# Modules

| Modules | Topics covered |
|---|---|
| Module 1 | Basic Introduction, Overview of C languages, Compilers, Interpreter, Programming Environments and Debugging: Types of error and debugging techniques |
| Module 2 | Programming Features: Constants, Variables, and Datatypes, Operators, and Expressions, Control statements, Iterations |
| Module 3 | Array, String, Structures and Union |
| Module 4 | Functions: Scope of variables, call by value, call by reference, Recursion, Pointers |
| Module 5 | File Management in C, Memory Allocation, and Linked Lists |
| Module 6 | Python: Introduction, Program Organization, Functions, Modules and Libraries. |

# Textbooks/Reference Book

1. C Programming Absolute Beginner's Guide by Greg Perry, Dean Miller
2. The C Programming Language (2nd Edition) by Dennis Ritchie
3. Learn C the Hard Way by Zed Shaw
4. Head First C by David and Dawn Griffith
5. Class notes

# Module1

**Basic Introduction, Overview of C languages, Compilers, Interpreter, Programming Environments and Debugging: Types of error and debugging techniques**

# Programming – Why?

- Computers are used for many different purposes in many different situations.
  - But, how can they be so versatile?
    - Answer: They can be programmed
- The ability for a computer to be programmed allows it to do whatever their programs tell them what to do.
- A program is a set of instructions that tell a computer what to do.
- A computer cannot do anything unless it has a program to tell it what to do.
- In this class, we will focus on writing these programs.

# Programming – What?

- Programs are used to operate the components of a computer, solve problems or satisfy a want/need.
  - How long will it take me to get home if I drive *x* miles per hour?
  - I want to be able to tell my friends what I am doing right now.
- Computer Programming is both an Art and a Science
  - Every aspect of a program must be carefully designed
- As an art, programming takes creativity and problem solving.
  - There is often no one correct way to solve a problem.
- As a science, there are formal and proven methods to go about creating a programming.
- In this course, you will learn both the art and science of programming.

# Hardware and Software

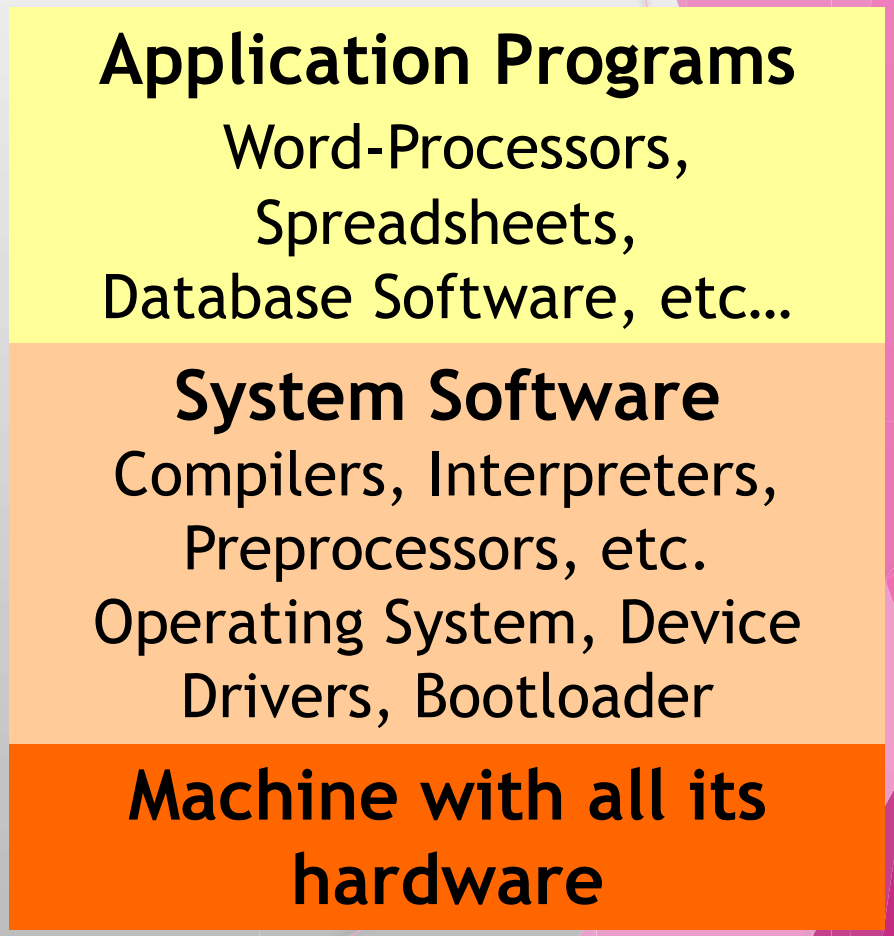
- Programs can also be called software.
  - Software refers to the computer programs that a computer uses to complete a task.
- Hardware refers to the physical components that a computer is made of.
  - A computer is not one device, but a system of devices working in tandem.
  - Each device plays a part.
  - Major components:
    - Central Processing Unit
    - Main Memory
    - Secondary Storage Devices
    - Input Devices
    - Output Devices

# Software

- Software refers to the programs that run on a computer.
- Two main categories (for this class):
  - Operating System (OS)
    - A set of programs that manages a computer's hardware devices and controls their processes.
    - Most modern operating systems are capable of running multiple programs at once.
    - UNIX, Linux, Mac OS X, and Windows are examples
  - Application Software
    - Programs that make the computer useful for the user
    - Solve specific problems or supply a service
    - Word processors, spreadsheets, databases, etc.
    - This is what we will be developing in this class.

# Software Categories

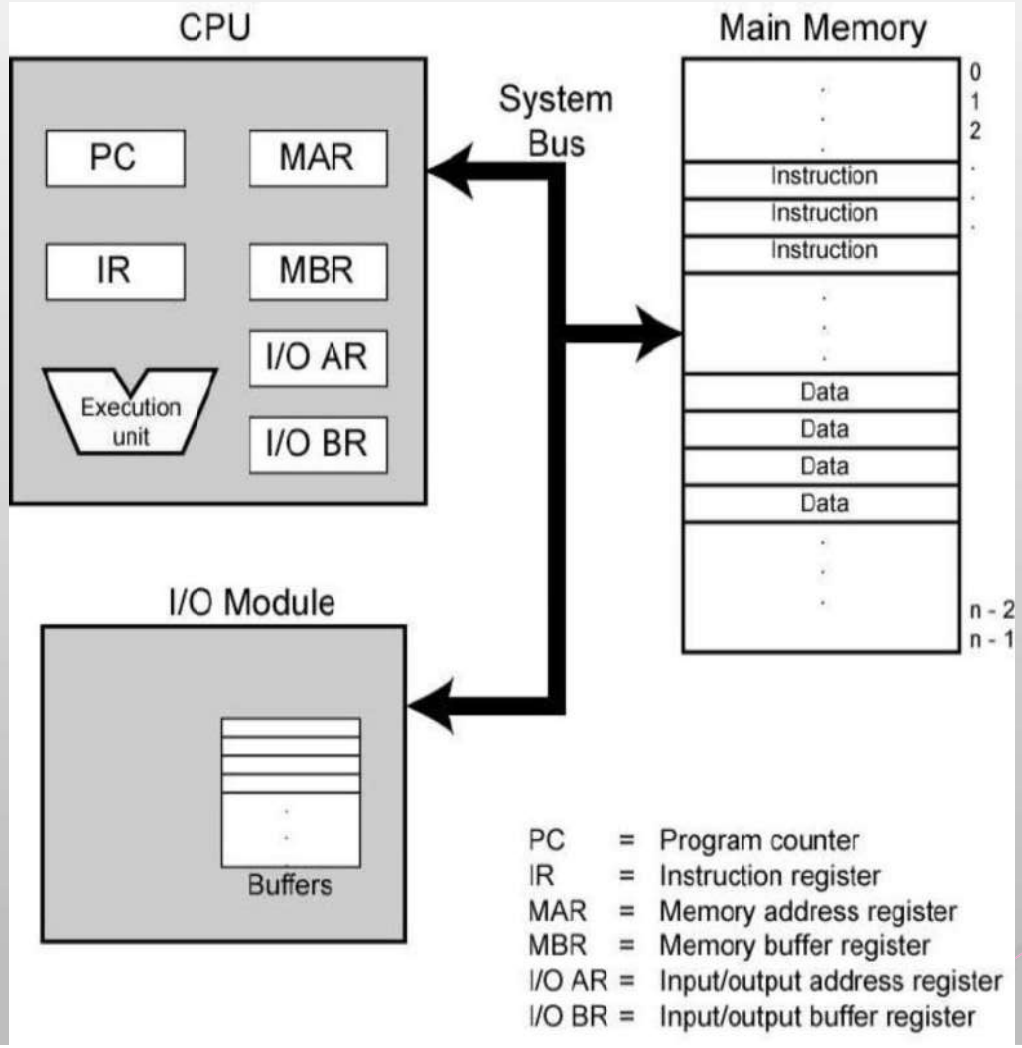
- System Softwares
  - Programs written for computer systems
    - Compilers, operating systems, …
- Application Softwares
  - Programs written for computer users
    - Word-processors, spreadsheets, & other application packages



# Central Processing Unit (CPU)

- The CPU is the heart and brain of the computer.
- The CPU continuously does the following things:
  1. Fetch an instruction
  2. Follow the instruction
  3. Produce some resulting data
- The CPU has two  parts:
  - Control Unit
    - Coordinates the computer's operations
    - Determines where to get the next instruction
    - Regulates the other major components of the computer
  - Arithmetic and Logic Unit (ALU)
    - Designed to perform mathematical operations

# Central Processing Unit (CPU)



# Main Memory

- Main memory holds information that the CPU needs to access quickly.
  - Namely, the instructions to be executed.
- When a program is running, some or all of its instructions are in main memory.
- Memory is divided into sections called bytes that hold equal amount of data.
- Each section is made up of 8 bits.
  - A Bit is the most basic unit of information a computer can hold. It is a switch that is either on (1) or off (0)
- Each byte is assigned and can be accessed by its address.
  - A Memory Address is a unique identifying number associated with a byte in memory.
- Main memory typically is volatile.
  - Volatile Memory – is memory that when it loses power, the contents are erased.

# Secondary Storage

- Secondary Storage is memory that can hold data for a long period of time.
- Programs are usually stored in secondary storage and loaded into main memory as needed.
  - This forms a hierarchy typically called the memory hierarchy.
- Common forms of secondary storage:
  - Hard Drive
    - Disk Drive
    - Solid State Drive
  - Removable Storage
    - Floppy Disk
    - CD-ROM
    - USB Drives
- Other files can be stored in secondary storage:
  - Documents
  - Pictures
  - Whatever else you save on your computer

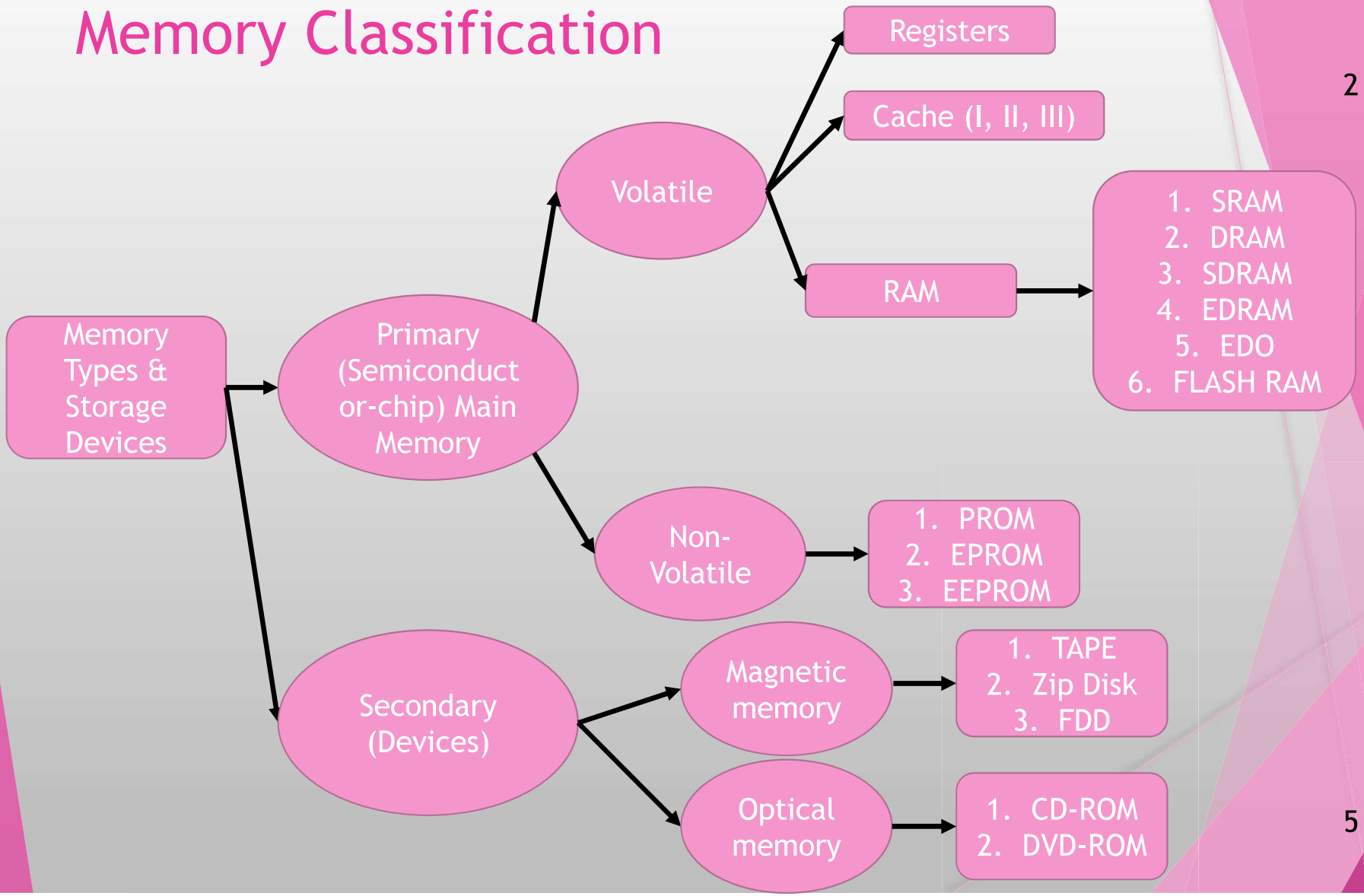
# Registers

- Registers are small, ***fast memory within the CPU***.
- Different registers hold different things like instructions and addresses of instructions, data (operands) and results of operations.
- Two Types:
  - ***Special Purpose Registers (SPRs):*** contain specific information for CPU
    - ***Instruction Register (IR):*** contains actual instruction which is currently being executed by the CPU.
    - ***Program Counter (PC):*** contains the address of the next instruction to be executed.
  - ***General Purpose Registers (GPRs):*** holds
    - Operands for arithmetic and logical operation (i.e. the value on which the operation will be performed)
    - Results of various operations
    - Useful for holding and manipulating the data

# Computer Memory Storage

- ***Computer Memory:*** millions/billions of on/off charges
  - ***Bits: 0 or 1***
  - ***Bytes: Group of 8 bits, A byte is the smallest unit of storage***
  - ***Words: Group of bits/bytes (8, 16, 32, 64-bits)***
- Storage usually expressed as
  - **Kilobyte (KB)**
  - **Megabyte (MB)**
  - **Gigabyte (GB)**
  - **Terabyte (TB)**

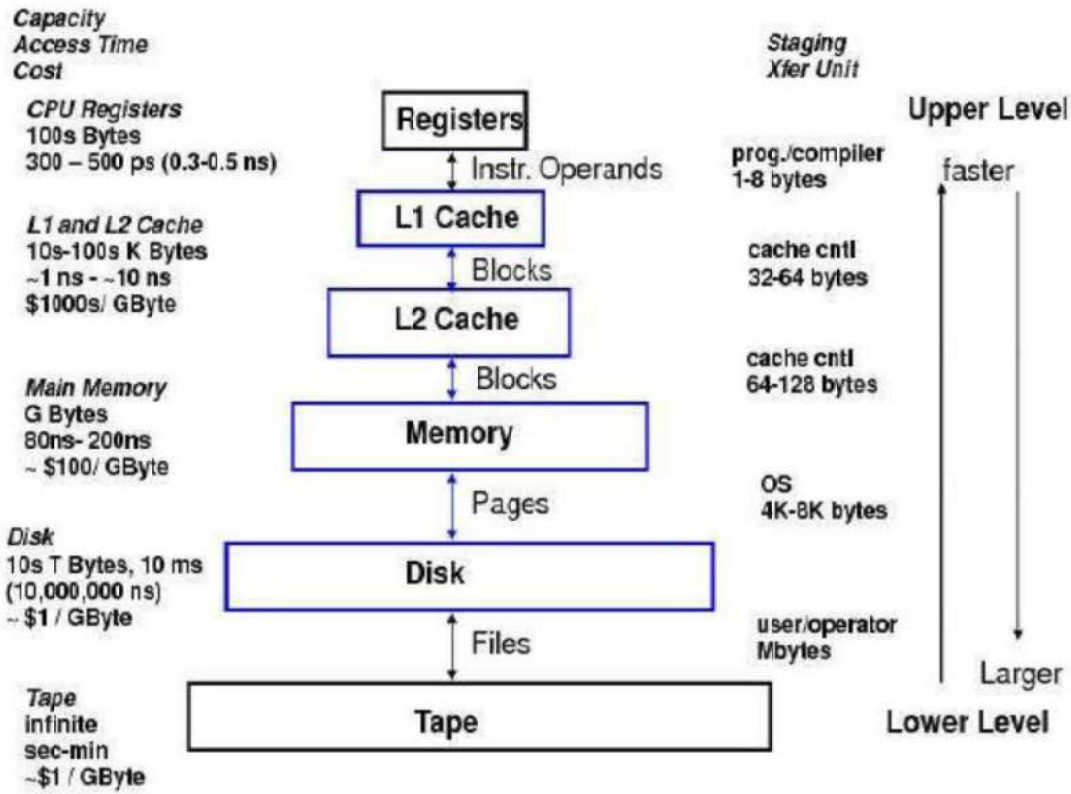
# Memory Classification



# CPU and Memory

- CPU interact with main memory in two ways:
- It can ***write a byte/word*** to a given memory location
- It can ***read a byte/word*** from a given memory location
- ***Main memory:*** connected closely to CPU, with quick updation of contents.
- Main memory holds programs and data that CPU is actively working
- Interacts with processor millions of times per second
- ***Secondary memory:*** Connected to main memory through bus and device controller
- Easy content modification, but with slow access time.
- Used for long-term storage of programs and data with larger capacity
- ***Cache Memory:*** Placed between main memory and CPU to provide faster transfer of information.
- Modern PC have cache memory on same silicon wafer to provide instructions at same clock speed as the CPU.

# Computer Memory Hierarchy



# Input Devices

- Input is any data the computer collects from the outside world.
- An Input Device is anything that collects data and sends it to the computer.
- Common Input Devices:
  - Keyboard
  - Mouse
  - Scanner
  - Digital Camera
  - Disk Drive
  - USB Drive

# Output Devices

- Output is any data the computer sends to the outside world.
- An Output Device formats data and presents it to the outside world.
- Common Output Devices:
  - Monitor
  - Printer
  - Disk Drive
  - USB Drive