1 Course and Instructor Information

Instructor: Ernesto Gomez  
Office location: Jack Brown Hall - Room 337  
Telephone: (909)537-5429  
Email: ernesto@csusb.edu  
Office Hours: TBA  
Class Days/Time: M-W 12:00  
Classroom: 17  
Lab Days/Time: MW 1:30  
Labroom: JB 360  
Textbook: Hennessy and Patterson’s Computer Architecture, 5th  
Prerequisites: CSE 401

2 Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Read</th>
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<th>Lab</th>
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<td>Power, cost, failure/dependability</td>
<td>1.5-8</td>
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<td>3</td>
<td>Amdahl’s Law, locality, parallelism</td>
<td>1.9-13</td>
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<td>4</td>
<td>Memory hierarchy optimization, perf.</td>
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<td>5</td>
<td>Virtual memory, security</td>
<td>2.4, B.4-8</td>
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<tr>
<td>6</td>
<td>Performance, practical issues</td>
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<td>8</td>
<td>Compilers, loop unrolling, GCD</td>
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<td>9</td>
<td>Branch prediction</td>
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<td>10</td>
<td>Dynamic schedules, speculation, Tomasulo</td>
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<td>15</td>
<td>Symmetric shared memory, snooping</td>
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<td>16</td>
<td>Distributed shared memory, directory</td>
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<td>17</td>
<td>Synchronization, consistency</td>
<td>5.5-10</td>
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<td>6</td>
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<td>18</td>
<td>Performance, scaling</td>
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<td>RP</td>
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<td></td>
<td>Final</td>
<td>-</td>
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3 Reading

You are to read it in advance for each class (except the first, which would not be possible). The reading assignments listed cover the material that will be discussed in class, but in a different way, and with a different emphasis. I would be wasting your time and insulting you if I did not add material, as I would be implying you are unwilling or incapable of reading and understanding. 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 and broader implications 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 can ask questions and your confusion will get cleared up. Reading will 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. You are to read it in advance for each class (except the first, which would not be possible). The reading assignments listed cover the material that will be discussed in class, but in a different way, and with a different emphasis. I would be wasting your time and insulting you if I did not add material, as I would be implying you are unwilling or incapable of reading and understanding. There are two main reasons for reading the material ahead of time.

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4 Grading

All assignments will be submitted in the course Moodle, by the time specified unless previously arranged with the instructor. The grading percentages and policies of each graded area are listed in their sections below.

The grading scheme is as follows.

<table>
<thead>
<tr>
<th>Letter</th>
<th>Score Range</th>
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<tbody>
<tr>
<td>A</td>
<td>94 - 100</td>
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<tr>
<td>A-</td>
<td>90 - 94</td>
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<tr>
<td>B+</td>
<td>87 - 90</td>
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<tr>
<td>B</td>
<td>83 - 87</td>
</tr>
<tr>
<td>B-</td>
<td>80 - 83</td>
</tr>
<tr>
<td>C+</td>
<td>77 - 80</td>
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<tr>
<td>C</td>
<td>73 - 77</td>
</tr>
<tr>
<td>C-</td>
<td>70 - 73</td>
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<tr>
<td>D+</td>
<td>67 - 70</td>
</tr>
<tr>
<td>D</td>
<td>63 - 67</td>
</tr>
<tr>
<td>D-</td>
<td>60 - 63</td>
</tr>
<tr>
<td>F</td>
<td>00 - 60</td>
</tr>
</tbody>
</table>

All grades will be available on the course Moodle.

I do not curve grades, but I do give unlimited extra credit. Extra credit for tests 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 risking expulsion for cheating. For the final, one and only one tutorial may be submitted in advance.

You may earn extra credit for homework by attending school seminars, attending relevant conferences, and participating in school outreach activities, like the open house.

Labs that are submitted on time can be fixed and re-graded, so no extra credit is needed.

- A 94 - 100
- A- 90 - 94
- B+ 87 - 90
- B 83 - 87
- B- 80 - 83
- C+ 77 - 80
- C 73 - 77
- C- 70 - 73
- D+ 67 - 70
- D 63 - 67
- D- 60 - 63
- F 00 - 60

I normally do not curve grades, but I do give unlimited extra credit. Extra credit for tests 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. 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 risking expulsion for cheating. For the final, one and only one tutorial may be submitted in advance.

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5 Homework (10%)

Homework has been implemented as quizzes in the course Moodle. You may take them in whenever you feel like and in a piecemeal fashion, just be careful of the closing date (see the Moodle calendar or main page, note since it is due by A it will look like the next day on the calendar). You will get immediate feedback on the correctness of each answer when you submit the homework, which should help you to learn as you go. In a few cases, extended answers, such as proofs, are required, which will require me to grade them and thus cannot be verified immediately. These proofs must be organized, and show all the steps and be done in \LaTeX\footnote{\LaTeX is a free document formatter, available on all platforms, that does a great job with both math and computer code, and thus will actually make your life easier. It comes with standard Linux and Unix installs, but for those who use other platforms, I have put links on my webpage (look for the Tex link on my main page) to where you can download it for your home computer.} For extended answer problems, how you get the answer is as important (if not more important) than what the answer is. For extended answer problems, cut and paste your \LaTeX code into the text box, and I will grade it asap. Please make sure your \LaTeX code works before cutting and pasting.
Homework is due by A on the due date, so you should consider it due the day before it says. Be very careful of this, as it might be confusing. You have been warned so please don’t try and use this as an excuse. Late homework will be not accepted, the Moodle will promptly close the quizzes. Your clock might differ, so please try to be in safely under the deadline. You can save your work without submitting, which allows you to divide up when you do your problems, but if in the end you don’t click submit it won’t be graded and you will get a zero. Please carefully watch the due date and time, as Moodle will automatically stop the quiz when time runs out. After I set it, I do not control it, it is automatic. If you don’t submit the quiz in time you will get a zero. Please do not risk this by waiting till the last second.

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.

6 Lab (50%)

The lab is an essential aspect in really understanding the material. All lab files must be zipped into a single file and uploaded to the class Moodle by the end of day on the Monday following the lab. If you submit your lab on time, you may re-submit a fixed lab for a re-grade. If you do not submit a completed lab on time, you will get a 0 and cannot re-submit the lab for a re-grade. Stay on top of your labs!

The labs you will do will mainly cover Verilog implementations, so you can test and become familiar with the issues around our designs. You will not finish the labs if you do not prepare by reading the lab in advance. You will be working in groups of two, but each member must contribute equally. I expect your code to be well documented and to perform as specified in the lab. Labs should be submitted electronically by uploading to the Moodle, a zip of all the Verilog files and a pdf lab report before the next lab starts. The lab manual must be done in LaTeX.

7 Final (40%)

The final is closed book, but I allow 4 pages of 8.5 x 11 front and back of notes in the final. You should bring paper to write on and a pen or pencil. You cannot use a calculator. No electronic device of any type is permitted in the final, use of one in any way will result in a 0 for the exam. Cell phones should be off and stored. The final is final will be take-home, but we will meet on the date and time of the final to complete presentations

8 Objective:

This is a graduate level course covering modern concepts and techniques in the design of high performance computer architectures. Particular attention will be paid to parallelism and various ways to exploit it to achieve speedup.

1. Performance, 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

9 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.

10 Getting Help

Everything always seems easier in class. The goal of this course is to learn the material, not to frustrate or confuse you. You will not know what is hard or confusing until you try though. When you hit that problem 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. You are also encouraged to discuss problems and methods with each other. Study groups can be very helpful. 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.

The class website also has my notes, some basic computer practice drills that check themselves if you need to refresh these topics, student tutorials, and links to other resources. You are encouraged to avail yourself of the help these provides.

11 University Policies

11.1 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 54-55). 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. For this class, all assignments are to be completed by the individual student unless otherwise specified.
11.2 Classroom Protocol
I expect you to be mature about your education and courteous to others. This means several things, such as,

1. being an active participant in class;
2. showing up on time each day ready for class
3. if you can’t make it, you should make provisions to get notes and such so you learn;
4. being respectful of others;
5. not using cell phones or web surfing - if you don’t want to be here, then don’t sign up for class;
6. leaving class quietly to take an important call or go to an essential meeting, so as not to disturb others.

11.3 Dropping and Adding
You are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. found at (CSUSB Bulletin, pages 48-50).

12 Support for Students with Disabilities
If you are in need of an accommodation for a disability in order to participate in this class, please contact Services to Students with Disabilities at (909)537-5238. You are advised to establish a buddy system and alternate in the class if you require assistance in the event of an emergency. Individuals with disabilities should prepare for an emergency ahead of time by instructing a classmate and the instructor.

13 Time
The dean’s initiative for student studying is called 25-35, which means 25 hours of study per week for a 3 course schedule or 35 hours for a 4 course schedule. I expect about 8-9 hours a week outside class time from students. These are expected averages, you should expect to have this commitment, though it may vary by the ease with which you pick up the material.

14 Other Information
The student is responsible for all material covered in the readings, class, labs, and also for all announcements made therein. The topics and dates in this syllabus are tentative, for instance in the fall at CSUSB fires and wind sometimes close the campus. I might need to cut a topic or move things around should we face unpleasant weather or other unforeseeable conditions. All changes will be discussed with the class.

My personal website, r2labs.org, which has my notes and helps for students is not required for the course, it is solely there for your help. The university will not provide technical support for resources available on r2labs.org. The university does not endorse any products which may be advertised through r2labs.org.