

Assembly Language Programming of 8085

Unit-2

Topics

- Introduction
- Programming model of 8085 
- Instruction set of 8085 
- Example Programs 
- Addressing modes of 8085 
- Instruction & Data Formats of 8085 

1. Introduction

- A **microprocessor** executes instructions given by the user
- Instructions should be in a language known to the **microprocessor**
- **Microprocessor** understands the language of 0's and 1's only
- This language is called **Machine Language**

- For e.g.

01001111

- Is a valid machine language instruction of 8085
 - It copies the contents of one of the internal registers of 8085 to another

A Machine language program to add two numbers

```
00111110  
00000010  
00000110  
00000100  
10000000
```

;Copy value 2H in register A

;Copy value 4H in register B

;A = A + B

Assembly Language of 8085

- It uses English like words to convey the action/meaning
- For e.g.
 - MOV to indicate data transfer
 - ADD to add two values
 - SUB to subtract two values

Assembly language program to add two numbers

```
MVI A, 2H ;Copy value 2H in register A  
MVI B, 4H ;Copy value 4H in register B  
ADD B      ;A = A + B
```

Note:

- Assembly language is specific to a given processor
- For e.g. assembly language of 8085 is different than that of Motorola 6800 microprocessor

Microprocessor understands Machine Language only!

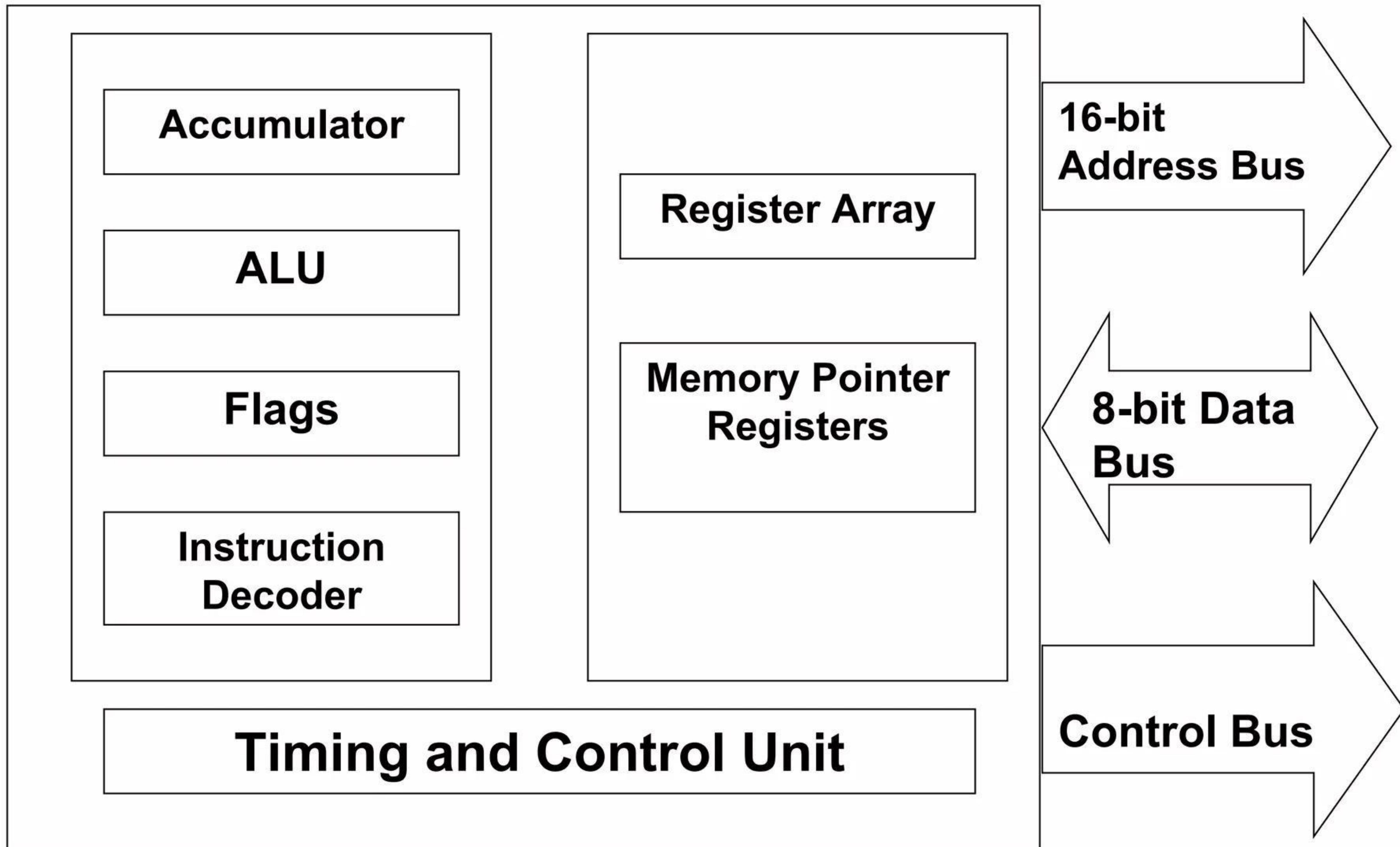
- Microprocessor cannot understand a program written in Assembly language
- A program known as **Assembler** is used to convert a Assembly language program to machine language



Low-level/High-level languages

- Machine language and Assembly language are both
 - Microprocessor specific (**Machine dependent**) so they are called
 - Low-level languages
- **Machine independent** languages are called
 - High-level languages
 - For e.g. BASIC, PASCAL,C++,C,JAVA, etc.
 - A software called **Compiler** is required to convert a high-level language program to machine code

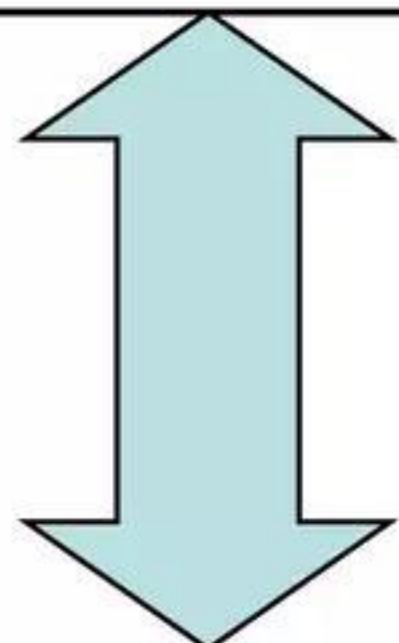
2. Programming model of 8085



A ccumulator (8-bit)	F lag Register (8-bit)
	S Z AC P CY
B (8-bit)	C (8-bit)
D (8-bit)	E (8-bit)
H (8-bit)	L (8-bit)
Stack Pointer (SP) (16-bit)	
Program Counter (PC) (16-bit)	

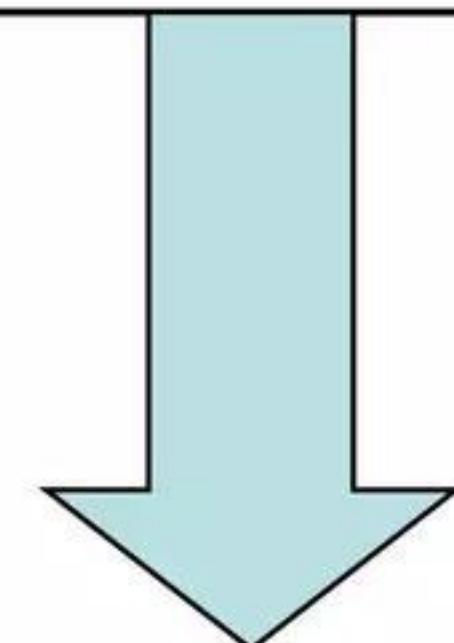
8- Lines

Bidirectional



16- Lines

Unidirectional



Overview: 8085 Programming model

1. Six general-purpose Registers
2. Accumulator Register
3. Flag Register
4. Program Counter Register
5. Stack Pointer Register

1. Six general-purpose registers

- B, C, D, E, H, L
- Can be combined as register pairs to perform 16-bit operations (BC, DE, HL)
- **Accumulator – identified by name A**
 - This register is a part of ALU
 - 8-bit data storage
 - Performs arithmetic and logical operations
 - Result of an operation is stored in accumulator

1. Flag Register

- This is also a part of ALU
- 8085 has five flags named
 - **Zero flag (Z)**
 - **Carry flag (CY)**
 - **Sign flag (S)**
 - **Parity flag (P)**
 - **Auxiliary Carry flag (AC)**

- These flags are five flip-flops in flag register
- Execution of an arithmetic/logic operation can **set or reset** these flags
- Condition of flags (set or reset) can be tested through software instructions
- 8085 uses these flags in decision-making process

1. Program Counter (PC)

- A 16-bit memory pointer register
- Used to sequence execution of program instructions
- Stores address of a memory location
 - where next instruction byte is to be fetched by the 8085
- when 8085 gets busy to fetch current instruction from memory
 - PC is incremented by one
 - PC is now pointing to the address of next instruction

1. Stack Pointer Register

- a 16-bit memory pointer register
- Points to a location in **Stack** memory
- Beginning of the stack is defined by loading a 16-bit address in stack pointer register

3. Instruction Set of 8085

- Consists of
 - 74 operation codes, e.g. MOV
 - 246 Instructions, e.g. MOV A,B
- 8085 instructions can be classified as
 - 1. Data Transfer (Copy)**
 - 2. Arithmetic**
 - 3. Logical and Bit manipulation**
 - 4. Branch**
 - 5. Machine Control**

1. Data Transfer (Copy) Operations

- Load a 8-bit number in a Register
- Copy from Register to Register
- Copy between Register and Memory
- Copy between Input/Output Port and Accumulator
- Load a 16-bit number in a Register pair
- Copy between Register pair and Stack memory

Example Data Transfer (Copy) Operations / Instructions

- Load a 8-bit number 4F in register **B**
MVI B, 4FH
- Copy from Register **B** to Register **A**
MOV A,B
- Load a 16-bit number 2050 in Register pair **HL**
LXI H, 2050H
- Copy from Register **B** to **Memory** Address 2050
MOV M,B
- Copy between **Input/Output** Port and **Accumulator**
OUT 01H
IN 07H

2. Arithmetic Operations

- **Addition** of two 8-bit numbers
- **Subtraction** of two 8-bit numbers
- **Increment/ Decrement** a 8-bit number

Example Arithmetic Operations / Instructions

- Add a 8-bit number 32H to Accumulator **ADI 32H**
- Add contents of Register B to Accumulator **ADD B**
- Subtract a 8-bit number 32H from Accumulator **SUI 32H**
- Subtract contents of Register C from Accumulator **SUB C**
- Increment the contents of Register D by 1 **INR D**
- Decrement the contents of Register E by 1 **DCR E**

3. Logical & Bit Manipulation Operations

- **AND** two 8-bit numbers
- **OR** two 8-bit numbers
- **Exclusive-OR** two 8-bit numbers
- **Compare** two 8-bit numbers
- **Complement**
- **Rotate Left/Right** Accumulator bits

Example Logical & Bit Manipulation

Operations / Instructions

- Logically AND Register H with Accumulator **ANA H**
- Logically OR Register L with Accumulator **ORA L**
- Logically XOR Register B with Accumulator **XRA B**
- Compare contents of Register C with Accumulator **CMP C**
- Complement Accumulator **CMA**
- Rotate Accumulator Left **RAL**

4. Branching Operations

These operations are used to control the flow of program execution

2.Jumps

- Conditional jumps
- Unconditional jumps

–Call & Return

- Conditional Call & Return
- Unconditional Call & Return

Example Branching

Operations

/

Instructions

- **Jump to a 16-bit Address 2080H if Carry flag is SET** **JC 2080H**
- **Unconditional Jump** **JMP 2050H**
- **Call a subroutine with its 16-bit Address** **CALL 3050H**
- **Return back from the Call** **RET**
- **Call a subroutine with its 16-bit Address if Carry flag is RESET** **CNC 3050H**
- **Return if Zero flag is SET** **RZ**

5. Machine Control Instructions

These instructions affect the operation of the processor. For e.g.

HLT	Stop program execution
NOP	Do not perform any operation

4. Writing a Assembly Language Program

- Steps to write a program
 - Analyze the problem
 - Develop program Logic
 - Write an Algorithm
 - Make a Flowchart
 - Write program Instructions using Assembly language of 8085

Program 8085 in Assembly language to add two 8-bit numbers and store 8-bit result in register C.

1. Analyze the problem

- Addition of two 8-bit numbers to be done

2. Program Logic

- Add two numbers
- Store result in register C
- Example

$$\begin{array}{r} 10011001 \quad (99H) \ A \\ +00111001 \quad (39H) \ D \\ \hline 11010010 \quad (D2H) \ C \end{array}$$

3. Algorithm

1. Get two numbers

4. Add them

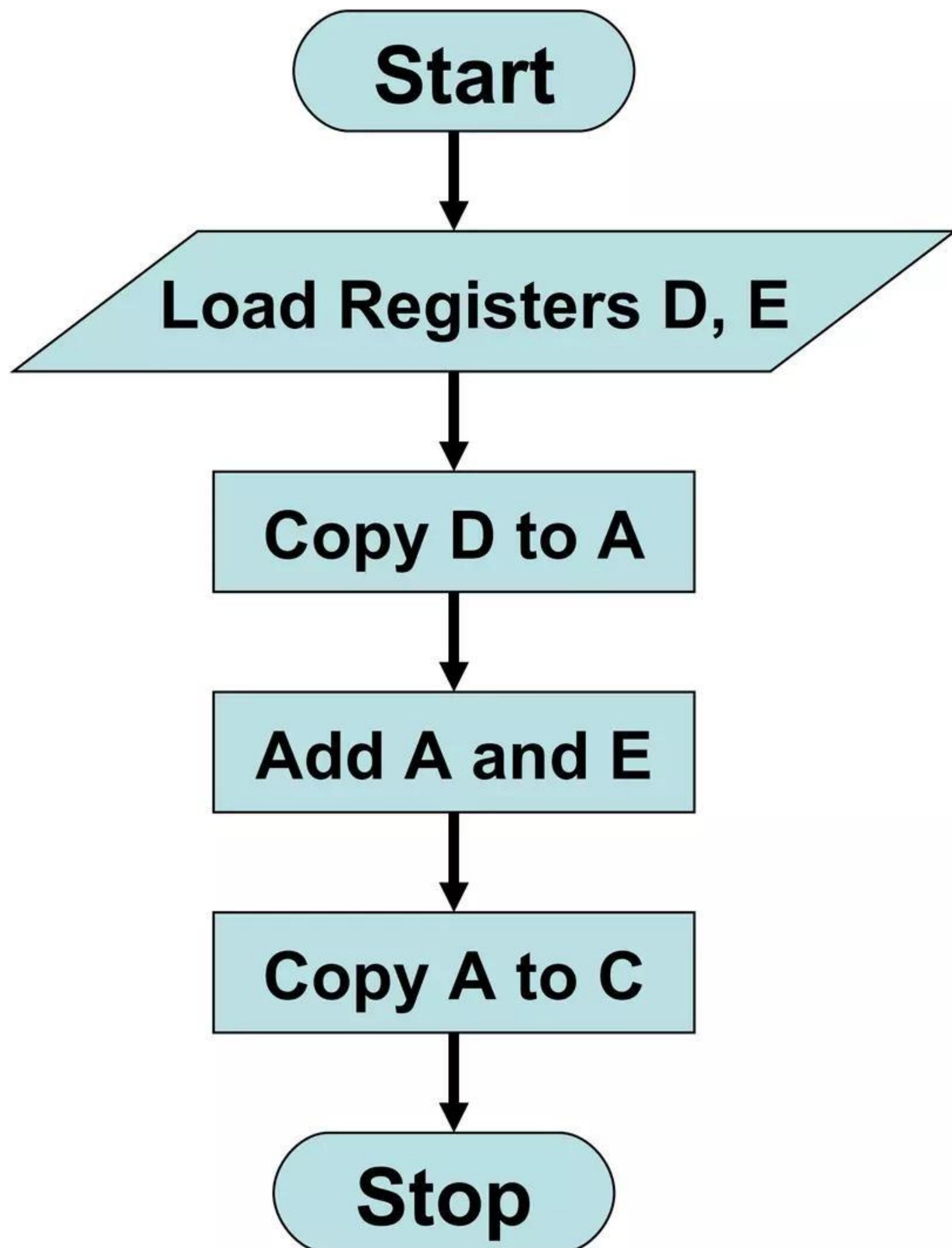
7. Store result

9. Stop

Translation to 8085 operations

- Load 1st no. in register D
 - Load 2nd no. in register E
-
- Copy register D to A
 - Add register E to A
-
- Copy A to register C
-
- Stop processing

4. Make a Flowchart



- Load 1st no. in register D
- Load 2nd no. in register E
- Copy register D to A
- Add register E to A
- Copy A to register C
- Stop processing

5. Assembly Language Program

1. Get two numbers

- Load 1st no. in register D
- Load 2nd no. in register E

MVI D, 2H
MVI E, 3H

4. Add them

- a) Copy register D to A
- b) Add register E to A

MOV A, D
ADD E

7. Store result

- a) Copy A to register C

MOV C, A

9. Stop

- a) Stop processing

HLT

Program 8085 in Assembly language to add two 8-bit numbers. Result can be more than 8-bits.

1. Analyze the problem

- Result of addition of two 8-bit numbers can be 9-bit
- Example

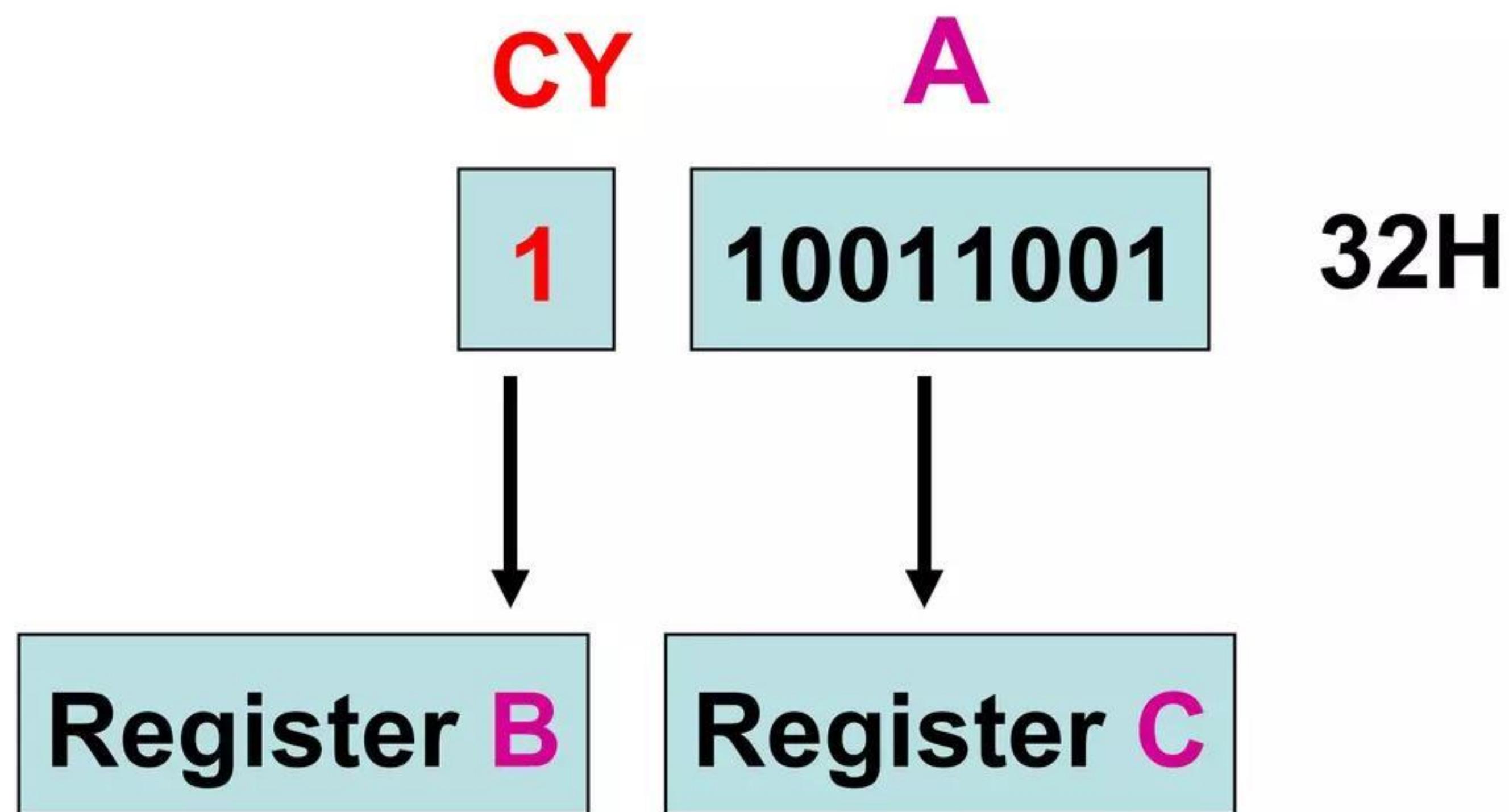
$$\begin{array}{r} 10011001 \quad (99H) \text{ A} \\ +10011001 \quad (99H) \text{ B} \\ \hline 100110010 \quad (\textcolor{red}{132H}) \end{array}$$

- The 9th bit in the result is called CARRY bit.

- How 8085 does it?
 - Adds register A and B
 - Stores 8-bit result in A
 - SETS carry flag (CY) to indicate carry bit

$$\begin{array}{r} \boxed{10011001} & 99H & A \\ + & & \\ \boxed{10011001} & 99H & B \\ \hline & & \\ \boxed{1} & \boxed{00110010} & 32H & A \\ & \text{CY} & & \end{array}$$

- Storing result in Register memory



Step-1 Copy A to C

Step-2

- Clear register B
- Increment B by 1

2. Program Logic

1. Add two numbers
2. Copy 8-bit result in A to C
3. If CARRY is generated
 - Handle it
4. Result is in register pair BC

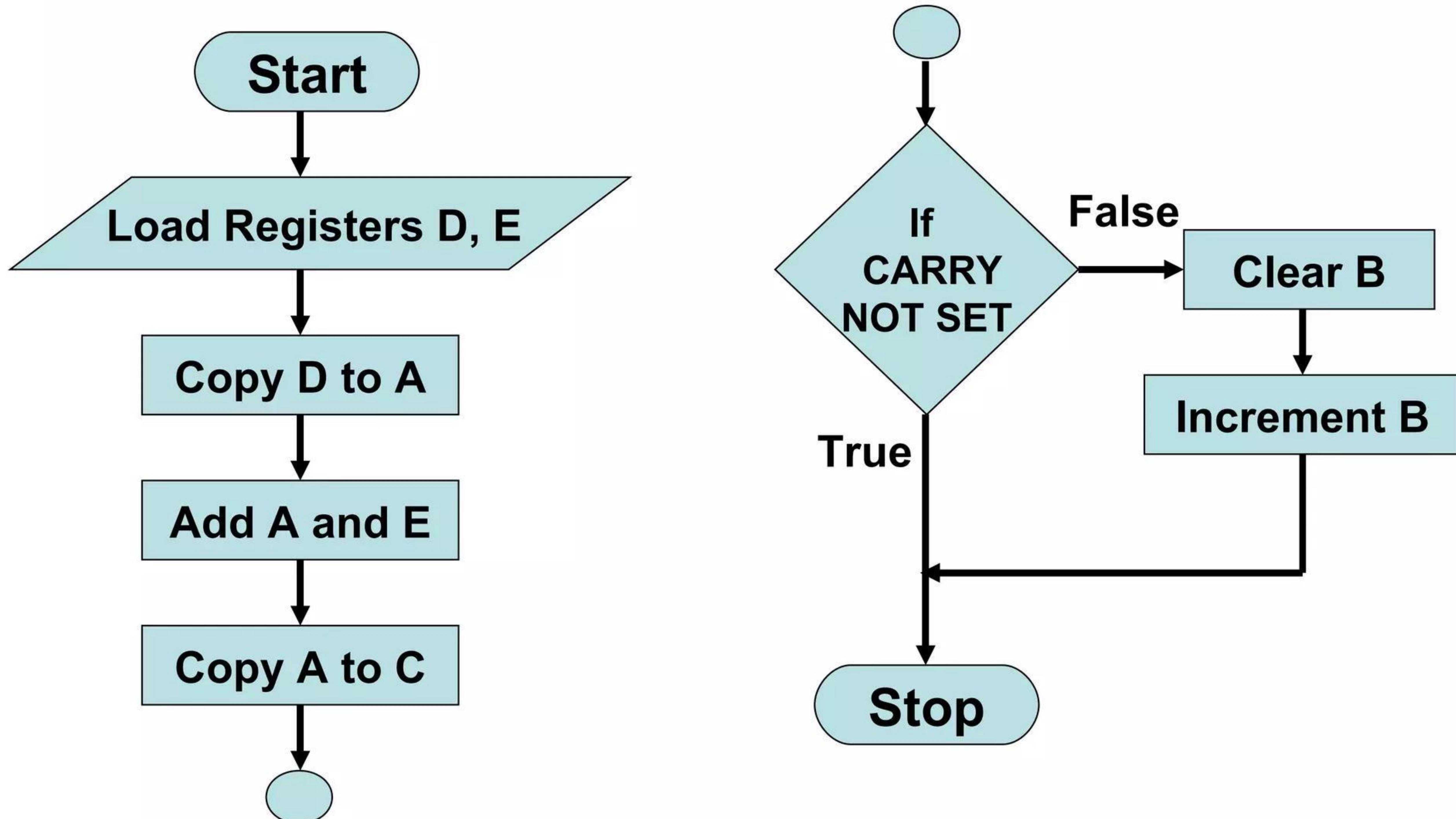
3. Algorithm

1. Load two numbers in registers D, E
4. Add them
6. Store 8 bit result in C
7. Check CARRY flag
8. If CARRY flag is SET
 - Store CARRY in register B
9. Stop

Translation to 8085 operations

- Load registers D, E
- Copy register D to A
- Add register E to A
- Copy A to register C
- Use Conditional Jump instructions
- Clear register B
- Increment B
- Stop processing

4. Make a Flowchart



5. Assembly Language Program

- Load registers D, E
- Copy register D to A
- Add register E to A
- Copy A to register C
- Use Conditional Jump instructions
- Clear register B
- Increment B
- Stop processing

```
MVI D, 2H  
MVI E, 3H  
MOV A, D  
ADD E  
MOV C, A  
JNC END  
MVI B, 0H  
INR B  
HLT
```

END:

4. Addressing Modes of 8085

- Format of a typical Assembly language instruction is given below-

[**Label:**] **Mnemonic** [**Operands**] [**;comments**]

HLT

MVI A, 20H

MOV M, A ;Copy A to memory location whose address is stored in register pair HL

LOAD: **LDA 2050H** ;Load A with contents of memory location with address 2050H

READ: **IN 07H** ;Read data from Input port with address 07H

- The various formats of specifying operands are called addressing modes
- Addressing modes of 8085
 - Register Addressing
 - Immediate Addressing
 - Memory Addressing
 - Input/Output Addressing

1. Register Addressing

- Operands are one of the internal registers of 8085
- Examples-

MOV A, B

ADD C

2. Immediate Addressing

- Value of the operand is given in the instruction itself
- Example-

MVI A, 20H

LXI H, 2050H

ADI 30H

SUI 10H

3. Memory Addressing

- One of the operands is a memory location
- Depending on how address of memory location is specified, **memory** addressing is of two types
 - **Direct** addressing
 - **Indirect** addressing

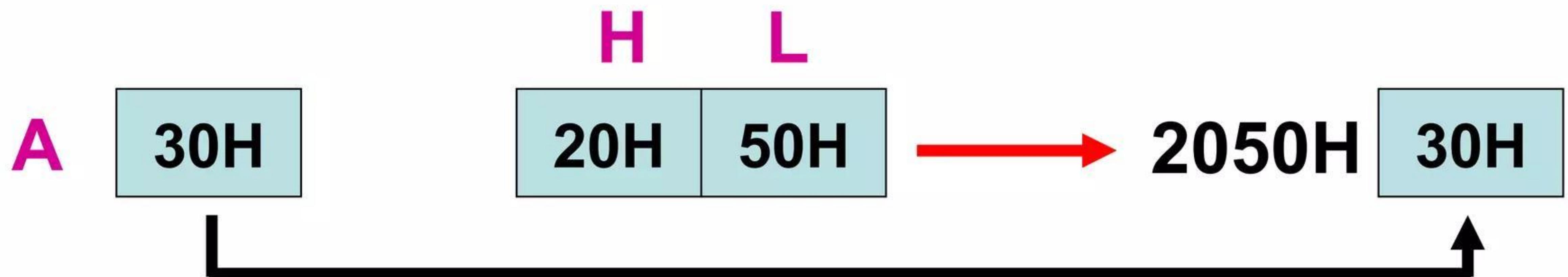
3(a) Direct Addressing

- 16-bit Address of the memory location is specified in the instruction directly
- Examples-
LDA 2050H ;load A with contents of memory location with address 2050H
STA 3050H ;store A with contents of memory location with address 3050H

3(b) Indirect Addressing

- A **memory pointer** register is used to store the address of the memory location
- Example-

MOV M, A ;copy register A to memory location whose address is stored in register pair HL



4. Input/Output Addressing

- **8-bit** address of the port is directly specified in the instruction
- Examples-

IN 07H

OUT 21H

5. Instruction & Data Formats

8085 Instruction set can be classified according to size (in bytes) as

1. 1-byte Instructions
2. 2-byte Instructions
3. 3-byte Instructions

1. One-byte Instructions

- Includes Opcode and Operand in the same byte
- Examples-

Opcode	Operand	Binary Code	Hex Code
MOV	C, A	0100 1111	4FH
ADD	B	1000 0000	80H
HLT		0111 0110	76H

1. Two-byte Instructions

- First byte specifies Operation Code
- Second byte specifies Operand
- Examples-

Opcode	Operand	Binary Code	Hex Code
MVI	A, 32H	0011 1110	3EH
		0011 0010	32H
MVI	B, F2H	0000 0110	06H
		1111 0010	F2H

1. Three-byte Instructions

- First byte specifies Operation Code
- Second & Third byte specifies Operand
- Examples-

Opcode	Operand	Binary Code	Hex Code
LXI	H, 2050H	0010 0001 0101 0000 0010 0000	21H 50H 20H
LDA	3070H	0011 1010 0111 0000 0011 0000	3AH 70H 30H

2. Two-byte Instructions