# CMP 334 Syllabus (Spring 2019)

## 1. CMP 334 Computer Organization

Introduction to digital logic-expressions, gates, flip-flops, adders. buses, multiplexers. Introduction to assembly language and assembly level organization – data representation, instruction formats, addressing modes, interrupts. Memory systems – caches (mapping and management policies) and memory hierarchies, latency and bandwidth, virtual memory (page-tables, TLB). Input/Output – busses, channels and DMA. Performance considerations – pipelining, RISC architecture, branch prediction, introduction to instruction level parallelism.

### Prerequisites:

**CMP 167**

Structured **computer programming** using a modern high-level programming language. Includes console I/O, data types, variables, control structures, including iteration, arrays, function definitions and calls, parameter passing, functional decomposition, and an introduction to objects. Debugging techniques.

**CMP 232**

Sets, relations, and functions; **propositional calculus**, **Boolean algebras**, and **combinatorial circuits**, counting methods; proof techniques; analysis of algorithms; graphs and trees, puzzles; finite machines, **sequential circuits**, and recognizers.

**Basic High-School Algebra**

Equation solving
Word problems

**Advanced Middle-School Arithmetic**

Fractions
Long division
Representation of numbers in different bases

**Credits: 4** *(expect to spend **12 hours per week** outside of class)*

## 2. Instructor: Bowen Alpern

email: Bowen.Alpern@lehman.cuny.edu
office: GI 137–A
hours: M W 5 to 6 pm, and by appointment

Please, see me, if you feel you are falling behind, don't understand something, or have any other questions. I only expect to be on campus Mondays and Wednesdays. I will be around and usually in my office between my classes and I can arrange to come in early or stay late if that is what works for you.

## 3. Sections

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CMP 344-01     M W   3:00 pm – 2:40 pm    Gillet 231
CMP 334-ZG81   M W   7:50 pm – 9:30 pm    Gillet 231
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## 4. Learning Objectives

At the end of this course students will be able to:

- Understand how basic processor components such as flip/flops, registers, buses, adders, clocks, and control logic are built from digital logic gates.
- Understand how the data-path and control of a processor are built from these components.
- Compare RISC, CISC, and Stack computer instruction set architectures.
- Use computer performance equations and Amdahl's law to predict the performance impact of changes to hardware configurations such as faster clocks, better floating-point units, etc.
- Understand computer pipelining including the performance benefits and hazards; and the hardware and software techniques used to minimize the negative impacts of the hazards.
- Understand the memory hierarchy and the impact of various cache organizations. Be able to predict the performance of memory hierarchy changes.
- Understand the implications of today's multi-core processor chips including synchronization and memory consistency

## 5. Textbook (optional)

**Computer Organization and Design**: *The Hardware / Software Interface*

— Hennessy and Patterson (any 4th or 5th edition: MIPS, ARM, or RISK V)

Computer Organization and Architecture - Null and Lobur

Computer Organization and Architecture - Stalling

## 6. Attendance

There is an **attendance requirement** at Lehman College. Students with poor attendance and/or repeated lateness (no matter what the reason) will have their grades reduced. *If I forget to pass our an attendance sheet, please start one for me.*

If an emergency prevents you from attending class, it is your responsibility to obtain notes from a classmate and study them for understanding. It is a wise move to get a buddy.

# 7. Grading

## **Exams** (80%)

There will be two in-class exams (20% each) and a final (40%). These are closed-book. You will **not** be allowed to use a calculator, computer, phone, or any other electronic equipment. You will be allowed to use one page (8 ½ x 11 inch, both sides) of your own notes in your own handwriting. Make sure your name is on this "cheat sheet" and turn it in with your blue book.

If you have conflicts with the exam dates, please discuss these with me as soon as possible, so that other arrangements can be made.

## **Quizzes** (10%)

There will be several unannounced quizzes, usually at the beginning of class. I will drop your lowest quiz scores, so there will be no makeup quizzes. Generally, a quiz will be on concepts covered in one or more previous homework problems that I will have gone over in class.

## **Homework** (10%)

Homework is an important component of your overall grade. Do not neglect it! Assignments will *generally* be due the midnight preceding the second class after it was assigned. (Use the intervening class to make sure that you are clear about what is being asked of you.) I intend to post solutions both to homework and to quizzes on Blackboard. Assignments submitted *after solutions are presented* in class or on Blackboard ***will not be graded***. Otherwise, late homework will receive partial credit.

I usually will not necessarily expect your homework submissions to be fully correct. The purpose of each assignment is for you to engage meaningfully with the problem so that you will be able to fully understand the solution when it is presented in class or on Blackboard (and would be able to answer correctly a similar problem should it appear on a quiz or an exam).

Assignments will *generally* be due the midnight preceding the second class after it was assigned. (Use the intervening class to make sure that you are clear about what is being asked of you.) It is fine to discuss the assignments and how to solve them with you classmates, but write up and submit your solution on your own.

My grading of homework is usually perfunctory: 2 points, if your answer is substantially correct, 1 point, if it is incorrect but reflects a credible effort, 0 if you do not submit a solution, if your solution answers a different problem from the one assigned, or if your solution is wrong and seems perfunctory. If you have a question or disagree with the grade I have given you on an assignment, quiz, or exam, please take it up with me either by email or in my office.

Homework will ***only*** be accepted through Blackboard. Where possible, answer the question in the text of your submission. If it is more convenient for you to include an attachment, I prefer pdf, Microsoft Office, or some open source office format. If you must attach a photo (jpg, jpeg, gif, or png file) of your work make sure it is legible! (Write clearly in dark ink on white paper, preferably unlined. Light the page well. Take the photo straight on, rather than at an angle. Before attaching, review it to make sure that you can read it *easily*. *Attach* photos rather than embedding them directly into your submission.) Attachments that I find difficult to decipher will receive reduced scores.

There is an anomaly in Lehman's grading system that occasionally makes it to a students advantage to fail a class rather that pass it with a low grade. If you feel that you might be in that rare situation, let me know the minimum passing grade you would want for the course (and check back later to make sure that I have taken note of it).

## 8. Accommodating Disabilities

Lehman College is committed to providing access to all programs and curricula to all students. Students with disabilities who may need classroom accommodations are encouraged to register with the Office of Student Disability Services, Shuster Hall, Room 238, phone number, 718-960-8441. Contact the office for more information.

## 9. Cheating (don't!)

I encourage you to collaborate on how to solve the homework problem. I expect you to submit your own work. For exams a, clear the working surface in front of you except for the problem sheet, blue book, writing implement(s), and your "cheat sheet". If you have a monitor in on your desk, turn it sideways, so that it can be seen from the side of the room opposite the windows (and so I can see you from the front of the room). The same for quizzes, except you will not have a blue book and I will provide a "cheat sheet".

## 10. Tentative Course Schedule

**Part 1** classes 1 — 12 (Exam 1: 3/13/18)

Review of propositional logic, Boolean algebra, truth tables, digital logic circuits, representation of integers base 2, 10, and 16, conversion between bases. Assembly language programming. Binary addition and subtraction. Combinational circuit design process, combinational circuits: inverters, decoders, multiplexors, adders, and the ALU (Arithmetic / Logical Unit).

**Part 2** classes 14 — 22 (Exam 2: 4/17/18)

Sequential circuits: latches, flip-flops, clocks, registers, counters, processors. More assembly language programming. Varieties of processor architectures, instruction formats, instruction execution. Processor performance problems. Implicit (instruction-level) parallelism, pipeline processors, pipeline hazards (structural, data, control), branch prediction, super–scalar processors. Pipeline performance problems.

**Part 3** classes 24 — 28

Memory hierarchy: cache, main memory, magnetic disks. Locality of reference (temporal and spacial). Multi–lever caches, latency and bandwidth, cache performance problems. Virtual memory, TLB (Translation Look-aside Buffer), MMU (Memory Management Unit), program execution Working Set, page replacement algorithms.

Explicit parallelism: Flynn hierarchy, message passing vs shared memory, synchronization (mutual exclusion, locks, atomic instructions), memory coherence, cache consistency.