2. Execution Unit (EU):

An execution unit (also called functional unit) is a part of CPU that performs the operations and calculations called for by the computer program. It is made up of three parts known as ALU, general purpose register and status and control flag (FLAG register).

The EU extracts instructions from the top of the queue in the BIU, decodes them, generates operand addresses if necessary, pass them to the BIU and requests it to perform the read or write bus cycles to memory or I/O, and performs the operation specified by the instruction on the operands, some of the status and control flags may be affected due to the execution of the instructions. The EU contains on the following:

i. ALU

The ALU is the calculator part of the execution unit. It consists of electronic circuitry that performs arithmetic operations or logical operations on the binary represented electrical signals.

ii. General Purpose Registers

EU has eight general purpose registers. These registers can be divided into four data registers and four (pointer and index) registers.

1. **Data Registers**

AX - the accumulator register (divided into **AH / AL**):

1. Generates shortest machine code.
2. Arithmetic, logic and data transfer.
3. One number must be in AL or AX.
4. Multiplication & Division.
5. Input & Output.

BX - the base address register (divided into **BH / BL**).

CX - the count register (divided into **CH / CL**):

1. Iterative code segments using the LOOP instruction.
2. Repetitive operations on strings with the REP command.
3. Count (in CL) of bits to shift and rotate.

DX - the data register (divided into **DH / DL**):

1. DX:AX concatenated into 32-bit register for some MUL and DIV operations.
2. Specifying ports in some IN and OUT operations.

2. Pointers and Index Registers

There are four 16-bits registers. These registers can be used for temporary storage of data (except SP register). However, their main use is to hold the 16-bit offset of a data word in one of the segments. That is, these registers are usually used to point to or index to an address in memory within specific segment.

BP - base pointer:

1. Primarily used to access parameters passed via the stack.
2. Offset address relative to SS.

SP - stack pointer:

1. Always points to top item on the stack.
2. Offset address relative to SS.

SI - source index register:

1. Can be used for pointer addressing of data.
2. Used as source in some string processing instructions.
3. Offset address relative to DS.

DI - destination index register:

1. Can be used for pointer addressing of data.
2. Used as destination in some string processing instructions.
3. Offset address relative to ES.

iii. Flag Register

Determines the current state of the processor. They are modified automatically by CPU after mathematical operations, this allows to determine the type of the result, and to determine conditions to transfer control to other parts of the program. Generally you cannot access these registers directly. Figure (1.7) shows the table of the flags

X	X	X	X	OF	DF	IF	TF	SF	ZF	X	AF	X	PF	X	CF

Fig. (1.7) ***Flag Register***

The flags can be divided into two types:

Status Flags: the EU set/reset these flags according to the result of tge ALU. These flags are read only; therefor they can only be teted.

CF (Carry Flag): Holds the carry after addition or the borrow after subtraction. Also indicates some error conditions, as dictated by some programs and procedures.

PF (Parity Flag): PF=0;odd parity, PF=1;even parity.

AC (Auxiliary Flag): AF is set (1) if there is a carry accurse from the 4th bit to the 5th bit (i.e. from the low nibble to the high nibble of the low byte in the data).

ZF (Zero Flag): Shows the result of the arithmetic or logic operation.

Z=1; result is zero. Z=0; The result is not zero.

SF (Sign Flag): represents the **MSB** after an arithmetic operation. Holds the sign of the result after an arithmetic/logic instruction execution. S=1; negative, S=0

OF (Over Flow): Overflow occurs when signed numbers are added or subtracted. An overflow indicates the result has exceeded the capacity of the Machine.

Control Flags: these flags are set and reset by program instruction to alter processor operation. These are:

TF (Trap Flag): if TF is set (1), the8086 goes into dingle-step mode of operation (for program debugging.

IF (Interrupt Flag): Controls the operation of the INTR (interrupt request) I=0; INTR pin disabled. I=1; INTR pin enabled.

DF (Direction Flag): this flag determines the direction of string operations; selects either the increment or decrement mode for the DI and/or SI, during string instruction. When set registers are automatically incremented, when reset registers are automatically decremented.

<u>Example 2:</u> What are the (S, Z, AC, P and C) flags after adding the two hexadecimal numbers (**B7**h) and (**AC**h) ?

ACF from the 4th bit to 5th bit

```
            1
          1011  0111
          1010  1100  +
        -------------
Carry [1] 0110  0011
```

SF = 0 , ZF = 0 , ACF = 1 , PF = 1 , CF = 1

iv. Control System (Timing and Control Circuit)

Contains control circuitry which directs internal operations and responsible for generating the control signals required for processing. It contains on the clock, decoder, and control logic circuit.