CS 692: Advanced Computer Architecture (Special Topics) (Spring 2025)

1 Course Basics

1.1 Instructor

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1.2 Description

This course covers the concepts and practice of modern computer architecture. Architecture is the interface of computer hardware and software that covers the essential design of instruction set architecture, organization of microarchitecture, and hardware for a computer system. Topics include classical computer architecture concepts and design, memory hierarchy, parallel computing in architecture, non-conventional architecture and domain specific architecture such as GPUs, multi-core systems, performance/security/reliability in architecture. The course also provides the students with hands-on experience in computer architecture through a project.

1.3 Prerequisites

Suggested prerequisites are the undergrad-level architecture, operating systems, or parallel computing. You need to be comfortable with programming in one of the following languages including C, Python. Knowing a language serves as a soft prerequisite.

1.4 Course Outcomes

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

- Demonstrate an understanding of the fundamental concepts in computer architecture.

- Get an overview of the recent computer architecture design and implementations.

- Have the ability to quantitatively evaluate the performance of a computer architecture.

- Optimize programs and applications based on the underlying architecture features.

- Demonstrate an ability to design, prototype, and implement an idea to improve computer architecture.

1.5 Textbooks

Computer Architecture: A Quantitative Approach
    By John L. Hennessy, David A. Patterson
    *I have the book with its 6th edition, but which edition really does not matter.

1.6 Course Project

You will get hands-on experience in computer architecture design through a project. Students will work individually or in group (depends on class size) on a project and will make a presentation (a final exhibition) to the whole class. Each student (or group) has to turn in a written report describing the motivation of the project, the designed methodology, the implementation, the evaluation, the related work, and conclusions obtained. Each student (or group) should also turn in the related programming code. In order for projects to complete successfully, it is very important to plan all activities and to follow a schedule. Starting to work on a project a few days before it is due will very likely cause problems to its successful completion. Details concerning the course project will be presented in class.

1.7 Discussion Board: Piazza

- Announcements, discussion and instructor contacts will be on Piazza.

- All correspondence will go through Piazza. You can send private messages to the instructors (visible to all professors and GTAs) as well as post public questions visible to all students, collaborate on responses, and tag everything by topic.

- All instructors and TAs can view all material on Piazza.

- No sharing answers or code solutions to assignments on the discussion board. You can include code in private posts to the instructors. See Honor code section below for more details.

- Email course staff only for logistical issues such as meeting outside of office hours, missing lab/lecture, grading disputes, medical situations, etc. Do not e-mail course staff about programming problems; use the discussion board. Project help questions sent via email are of extremely low priority, as they were sent to the wrong place and will most likely be responded to with "please post on Piazza".

- The discussion board on Piazza is required reading for all projects. You MUST read the discussion board for clarifications and project updates.

1.8 Canvas

- Course schedule, course syllabus, description of assignments, course project instructions and lecture slides will be posted on Canvas.

- All assignments will be submitted (per published deadlines) via Canvas.

- Midterm and final exam will be held in class.

- All grades will be posted to Canvas.

1.9 Office Hours

- Office hours can be used for asking questions, discussing homeworks, and also discussing and presenting course projects for feedback.

- Office hours are often crowded - do not rely on them for last minute help, as we cannot guarantee that we will be able to spend significant time with every student. You can also use the discussion board for posting questions.

2 Grading

Your grade will be calculated as follows:

- 35% course project

- 5% quizzes and in-class activities

- 10% homeworks

- 20% midterm exam

- 30% final exam

The final grade is computed according to the following rules:

- A+: $\geq$ 97%; A: [93%, 97%); A-: [88%, 93%)

- B+: [85%, 88%); B: [81%, 85%); B-: [77%, 81%)

- C: [60%, 77%)

- F: < 60%

There is **no curving**. There will be no make-up or extra-credit assignments at the end of the semester; your grade should be a measure of your semester-long progress. The instructor may decide to give an extra-credit assignment during the semester. Everyone will be given the opportunity to do the extra-credit assignment.

2.1 Collaboration Policy

No collaboration is allowed among students in any of the individual exams. We encourage you to have high-level discussions with other students in the class about the homework and course project. Please list the students you discussed with when turning in the homework. However, we require that when you turn in an assignment, it is only your work. That is, copying any part of another student's assignment is strictly prohibited. Anything that you hand in, whether it is a written problem or a computer program, must be written in your own words. If you base your solution on any other written solution, you are cheating.

Never look at the code from other students or share your code with any other student. You must not make your code and homework solutions public (on GitHub/GitLab/Piazza/Pastebin or by any other means). It is your responsibility to lock your computers with a password, to not post your code to websites that are publicly accessible, to guard your USB drives and computers, to not upload your files to someone else's computer, etc. You are liable for any access gained to your code.

For students in the same course project group, sharing and working on the same code of the course project is allowed. However, for individual assignments and exams, code sharing is not allowed.

2.1.1 AI-assisted tool usage policy

ChatGPT or other Generative-AI models may be used (but **not encouraged**) in this course as an assistant in projects and homework assignments. Any use must follow the fundamental principles of the Honor Code and include the following statement with assignment submission:

The ideas in this submission are original and were generated by (my name). ChatGPT (or name other Generative-AI model) was used as an editorial/coding assistant, however, I take full responsibility for the originality and accuracy of the content.

Risk accompanies use of any powerful tool. Students are cautioned that sharing their own original ideas with Generative-AI models can lead to loss of control and ownership of those ideas and coding. Furthermore, in terms of learning in this class, students who replace their own learning and project work with materials prepared by Generative-AI models:

- Surrender control over the material's truthfulness and accuracy, and violate the university's Honor Code.

- Sacrifice the opportunity to acquire the knowledge, skills, and critical thinking taught in the course.

- Risk being unable to perform to expectations when Generative-AI models are unavailable, such as in exams.

- Ultimately endanger their employability if they are unable to produce work other than that produced by Generative-AI models.

2.2   Late Policy

The deadline of assignments and course project is 11:59pm New York time of the due date.

10% will be deducted for late assignments each day after the due date. That is, if an assignment is late, we will grade it and scale the score by 0.9 if it is up to one day late, by 0.8 if it is up to two days late, and by 0.7 if it is up to three days late.

Late assignments will only be accepted for 3 days after the due date. Assignments submitted more than 3 days late will receive a zero. If you're worried about being busy around the time of a HW submission, please plan ahead and get started early.

Each student gets two "Emergency Day" tokens, which are automatically used by late submissions to avoid the degrading penalty. Unused emergency-tokens will be worth 0.25% bonus to a student's overall grade at the semester's end.

Canvas being unavailable is not an excuse for turning in a late assignment; in the rare situation that the website is somehow unavailable or giving the student an error, the student MUST email their submission to the instructor or GTA before the deadline, otherwise it will be considered late. Catastrophic computer failure will not be cause for an extension. Use a backup service such as DropBox (or any cloud service), emailing yourself, making multiple rounds of submissions to Canvas, whatever it takes.

2.3   Contested Grades

If you feel points have been incorrectly deducted, contact the instructors. Contesting of grades on any/all submissions must be requested within one week of receiving the grade (on Canvas). No grade changes will be considered after that deadline.

3   University & Departmental Policies

3.1   Academic integrity

All students must adhere to the GMU Honor Code (https://oai.gmu.edu/mason-honor-code) and the Computer Science Department's Honor Code (http://cs.gmu.edu/resources/honor-code) Policies. Only high-level discussion is allowed. The students are supposed to work individually on the homework, assignments and course project. Anything you hand in, should be only written in your words and show your own efforts. We reserve the right to use MOSS (http://theory.stanford.edu/ aiken/moss) to detect plagiarism. **Violation of the Honor Code will result in an F.**

3.2   Privacy

All course materials posted to Canvas or other course sites are private; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class. Video recordings of class meetings that include audio or visual information from other students are private and must not be shared. Live Video Conference Meetings (e.g. Collaborate or Zoom) that include audio or visual information from other students must be viewed privately and not shared with others.

3.3   Non-Discrimination and Inclusiveness

We are committed to providing an educational environment free from any discrimination on the basis of race, color, religion, national origin, sex, disability, veteran status, sexual orientation, gender identity, gender expression, age, marital status, pregnancy status, or genetic information. If you feel there has been a violation of the University's policies on this, please contact GMU's Office of Diversity, Equity, and Inclusion (703-993-8730; dei@gmu.edu).

Gender identity and pronoun use: If you wish, please share your name and gender pronouns with us and we will attempt use them to address you in class and via email. You can update your chosen name and pronouns here: https://registrar.gmu.edu/updating-chosen-name-pronouns.

3.4 Sexual Harassment, Sexual Misconduct, and Interpersonal Violence

All faculty members are designated "Responsible Employees", and are required to report all disclosures of sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per university policy 1412. If you wish to speak with someone confidentially, please contact the Student Support and Advocacy Center (703-380-1434) or Counseling and Psychological Services (703-993-2380). You may also seek assistance from Mason's Title IX Coordinator (703-993-8730; titleix@gmu.edu).

3.5 Auditing Policy

Auditors must be admitted Mason students. Students who wish to audit a class for no grade or credit must submit a course audit form with the instructor's signature to the Registrar's Office before the last day to drop a course. After the drop date has passed, students may not alter their status from credit to audit.

For admitted students over 60, there is a form they can complete to waive the Tuition. However, they still must apply to Mason, be accepted by Mason and then register to the course.

4 Campus Resources

Disability Services:

- Due to the size of the class, individual professors and GTAs cannot support students with injuries or disabilities on an ad-hoc basis. We ask that all accommodations for such conditions be arranged through GMU's Office of Disability Services (http://ds.gmu.edu).

- Students with a physical or learning disability which is already documented with the Office of Disability Services) should speak with the professor ASAP to discuss their approved accommodations. Even if you don't know whether you plan on utilizing the accommodations for any assignment/test, you need to make sure you and your professor are working together from the beginning of the semester to ensure your success in the class.

- Students with a physical or learning disability who have not yet registered with the Office of Disability Services should register with that office as soon as possible. Even if you don't know whether you'll need to utilize the accommodations, it's in your best interest to prepare ahead of time and get your condition documented as accommodations are not retroactive. They have a quick and easy registration process. All you need is documentation for your condition.

- The Office of Disability Services also handles services for many temporary disabilities (for example, if you break your arm, they can arrange note taking services). Please contact them if you discover any sudden impairment that affects your ability to function in class and/or on your projects. They have a quick and easy registration process. All you need is documentation for your condition.

Student Support Resources on Campus:

https://stearnscenter.gmu.edu/knowledgecenter/knowing -mason-students/student-support-resources-on-campus