Syllabus
CS 270: Introduction to Computer Architecture II
Spring 2021 (CRN 32282)

Course Description
From the ODU Catalog

Prerequisites
A grade of C or better in CS 150 and CS 170.

Course Overview
In this asynchronous online class, you will study the architectural and operational basics of modern computers. The course is designed to give students a good understanding of design and operation of an ALU (Arithmetic/Logic Unit), and implementation and control of single and multicycle processors. Further, the course covers processor pipelining, technology and operation of the memory hierarchy, virtual memory, and the importance of performance.

Instructor
Susan Zehra
Dragas 1103 E
(757) 683-7735
szehra@odu.edu

Office Hours
Mondays and Wednesdays: 10:00AM - 11:00AM, or by appointment. All office hours will be held via Zoom. A private Zoom link be shared with only the student who takes an appointment via email.

Course Readings
Required Textbook

Recommended Topics
- Overview of the Course & Review - Chapter 1 and Appendix B
- Processor - Chapter 4,
- Controller - Appendix D
- Exploiting memory hierarchy - Chapter 5
- Parallel computing overview - Chapter 6
Other Requirements
As this is an online-only course, you must have access to a computer with high-speed Internet. If you are an on-campus student, you may use the university computer labs or Computer Science computer labs. Otherwise, you must provide your own computer and Internet access.

Course Goals and Objectives
After completing this course, students should have a strong foundation in the principles of the computer architecture, building a Datapath, an overview of pipelining, exploiting memory hierarchy, and virtual memory and parallel processors.

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

<table>
<thead>
<tr>
<th>Module#</th>
<th>Objectives</th>
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| 1       | - Describe the basic architecture of general computers.  
          - Explain the eight great ideas in computer architecture.  
          - Explain the role of high-level language and assembly language.  
          - Understand how the great idea of abstraction helps improve design.  
          - Identify the instruction set architecture.  
          - Appreciate the technologies for building processors and memory.  
          - Explain how hardware designers improve performance. |
| 2       | - Understand gates, truth tables, and logic equations.  
          - Describe the basic functionality of combinational logic.  
          - Explain the basics of Arithmetic Logic Unit (ALU).  
          - Understand how clocking works.  
          - Identify memory elements. |
| 3       | - Understand logic design conventions.  
          - Explain a basic MIPS implementation.  
          - Explain all the steps involved in an instruction execution.  
          - Build a datapath. |
| 4       | - Understand ALU control unit.  
          - Design the main control unit.  
          - List various control signals and explain their effects.  
          - Build datapath for various instructions with control signals. |
| 5       | - Understand the performance issues of single-cycle implementation.  
          - Compare between nonpipelined and pipelined execution.  
          - Explain the advantages of using MIPS instructions in pipelining.  
          - Understand different types of pipelining hazards.  
          - Understand the effect of pipelining hazards on processor performance. |
| 6       | - Understand the operation of pipelined datapath and control. |
| 7 | Identify all pipeline registers.  
Understand the operation of pipelined datapath for load/store instruction.  
Appreciate the importance of pipelined registers.  
Graphically illustrate pipelines.  
Understand pipelined control.  
Understand data hazards in pipeline execution.  
Describe data dependence and dependence detection.  
Understand the mechanism of proper data forwarding.  
Understand the process hazards detection.  
Compare and contrast forwarding vs stalling.
Resolve data hazards using control signals.  
Understand control hazards.  
Compare and contrast branch prediction vs dynamic branch prediction. |
|---|---|
| 9 | Understand Instruction-Level Parallelism (ILP) and multiple-issue pipeline.  
Compare and contrast static multiple issue and dynamic multiple issue.  
Understand the process of multiple-issue code scheduling and loop unrolling.  
Understand the process of dynamic pipeline scheduling.  
Name all four memory technologies.  
Compare and contrast SRAMs and DRAMs.  
Understand the working of magnetic disk.  
Understand the two principles of locality – temporal and spatial.  
Understand the basic structure of memory hierarchy.  
Define block, hit rate, miss rate, hit time, miss penalty.  
Explain the importance of the location of caches.  
Illustrate the direct-mapped cache.  
Determine the presence of a block in the cache. |
| 10 | Describe how the control unit deals with cache misses.  
Define the steps to be taken on an instruction cache miss.  
Compare and contrast write-through and write back.  
Understand direct mapped, fully associative, and set associative cache.  
Explain the effect of associativity of cache on cache misses.  
Explain how multilevel caches may help reduce miss penalty.  
Describe the concept and importance of virtual memory.  
Explain the difference between physical address and virtual address.  
Describe the process of address translation.  
Explain the importance of page table.  
Describe Translation Lookaside Buffer (TLB) with a diagram. |
| 11 | Explain the use of multiprocessor.  
Define task-level parallelism.  
Appreciate program execution using parallel processing.  
Understand the challenges and issues in developing fast parallel software.  
Explain the speed-up challenge.  
Understand hardware multithreading and simultaneous multithreading.  
Understand coarse-grained multithreading and fine-grained multithreading. |
More specific objectives for each topic are listed within each module.

**How the Course Works**

**Methods of Delivery/Learning Activities**
This online course employs several methods of delivery and learning activities including online videos and screencasts, discussions, readings, homework assignments, quizzes, exams, etc.

**Course Outline**
The material is divided into modules, with each module lasting one week.

Module 1 – Introduction to Computer Architecture  
Module 2 - Review of Logic Design Conventions  
Module 3 – Building a Datapath  
Module 4 – Implementation of Datapath with Control  
Module 5 – Introduction to Pipelining  
Module 6 – Pipelined Datapath and Control  
Module 7 – Hazards in Pipelining  
Module 8 – Midterm Exam  
Module 9 – Parallelism and Memory Technologies  
Module 10 – Memory Hierarchy and Caches  
Module 11 - Cache Performance  
Module 12 –Virtual Memory  
Module 13 – Parallel Processing  
Module 14 – Multithreading  
Module 15 - Final Exam

All the modules will be available on PLE.

**Weekly Schedule**

<table>
<thead>
<tr>
<th>Day</th>
<th>Event</th>
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<tbody>
<tr>
<td>Sunday</td>
<td>New module begins</td>
</tr>
<tr>
<td>Saturday</td>
<td>Module ends. All materials, i.e., weekly discussion replies, weekly quiz, and homework assignment (if any) are due before 11:59pm.</td>
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</table>

Even though this is an asynchronous online class, you must progress through the modules weekly and meet the required due dates. A detailed course schedule with due dates will be available on PLE.
Discussion Board Policy
Almost every week we will have a discussion question related to the material being covered that week. Each student will be required to participate in all these discussion questions during the semester.

Grading Criteria
Your grade in this class will be based on the following:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Quizzes</td>
<td>20%</td>
</tr>
<tr>
<td>Discussion Participation</td>
<td>10%</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>20%</td>
</tr>
<tr>
<td>Mid-term Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
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Grading Scale
The grading scale is as follows (+ and - modifiers will be applied as appropriate):

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Range</th>
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<tbody>
<tr>
<td>A</td>
<td>95-100</td>
</tr>
<tr>
<td>A-</td>
<td>90-94</td>
</tr>
<tr>
<td>B+</td>
<td>87-89</td>
</tr>
<tr>
<td>B</td>
<td>84-86</td>
</tr>
<tr>
<td>B-</td>
<td>80-83</td>
</tr>
<tr>
<td>C+</td>
<td>77-79</td>
</tr>
<tr>
<td>C</td>
<td>74-76</td>
</tr>
<tr>
<td>C-</td>
<td>70-73</td>
</tr>
<tr>
<td>D+</td>
<td>67-69</td>
</tr>
<tr>
<td>D</td>
<td>64-66</td>
</tr>
<tr>
<td>D-</td>
<td>60-63</td>
</tr>
<tr>
<td>F</td>
<td>0-59</td>
</tr>
</tbody>
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Late Submissions
Any submission after its deadline is considered late. The following penalties for late submissions apply:

- 0-24 hours late: -10%
- 25-48 hours late: -20%
- after 48 hours: not accepted

This time limit includes weekends—they are counted just like weekdays.

I reserve the right to specify that late submissions will not be accepted for specific submissions.
Student Responsibilities

Time Management
Students are expected to spend 10 hours per week on the course materials and assignments. Out of 10 hours, students are expected to spend approximately 5 hours/week to read the material, approximately another 4 hours/week for the homework assignment and quiz, and another 1 hour/week for discussions.

Attendance
Since this is an on-line course, there is no mandatory attendance policy. However, students are expected to actively participate in the discussions, homework submissions, and quizzes. Each of these components is graded and counted toward the final grade.

Academic Integrity / Honor Code
By attending Old Dominion University, you have accepted the responsibility to abide by the honor code and honor pledge. This is an institutional policy approved by the Board of Visitors. If you are uncertain about how the honor code applies to any course activity, you should request clarification from the instructor. The honor pledge is as follows:

"I pledge to support the honor system of Old Dominion University. I will refrain from any form of academic dishonesty or deception, such as cheating or plagiarism. I am aware that as a member if the academic community, it is my responsibility to turn in all suspected violators of the honor system. I will report to Honor Council hearings if summoned."

Any evidence of an honor code violation (cheating) will result in a 0 grade for the discussion forum/quiz/assignment/exam, and the incident will be considered for further review. Evidence of cheating may include a student being unable to satisfactorily answer questions asked by the instructor about a submitted solution. Cheating includes not only receiving unauthorized assistance, but also giving unauthorized assistance.

Students may still provide legitimate assistance to one another. You are encouraged to form study groups to discuss course topics. Students should avoid discussions of solutions to ongoing quiz/assignment/exam and should not, under any circumstances, share solutions for an ongoing quiz/assignment/exam.

Read the Academic Integrity page for more information on what is considered cheating or plagiarism in the Department of Computer Science.

All students are responsible for knowing the rules. If you are unclear about whether a certain activity is allowed or not, please contact the instructor.
Course Policies

Online Classroom Conduct
As most of our interactions will be online, please follow proper online etiquette. The following is a list of general guidelines for this course:

- Check your grammar and spelling
- Keep your comments focused on the topic
- Strive to write succinctly and clearly
- Share your knowledge and include supportive evidence for your comments
- Do not use all capital letters, as that is viewed as shouting
- Disrespectful language is unacceptable

Getting Help
Please use the Hallway forum (on Blackboard) to ask questions about the course material or ask clarifying questions about an assignment. Please do not discuss solutions to homework assignments in Hallway. Feel free to answer questions that other students have posted in the Hallway forum.

If you need to contact the instructor about a private matter, the best way is through email, but do not expect or rely on an immediate response.

Attendance
As mentioned earlier, since this is an online course, there is no mandatory attendance policy. However, students are expected to actively participate in the discussions, homework submissions, and feedback. Each of these components is graded and counted towards the final grade.

Notification of Extenuating Circumstances
If a serious situation has occurred that will prevent you from submitting your work (quizzes, homework assignments, exams, etc.) on time, notify your instructor 24 hours before the scheduled due date.

Disclaimer
Every attempt is made to provide a syllabus that is complete and that provides an accurate overview of the course. However, circumstances and events may make it necessary for the instructor to modify the syllabus during the semester. This may depend, in part, on the progress, needs, and experiences of the students.

University Policies

Honor Pledge
"I pledge to support the honor system of Old Dominion University. I will refrain from any form of academic dishonesty or deception, such as cheating or plagiarism. I am aware that as a member of the academic community, it is my responsibility to turn in all suspected violators of the honor system. I will report to Honor Council hearings if summoned."
Special Needs
Old Dominion University is committed to achieving equal educational opportunity and full participation for persons with disabilities. It is the university's policy that no qualified person be excluded from participation in any university program or activity, be denied the benefits of any university program or activity, or otherwise be subjected to discrimination with regard to any university program or activity. This policy derives from the university's commitment to non-discrimination for all persons in employment, access to facilities, student programs, activities, and services.

Disability Services
In compliance with PL94-142 and more recent federal legislation affirming the rights of disabled individuals, provisions will be made for students with special needs on an individual basis. Old Dominion University is committed to ensuring equal access to all qualified students with disabilities in accordance with the Americans with Disabilities Act. The Office of Educational Accessibility (OEA) is the campus office that works with students who have disabilities to provide and/or arrange reasonable accommodations.

- If you experience a disability which will impact your ability to access any aspect of my class, please present me with an accommodation letter from OEA so that we can work together to ensure that appropriate accommodations are available to you.
- If you feel that you will experience barriers to your ability to learn and/or testing in my class but do not have an accommodation letter, please consider scheduling an appointment with OEA to determine if academic accommodations are necessary.

The Office of Educational Accessibility is located at 1021 Student Success Center and their phone number is (757) 683-4655. Additional information is available at the OEA website: https://www.odu.edu/educationalaccessibility