CSCI 401: Contemporary Computer Architectures

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Phone:	537-5429	Class:	JB-113, TR 4-5:50 P
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Prerequisites:	CSCI 310 and CSCI 313		

1 Objective:

To provide the basic knowledge of computer architecture and how the influences of VLSI technology, high level languages, and assembly language interacts in the design of hardware. Upon successful completion of this course, the student will have learned the techniques and theories of:

1. Performance metrics
2. Arithmetic and ALU
3. Hardware and Microprogrammed Control
4. Pipelining
5. Cache and Virtual Memory
6. Bus and I/O

2 Grading:

Your grade is determined from four basic areas: homework (15%), labs (25%), test (15% each), and a final (30%). Homework and labs have been weighted heavily since they tend to be better for students. If the final is better than your homework grade, I will shift 10% from homework to final (thus homework 5%, final 40%). Homework problems will be graded on a 0-2 basis (0=no valid attempt, 1=something valid, 2= correct).

The grading scheme is listed below.

Ltr	Percent	Ltr	Percent
A	94 - 100	C	73 - 76
A-	90 - 94	C-	70 - 73
B+	86 - 90	D+	66 - 70
B	83 - 86	D	63 - 66
B-	80 - 83	D-	60 - 63
C+	76 - 80	F	00 - 60

3 Reading

The reading assignments are connected to the Lab (read the chapter the lab is from). You are to read it in advance for each class (except the first, which would not be possible). There are two main reasons for reading the material ahead of time.

1. Reading the text before class gives you the basic ideas, so the deeper truths can be covered in class.
2. Even the best of textbooks will cause most people to get confused on some aspects. If you read the book before the class, your confusion will get cleared up and make the course easier for you.

I know that reading before class is not frequently done, but I encourage you to do it. You are here to get a top quality education, but in order to get it you must do more than just show up.

4 Tests and Final

The tests and final are closed book, but I allow 1 page of 8.5×11 front and back of notes in the test and 3 pages for the final (theoretically two from the test and one new). You should bring paper to write on and a pen or pencil. You cannot use a calculator and all electronic devices must be off.

I will provide sample exams with solutions on the class website. Try the exam before looking at the solution. Additionally I will schedule a two hour review session outside class (if desired) for each exam at the best overlap between the classes and my schedule.

5 Lab

The lab is an essential aspect in really understanding the material. The labs you will do will familiarize you with designing modern computers in a hardware description language (HDL). You will not finish the

labs if you do not prepare by reading the lab in advance and looking over the review questions. You will be working in groups of two, but each member must contribute equally. You must electronically submit a text document (.doc, .pdf, .ps, .tex, .rtf) that contains a copy of the verilog code with comments and the answers/results to the exercises, such as output of code runs (from verilog.log file). The verilog code must have a comment block for each module that is formatted like:

```
// Names       :
// Lab         :
// Date        :
// Title       :
// Description :
```

Additionally, brief comments explaining the pseudocode must be included to make your code readable.

6 Homework:

This course is a design course, which means that how you get the answer is as important (if not more important) than what the answer is. *Given that your work is the most important part, no credit will be given to homework which just gives the results or that the work is not decipherable.* All homework must be neat, organized, and show all the steps. Assembly programs must be typed. Homework must have

```
Name
Date
Assignment #
CSCI 401
```

in the upper right corner of the first page. Multiple page homework must be stapled. Homework is due at the beginning of the class meeting on the due date. Late homework will be not accepted.

Students are encouraged to discuss class material, *but the work must be done individually.* The homework and all other graded work should reflect the effort of the individual who receives credit for it. Cheating will not be tolerated. The student may never copy other student's work, nor allow others to copy one's own work. If two assignments look excessively similar, and are not narrow enough to justify the similarity, automatically a grade of zero results, with the likely referral to appropriate university bodies. According to the current CSUSB Bulletin, the offending student may receive penalties up to and including expulsion. Again, students are allowed and encouraged to discuss the material related to assignments, but when it comes to actually doing the assignment work it is to be done individually.

7 Extra Credit

I do not curve grades, but I do give extra credit. Extra credit takes the form of writing tutorials that I will post on the website for other students to benefit. You must write the tutorial on an area you lost points on. You must write the tutorial yourself, do not copy it from the web. I get really annoyed when students copy tutorials from others. I always find it, don't try. Writing a tutorial teaches you to do the work. All who have done them have remarked how much they learned. Don't cheat yourself of a valuable learning experience, while earning nothing for cheating.

8 Getting Help

Everything always seems easier in class. The goal of this course is to prepare you to generate good digital designs, not to frustrate or confuse you. You will not know what is hard or confusing until you try though. When you hit things that you can't figure out, don't get frustrated, get help. You are highly encouraged to take advantage of office hours. Office hours are the premiere assistance methodology of this class. The class website also has my notes, and links to the book's website.

When discussing labs with other groups, do not cheat yourself though by getting solutions and not understanding! All work must be your own. You can discuss and help, but may not copy someone else's work, or allow your work to be copied. That is plagiarism and is treated very severely.

Schedule

Date	Topic	Reading	Homework Due
1	Intro, fabrication, & power	**1**.1-3,5-7	
2	Performance	**1**.4, 6-9	
3	ISA, addressing, numbers, datastructures	**2**.1-6	1.5, 1.6, 1.13
4	Control, proceedures, pointers, compiling	**2**.7-14	
5	Binary arithmetic (review)	**3**	
6	Datapaths, Pipelines, Structural Hazards	**4**.1-5	2.4, 2.9
7	Pipelines: Data Hazards & Performance	**4**.6-7	
8	Test 1	**1-4.5**	
9	Pipelines: Control Hazards & Performance	**4**.8-14	
10	Pipelines	**4**	
11	Memory & Cache Design	**5**.1-2	4.21, 4.22, 4.23
13	Cache Performance & Strategies	**5**.3, 5, 7	
14	Virtual Memory	**5**.4-11	
15	Test 2	**4-5**	5.2, 5.7
16	I/O Basics & Performance	**6**.1, 5-8	
17	Storage Devices: Disks, RAID	**6**.3-4, 9-10	
18	Reliability & Networks	**6**.2, 11-14	
19	Network Topologies & Roofline	**7**.8-13	6.2, 6.3, 6.14
20	GPUs	**7**.7, **A**	
21	Final	**1-A**	

9 University Policies

Students are referred to the "General Regulations and Procedures" in the CSUSB Bulletin of Courses for the university's policies on course withdrawal, cheating, and plagiarism.

Dropping and Adding You are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. found at (CSUSB Bulletin, pages 46-48).

Plagiarism and Cheating Students are expected to be familiar with the University's Policy on cheating and Plagiarism. Please review this at (CSUSB Bulletin, pages 51-52). Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University.

10 Other Information

The student is responsible for all material covered in class, and also for all announcements made therein. The schedule can be changed by class vote to accommodate unforseen events (campus closures and such).

11 Prerequisite Knowledge

I expect you have taken both CSCI 310: Digital Logic and CSCI 313: Machine Organization, and understand the basics. I suggest you read over appendix C and E from the book and make sure you are comfortable with it. We will not design components but I expect you could understand, analyze, and design simple circuits. Additionally I expect you recall the basics of codes, representing numbers, and calculations. We will be going into more advanced methods. If you are not comfortable with your knowledge from Digital Logic, come see me early and we can try to get you up to speed.

12 Objective:

This is a graduate level course covering modern concepts and techniques in the design of high perfor-

mance computer architectures. Particular attention will be paid to parallelism and various ways to exploit it to achieve speedup.

1. Perfomance, power, and price metrics and comparison techniques
2. Data parallelism, GPUs, vector machines, hazards, and design techniques
3. Instruction-Level Parallelism (ILP), data hazards, dynamic scheduling, multiple issue, compilers
4. Multiprocessors, Thread-Level Parallelism (TLP), clusters, memory, synchronization
5. Memory hierarchy, cache, virtual memory
6. Design of 32 bit out-of-order computer in Verilog

13 Prerequisite Knowledge

I expect that you are familiar with the basics of computer design, such as, memory, cache, ALU, pipelines, instruction set architectures (ISA), and performance metrics. We will not design components but I expect you could understand, analyze, and design simple circuits. Additionally I expect you recall the basics of codes, representing numbers, and calculations. Finally, I expect you know the basics of Verilog. If you are not comfortable with your knowledge, come see me early and we can try to get you up to speed. Students who come from our program have a year sequence (CSE 310, CSE 313, CSE 401), which covers this material. If you took CSE 510 here, you can't get credit for this course (they are the same), please talk to Dr. Mendoza to get this fixed. If you came from another school and took CSE 598, realize you did the year sequence in a quarter so you probably are missing a few things. I am happy to give extra help outside class, but to make this effective you will need to *read in advance* and then *come to me before class* so we can cover the material you need.

14 Learning Outcomes

The following are learning outcomes for the Computer Science program, accredited by ABET This course supports these outcomes.

a) An ability to apply knowledge of computing and mathematics appropriate to the discipline

b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution

c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs

d) An ability to function effectively on teams to accomplish a common goal

e) An understanding of professional, ethical, legal, security and social issues and responsibilities

f) An ability to communicate effectively with a range of audiences

g) An ability to analyze the local and global impact of computing on individuals, organizations, and society

h) Recognition of the need to and an ability to engage in continuing professional development

i) An ability to use current techniques, skills, and tools necessary for computing practice

j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices

k) An ability to apply design and development principles in the construction of software systems of varying complexity

15 The following are CSUSB policies

15.1 Plagiarism and Cheating

Plagiarism and cheating are violations of the Student Conduct Code (see Appendix) and may be dealt with by both the instructor and the Judicial Affairs Officer. Definition and procedures for addressing cheating and plagiarism are found below. Questions about academic dishonesty and the policy should be addressed to the Office of the Vice President, Student Services. Plagiarism is the act of presenting the ideas and writings of another as ones own. 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 includes but is not limited to:

1. Copying, in part or in whole, from anothers test, software, or other evaluation instrument.

2. Submitting work previously graded in another course unless this has been approved by the course instructor or by departmental policy.

3. Submitting work simultaneously presented in two courses, unless this has been approved by both course instructors or by the department policies of both departments.

4. Using or consulting during an examination sources or materials not authorized by the instructor.

5. Altering or interfering with grading or grading instructions.

6. Sitting for an examination by a surrogate, or as a surrogate.

7. 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 is academically dishonest and makes the offending student liable to penalties up to and including expulsion. Students must make appropriate acknowledgements of the original source where material written or compiled by another is used. Procedure. Allegations of academic dishonesty may be handled directly by the instructor or may be referred by the instructor to the Judicial Affairs Officer. If handled by the instructor, the instructor has the following responsibilities:

1. To preserve the evidence in support of the allegation;

2. To notify the student of the allegation and of the evidence on which it is based;

3. To provide the student a reasonable opportunity to challenge or rebut the allegation;

4. To notify the student of the action being taken.

The instructor may employ any of the following sanctions:

1. Verbal or written reprimand;

2. Assignment or appropriate task or examination;

3. Change of grade, including assigning a punitive grade to work involving dishonesty, or for the course, project, thesis, or any other summary evaluation of the students academic work.

If the student does not wish to accept the sanction proposed by the instructor, the student may request and require that the allegation be referred to the Judicial Affairs Officer. In that event, the procedures specified under Executive Order 970 (Student Disciplinary Procedures of the California State University) shall be observed. The instructor shall not impose any sanction other than the sanction(s) imposed through the disciplinary procedure.

15.2 Students with Disabilities:

If you are in need of an accommodation for a disability in order to participate in this class, please let me know and also contact Services to Students with Disabilities at UH-183, (909)537-5238.