Syllabus

605.611 Computer Architecture

Instructor Contact

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Students can check to see if I am on Zoom. You are welcome to try to connect if I am on. If I am in a class, there should be a password so you will not connect to the class. If I cannot talk, I will tell you and we will schedule a time.

If this is not urgent, or I am not on zoom, I prefer that students contact me via email. Please be sure to include course number in the subject line. I will make every effort to respond to your inquiry within 48 hours or earlier. If an issue is urgent, you can call me.

Course Lecture and Office Hours via Zoom

This course will use Zoom to facilitate weekly, synchronous cource lecture and office hours. Lectures will be recorded for those who miss the lecture, and to allow students to replay parts of the lecture they need reenforcement on. Before the lecture each week students will be provided with a link and password for the zoom lecture for that week. Office hours are open, and well be Tuesday and Friday nights from 7-9. I am free most days, so if I am on zoom you can connect, or email me and I will log on.

For more information regarding Zoom, please see the Zoom Student Quick Start Guide.

Course Description

This course provides a detailed examination of the internal structure and operation of modern computer systems. Each of the major system components is investigated, including the following topics: the design and operation of the ALU, FPU, and CPU; microprogrammed vs. hardwired control, pipelining, and RISC vs. CISC machines; the memory system including caches and virtual memory; parallel and vector processing, multiprocessor systems and interconnection networks; superscalar and super-pipelined designs; and bus structures and the details of low-level I/O operation using interrupt mechanisms, device controllers, and DMA. The impact of each of these topics on system performance is also discussed. The instruction set architectures and hardware system architectures of different machines are examined and compared. The classical Von Neumann architecture is also compared with alternative approaches such as data flow machines and neural networks

Prerequisites

One year of college mathematics.
605.201 – Introduction to Programming Using Java or equivalent.
605.204 – Computer Organization

Technical Requirements

- Students should be familiar with Boolean algebra and binary arithmetic, including additions, two's complement subtractions, multiplication, and division.
- Students should be proficient in at least one higher level language (Java, C/C++, Ada, Scala, etc).

- Students should be able to implement programs in Assembly language that illustrate the concepts of branching, loops, subprogram (method or function) calls, and memory access using pointers and arrays.
- Students should be able to read simple schematic circuit diagrams consisting of AND, OR, and NOT gates. The knowledge of basic Integrated Circuits will be covered, and is not required.

Course Goals

This course builds upon the knowledge acquired in a typical computer organization course to provide a more in-depth understanding of the internal operation of the control unit, the execution units, memory management, and the I/O and bus systems, as well as multiprocessor systems. Emphasis is placed on the more advanced features such as pipelining, cache memory organization and operation, superscalar and VLIW techniques. An examination of performance metrics will allow the student to better access the effectiveness of the various performance enhancement techniques.

Course Objectives

By the end of the course, you will be able to:

- Know the various common Integrated Circuits (IC), specifically the multiplexer (mux), adder, decoder, and static ram. Know to implement the ICs, and how to use them in the design of a CPU.
- Be able to explain the purpose of all components in a Harvard CPU, including all data lines in the data path, and the function of the control unit and all control lines in the CPU.
- Understand the hardware/software interface
- Know the difference between parallel architectures, and when to appropriately use each.
- Explain how pipelining and superscalar operation affect program execution and outline the problems and potential of each of these techniques.
- Be able to apply the principals behind the organization and operation of cache memory and virtual memory systems to correctly work with this memory in multi-core and multiprocessor environments.
- Effectively apply storage I/O solutions to problems.

Course Structure

This class consists of a 2 hour 40 minute synchronous lecture each week, and weekly homework assignments. If possible students should attend the lecture, but lectures will be recorded for students who cannot attend for any reason.

This course is Blackboard enhanced. All notes and other materials will be provided on Blackboard. All assignments will be given in Blackboard and should be submitted in Blackboard.

The course materials are divided into sections which will correspond to the various layers of the computer architecture. See the course schedule and course modules for more information.

To get an A in the class, an individual or group project will be required. An A+ will require that the student(s) prepare the project and submit it for a conference/journal publication or at least an internet web site publication. If a paper is accepted, the school will pay costs associated with the student(s) attending the conference.

Textbook

Required

Author	Title	Publisher	ISBN
Patterson	Computer Organization & Design: The Hardware/Software Interface	Morgan Kaufman	0124077269

Note that the material does not change in this textbook. Parts are renumbered and problems changed. So any version of this textbook is acceptable. Get it as cheap as you can (unless your company is paying for it).

Textbook information for this course is available online through the appropriate bookstore website: For online courses, search the MBS website.

Optional

Other textbooks will be used in the class, but are free and provided by the professor.

Required Software

Students will be required to download and install a number of free software packages. These will be listed in the course moduels.

Student Coursework Requirements

It is expected that each week students will spend about 3 hours in lecture, and approximately 4–7 hours to complete the homework.. Here is an approximate breakdown: reading the assigned sections of the texts (approximately 3–4 hours per week) as well as some outside reading, listening to the audio annotated slide presentations (approximately 2–3 hours per week), and writing assignments (approximately 2–3 hours per week).

This course will consist of the following basic student requirements:

Preparation and Participation (10% of Final Grade Calculation)

I tend to call on students in class, even using Zoom. While you do not technically have to attend class, it will help you if I at least recognize your name by the end of class.

Assignments (50% of Final Grade Calculation)

Assignments will include a mix of qualitative assignments (e.g. literature reviews, model summaries), quantitative problem sets, and case study updates. Include a cover sheet with your name and assignment identifier. Also include your name and a page number indicator (i.e., page x of y) on each page of your submissions. Each problem should have the problem statement, assumptions, computations, and conclusions/discussion delineated. All Figures and Tables should be captioned and labeled appropriately.

All assignments are due according to the dates in the Calendar.

Late submissions will be reduced by one letter grade for each week late (no exceptions without prior coordination with the instructors).

If, after submitting a written assignment you are not satisfied with the grade received, you are encouraged to redo the assignment and resubmit it. If the resubmission results in a better grade, that grade will be substituted for the previous grade.

Qualitative assignments are evaluated by the following grading elements:

1. Each part of question is answered (20%)
1. Writing quality and technical accuracy (30%) (Writing is expected to meet or exceed accepted graduate-level English and scholarship standards. That is, all assignments will be graded on grammar and style as well as content.)
2. Rationale for answer is provided (20%)
3. Examples are included to illustrate rationale (15%) (If you do not have direct experience related to a particular question, then you are to provide analogies versus examples.)
4. Outside references are included (15%)

Qualitative assignments are graded as follows:

- 100–90 = A—All parts of question are addressed; Writing Quality/ Rationale/ Examples/ Outside References [rich in content; full of thought, insight, and analysis].
- 89–80 = B—All parts of the question are addressed; Writing Quality/ Rationale/ Examples/ Outside References [substantial information; thought, insight, and analysis has taken place].
- 79–70=C—Majority of parts of the question are addressed; Writing Quality/ Rationale/ Examples/ Outside References [generally competent; information is thin and commonplace].
- <70=F—Some parts of the question are addressed; Writing Quality/ Rationale/ Examples/ Outside References [rudimentary and superficial; no analysis or insight displayed].

Quantitative assignments are evaluated by the following grading elements:

1. Each part of question is answered (20%)
2. Assumptions are clearly stated (20%)
3. Intermediate derivations and calculations are provided (25%)
4. Answer is technically correct and is clearly indicated (25%)
5. Answer precision and units are appropriate (10%)

Quantitative assignments are graded as follows:

- 100–90 = A—All parts of question are addressed; All assumptions are clearly stated; All intermediate derivations and calculations are provided; Answer is technically correct and is clearly indicated; Answer precision and units are appropriate.
- 89–80 = B—All parts of question are addressed; All assumptions are clearly stated; Some intermediate derivations and calculations are provided; Answer is technically correct and is indicated; Answer precision and units are appropriate.
- 79–70=C—Most parts of question are addressed; Assumptions are partially stated; Few intermediate derivations and calculations are provided; Answer is not technically correct but is indicated; Answer precision and units are indicated but inappropriate.
- <70=F—Some parts of the question are addressed; Assumptions are not stated; Intermediate derivations and calculations are not provided; The answer is incorrect or missing; The answer precision and units are inappropriate or missing.

Course Project (10% of Final Grade Calculation)

A course project will be assigned several weeks into the course. The next-to-the-last week will be devoted to the course project. The grading is defined in Blackboard.

Exams (30% of Final Grade Calculation for Final)

The final exam will be given the last week of class. You will have one week to complete the exam and it will be due by 5PM exactly one week from their release. You may use the course text to complete the exams.

Grading

Assignments are due according to the dates posted in your Blackboard course site. You may check these due dates in the Course Calendar or the Assignments in the corresponding modules. I will post grades one week after assignment due dates.

I will accept late work, but for a penalty of my choosing. I generally do not directly grade spelling and grammar. However, egregious violations of the rules of the English language will be noted without comment. Consistently poor performance in either spelling or grammar is taken as an indication of poor written communication ability that may detract from your grade.

A grade of A indicates achievement of consistent excellence and distinction throughout the course—that is, conspicuous excellence in all aspects of assignments and discussion in every week.

A grade of B indicates work that meets all course requirements on a level appropriate for graduate academic work. These criteria apply to both undergraduates and graduate students taking the course.

EP uses a +/- grading system (see “Grading System”, *Graduate Programs* catalog, p. 10).

100-96 = A+ plus an attempt to publish a project
95-90 = A plus taking part in a group or individual project
89-84 = A−
83-78 = B+
77-72 = B
71-66 = B−
66-61 = C+
60-55 = C
<55 = F

Final grades will be determined by the following weighting:

Item	% of Grade
Preparation and Participation	10%
Assignments	50%
Course Project	10%
Exams (Final)	30%

Help & Support

You should refer to **Help & Support** on the left menu for a listing of all the student services and support available.

Academic Integrity

Academic Misconduct Policy

All students are required to read, know, and comply with the Johns Hopkins University Krieger School of Arts and Sciences (KSAS) / Whiting School of Engineering (WSE) Procedures for Handling Allegations of Misconduct by Full-Time and Part-Time Graduate Students.

This policy prohibits academic misconduct, including but not limited to the following: cheating or facilitating cheating; plagiarism; reuse of assignments; unauthorized collaboration; alteration of graded assignments; and unfair competition. You may request a paper copy of this policy at this by contacting jhep@jhu.edu.

Policy on Disability Services

Johns Hopkins University (JHU) is committed to creating a welcoming and inclusive environment for students, faculty, staff and visitors with disabilities. The University does not discriminate on the basis of race, color, sex, religion, sexual orientation, national or ethnic origin, age, disability or veteran status in any student program or activity, or with regard to admission or employment. JHU works to ensure that students, employees and visitors with disabilities have equal access to university programs, facilities, technology and websites.

Under Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act (ADA) of 1990 and the ADA Amendments Act of 2008, a person is considered to have a disability if c (1) he or she has a physical or mental impairment that substantially limits one or more major life activities (such as hearing, seeing, speaking, breathing, performing manual tasks, walking, caring for oneself, learning, or concentrating); (2) has a record of having such an impairment; or (3) is regarded as having such an impairment class. The University provides reasonable and appropriate accommodations to students and employees with disabilities. In most cases, JHU will require documentation of the disability and the need for the specific requested accommodation.

The Disability Services program within the Office of Institutional Equity oversees the coordination of reasonable accommodations for students and employees with disabilities, and serves as the central point of contact for information on physical and programmatic access at the University. More information on this policy may be found at the Disabilities Services website or by contacting (410) 516-8075.

Disability Services

Johns Hopkins Engineering for Professionals is committed to providing reasonable and appropriate accommodations to students with disabilities.

Students requiring accommodations are encouraged to contact Disability Services at least four weeks before the start of the academic term or as soon as possible. Although requests can be made at any time, students should understand that there may be a delay of up to two weeks for implementation depending on the nature of the accommodations requested.

Requesting Accommodation

New students must submit a Disability Services Graduate Registration Form along with supporting documentation from a qualified diagnostician that:

- Identifies the type of disability
- Describes the current level of functioning in an academic setting
- Lists recommended accommodations

Questions about disability resources and requests for accommodation at Johns Hopkins Engineering for Professionals should be directed to:

EP Disability Services
Phone: 410-516-2306
Fax: 410-579-8049
E-mail: ep-disability-svcs@jhu.edu