EEL 5741

Advanced Microprocessor Systems

Section: RVC

Internet/Fully Online

Spring Term 2026

Course Time Zone: Eastern Time (ET). Course due dates and times are according to this time zone.

Professor Information

Gang Quan

Roles: Primary Instructor

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Office Hours: By Appointment

Course Prerequisites

Course prerequisites, if any, are listed below.

Course Description

Course Description and Purpose

This graduate course delves into the design, analysis, and optimization of modern computer systems. Building on basic computer knowledge from undergraduate studies, this course explores advanced topics and cutting-edge research that drive the performance and efficiency of contemporary processor architectures and systems. Students will engage with complex concepts such as pipelining, memory hierarchy, static/dynamic exploitation of instruction-level parallelism, and parallel and distributed computing systems. By the end of this course, students will understand why computers work the way they do and appreciate the art of building computer systems to execute programs. They will be prepared to contribute to advancements in computer architecture and anticipate future advancements in computer architectures and systems.

Course Topics

- Introduction to computer architecture;
- Performance measurement and comparison;
- Instruction set architecture;
- Pipelining and instruction level parallelism;
- Memory hierarchy;
- Parallel and Distributed computers;
- SIMD and GPU.

Textbook and Course Materials

COMPUTER ARCHITECTURE: A Quantitative Approach (5 or 6 Edition)

Required/Recommended: Required

Authors: HENNESSY & PATTERSON

Publisher: Kaufmann

ISBN 13: 9780128119051

COMPUTER ARCHITECTURE

Required/Recommended: Recommended

Authors: HENNESSY

Publisher: ELSEVIER

ISBN 13: 9780443154065

Student Learning Outcomes/Objectives

- **CLO 1: Evaluate the performance of a computer using various performance metrics and benchmarks and make a compelling quantitative and/or qualitative argument when comparing different design alternatives or systems**

- **CLO 2: Describe the major characteristics of the modern instruction set architecture of a processor**

- **CLO 3: Recognize the pipeline design in the contemporary processor and learn more advanced processor design techniques, including out-of-order execution, branch prediction, and speculative execution**

- **CLO 4: Recognize instruction level parallelism (ILP) and identify static/ dynamic techniques to explore the ILP and improve performance in computer architecture**

- **CLO 5: Recall the memory hierarchy, including cache design, main memory, and virtual memory, and the impact of memory access latency on system performance**

- **CLO 6: Describe the motivations and challenges of switching from sequential to parallel processing, explore specialized architectures such as GPUs for performance improvement**

Expectations of this Course

This is an online course, which means most (if not all) of the course work will be conducted online. Expectations for performance in an online course are the same as a traditional course. In fact, online courses require a degree of self-motivation, self-discipline, and technology skills which can make these courses more demanding for some students.

Students are expected to:

- **review the getting started page located in the course modules;**
- **introduce yourself to the class during the first week by posting a self-introduction in the appropriate discussion;**
- **take the practice quiz to ensure that your computer is compatible with the learning management system, Canvas;**
- **interact online with instructor and peers;**
- **review and follow the course calendar and weekly outlines;**
- **log in to the course 5 times per week;**
- **respond to discussions by the due date specified.**
- **respond to emails within 2 days;**

- **submit assignments by the corresponding deadline.**

The instructor will:

- **log in to the course at least 4 times** a **week;**
- **respond to emails within one to two days; two to three days in weekends**
- **grade assignments and/or provide feedback within 7-14 days of the assignment deadline.**

Assignments & Assessments

Exams

One midterm and one final exam will be given for the class, which will be worth a total of 35% of the final grades. The date and time will be announced in the class. No makeup exams will be given without valid and documented excuses and prearranged with the instructor. Exams will be closed book and will be discussed later in the course.

In order to mitigate any issues with your computer and online assessments, it is very important that you take the Practice Quiz from each computer you will be using to take your graded quizzes and exams. Assessments in this course are not compatible with mobile devices and should not be taken through a mobile phone or a tablet.

Reading Assignments/Zoom Discussion Sessions

The textbook selected for this course is perhaps the most renowned textbook on computer architecture and system design, encompassing almost every aspect of advanced topics in this field (The 6th edition of this textbook has a total of 1526 pages!). However, we cannot cover all these topics in a single semester. Therefore, students are expected to grasp the key concepts and techniques using the PowerPoint slides as a study guide, supplemented by non-graded reading assignments, recommended online lectures, Zoom discussions, and homework/project assignments to delve into the details.

The instructor will schedule Zoom discussion sessions as needed for the Q&A, and students are expected to interact with the instructor and their peers actively during these sessions.

Homework and Lab Assignments

There will be six homework assignments for students in this course, contributing 25% toward the final grades. These assignments are designed to illustrate concepts, facilitate discussions, and prepare students for examination. Students are expected to provide not only the answers to the homework problems but also detailed explanations of their reasonings and solutions.

Three lab assignments will be assigned to students, totaling a significant portion of student grades (40%). These lab assignments aim to provide students with a series of hands-on opportunities to deepen their understanding of computer architecture concepts and to gain practical experiences and skills in designing, optimizing, and evaluating computer architectures and systems.

Students are expected to complete their assignments in a timely manner and submit them by the corresponding deadline.

Student interactions and participation

This is a group assignment though individual work is also permitted. A central component of this assignment is a semester-long "**Explain Like I'm Five**" **(ELI5)** peer teaching project. In this project, students will select one topic from core areas of computer architecture, such as benchmarking/performance evaluation, instruction/data/thread parallelism, pipeline design/branch prediction, memory hierarchy, and parallel/distributed computing, and explain the complex topic with the simplicity and clarity to your peer.

Each group will post online a presentation to the class for peer questioning and answering. All groups are required to watch all presentations and expected to engage actively by asking thoughtful questions.

Following each presentation, all groups will complete a structured peer-assessment form. You will provide feedback on the presentation's content accuracy, clarity, organization, visual aid quality, and the effectiveness of the Q&A responses.

The primary goals of this project are to encourage student interaction throughout the course and to deepen your understanding of a core computer architecture concept by preparing and delivering a lesson to your peers with exceptional clarity and insight.

Grading

Course Grades Distribution Table

Course Requirements	Number of Items	Weight
Homework assignments	6	25%
Lab assignments	3	30%
ELI5 Peer Teaching Project	3	15%
Midterm	1	15%
Final	1	15%
Extra Credit (introduce yourself and surveys)	4	2%
Total	10	102%

Letter Grade Distribution Table

Letter Grade	Sample Range %
A	91 to 100
A-	90 to 91
B+	89 to 90
B	81 to 89
B-	80 to 81
C+	79 to 78
C	70 to 79

Letter Grade	Sample Range %
D	60 to 70
F	<60

Proctored Exams

Please note that the information contained in this section applies only if your course requires a proctored exam.

Through a careful examination of this syllabus, it is the student's responsibility to determine whether this online course requires proctored exams. Please visit our Student Proctored Exam Instructions webpage for important information concerning proctored exams, proctoring centers, and important forms.

Schedule of Topics

Course Calendar

Module	Topics Covered	Assignments Due
1 (Includes Weeks 1-2)	**Performance measurement** Performance evaluations using different methods; Amdahl's Law; Quantitative CPU performance evaluation	**Reading Assignment** • Textbook 1.1 - 1.3 **Homework Assignme** • HW 1 **Lab Assignment** • Lab 1: Performanc
2 (Includes Week 3)	**Instruction set architecture** Instruction and instruction set architecture; how instructions are	**Reading Assignment** • Textbook A.1,A.3-

	represented in the computer; Memory alignment/endianness; MIPS ISA	**Homework Assignme** • HW 2
3 **(Includes Weeks 4-5)**	**Pipelining** What is the pipeline; Pipelining hazards and how to resolve them; Pipeline implementation	**Reading Assignment** • Textbook C.1-C.5 **Homework Assignme** • HW 3 **Lab Assignment** • Lab 2: Exploring M Endianness, and In Parallelism
4 **(Includes Weeks 6-9)**	**Static/dynamic instruction level parallelism** The concept of instruction level parallelism; Compiler-assisted Instruction scheduling and loop unrolling; Dynamic ILP exploitation using Tomasulo's approach; Speculative execution and branch prediction;	**Reading Assignment** • Textbook 3.1-3.6, **Homework Assignme** • HW 4 • HW 5 **Midterm Exam**
5 **(Includes Weeks 10-12)**	**Memory Hierarchy** The memory hierarchy and the principle of locality; Cache architecture and design optimization; Main memory; Virtual Memory	**Reading Assignment** • Textbook B.1-B.4, **Homework Assignme** • HW 6 **Lab Assignment**

		Lab 3: Memory Hiera Analysis
6 **(Includes Weeks 13-15)**	**Parallel/distributed computing systems** The motivations and challenges for parallel/distributed programs; The cache coherence problem; Two cache coherence protocols (snooping and directory); The concept of SIMD computer architecture; Data level parallelism and its exploitation; GPU architecture, programming model, and execution.	**Reading Assignment** • Textbook 5.1 - 5.4 **Final Exam**

Canvas Schedule

Due Date	Assignment Name
	Academic Honesty Policy
	Explain Link I am Five (Q&A)
	Open Forum
	Practice Quiz
1/18/26	Introduce Yourself
1/18/26	Homework Assignment #1
1/18/26	Pre-class survey

Due Date	Assignment Name
2/2/26	Homework Assignment #2
2/8/26	Lab #1 Benchmark Profiling And Processor Architecture
2/22/26	Homework Assignment #3
3/1/26	Homework Assignment #4
3/5/26	Mid-Term Exam
3/10/26	Midterm Survey
3/15/26	Lab #2 Exploring Memory Alignment, Endianness, and Instruction Level Parallelism
3/19/26	Explain Like I am Five (ELI5) Project - Proposal
3/29/26	Homework Assignment #5
4/19/26	Explain Like I am Five (ELI5) Project - Peer-Review
4/19/26	Homework Assignment #6
4/19/26	Lab #3 Memory Hierarchy Performance Analysis
4/19/26	Post-class survey
4/22/26	Explain Like I am Five (ELI5) Project - Participation
4/23/26	Final Exam

Course Communication

Communication in this course will take place via **the Canvas Inbox**. Check out the Canvas Conversations Tutorial or Canvas Guide to learn how to communicate with your instructor and peers using Announcements, Discussions, and the Inbox.

I will respond to all correspondence within **X days.**

Policies & Resources

Before starting this course, please review the Policies & Resources Page in Canvas, which includes comprehensive information on various University and Course Level Policies, such as:

- **University Policies**
- **Accessibility and Accommodations**
- **Online Etiquette**
- **Technical Requirements and Skills**
- **Computer & Digital Literacy Skills**
- **Course Technology Accessibility Statements and Privacy Policies**
- **Academic Integrity**
- **Copyright Statement**
- **Nondiscrimination Statement**
- **Panthers Care & Counseling and Psychological Services (CAPS)**
- **Fair Use Policy**

Zoom Video Conference

Zoom is a video conference tool that you can use to interact with your professor and fellow students by sharing screens, chatting, broadcasting live video/audio, and taking part in other interactive online activities.

Zoom meetings can be accessed via the Zoom link in the course navigation menu. Once you click on the Zoom link, it will route you to join the meeting for the respective class session. You will also be able to view upcoming meetings, previous meetings that you have already joined, and meeting recordings. Before joining an actual class session:

• Reference the Zoom Student Tutorials to learn about the tool, how to access your meeting room, and share your screen.

• Access the Zoom Test Meeting Room to test out the software before joining an actual session.

If you encounter any technical difficulties, please contact the FIU Canvas Help Team. Please ensure you contact support immediately upon the issue occurring.

Nondiscrimination Statement

The **Office of Civil Rights Compliance and Accessibility** (CRCA) is responsible for ensuring that FIU maintains a workplace and learning environment free from discrimination, where current and prospective faculty, staff, and students are treated equitably. If any student, employee, or applicant has a sincere and reasonable belief that they have been discriminated against or harassed based on age, color, disability, marital status, ethnic or national origin, race, religion, retaliation, sex, or any other protected category, they can report their concerns to the CRCA team through report.fiu.edu.