CS & IT ENGINEERING

COMPUTER ORGANIZATION AND ARCHITECTURE

Basics of COA

Lecture No.- 01

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Topics to be Covered

- Topic: Prerequisites
- Topic: Why COA
- Topic: Data In Computers
- Topic: Components of Computer
- Topic: Binary Numbers

Topic : Introduction

- **GATE Ranks:**
  - 682 (2009) – 3rd year
  - 19 (2010) – 4th year
  - 119, 440 etc.

- **Education:**
  - ME from IISc Bangalore
  - M. tech from BITS-pilani in Data Science

- **Work:**
  - 18+ Year Teaching Experience — 2007
  - 14+ in GATE/IES — 2011
  - Worked in Cisco, Audience Communication

Topic : Prerequisites

- Basic components of computer: CPU, memory (RAM, ROM, HDD), I/O
- Number system: Binary, Decimal, Hexadecimal etc.
- Digital logic basics: Mux, Decoder etc.

Powers of 2:

Unit	Time	Bit or Byte
K (Kilo)	10^3	2^{10}
M (Mega)	10^6	2^{20}
G (Giga)	10^9	2^{30}
T (Tera)	10^{12}	2^{40}

Prerequisites

- **Number System**

  Binary, Hexadecimal, Decimal

  Conversion from one system to another

  Signed numbers: Sign-Magnitude, 1's Complement, 2's Complement

- **Decoder**
- **Multiplexer**

Basics of computer system

↳ 10 lectures (L6) ⇒ Unit Conversion

range of numbers

Topic : Why COA

- To understand: How a computer works
- To understand other courses: OS, Compiler, Programming etc.
- Help in real world development: DBMS, Hardware Design, IoT problems etc.

Topic : Computer Organization & Architecture

Computer Architecture:

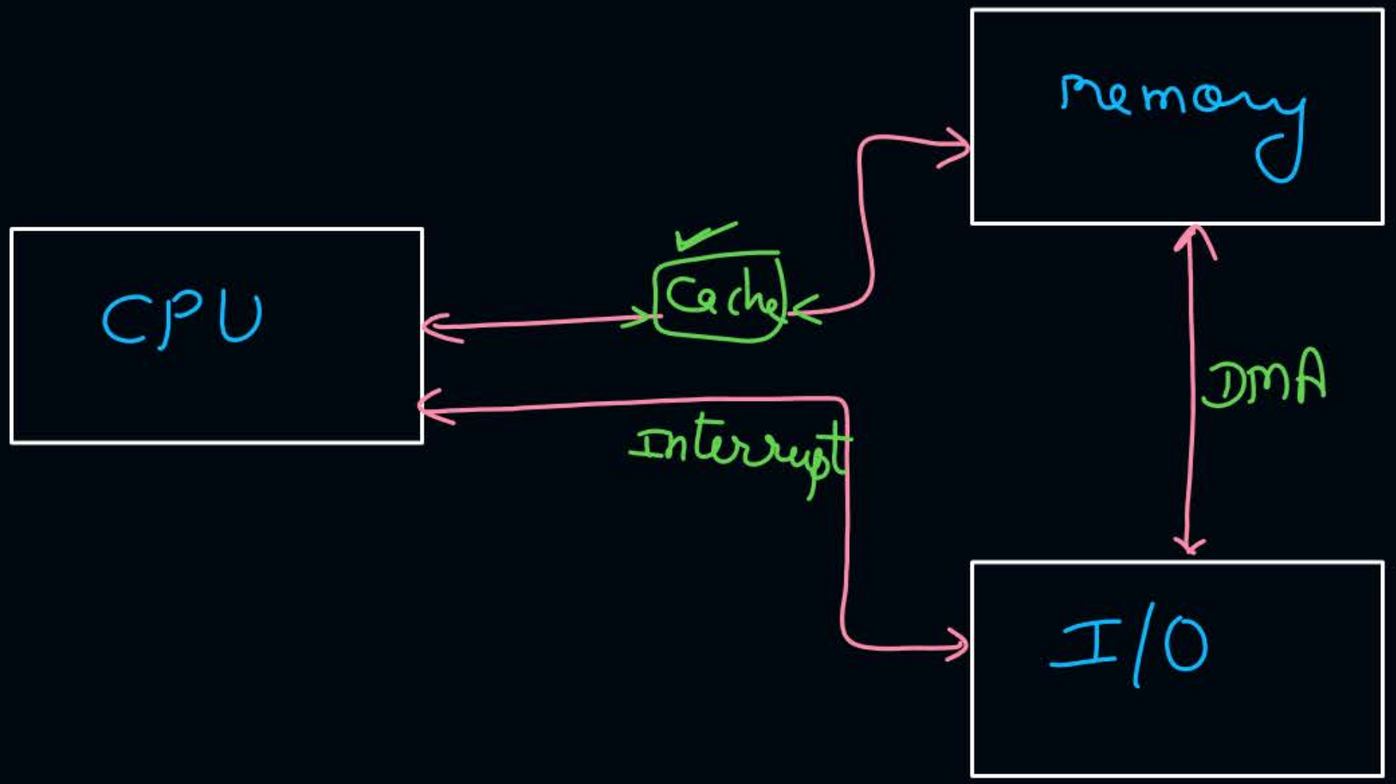
- Conceptual design and fundamental operational structure.

Implementation

Computer Organization:

- Deals with physical devices and their interconnections
- With a perspective of improving the performance.

Computer Architecture	Computer Organization
• CPU Design	• I/O Organization
• Instructions	• Memory Organization
• Addressing modes	• Performance
• Data format	


Memory
CPU
Cache
DMA
Interrupt
I/O

Topic : Data In Computers

- Number
  - fixed point
    - unsigned
      - $5 = (101)_2$
      - $8 = (1000)_2$
    - signed
      - → sign-magnitude
      - → 1's complement
      - → 2's complement
  - floating point
- Char
  - → ASCII
  - → EBCDIC

Topic : Binary Numbers

Hexadecimal

$(A12C6)_{16}$

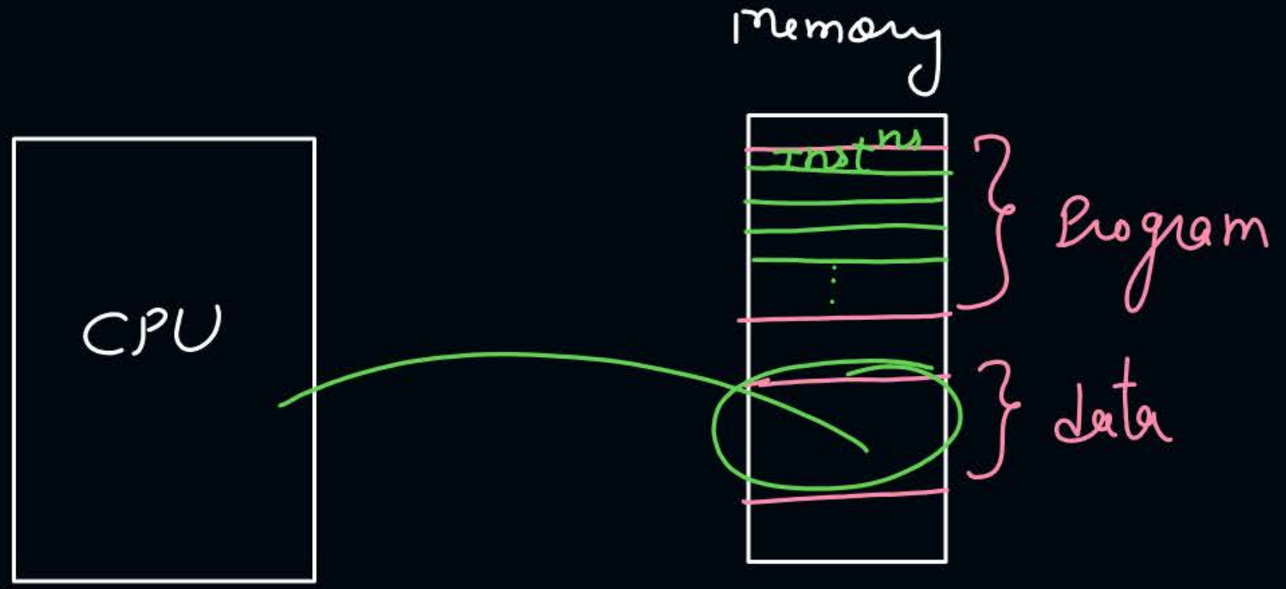
A12C6 H

0x A12C6

Topic : Components of Computer

- CPU :- 2 parts → ALU ⇒
  → CU ⇒
- Memory: (main memory) :- Used to store current running programs and data.
- I/O Devices:
  → input devices
  → output devices
  → storage devices

How computer works :-



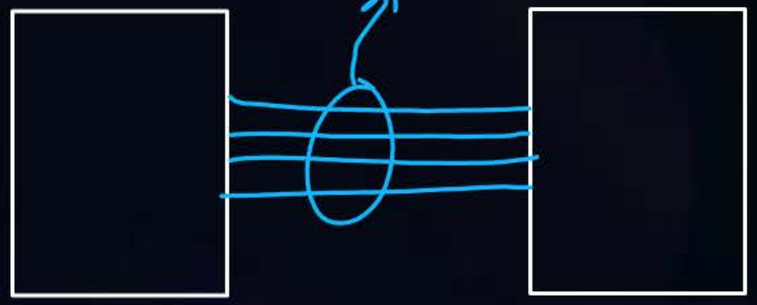
Topic : Other Components

- System Buses
- CPU Registers

Topic : Other Components

System Buses:

Collection of communications lines to connect CPU with memory & I/O

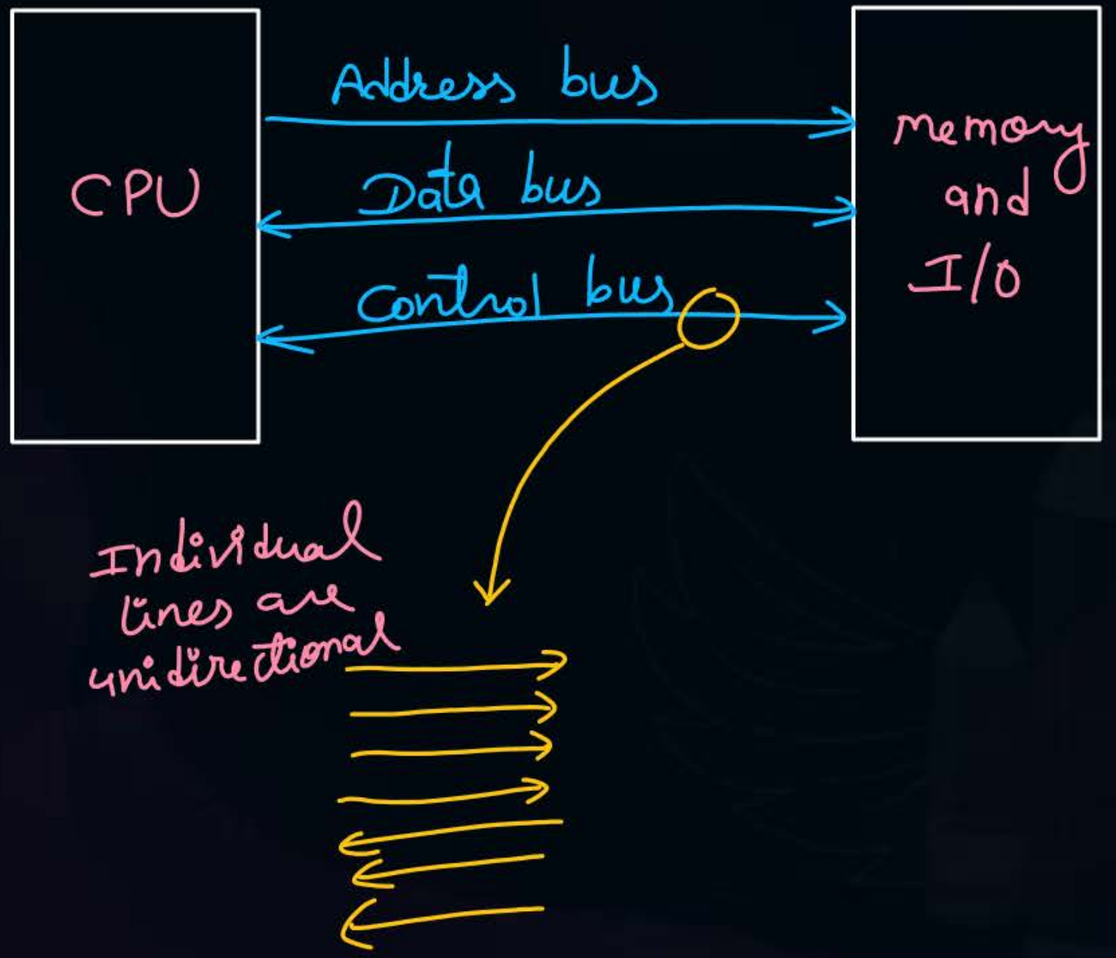


4 lines bus (4 bits bus
or
4 lines wide bus
or
4 bits wide bus)

Topic : Other Components

System Buses:

- Address Bus
- Data Bus
- Control Bus



Topic : CPU Registers

small memories inside CPU to store some specific contents from program execution.

Topic : CPU Registers

CPU Register

- General Purpose Registers (GPRs) ⇒ R0, R1, R2, ...
- Special Purpose Registers

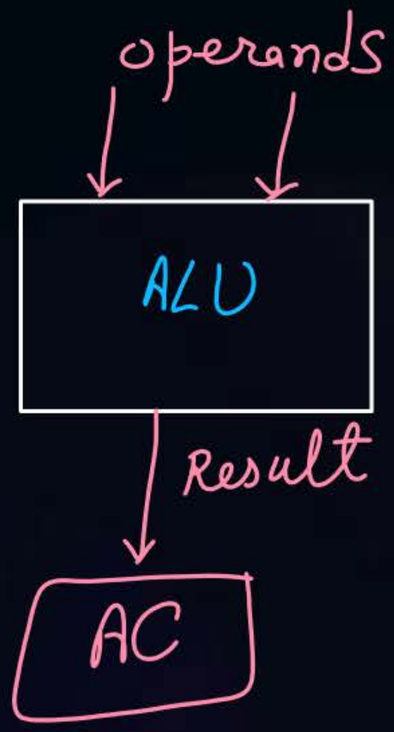
Topic : CPU Registers

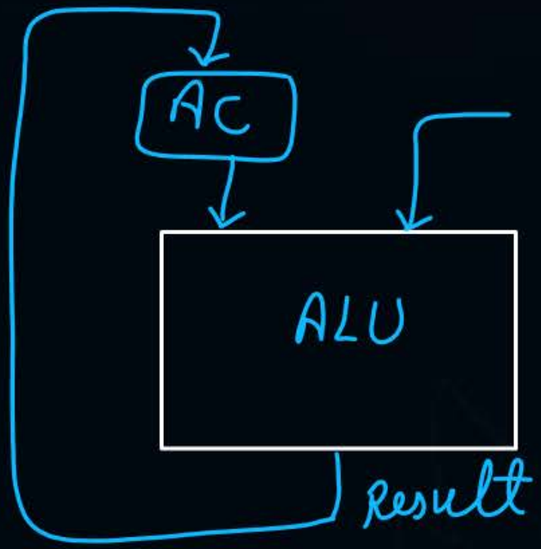
CPU Register

- General Purpose Registers (GPRs)
- Special Purpose Registers
  1. Accumulator (AC)
  2. Program Counter (PC)
  3. Instruction Register (IR)
  4. Stack Pointer (SP)
  5. Flag Register / Program Status Word (PSW) / Status Reg.
  6. Address Register (AR) / Memory Address Register (MAR)
  7. Data Register (DR) / Memory Data Register (MDR) / MBR (Mem. Buffer Reg.)

Topic : Accumulator

- Used to store result of ALU and sometimes ~~on~~ one of the operand~~s~~ for ALU too.



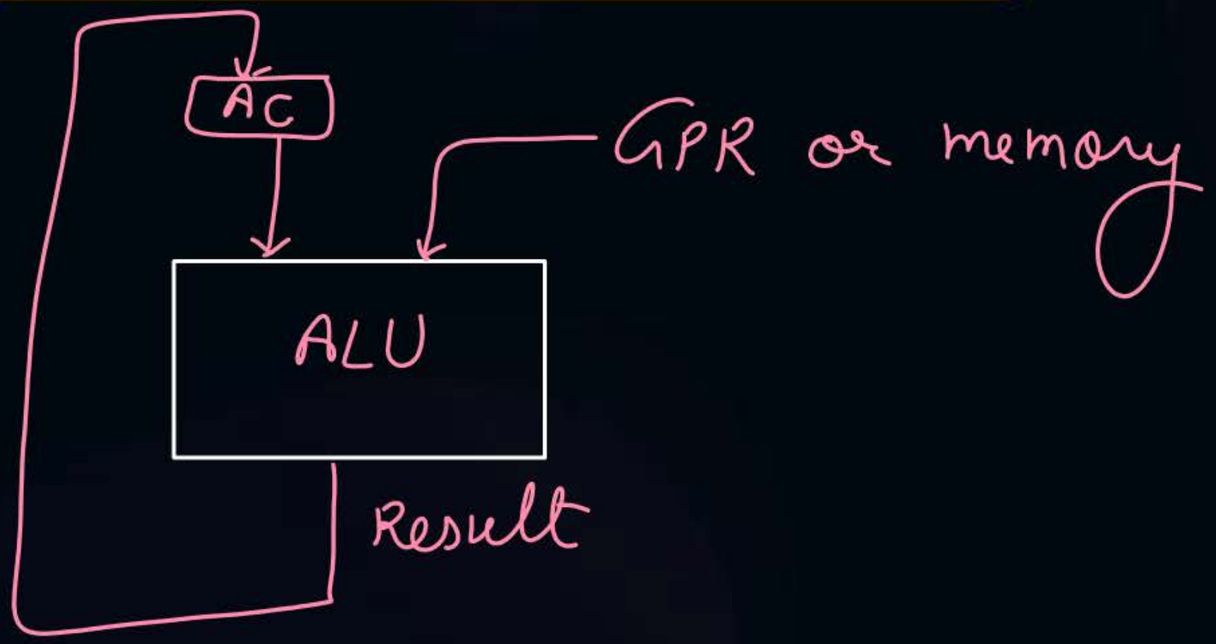


Topic : Types of Architecture

Based on ALU input: → from where the 2 input operands in ALU taken.

- AC-Based Architecture
- Register Based Architecture
- Register-Memory Based Architecture
- Complex System Architecture
- Stack Based Architecture

Topic : AC-Based Architecture



$C = a + b$

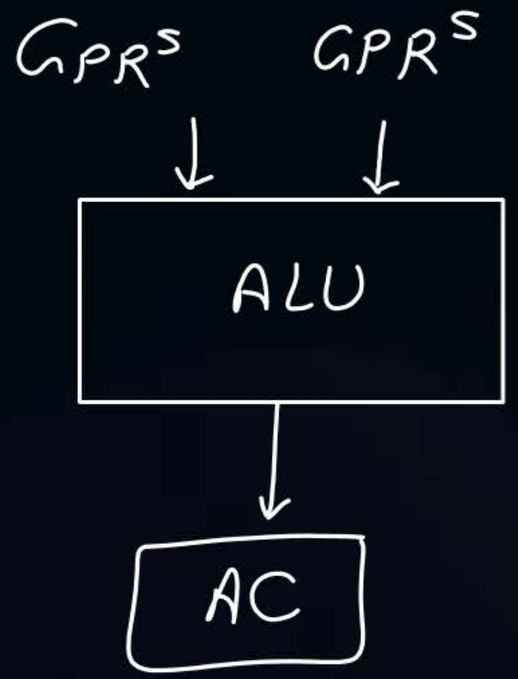
a, b, C ⇒ mem. operands

$AC \leftarrow a$

$AC \leftarrow AC + b$

$C \leftarrow AC$

Topic : Register-Based Architecture



$c = a + b$

$\Downarrow$

$R1 \leftarrow a$

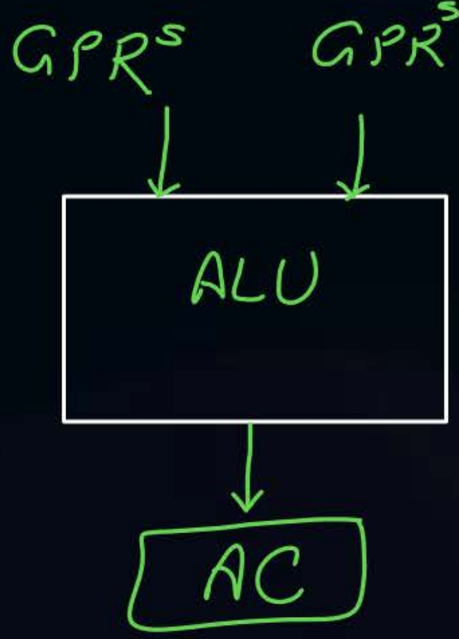
$R2 \leftarrow b$

$AC \leftarrow R1 + R2$

$C \leftarrow AC$

a, b, c are mem. operands

Topic : Register-Memory Based Architecture



$c = a + b$

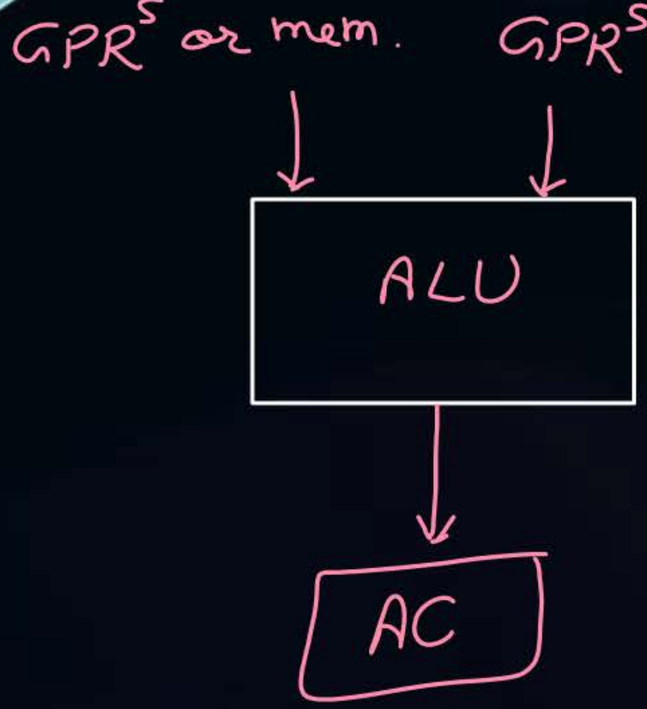
$\Downarrow$

$R1 \leftarrow a$

$AC \leftarrow R1 + b$

$c \leftarrow AC$

Topic : Complex System Architecture



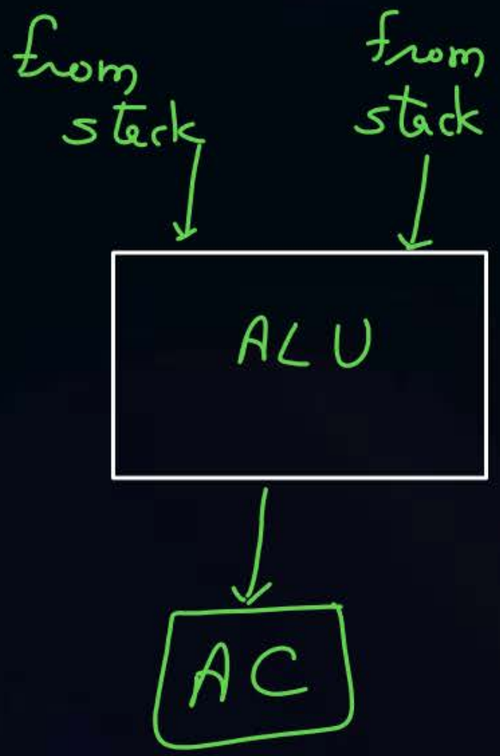
$C = a + b$

$\Downarrow$

$AC \leftarrow a + b$

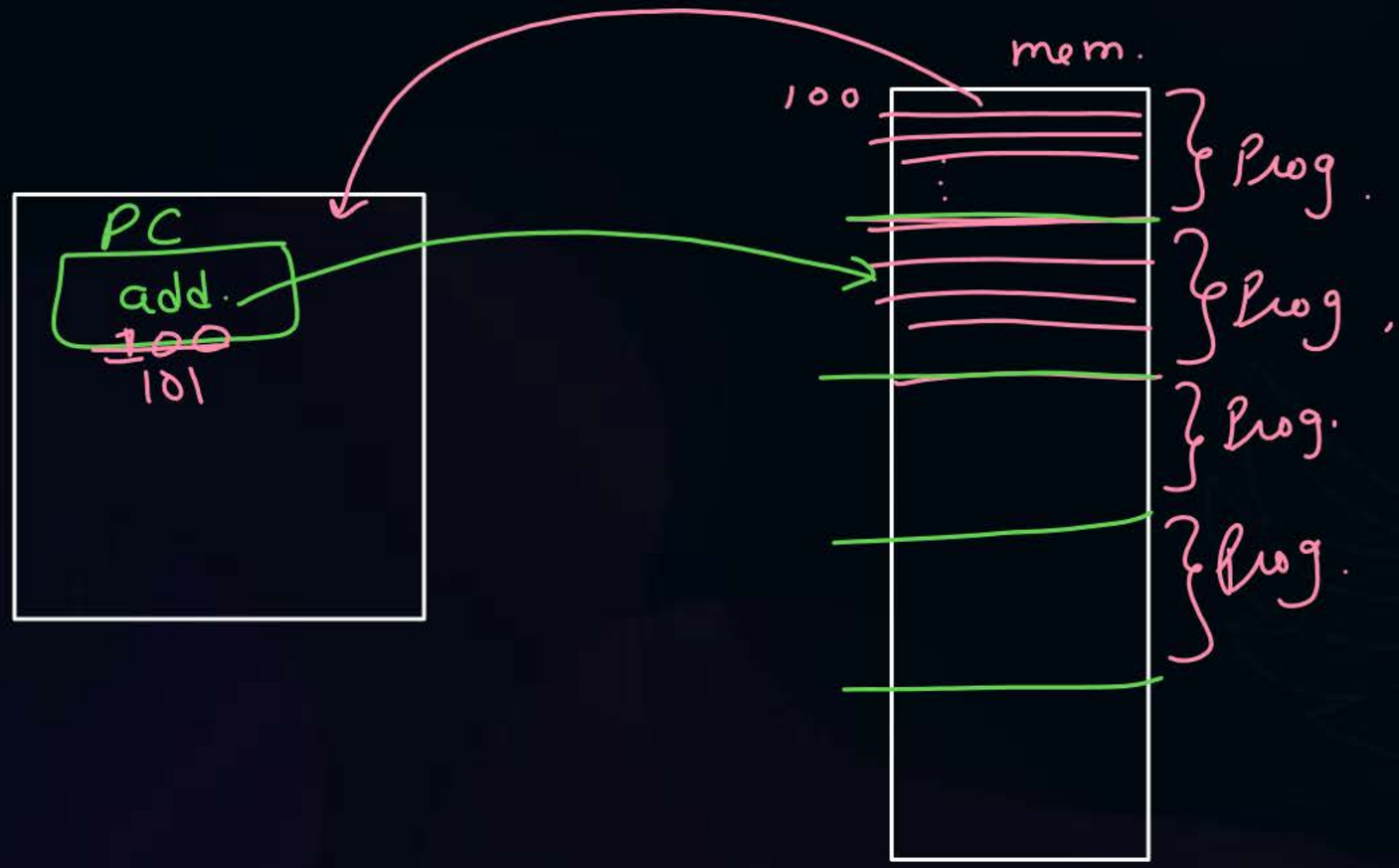
$C \leftarrow AC$

Topic : Stack-Based Architecture



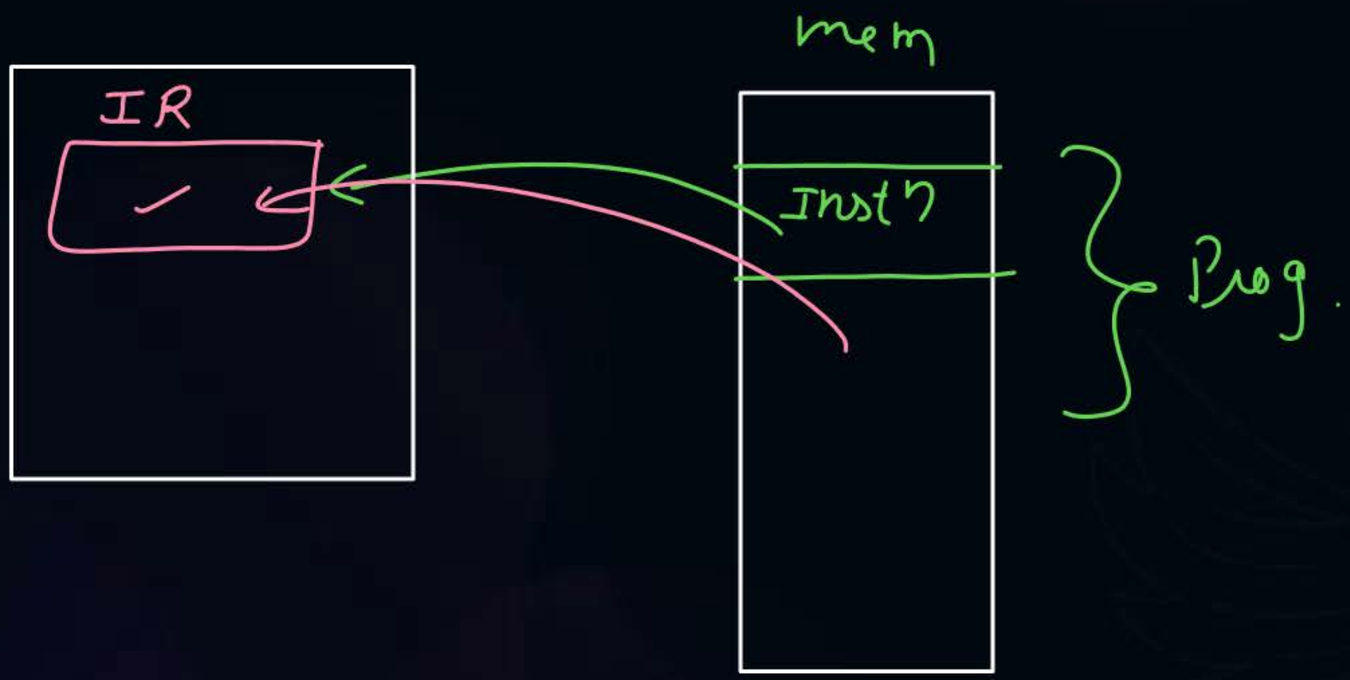
Topic : Program Counter (PC)

- Stores address of next instruction to be executed



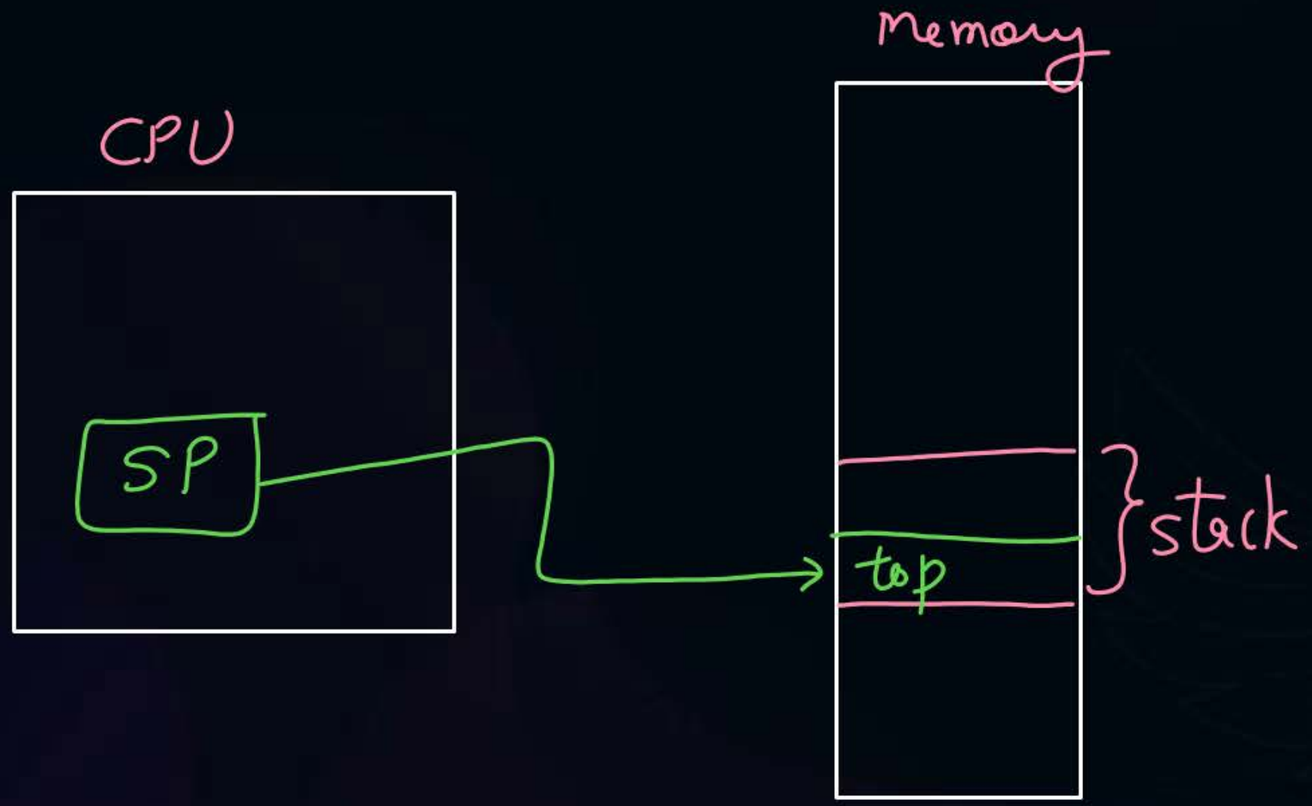
Topic : Instruction Register

- Stores the current instruction to be executed



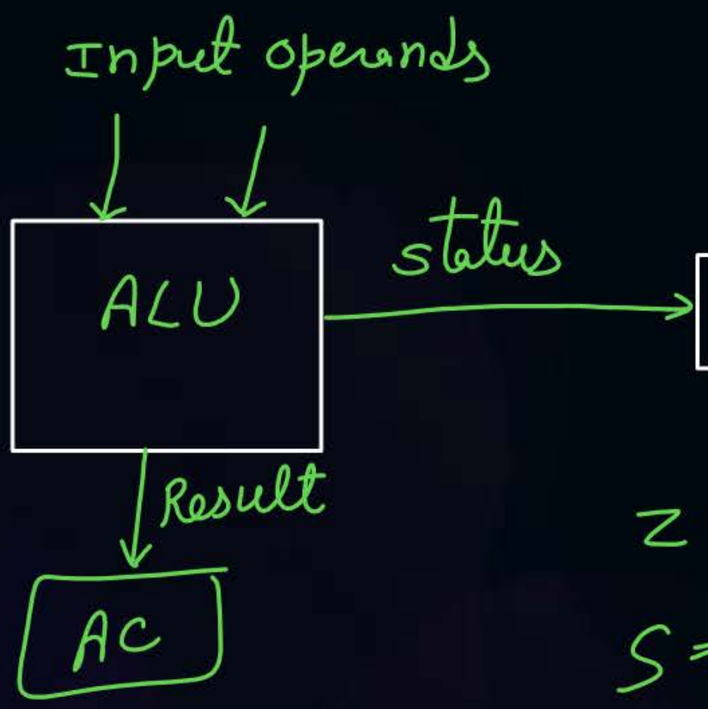
Topic : Stack Pointer

- Stores the address of the top of the stack



Topic : Flag or Status Register

- Stores the status of the ALU result



status Register

for condition checking

if (a > b)

a − b in ALU

if result is non zero and +ve

Z = zero flag ⇒ Result is zero or non-zero

S ⇒ sign flag ⇒ —11— +ve or −ve

Ca ⇒ Carry flag ⇒ —11— has carry or not

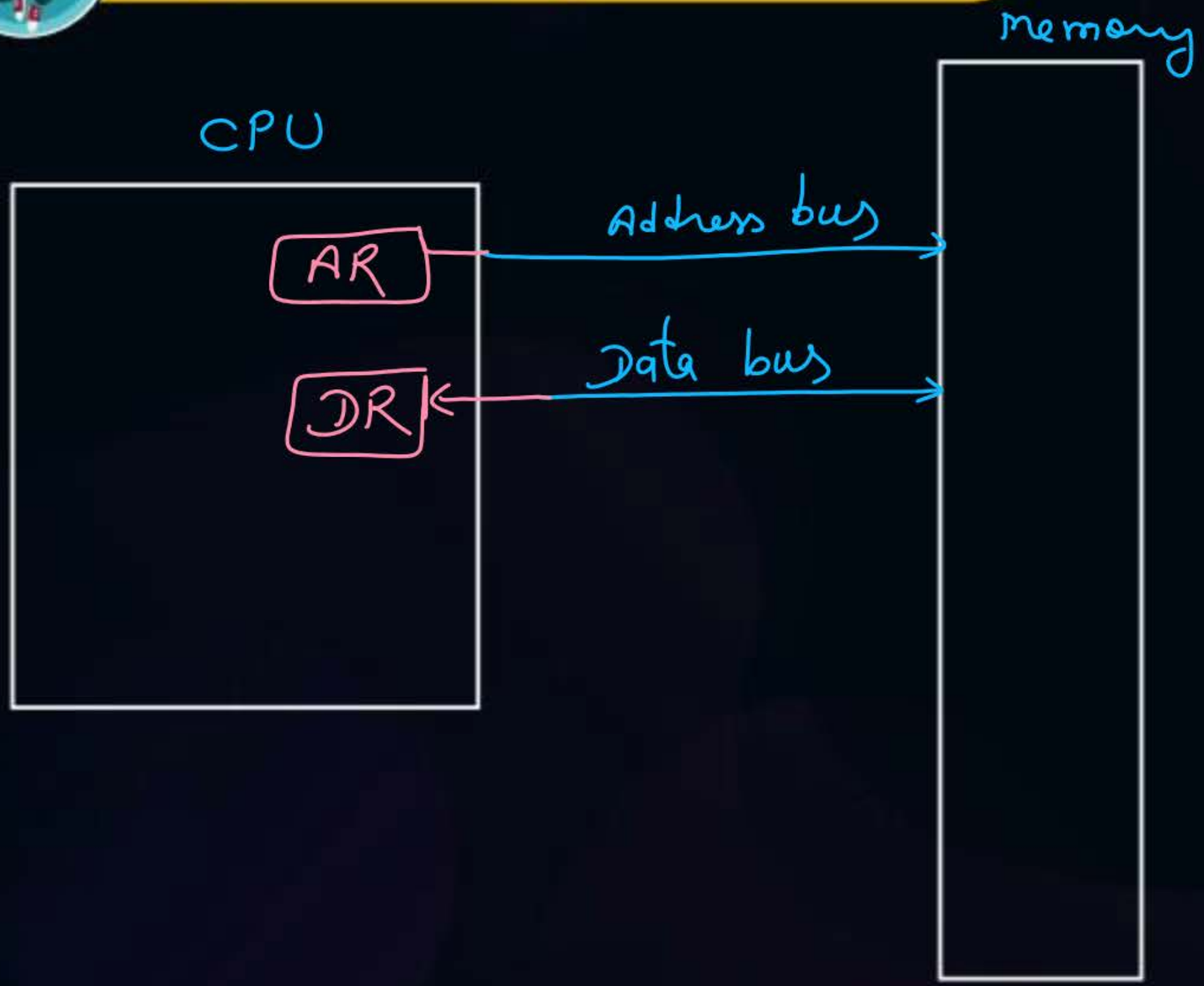
Topic : Address Register or MAR

- Used to send address to memory

Topic : Data Register or MDR

- Used to send data to memory
- And to receive data from memory

Topic : Memory Access



2 mins Summary

- **Topic** Architecure vs Organization
- **Topic** Numbers & Data in Computers
- **Topic** Components of Computer
- **Topic** System Buses
- **Topic** CPU Registers

Happy Learning

THANK - YOU