Prerequisite Review

MC68HC11 Programmer's Model

1. **What is the programmer's model?**
   a. View of the processor registers and state as seen by a programmer
2. **What are the registers of the programmer's model?**
   a. CPU register on the MC68HC11
   b. 8-bit accumulator A
   c. 8-bit accumulator B
   d. 8-bit condition code register, CCR
   e. 16-bit accumulator D
   f. 16-bit index register X
   g. 16-bit index register Y
   h. 16-bit program counter PC
   i. 16-bit stack pointer SP
3. **What are accumulators?**
   a. Single-location storage for data
4. **What are index registers?**
   a. Meant to hold pointers to data structures
5. **What makes assembly language unique?**
   a. Operations and data movement are specified as memory locations and registers
   b. High level language functionality is gone because it isn't high level
   c. Assembly language is the closest representation to the instruction-set architecture of the machine
   d. Most people find assembly language hard to program in.
6. **Why do we have to write our OS in assembly for an MC68HC11?**
   a. Reinforce the understanding of how computers actually move data, what compilers do for us, how optimization can improve performance, etc.
   b. CS-391 – "car-in-the-box" – is a small-memory robot. Tight assembly language code is better in that environment. You take your OS to CS391.
   c. Dr. Meier – why do we write our OS by ourselves instead of in a team?
      i. Because you build your own robot in CS391 and we want you to **completely** understand your own OS.

Microprocessors and Microcontrollers

1. **What are the five components of any computer?**
   a. Memory
   b. Input devices
   c. Output devices
   d. Arithmetic circuits (data path)
   e. Data path controller
2. **What is a microprocessor?**
   a. Processor on a chip

      b. Note that it is only d and e
3. **What is a microcontroller?**
   a. Complete computer on a chip; contains all five components
   b. Peripheral devices are on the chip

The most used microcontroller is the Intel 8051
Microcontroller company: Motorola
Microprocessor company: Intel

4. **How is the MC68HC11 a microcontroller?**
   a. Central Processing Unit (processor)
   b. Contains:
      1. Memory: on-chip RAM, on-chip EEPROM, others have more memory
      2. Input devices: port C, port D, port E, some pins on port A, analog to digital converter, serial inputs for communication, timer inputs for timing events
      3. Output devices: port B, port C, port D, some pins on port A, timer outputs, serial outputs
      4. 8-bit processor
      5. (8-bit processor)
5. **What are the MC68HC11's ports?**
   a. The HC11 pins are grouped into sets called "ports."

	Pins	**Peripherals Sharing Pins**
Port A	3I, 1B, 4O*	Timer Subsystem
Port B	8O	Memory Address
Port C	8B	Memory Address & Data
Port D	6B	Serial Communication
Port E	8I	A/D Converter

* Sometimes has 2B and 3O.

Default direction of bi-directional is in. Good programming practice, though, will always define the direction

```
LDAA        #0b10101010
STAA        DDRC
```

1 on data direction register = out
0 on data direction register = in