

1. Credits: 3.00 **Contact Hours:** 3 hours of lecture.

2. Instructor Information

Instructor Name: Dr. Anup Das

Office: 3101 Market Street, Room 236

Phone: 215-895-2847

Office Hours: By appointment

E-mail: anup.das@drexel.edu

Teaching Assistants: Ankita Paul (ap3737@drexel.edu)

3. Student Learning Information

a. Brief description of the content of the course (*Course Catalog Description*):

This course introduces modern processor design in a systematic manner. It discusses dynamically scheduled superscalar techniques including advanced branch prediction, performance analysis of static and dynamic branch prediction techniques, cache design principles, cache replacement policies, techniques to exploit instruction-level parallelism via out-of-order execution, and techniques to tolerate long memory latencies via speculative and run-ahead executions. The course provides a comprehensive coverage of modern practices in processor design.

b. Pre-requisites or Co-requisites: (ECE 355 or equivalent).

Course Purpose within a Program of Study: This course teaches students the skills necessary to: (1) analyze performance of a modern computer systems; (2) exploit techniques to achieve high performance computing, and (3) analyze the limitations of current techniques. This course will provide the foundation for follow-up courses such as ECEC 520 (Dependable Computing) and ECEC 623 (Advanced Computer Architecture).

Statement of Expected Learning: This course consists of two 80 minutes lectures.

Course Outcomes: Upon completion of this course, students will be able to understand the tradeoffs associated with design decisions at the computer architecture and how it affects the computing stacks above and below. This will help them to reason and answer why a computer is designed the way it is. The course will also introduce the students on advanced concepts such as branch prediction, out-of-order execution, DRAM, non-volatile memories and cache design to help understand the limitations of the existing architectures and the design of future computing systems.

Student Outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Drexel Student Learning Priorities:

Creative and Critical Thinking: Uses divergent (e.g., generation of novel ideas, thinking out of the box, brainstorming) and convergent thinking (e.g., critical thinking, evaluation of ideas, quantitative and qualitative analysis, scientific reasoning) to generate novel and relevant ideas, strategies, approaches or products.

Technology Use: Make appropriate use of technologies to communicate, collaborate, solve problems, make decisions, and conduct research, as well as foster creativity and life-long learning.

4. Course Materials

The required textbook for this course is: J. Hennessy and D. Patterson, *Computer Architecture: A Quantitative Approach*, 6th Edition, Morgan Kaufmann.

5. Course Schedule

The following is the tentative outlines the course coverage by term week:

- **Weeks 1 and 2.** Memory Hierarchy Design and Optimization

Reading: Chapter 2 and Slides.

- **Week 3 and 4:** Advanced Branch Prediction.

Reading: Reading Notes and Slides.

- **Week 5 and 6:** Instruction-Level Parallelism.

Reading: Chapter 3 and Slides.

- **Week 7:** DRAM/NVM for Main Memory.

Reading: Reading Materials and Chapter 2.

- **Week 8:** Other Techniques to Exploit Parallelism.

Reading: Chapters 4 and 5, and Slides

- **Week 9 and 10:** Speculative Execution + Run-ahead Execution + Other techniques to Improve Single-Thread Performance

Reading: Reading Materials and Slides

- **Final Exam**

6. Grading Policy

The grading in this course is based on quizzes, programming projects, and in-class exams. The cumulative grade is based on the following:

- Online Quizzes: 30
- Programming projects: 30
- Midterm exam: 20
- Final exam: 20

The mapping between the percent grade and the final letter grade will be assigned as follows (may be curved):

A:95-100, A-:90-94, B+:87-89, B:83-86, B-:80-82, C+:77-79, C:73-76, C-:70-72, D+:65-69, D:60-64, F:00-59

7. Academic Policies

Course-Specific Policies

- **Quiz Policy:** Quizzes are all online. Students will use personal mobile devices or laptops to complete quizzes.
- **Project Policy:** Projects is always to be submitted on or before the date on which it is due. Projects submitted after the due date will be accepted with penalty. Project must be submitted using Black Board Learn unless otherwise instructed. Assignments must never be submitted via e-mail.
- **Examination Policy:** All exams in the course are closed-textbook and closed-“reading assignment material.” Use of other books or any other material (such as solutions to homework assignments), however, is not permitted. Use of cell phones, laptops, tablets, PDAs, or any other device capable of wireless communication is prohibited. Exams will cover material discussed in the lectures, homework assignments, or textbook sections given as reading assignments. For example, the exams may include questions on material covered in class lectures or homework but not specifically covered in the textbook.

Similarly, the exams may include any material covered in a section of the textbook given as a reading assignment but not specifically covered in the lectures or homework.

- **Absentee Policy:** Absence from examinations will be excused only under extraordinary circumstances such as medical or family emergencies. A missed examination without prior approval and without legitimate reason will be graded at zero points. An absence will be excused only if the student is able to provide legitimate documentation (such as a physician note). An absence from an examination with prior approval will require the student to take an alternate exam at a later time. Special examinations will not be held earlier or on later dates to accommodate, for example, flight schedules for overseas vacations.

University Academic Policies

- **Missed Classes:** Absence from class will be based on the University's absence policy. Please review the link below.
 - <http://drexel.edu/provost/policies/absence/>
- **Academic Integrity, Plagiarism and Cheating Policy:** Each student is expected to complete all assignments independently unless otherwise explicitly instructed. It is unacceptable to copy another student's work or solutions from any other source. Submitted assignments will be checked for plagiarism using Stanford's MOSS plagiarism detection system (<https://theory.stanford.edu/~aiken/moss/>). Violators of this policy will be reported to the Office of Student Conduct and Community Standards (SCCS). Academic integrity violations could result in failure for the course or the assignment among other sanctions determined by the instructor. A second violation of the academic integrity policy will likely result in suspension. Please review the University's policy regarding academic integrity at:
<http://drexel.edu/provost/policies/academic-integrity/>
http://drexel.edu/studentlife/community_standards/studentHandbook/
- **Office of Equality and Diversity - Disability Resources:** Students [requesting accommodations](#) due to a disability at Drexel University need to request a current Accommodations Verification Letter (AVL) in the [ClockWork database](#) before accommodations can be made. These requests are received by Disability Resources (DR), who then issues the AVL to the appropriate contacts. For additional information, visit the DR website at drexel.edu/oed/disabilityResources/overview/, or contact DR for more information by phone at 215.895.1401, or by email at disability@drexel.edu.
- **Drexel Coronavirus Information**
Students should refer to the following links for Drexel's Coronavirus Information.
<https://drexel.edu/coronavirus/>

<https://drexel.edu/coronavirus/health-safety/monitor-your-health/if-you-feel-sick/>

- **Drexel's commitment to Diversity and Inclusion:**
<https://drexel.edu/studentlife/diversity/overview/>
- **Course Drop Policy:**
<http://drexel.edu/provost/policies/course-add-drop/>
- **Course Withdrawal Policy:**
<http://drexel.edu/provost/policies/course-withdrawal/>
- **Course Change Policy:** The instructor reserves the right to modify the course, as necessary, during the term: including policies, evaluations, due dates, course content, schedule, assignments or requirements. All changes will be communicated in lecture and/or *via* the course *DrexelLearn* page.
- **Weather, Emergencies and University Closing:** University closing or delayed opening information will be posted on www.drexel.edu. In the event of the need to close or delay the daily opening of a campus, the University will provide notice *via* Web, telephone, and the DrexelALERT system. Closing or delayed opening information will be announced at 215-895-MELT (6358). The University determines whether to close or delay opening due to inclement weather, not the instructor. Therefore, please do not contact the instructor for this information.

8. Mask Etiquette for the 2021 Fall Quarter

As of August 3, 2021, [Drexel requires all students and employees to wear a mask](#) in all on-campus public and shared spaces, including instructional and research settings, regardless of vaccination status. Specifically, masks are to be worn in classrooms, laboratories, lecture halls and seminar rooms. Students are not permitted to eat during class or otherwise remove their mask. If a student needs to remove their mask (to drink water etc.) they may step outside the class, to do so and then return to class. Please remember your mask to avoid class disruption.

9. Class Information

This class will be offered in hybrid mode. Those who are attending via online section should use the link below to join the class.



Hi there,

Anup Kumar Das is inviting you to a scheduled Zoom meeting.

[Join Zoom Meeting](#)

One tap mobile: US: [+12678310333..88029247663#](tel:+1267831033388029247663) or [+13126266799..88029247663#](tel:+1312626679988029247663)

Meeting URL: <https://drexel.zoom.us/j/88029247663?from=addon>

Meeting ID: 880 2924 7663

Join by Telephone

For higher quality, dial a number based on your current location.

Dial:

US: +1 267 831 0333 or +1 312 626 6799 or +1 470 250 9358 or +1 470 381 2552 or +1 646 518 9805 or +1 646 876 9923 or +1 651 372 8299 or +1 786 635 1003 or +1 301 715 8592 or +1 253 215 8782 or +1 346 248 7799 or +1 602 753 0140 or +1 669 219 2599 or +1 669 900 6833 or +1 720 928 9299 or +1 971 247 1195 or +1 213 338 8477

Meeting ID: 880 2924 7663

[International numbers](#)

Join from an H.323/SIP room system

H.323:

- 162.255.37.11 (US West)
- 162.255.36.11 (US East)
- 115.114.131.7 (India Mumbai)
- 115.114.115.7 (India Hyderabad)
- 213.19.144.110 (Amsterdam Netherlands)
- 213.244.140.110 (Germany)
- 103.122.166.55 (Australia Sydney)
- 103.122.167.55 (Australia Melbourne)
- 149.137.40.110 (Singapore)
- 64.211.144.160 (Brazil)
- 149.137.68.253 (Mexico)
- 69.174.57.160 (Canada Toronto)
- 65.39.152.160 (Canada Vancouver)
- 207.226.132.110 (Japan Tokyo)
- 149.137.24.110 (Japan Osaka)

Meeting ID: 880 2924 7663

SIP: 88029247663@zoomcrc.com

Skype for Business (Lync)

<https://drexel.zoom.us/skype/88029247663>