specified in various ways. It may include 8-bit (or 16-bit) data, an internal register, a memory location, or 8-bit (or 16-bit) address. In some instructions, the operand is implicit.

Instruction word size

- The 8051 instruction set is classified into the following three groups according to word size:
- ü One-word or 1-byte instructions
- ü Two-word or 2-byte instructions
- ü Three-word or 3-byte instructions

1 One-Byte Instructions

- A 1-byte instruction includes the opcode and operand in the same byte. Operand(s) are internal register and are coded into the instruction.
- These instructions are 1-byte instructions performing three different tasks. In the first instruction, both operand registers are specified. In the second instruction, the operand B is specified and the accumulator is assumed. Similarly, in the third instruction, the accumulator is assumed to be the implicit operand. These instructions are stored in 8- bit binary format in memory; each requires one memory location.

2 Two-Byte Instructions

- In a two-byte instruction, the first byte specifies the operation code and the second byte specifies the operand. Source operand is a data byte immediately following the opcode.

3 Three-Byte Instructions

- In a three-byte instruction, the first byte specifies the opcode, and the following two bytes specify the 16-bit address. Note that the second byte is the low-order address and the third byte is the high-order address.

ADDRESSING MODES OF THE 8051 MICROCONTROLLERS

Different addressing modes of the 8051 microcontrollers. In 8051 there are 1-byte, 2-byte instructions and very few 3-byte instructions are present. The opcodes are 8-bit long. As the opcodes are 8-bit data, there are 256 possibilities. Among 256, 255 opcodes are implemented.

The clock frequency is12MHz, so 64 instruction types are executed in just 1 µs, and rest are just 2 µs. The Multiplication and Division operations take 4 µsto to execute.

In 8051 There are six types of addressing modes.

- Immediate AddressingMode
- Register AddressingMode
- Direct AddressingMode
- Register IndirectAddressing Mode
- Indexed AddressingMode
- Implied AddressingMode

Immediate addressing mode

In this Immediate Addressing Mode, the data is provided in the instruction itself. The data is provided immediately after the opcode. These are some examples of Immediate Addressing Mode.

```
MOVA, #0AFH;
MOVR3, #45H;
MOVDPTR, #FE00H;
```

In these instructions, the # symbol is used for immediate data. In the last instruction, there is DPTR. The DPTR stands for Data Pointer. Using this, it points the external data memory location. In the first instruction, the immediate data is AFH, but one 0 is added at the beginning. So when the data is starting with A to F, the data should be preceded by 0.

Register addressing mode

In the register addressing mode the source or destination data should be present in a register (R0 to R7). These are some examples of RegisterAddressing Mode.

```
MOVA, R5;
MOVR2, #45H;
MOVR0, A;
```

In 8051, there is no instruction like **MOVR5, R7**. But we can get the same result by using this instruction **MOV R5, 07H**, or by using **MOV 05H, R7**. But this two instruction will work when the selected register bank is **RB0**. To use another register bank and to get the same effect, we have to add the starting address of that register bank with the register number. For an example, if the RB2 is selected, and we want to access R5, then the address will be (10H + 05H = 15H), so the instruction will look like this **MOV 15H, R7**. Here 10H is the starting address of Register Bank 2.

Direct Addressing Mode

In the Direct Addressing Mode, the source or destination address is specified by using 8-bit data in the instruction. Only the internal data memory can be used in this mode. Here some of the examples of direct Addressing Mode.

```
MOV80H, R6;
MOVR2, 45H;
MOVR0, 05H;
```

The first instruction will send the content of registerR6 to port P0 (Address of Port 0 is 80H). The second one is forgetting content from 45H to R2. The third one is used to get data from Register R5 (When register bank RB0 is selected) to register R5.

Register indirect addressing Mode

In this mode, the source or destination address is given in the register. By using register indirect addressing mode, the internal or external addresses can be accessed. The R0 and R1 are used for 8-bit addresses, and DPTR is used for 16-bit addresses, no other registers can be used for addressing purposes. Let us see some examples of this mode.

```
MOV0E5H, @R0;
MOV@R1, 80H
```

In the instructions, the @ symbol is used for register indirect addressing. In the first instruction, it is showing that theR0 register is used. If the content of R0 is 40H, then that instruction will take the data which is located at location 40H of the internal RAM. In the second one, if the content of R1 is 30H, then it indicates that the content of port P0 will be stored at location 30H in the internal RAM.

```
MOVXA, @R1;
MOV@DPTR, A;
```

In these two instructions, the X in MOVX indicates the external data memory. The external data memory can only be accessed in register indirect mode. In the first instruction if the R0 is holding 40H, then A will get the content of external RAM location40H. And in the second one, the content of A is overwritten in the location pointed by DPTR.

Indexed addressing mode

In the indexed addressing mode, the source memory can only be accessed from program memory only. The destination operand is always the register A. These are some examples of Indexed addressing mode.

```
MOVCA, @A+PC;
MOVCA, @A+DPTR;
```

The C in MOVC instruction refers to code byte. For the first instruction, let us consider A holds 30H. And the PC value is1125H. The contents of program memory location 1155H (30H + 1125H) are moved to register A.

Implied Addressing Mode

In the implied addressing mode, there will be a single operand. These types of instruction can work on specific registers only. These types of instructions are also known as register specific instruction. Here are some examples of Implied Addressing Mode.

```
RLA;
SWAPA;
```

These are 1- byte instruction. The first one is used to rotate the A register content to the Left. The second one is used to swap the nibbles in A.