tradeoff analysis and design optimization. Digital breadboard labs and programming projects using the VHDL language and simulation environment will be used to demonstrate gate-level computer-aided design and functional verification techniques for digital systems.

Prerequisites: Math 42 and CS 47, each with a grade of "C-" or higher.

Instructor: Robert K. Chun

Messages: Email: Robert.Chun@sjsu.edu, Phone: 408-924-5137, Office: MH 413

Office Hours: MW 4:30pm-5:30pm

Textbook: *Required:* Computer Organization and Design: The Hardware/Software Interface, 4th Ed., Revised Printing, D. Patterson, 2009, Morgan Kaufmann, ISBN 9780123744937 (Alternative editions/versions of this textbook are also suitable)

*Required* CS 147 Course Reader, Chun. These notes will be provided by the instructor.

*Optional:* A VHDL Primer, J. Bhasker, 3rd Ed., 1999, Prentice Hall, ISBN 9780130965752 (or an equivalent VHDL Primer/Reference Manual)

### **COVID-19 and Monkeypox**

Students registered for a College of Science (CoS) class with an in-person component should view the [CoS COVID-19 and Monkeypox Training](#) slides for updated CoS, SJSU, county, state and federal information and guidelines, and more information can be found on the [SJSU Health Advisories](#) website. By working together to follow these safety practices, we can keep our college safer. Failure to follow safety practice(s) outlined in the training, the SJSU Health Advisories website, or instructions from instructors, TAs or CoS Safety Staff may result in dismissal from CoS buildings, facilities or field sites. Updates will be implemented as changes occur (and posted to the same links).

Classroom Protocol: In light of the evolving safety concerns as discussed in the University-issued paragraph above, this course will be taught using a "flipped" classroom model. Our specific day-by-day meeting pattern will be discussed and finalized by consensus on the first day of class; however, the majority of lecture material will be distributed via pre-recorded videos that students can view on-line and remotely. Classroom time will be reserved for Q&A, further in-depth discussion of topics, review sessions, and exams. Students are responsible for viewing the assigned pre-recorded material outside of classroom hours since HWs/projects and exams will be based on that material.

Grading:

Grading consists of two midterms, one final, and a set of projects (consisting of a combination of written problems and VHDL programming assignments) weighted as shown below. Grading for the class is based on a metric shown below. All assignments must be completed by the student on the due date specified to receive credit for the class. All students must uphold academic integrity and honesty for all assignments, per university policy detailed at <http://www2.sjsu.edu/senate/f88-10.htm>.

Midterm	Approx. Week 6	20%
Midterm	Approx. Week 12	20%
Final	12/13/22 @ 12:15pm	40%
Projects		20%

After each assignment is weighted as listed above, the overall course grade will be determined per this table:

- A plus = 100 to 97.0 points
- A = 96.9 to 93 points
- A minus = 92.9 to 90.0 points
- B plus = 89.9 to 87.0 points
- B = 86.9 to 82.0 points
- B minus = 81.9 to 80.0 points
- C plus = 79.9 to 77.0 points
- C = 76.9 to 72.0 points
- C minus = 71.9 to 70.0 points
- D plus = 69.9 to 67.0 points
- D = 66.9 to 62.0 points
- D minus = 61.9 to 60.0 points
- F = 59.9 points or lower

Schedule (Tentative):

<b>Lecture</b>	<b>Topic</b>
1-4	Introduction, VHDL
5-7	Data, Number Representation
8-9	Computer Arithmetic: Addition (CLA, CSA)
10	Computer Arithmetic: Multiplication
11	Computer Arithmetic: Division
<b>Midterm</b>	
12-14	Memory Organization
15	Flynn Architectures
16	Pipelining
17	Multi-Function Unit Processing
18	Parallel Processing Hazards, VLIW
<b>Midterm</b>	
19	RISC
20-21	Fault-Tolerance, Parity, Hamming Codes

**Final - Tuesday, Dec. 13, 2022, 12:15pm - 2:30pm**

## **Course Objectives:**

- To quickly review basic Boolean number representation schemes, digital logic gates, and basic combinatorial and sequential circuit structures.
- To introduce students to the basic roles and responsibilities for each of the major hardware components of a computer.
- To acquaint students with the need to use a memory hierarchy, perform memory management, and to explain to them the various memory management techniques and their tradeoffs.
- To help students appreciate how the fundamental mathematical operations such as addition, subtraction, multiplication, and division are implemented and can be optimized with Boolean operands.
- To educate students about the tradeoffs between complex instruction set computers (CISC) and reduced instruction set computers (RISC).
- To discuss non-classical architectures such as parallel processors and pipelined machines which are used to accelerate hardware performance without impacting legacy sequential software programming languages or techniques.
- To introduce computer-aided design tools and hardware description languages useful to computer architects in performing functional verification and performance measurements of digital systems.
- Appreciate how hardware and software (especially the operating system) must work synergistically together.

## **Student Learning Outcomes:**

Upon successful completion of this course, students should be able to:

- Understand the role of each major hardware component of a computer system and their synergistic interaction with each other and software.
- Analyze and perform tradeoffs between the cost, performance, and reliability of alternative computer architectures.
- Understand, analyze, and design digital logic structures for the basic combinatorial and sequential circuits.
- Understand the alternative binary internal representation of information (such as sign-magnitude, one's complement, two's complement, and floating point) along with their optimizations and tradeoffs.
- Be able to perform basic mathematical operations (add, multiply) in the various Boolean number representation schemes.
- Understand the operation of, and be able to analyze from a cost/performance standpoint, certain optimized hardware structures (for instance, fast ALU circuits such as carry look-ahead adders, carry select adders, Booth multipliers).
- Appreciate the need to use a memory hierarchy and understand how locality of memory referencing in typical programs can be leveraged to perform effective memory architecture management.
- Understand and emulate the various mapping, replacement, and dynamic memory allocation algorithms for cache and virtual memory management.
- Understand the rationale and philosophy behind both complex instruction set computers (CISC) and reduced instruction set computers (RISC), and the tradeoffs between the two architectures.
- Understand how pipelining and parallel processing are cost-effective methods of increasing hardware performance.
- Appreciate how computer-aided design tools and hardware description languages can be used to verify and measure the performance of hardware designs.

# General University Policies

## **DISABILITIES:**

If you need course adaptations or accommodations because of a disability, or if you need special arrangements in case the building must be evacuated, please inform the instructor as soon as possible. Presidential Directive 97-03 requires that students with disabilities register with DRC to establish a record of their disability.

## **ACADEMIC INTEGRITY:**

Academic integrity is essential to the mission of San José State University. As such, students are expected to perform their own work (except when collaboration is expressly permitted by the course instructor) without the use of any outside resources. Students are not permitted to use old tests or quizzes when preparing for exams, nor may they consult with students who have already taken the exam. When practiced, academic integrity ensures that all students are fairly graded.

We all share the obligation to maintain an environment which practices academic integrity. Violations to the Academic Integrity Policy undermine the educational process and will not be tolerated. It also demonstrates a lack of respect for oneself, fellow students and the course instructor, and can ruin the university's reputation and the value of the degrees it offers. Violators of the Academic Integrity Policy will be subject to failing this course and being reported to the Office of Judicial Affairs for disciplinary action which could result in suspension or expulsion from San José State University.

## **CHEATING:**

At SJSU, cheating is the act of obtaining or attempting to obtain credit for academic work through the use of any dishonest, deceptive, or fraudulent means. Cheating at SJSU includes but is not limited to:

Copying in part or in whole, from another's test or other evaluation instrument; Submitting work previously graded in another course unless this has been approved by the course instructor or by departmental policy. Submitting work simultaneously presented in two courses, unless this has been approved by both course instructors or by departmental policy. Altering or interfering with grading or grading instructions; Sitting for an examination by a surrogate, or as a surrogate; any other act committed by a student in the course of his or her academic work which defrauds or misrepresents, including aiding or abetting in any of the actions defined above.

## **PLAGIARISM:**

At SJSU plagiarism is the act of representing the work of another as one's own (without giving appropriate credit) regardless of how that work was obtained (hardcopy, softcopy, Internet), and submitting it to fulfill academic requirements. Plagiarism at SJSU includes but is not limited to:

The act of incorporating the ideas, words, sentences, paragraphs, or parts thereof, or the specific substances of another's work, without giving appropriate credit, and representing the product as one's own work; and representing another's artistic/scholarly works such as musical compositions, computer programs, photographs, painting, drawing, sculptures, or similar works as one's own.

## **Additional Information:**

<http://www.cs.sjsu.edu/greensheetinfo/index.html>