# CS 219: Homework #2

Due on September 14, 2016 at 4:00pm

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# Problem 1

Review Questions:

(All answers are from the slides provided for the course)

1.1.) What, in general terms, is the distinction between computer organization and computer architecture?

**Answer:** Computer organization refers to the way a given instruction set is implemented in a particular processor. Computer Architecture refers to the attributes of a system visible to the programmer. This is more analagous to an interface while the organization describes the implementation.

1.2.) What, in general terms, is the distinction between computer structure and computer function?

**Answer:** Computer structure refers to the way in which componenets relate to each other, while Computer function refers to the operation of individual components as part of the structure.

1.3.) What are the four main functions of a computer?

**Answer:**

1.) Data Processing
   a.) Data may take a wide variety of forms and the range of processing requirements is broad.
2.) Data Storage
   a.) Short-term
   b.) Long-term
3.) Data Movement
   a.) Input-Output (I/O) - When data is received from or delivered to a device (peripheral) that is directly connected to the computer.
   b.) Data Communications - When data is moved
4.) Control
   a.) A control unit manages the computer's resources and orchestrates the performance of its functional parts in response to instructions.

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1.4.) List and briefly define the main structural components of a computer.
**Answer:** There are four main structural components of the computer:

1. CPU - Controls the operation of the computer and performs its data processing functions.
2. Main Memory - Stores Data
3. I/O - Moves data between the computer and its external environment.
4. Sytem Interconnection - Some mechanism that provides for communication among CPU, main memory, and I/O.

1.5.) List and briefly define the main structural components of a processor.
**Answer:** There are four main structural components of a CPU:

1. Control Unit - Controls the operation of the CPU and hence the computer.
2. Arithmetic Logic Unit - Performs the computer's data processing function.
3. Registers - Provide storage internal to the CPU.
4. CPU Interconnection - Some mechanism that provides for communication among the control unit, ALU, and registers.

1.6.) What is a stored program computer?
**Answer:** A stored program computer is one that stores program instructions in memory.

1.7.) Explain Moore's law.
**Answer:** Moore's law was an observation made in 1965 that the number of transistors per square inch on integrated circuits was doubling each year since its inception. Gordon Moore (co-founder of Intel) predicted that this would continue to happen ad-infinitum.

1.8.) List and explain the key characteristics of a computer family.
**Answer:**

a.) Similar or identical instruction set
b.) Similar or identical operating system
c.) Increasing speed
d.) Increasing number of I/O ports
e.) Increasing memory size
f.) Increasing cost

1.9.) What is the key distinguishing feature of a microprocessor?
**Answer:** The key distinguishing feature of a microprocessor is that it is a combination of many different circuits integrated into a single chip to provide highly complex functionality.

# Problem 2

Problems:

2.1) You are to write an IAS program to compute the results of the following equation.

$$Y = \sum_{X=1}^{N} X$$

Assume that the computation does not result in an arithmetic overflow and that X, Y, and N are positive integers with $N \geq 1$. Note: Even though the IAS did not have assembly language, only machine language, you will use the assembly language show in the text for this program.

a.) Use the equation $Sum(Y) = \frac{(N(N+1))}{2}$ when writing the IAS program.

b.) Do it the "hard way", without using the equation from part (a).

**Solution**
**Part A**

| Location | Instruction | Comments |
|---|---|---|
| 0 | (value) | Constant N initialized to some value |
| 1 | 1 | Constant integer value = 1 |
| 2 | 2 | Constant integer value = 2 |
| 3 | 0 | Variable Y = Sum (initialized to 0) |
| 4L | LOAD M(0) | $AC \leftarrow N$ |
| 4R | ADD M(1) | $AC \leftarrow AC + 1$ |
| 5L | MUL M(0) | $AC \leftarrow N(N + 1)$ |
| 5R | DIV M(2) | $AC \leftarrow \frac{AC}{2}$ |
| 6L | STOR M(3) | $Y \leftarrow AC$ (Save the accumulated sum in variable Y) |
| 6R | JUMP M(6,20:39) | Done. HALT |

Problem 2 continued on next page...

## Part B

| Location | Instruction | Comments |
|---|---|---|
| 0 | (value) | Constant N initialized to some value |
| 1 | 1 | Increment step size |
| 2 | 1 | Current index |
| 3 | 1 | Variable Y = Sum (initialized to 1) |
| 4L | LOAD M(0) | $AC \leftarrow N$ |
| 4R | SUB M(2) | $AC \leftarrow N - i$ |
| 5L | JUMP + M(6,0:19) | Check $AC \geq 0$ |
| 5R | JUMP + M(5,20:39) | $i = N$ Done. HALT |
| 6L | LOAD M(2) | $i < N$ so continue by retrieving the current index |
| 6R | ADD M(1) | $AC \leftarrow i + 1$ |
| 7L | STOR M(2) | $AC \rightarrow i$ |
| 7R | ADD M(3) | $AC \leftarrow i + Y$ |
| 8L | STOR M(3) | $AC \rightarrow Y$ |
| 8R | JUMP M(4,0:19) | Jump to instruction located at 4L |