Microcontrollers
Cornerstone Electronics Technology and Robotics II

- **Administration:**
  - Prayer
- **Electricity and Electronics, Section 26.1, Overview of the Microcontroller:**
  - A microcontroller (MCU) is a digital integrated circuit that can be programmed to control electrical or electronic devices. Programming a microcontroller means that the student puts into the microcontroller a set of commands that the microcontroller executes when it is turned on.
  - A microcontroller in essence is a tiny cheap stand alone mini-computer on a single chip that is suited for controlling robotics applications.
  - Microcontrollers contain the following on the same microchip:
    - A central processing unit (CPU)
    - Memory (both ROM, read-only memory, and RAM, random-access memory
      - ROM type memory is used to store the program code.
      - RAM is used for data storage, stack management tasks, and register stacks.
    - Some digital input and output ports (I/O ports)
      - The digital I/O ports are the means by which the microcontroller interfaces with the environment.
  - Microcontrollers will also contain other devices:
    - Timers
    - Serial and parallel ports to allow data transmission to other devices
    - Analog-to-digital converters (ADC)
    - Digital-to-analog converters (DAC)
  - All the components on the microcontroller are located on a singe piece of silicon. For this reason, the executions run much faster than it does on a computer.
  - First microcontroller was Intel 8048 released in 1976.
  - A typical mid range automobile has as many as 50 or more microcontrollers.
  - There two types of microcontroller memories:
    - The first memory is used to store the program. This memory, (EEPROM), is preserved when the power is turned off.
      - Electrically Erasable Programmable Read Only Memory (EEPROM): The contents of the memory can be erased by the programmer from the memory chip. Some data may be stored in EEPROM that will be saved after the chip is turned off.
    - The second memory is used to store data. This memory, (RAM), is lost when the power is turned off.
      - Random Access Memory (RAM) memory is used to store dynamic data that will change during the operation of the program.
    - The two memories greatly speed up execution time since the memories can be accessed at the same time.

- Types of microcontrollers (MCUs):
  - Flash devices which can be reprogrammed in the programmer, e.g. 16**F**88.
    - The chip we use to use, the 16F84A, can store 1024 instructions
    - 16F88 can store 4096 instructions
    - Program memory can be erased and rewritten 100,000 times.
    - Data stored in the EEPROM can be erased and rewritten 1,000,000 times.
    - Data stored in the EEPROM will be retained over 40 years.
  - One Time Programmable (OTP) devices which can only be programmed once.
  - Some MCUs are windowed devices that have a quartz window which enables them to be erased under ultraviolet light in about 15 minutes, after which they can then be reprogrammed. The program is stored in the Erasable Programmable Read Only Memory (EPROM)
- Important Features in a Microcontroller for Robotics:
  - Size of flash program memory
  - The number of I/O ports:
    - Input ports are connected to external sensors and receive data from the sensor.
    - Output ports are connected to external actuators (like dc motors)
- Most microcontrollers today are 8 bit, that is, they have a range of 256 ($2^8 = 256$).
- There is no standard program for programming microcontrollers. Each type has its own language, its own compiler, and its own method to upload to the microcontroller.
- Microchip manufactures a series of microcontrollers called PIC (Programmable Interface Controller).
- The microcontroller that we will be using is the PIC 16F88. Its features are as follows:
  - The flash program memory stores 4K (4096) 14 bit instructions.
  - 64 data memory bytes
  - 68 bytes of user RAM
  - PIC 16F84A has 13 I/O pins
  - PIC 16F88 has 16 I/O pins

- **Complete Robotic Car Hardware**
  - When soldering leads to the motors, solder the red lead to the (+) motor terminal and the black lead to the (–) motor terminal.