#### Midterm1 Preparation CS 3853 Computer Architecture, Spring 2021

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# **Goals and Topics**

- The goal is to help you systematically review the basic knowledge in Computer Architecture.
  - Only basic knowledge is tested.
  - No trick questions.

#### ► Topics for this exam:

- Introduction
- Instruction Set Architecture
- Computer Arithmetic
- Performance Metrics

# Location, Time and Logistics

- Mar 04th 2020, Thursday, in-class, through Blackboard
- ► open-book, open-notes
- ► You can bring a calculator, but no cellphones.
  - The math is simple, you probably won't need a calculator.
- Do not waste time if you stuck on a problem, move forward and revisit the problem later.
- The exam have Conceptual questions and Problems.
  - The problems will be similar as those in the assignments.

### Materials to Review

- Slides, all questions are from slides
- ► Assignment 1 and 2.
- ► You can check out the textbooks, but it is not required.

# Introduction

- ► The three topics in Computer Architecture
  - ISA, micro-arch and system architecture.
- ► The definitions of Moore's Law and Dennard Scaling.
- ► The impact of the failure of Dennard Scaling.
- Design metrics for computer architectures:
  - Performance, cost, availability and power dissipation
- The definition of Von Neumann architecture and Harvard Architecture.

#### Instruction Set Architecture

- Be able to read basic instructions with source and destination operands.
  - Know the basic syntax.
- Four source devices for operands, and their examples.
  - Stack, x86 FP instructions.
  - Accumulator, x86 multiplication/division instructions.
  - Register-Register, most RISC ISAs.
  - Register-Memory, most CISC ISAs.
- Know all addressing modes and their examples from the slides.
  - Be able to write and recognize an addressing mode.
  - Especially the example for addressing elements in two-dimensional arrays.
- ► Fixed-length and variable length ISAs.
  - Their definitions, advantages and disadvantages.

# Instruction Set Architecture cont'd

#### CISC and RISC

- The full names of CISC and RISC.
- Examples ISAs of CISC and RISC.
- The features of CISC and RISC (slide 50 from the ISA lecture)
- CISC vs. RISC
  - ► CISC has better programmability, smaller code sizes
  - RISC is easier to implement, thus needs fewer transistors and has better energy efficiency.
- Modern processors mostly use RISC internally.
- ► SIMD instructions, definition and examples
  - Examples: MMX, SSE, AVX, 3D!Now

# **Computer Arithmetic**

- Remember the binary representations of numbers 0 to 15.
- ► Two's complement encoding.
  - Be able to write two's complement encoding given a decimal number.
  - Why two's complement?
  - The problem is similar to the one from Assignment 2.
- ► Floating point encoding.
  - Be able to write 32-bit encoding given a binary real number.
  - The problem is similar to the one from Assignment 2.
- Know the four logic gates, and know that logic gates are used to construct functional units.

## **Performance Metrics**

- ► Why use benchmarks and simulators?
- ► Know the definition of MIPS, MFLOPS, CPI and IPC.
- Problems, very similar to those in Assignment 2.
  - Be able to compute average, weighted average, geometric and harmonic mean given some execution times.
  - Amdahl's Law
    - Review the equations and examples in the slides for Amdahl's Law.
    - You should be able to compute the overall speedup given a percentage of enhance-able part and a speedup.
- Know the relationship of instructions per program, cycles per instruction (CPI) and cycles per second (frequency).

## **Example Questions**

- Conceptual question: What is the impact of the failure of Dennard scaling?
  - Answer: The growth of CPU frequency has stopped, and the growth of single core performance has significantly slowed down.
- Problem: If the 60% of an application can be improved by a speedup of 6, which is the overall speedup for the whole application?

- Answer: 
$$Spd = \frac{1}{(1-60\%) + \frac{60\%}{6}} = \frac{1}{40\% + 10\%} = 2.$$