CS2011: Introduction to Machine Organization and Assembly Language

Class 1: Introduction

Today's Class:

- What we'll be learning!
- Logistics of the course
  - Who's who
  - Syllabus
  - Grading
  - etc.
- Introduction to Machine Organization (very brief!)
- Introduction to Assembly Language
  - What
  - Why
  - Brief Example

CS2011: What We'll be Learning

- Major parts to the course:
  - Data representation (homework 1)
  - Machine language (homework 2)
  - Assembly language (homeworks 3-5)
  - Machine architecture (logic, circuits, microprogramming, etc.) (homework 6)

Teaching Staff

- Instructor: Janet Burge
  - office hours: TBD in FL144
  - email: jburge@cs.wpi.edu
- TAs:
  - Andrei Dancus, Chris Shoemaker
  - Office hours (to be determined) will be in FL A20 (sub-basement)
  - cs2011_ta@cs.wpi.edu

Class Mailing Lists

- For the instructor and TAs:
  - cs2011_ta@cs.wpi.edu
  - This is what you should use for questions on the classwork!
- For the whole class (also includes instructor and TAs):
  - cs2011@cs.wpi.edu
- You should be added to these automatically when you register for the course.

Class Web Page

- http://www.cs.wpi.edu/~jburge/courses/c01/cs2011
- This will be updated throughout the course.
- This is also the best place to check to see when office hours are.

Textbook

- Required:
  - K.R. Irvine, *Assembly Language for Intel-Based Computers*
  - R. Hyde, *The Art of Assembly Language Programming* – http://webster.cs.ucr.edu/Page_asm/ArtOfAsm.html
- Optional:
  - A.S. Tannenbaum, *Structured Computer Organization*
    - Five copies of the previous edition are on reserve at the library.

Syllabus

- From web-page

Lectures

- Lecture slides will be (mostly) available on the web in advance of the lecture (PDF format).
- Most lectures will also include in-class exercises on the material covered in the lecture.
  - these are NOT quizzes
  - they are done in groups
  - you will be expected to have your book with you in class
  - you should take notes on them!

Labs

- You *must* attend your scheduled lab section:
  - Section C02: 12:00 Washburn, 216
  - Section C03: 1:00 Washburn, 216
  - Section C04: 2:00 Kaven, 202
  - Section C05: 8:00 Kaven, 202
- Bring:
  - your text (Irvine)
  - a floppy disk
  - a pen or pencil – you will be turning in your lab results
- You will need a Novell account!!!

Homework

- Due at the START of class on the day it is due. Homework is always due each Friday. Homework due-dates will not be extended until Monday unless Friday's class was cancelled.
- No late homework will be accepted under *any* circumstances (but lowest grade will be dropped)
- Homework will be returned during lab the following week.
- If you do not pick it up in lab, you can pick it up from the TA assigned to record grades for your lab section *during their office hours* (this will be posted on the web)

Exams

- Closed book
- You can bring one 8 ½ by 11 sheet of paper (with notes, hand-written, both sides)
- NO CALCULATORS
- No make-up exams except in cases of serious health-related emergencies with appropriate documentation signed by a medical doctor.
- Sample exam questions will be posted one week prior to the actual exam. Sample exam answers will *not* be posted. Some problems will be worked out in-class, for others you will need to check your answers with a TA.

Grading Policy

- Two Exams – 25% each: 50%
- Six Homework Assignments, 7% each, lowest dropped: 35%
- Six Laboratory Assignments, 2% each, lowest dropped: 10%
- In-Class Exercises – 5% total, lowest dropped

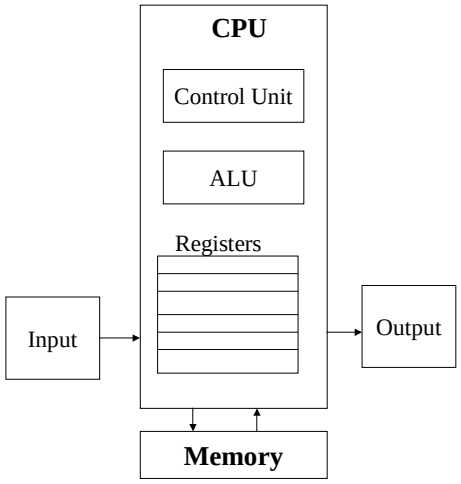
Academic Honesty Policy

- All assignments must be performed *individually*.
  - Students may ask general questions of each other but should not see each other's homework assignments under any circumstances.
  - Working together on a homework assignment is considered an academic honesty violation.
  - Comparing homework answers is also an academic honesty violation.
- It is expected that students follow the policies of this class. There will be opportunities for collaborative work during class but homework assignments are not collaborative.

Academic Honesty Policy (continued)

- If cheating is suspected the following procedure will be followed:
  - The students will receive a photocopy of their homework assignment rather than the original.
  - The instructor will examine the homework to determine if an academic honesty violation has occurred.
  - The instructor will meet with the students prior to computing final grades for the course to discuss the situation and give an appropriate penalty.

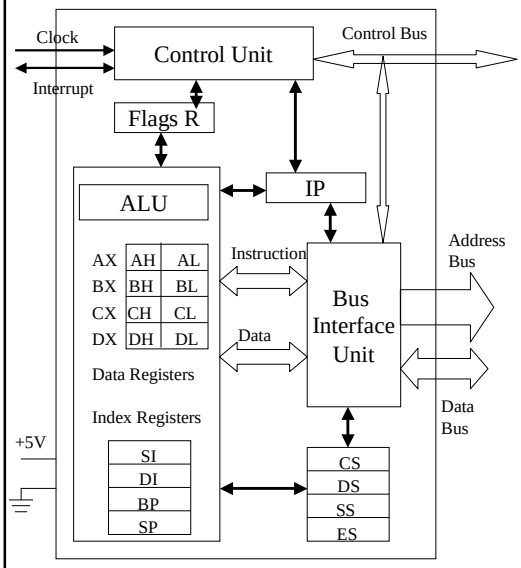
Computer Organization



CPU Components

- Control Unit – fetches instructions, decodes instructions, causes instructions to be carried out.
- Arithmetic logical unit (ALU) – performs arithmetic operations (addition, etc.) on data.
- Buses – communication pathways connecting different devices/components.
- Registers – high speed memory cells (don't need to go through the bus to access). They vary in number and purpose on different machines.

8086 Block Diagram



Registers

- 8, 16, or 32 bit high-speed storage locations inside the CPU
- They can be accessed at a much higher speed than conventional memory.
- When optimizing for speed, use registers.
- Four types: general purpose, segment, index, status, and control

What is Assembly Language?

- From Irvine:

  "Assembly language is a machine-specific programming language with a one-to-one correspondence between its statements and the computer's native machine language"
- What does this mean?
  - Each computer has its own machine language and, therefore, its own assembly language
  - Each assembly language statement is translated (by an Assembler) into one machine language statement

What is Machine Language?

- Machine language is the language understood by the computer.
- The language is made of numbers which can be interpreted by the processor.
- The processor has a microprogram that translates machine instructions into hardware signals

Example

- Assembly language instruction:

  mov al, 5 ;move 5 to the al register
  (registers are high speed storage locations in the CPU)

- Machine language instruction:

  1011000000000101

  10110000: *operation* – move operand to the AL register

  00000101: *operand* – the number 5 (in binary)

Context

- table 1 from the text

Why Learn Assembly Language?

- Some programming MUST be done in assembler:
  - direct communication may be needed with the operating system or peripheral devices
  - size and speed constraints (embedded programming)
  - custom hardware with no high level language support
- Assembly can be used in debugging
- A learning tool!

Comparison of Assembly Language and High Level Languages

- table 2 from the text

Differences in Assembly Languages

- Our move example:
  - Intel: `MOV AL, 5`
  - MC6800: `MOVQ #5, D0`
- Defining memory:
  - Intel: `COUNT DW 5`
  - MC68000: `COUNT DS.W 1`

    reserves space only!

Assembly Language Instructions

- A symbolic representation of a single machine instruction.
- Consists of a mnemonic and zero or more operands:

```
clc             ; just a mnemonic
inc ax          ; single operand
mov ax, bx      ; two operands
```

- Operand types:

```
10      (immediate operand)
count   (variable or memory operand)
AX      (register operand)
[0200]  (memory location)
```

Sample Program

- Figure 5 from text