Advanced Microcontrollers

- Syllabus
    - ARM (CM3) 32-bit controller
        - ARM7 + CM3 Architecture
        - ARM assembly
        - LPC1768 Peripheral Programming
    - AVR 8-bit controller
        - AVR Architecture
        - AVR assembly
        - ATMEGA32 Peripheral Programming
- Pre-requisites
    - C programming
    - Computer fundamentals
    - Embedded hardware
    - 8086 Architecture (16-bit)
- Books
    - AVR
        - Mazidi
    - ARM
        - CM3 Architecture
        - ARM System Developer Guide
        - LPC1768 User Manual -- Programming
    - Sunbeam Notes
- Boards
    - ARM LPC1768 board -- BlueBoard -- NGX Technologies
    - AVR ATMEGA32 board -- EmbeddedMarket/RhydoLabz

CDAC Project

- One project -- 100 marks
    - Project design
    - Project implementation
    - Seminar/presentation
- Technologies
    - Controllers (ARM-7 + ARM-CM3, AVR) + hardware
    - IoT (Sensors, NodeMCU, BBB/RPI, Db/WebAPI) + hardware

        - Linux Device Drivers + hardware

- Hardware Support
    - Boards (ARM+AVR) + BBB + NodeMCU -- available in Sunbeam
    - Any other circuits/components you need to purchase

- Continuous Evaluation
    - Step 1: Title, Description, Block diagram, Sensors, circuits, Datasheets, ...
    - Further steps depends on project.

Embedded fundamentals

Memory

- Memory
    - Width: Number of bits per location.
    - Data bus: Number of wires through which is data is transferred from CPU to RAM and vice-versa. Depends on memory width.
    - Address bus: Number of wires thorough which address is given from CPU to RAM. Depends on number of locations.
    - Control bus: Usually RD/WR signal.

- Primary memory: Directly accessible to CPU.
    - CPU registers: Depends on Architecture
        - x86: ax, bx, cx, dx, si, di, sp, bp, ip, ...
        - ARM: r0, r1, r2, ...
    - Cache
        - Between CPU and RAM to improve speed of data transfer.
    - RAM: Random access memory : RD/WR
        - SRAM: Static RAM
            - Part of controller chip.
            - Made of flipflops.
            - Faster
        - DRAM: Dynamic RAM
            - External RAM chips.
            - Made of capacitors, need to refresh periodically.
            - Slower
        - NVRAM: Non-Volatile RAM
    - ROM: Read Only Memory
        - Mask ROM:

            - Programmed during manufacturing using Mask
            - Mass production
        - PROM: Programmable ROM
            - One time programmable/burn.
        - EPROM: Erasable Programmable ROM -- fixed number of erase cycle
            - UV-EPROM: Erased using UV light
            - E-EPROM: Erased using Electric current.
        - Flash
            - Like EEPROM
            - But erased or written sector by sector.
- Secondary memory: Accessible via Primary memory -- Storage
    - Optical devices: CD/DVD
        - Made of polycarbonate material.
        - Written using LASER -- pits & lands.
    - Magnetic devices: Tapes, Disk
        - Based on electro-magnetism / ferro-magetism.
        - Data is stored in magnetic dipole.
            - N -> S : represent 1
            - S -> N : represent 0
        - Written using magetic field induced due to current. Read using electric current generated due to magnetic movement.
        - Solid state devices: Flash drives, SSD drives

CPU

- Processor: ALU + CU + Registers
- Each IO device have its own internal dedicated processing unit called as "Device controller" e.g. Keyboard, Monitor, Mouse, Disk, ...
- Other Processing Units
    - GPU
    - Co-processor
- Central coordinator that gives instructions to other processing units is called as "Central Processing Unit".

Von Neumann vs Harvard Architecture

Memory mapped IO vs IO mapped IO

uP vs uC

RISC vs CISC